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RESEARCH NOTES

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Long Term Fertilization and Manuring Effect on Soil Properties and Sorghum Yield under Sorghum-Wheat Cropping Sequence in Vertisol

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Abstract

Integrated application of 100 per cent NPK through chemical fertilizers along with FYM @ 10 t ha^{-1} significantly improved the physico-chemical properties as well as fertility of Vertisol. Similarly, combined use of chemical fertilizers (100% NPK) and FYM @10 t ha^{-1} recorded significantly the highest sorghum yield followed by 150 per cent NPK. Hence, it can be concluded that integrated use of FYM @ 10 t ha^{-1} in combination with recommended dose of fertilizer to sorghum (100:50:40 NPK kg ha^{-1}) and wheat (120:60:60 NPK kg ha^{-1}) found to be superior in improving the properties of Vertisol and sustaining the crop productivity in semi arid climatic conditions of Maharashtra.

Key words : Long term fertilization, soil properties, fertility, sorghum yield, Vertisol.

The integrated plant nutrient supply system is emerging as the most logical concept for managing long term soil fertility and productivity. Integrated use of organic manures and chemical fertilizers has been found to be promising in arresting the decline in productivity through the correction of marginal deficiencies of some secondary and micro-nutrient elements and its beneficial influence on physico chemical and biological properties of soil.

Sorghum and wheat are the premier food grain crops of the peninsular central India. In sorghum-wheat sequence, both the crops remove large quantities of nutrients from soils. The long term effects of integrated nutrient management in rice-wheat and soybean-wheat cropping system in terms of productivity and soil fertility are reported by several workers (Swarup *et al*., 2000; Sharma *et al*., 2001; Singh *et al*., 2004; Manna *et al*., 2007; Bhattacharyya *et al*., 2008; Bandyopadhyay, 2011. However, such information in Vertisol on sorghum-wheat under semi arid climatic conditions in Maharashtra is scanty. Therefore, the present investigation was focused to study the long term fertilization and manuring effect on properties of Vertisol and productivity of sorghum under sorghum-wheat sequence.

Materials and Methods

The field experiment was conducted at Research farm, Dept. of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) during 2006-07 (18th cropping cycle) on the ongoing long term fertilizer experiment under sorghum-wheat cropping sequence initiated during 1988-89. The experiment was laid out in a randomized block design with twelve treatments replicated four times for sorghum in kharif and wheat in rabi season. The treatments were (T_1)- 50 per cent NPK, (T_2)- 100 per cent NPK, (T_3)- 150 per cent NPK , (T_4) - 100 per cent NPK (S free), (T_5)- 100 per cent NPK + 2.5 kg $ZnSO_4$ ha^{-1}, (T_6)- 100 per cent NP, (T_7)

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- 100 per cent N, (T_8) - 100 per cent NPK + FYM 10 t ha^{-1}, (T_9) - 100 per cent NPK S free + 37.5 kg S ha^{-1}, (T_{10}) - 10 t FYM ha^{-1}, (T_{11}) - 75 per cent NPK and (T_{12}) - control.

The experimental soil was fine smectitic, hyperthermic, family of *Typic Haplusterts*, slightly calcareous (4.7%), slightly alkaline in reaction (8.1 pH), low in organic carbon (4.6 g kg^{-1}) and available N (120 kg ha^{-1}), very low in available P (8.4 kg ha^{-1}) and very high in available K (358 kg ha^{-1}). The nutrients were applied through the mineral fertilizers like urea, single superphosphate, muriate of potash, diammonium phosphate (T_4 and T_9). Sulphur was applied through gypsum (T_9) to sorghum every year and zinc applied through zinc sulphate once in two years for wheat only (T_5). The farmyard manure was applied every year one month before sowing of sorghum only on oven dry weight basis. The recommended fertilizer doses were applied @ 100:50:40 and 120:60:60 N, P_2O_5 and K_2O kg ha^{-1} to sorghum and wheat respectively.

The sorghum crop was harvested at maturity. The grain and straw yield of was recorded separately for each plot and the yield per hectare was calculated. Plot-wise surface (0-20 cm) soil samples were collected after the harvest of sorghum. These samples were analyzed for pH (1:2.5), electrical conductivity by conductivity meter, bulk density by Core method (Jamison *et al*., 1950) and hydraulic conductivity by constant head method (Richards, 1954). The organic carbon was estimated by Walkey and Black method (Walkley and Black, 1934), total N by Kjeldahl method (Jackson, 1967) and available K by ammonium acetate extraction method (Jackson, 1967). Available N was estimated by alkaline permanganate method (Subbiah and Asija, 1956) and available P by Olsen's method (Olsen *et al*., 1954). The yield data pertaining sorghum crop only given in the present study.

Results and Discussion

Physico-chemical properties of soil

Bulk density : The values of bulk density under various treatments were found statistically non significant even after 18th cycle of experimentation of continuous use of fertilizers and manures (Table 1). The values of bulk density under different treatments varied at narrow range of 1.30 to 1.41 Mgm^{-3}. Continuous use of 100 per cent NPK + 10 t FYM ha^{-1} decreased bulk density to 1.30 which was found the lowest as compared to other treatments. The reduction of bulk density in FYM treated plots along with 100 per cent NPK might be due to better soil aggregation (Singh *et al*., 2000), higher organic carbon, more pore space (Selvi *et al*., 2005). Similar observations in bulk density of soil due to application of FYM with NPK were also observed by Bhattacharyya *et al*. (2004).

Hydraulic conductivity : The hydraulic conductivity of soil varied from 0.43 to 1.09 cm hr^{-1} and was found statistically significant. Significantly the lowest hydraulic conductivity (0.43 cm hr^{-1}) was found under control treatment. The significantly higher hydraulic conductivity (1.09 cm hr^{-1}) was observed with the application of 100 per cent NPK in combination with 10 t FYM ha^{-1} over the use of FYM alone or 100 per cent NPK through chemical fertilizer alone. Selvi *et al*. (2005) also reported that application of FYM along with 100 per cent NPK had improved hydraulic conductivity of soil.

Organic carbon : The soil organic carbon was enhanced due to long-term application of farm yard manure at 10 t ha^{-1} +100 per cent NPK by nearly 10.3 and 18.5 per cent compared to supra optimal dose of fertilizers (150% NPK) and optimum dose of fertilizers

(100% NPK). Application of sulphur at 37.5 kg ha^{-1} along with 100 per cent NPK also recorded increase in organic carbon (4.9 g kg^{-1}) as compared to 100% NPK (S free) (4.6 g kg^{-1}). This was probably due to higher biomass production with balanced supply of NPK and S. Plots with NPK + FYM had higher SOC sequestration than NPK treated plots, which is a result of increased yields of roots and plant residues, and the direct application of organic matter through FYM (Bhattacharyya *et al*., 2010).The increase in organic carbon over a period of 18 years under integrated nutrient management (T_8) over the initial can be attributed to addition of farm yard manure which stimulated the growth and activity of micro organism and better root biomass. The beneficial effect of recommended rate of fertilizer application was observed over control, 100 per cent N and 50 per cent NPK. The soil organic carbon varied significantly with long-term application of manure and mineral fertilization (Table 1). Significantly highest soil organic carbon (6.4 g kg^{-1}) recorded in the treatment T_8 was ascribed to better crop growth with concomitantly higher root biomass generation and higher return of leftover surface plant residues (Christensen, 1988). In case of 100 per cent NPK + FYM treatment, direct addition of organic matter from the farmyard manure, containing 30 per cent carbon, was the reason for the increase in organic carbon content (Acharya *et al*., 1988; Benbi *et al*., 1998). Total below ground biomass C in sorghum-wheat system was as good as triple cropping system, which directly reflects on better SOC storage (Manna *et al*., 2005). This has clearly indicated that INM followed over a long-term period was beneficial in maintenance of organic carbon levels in Vertisols of semi-arid regions of central India. Vineela *et al*. (2008) also observed that soil organic carbon levels increased considerably due to long-term fertilization and/or manuring applied for 16-29 years in Vertisol and Alfisol under semi-arid climatic condition.

Table 1. Long term fertilization and manuring effect on physico chemical properties of soil after harvest of sorghum and yield (18^{th} cycle).

Treatment	BD (Mg m^{-3})	HC (cm hr^{-1})	O.C. (g kg^{-1})	Total N (%)	Available nutrients (kg ha^{-1})			Sorghum yield (q ha^{-1})	
					N	P	K	Grain	Fodder
T_1 - 50% NPK	1.32	0.64	4.5	0.045	257	22.04	321	24.80	61.00
T_2 - 100% NPK	1.36	0.66	5.2	0.050	266	33.25	364	36.40	89.17
T_3 - 150% NPK	1.37	0.78	5.8	0.056	309	33.30	437	43.65	106.92
T_4 - 100% NPK S free	1.38	0.54	4.6	0.049	223	31.69	349	33.35	81.70
T_5 - 100% NPK + 2.5 kg $ZnSO_4$ ha^{-1}	1.37	0.54	4.6	0.051	242	32.57	387	37.92	92.90
T_6 - 100% NP	1.37	0.57	4.3	0.048	235	25.82	363	24.70	62.96
T_7 - 100% N	1.35	0.55	4.3	0.042	264	22.82	352	20.70	52.96
T_8 - 100% NPK + FYM 10 t ha^{-1}	1.30	1.09	6.4	0.062	311	34.35	476	47.70	116.85
T_9 - 100% NPK S free + 37.5 kg S ha^{-1}	1.40	0.49	5.1	0.054	271	30.15	358	37.47	91.80
T_{10} - FYM 10 t ha^{-1}	1.32	0.89	4.9	0.046	218	23.22	378	11.62	31.43
T_{11} - 75% NPK	1.39	0.60	4.5	0.047	246	28.48	362	25.67	62.87
T_{12} - Control	1.41	0.43	3.9	0.037	108	6.81	308	1.062	2.60
SE (m) ±	0.0081	0.020	0.68	0.01	2.25	0.23	5.74	0.66	1.96
CD at 5%	0.023	0.056	1.9	0.003	6.34	0.64	16.12	1.85	5.50
Initial (1987-88)	1.26	5.47	4.6	0.044	120	8.4	358		

Total N : Significantly the highest total nitrogen of soil (0.062%) was recorded with the application of 100 per cent RDF + FYM @ 10 t ha^{-1}. The 16.1 and 20.4 per cent increase in total nitrogen was observed under NPK + Farmyard manure over 150 per cent NPK (T_3) and 100 per cent NPK + Zn (T_5) through mineral fertilizers. The increase in total soil N is likely due to the positive balance of soil organic carbon and might have been partially due to a slow release of N from the manure (Garni *et al.*, 2001). In addition, the NPK + FYM treatment produced more crop biomass and therefore, possibly had more extensive root system that might have contributed to increased N levels (Bhattacharyya *et al.*, 2008). The increase in fertilizer levels from 50 to 150 per cent NPK gradually increased the total N in soil due to indirect addition of organic matter through plant roots.

Residual soil fertility : Long-term manuring and fertilization registered significant increase in available N, P and K (Table 1). The highest availability of N in soil (311 kg ha^{-1}) was observed with the combined application of 100 per cent NPK + FYM 10 t ha^{-1} (T_8) and on par with 150 per cent NPK through chemical fertilizers (309 kg ha^{-1}). The application of FYM 10 t ha^{-1} + 100 per cent NPK increased the availability of N, P and K by 16.9, 3.3 and 30.8 per cent, respectively as compared to recommended dose of fertilizers (100% NPK) without organic manure. Annual applications of FYM @ 10 t ha^{-1} alone in *kharif* to sorghum decreased soil NPK status as compared to other treatments. The increase in available N was observed with NPK + FYM. This might be due to direct addition of organic matter from farmyard manure in combination with 100 per cent NPK which helped in multiplication of soil microbes, ultimately enhancing the conversion of organically bound N to mineral form (Tolanur and Badanur, 2003).

Availability of P increased to the extent of 50.9 and 45.7 per cent in the plots under NPK (T_2) compared to 50 per cent NPK (T_1) and 100 per cent N (T_7) treated plots. The maximum build up of soil P under 100 per cent NPK+ FYM 10 t ha^{-1} (T_8) might be attributed to build up of P in soil by its addition every year and solubilization of native P in the soil through release of organic acids from farmyard manure (Tolanur and Badanur, 2003). The increase in availability of P in soil on use of organic manure suggests that organic manure was responsible for maintaining the greater concentration of Olsen P in the plots that received organic manure in a Vertisol (Singh *et al.*, 2007).

The highest available K was observed in the plots under 100 per cent NPK + FYM 10 t ha^{-1} and the lowest under control. Increase in available K might be due to the direct addition to the available K pool of the soil besides reduced K fixation and release of K due to the interaction of organic matter with clay (Sharma *et al.*, 2001).

Yield of sorghum : In the present investigation (Table 1) various treatments of manuring and fertilization significantly influenced grain and fodder yield of sorghum. The maximum grain and fodder yield of sorghum (47.70 and 116.85 q ha^{-1}) was obtained with the application of 100 per cent NPK + FYM 10 t ha^{-1}, which was superior over rest of the treatments. This was significantly higher than 150 per cent NPK (T_3) (43.65 and 106.92 q ha^{-1}). The higher biomass yield in 100 per cent NPK + FYM @ 10 t ha^{-1} amended soil might have been associated with improvements in microbial activity and soil physical conditions (Bhattacharyya *et al.*, 2004). This indicated that sustainability in productivity of sorghum could be maintained by integrated use of organic and chemical fertilizers. Application of 100 per cent NP without potassium (T_6) and only 100 per cent

nitrogen (T_7) through chemical fertilizer showed reduction in the sorghum productivity over 100 per cent NPK (T_2) to the tune of 41.6 and 75.8 per cent (Table 3). Similarly, imbalanced fertilization of 50 per cent NPK (T_1)and 75 per cent NPK (T_{11}) also showed significant reduction in yield over balanced nutrition i.e. 100 per cent NPK (T_2). The lowest yield was obtained in control plot.

The application of FYM @ 10 t ha^{-1} during only kharif season in absence of chemical fertilizers (T_{10}) could not sustain the yield of sorghum. The significant decline in the sorghum yield was observed in only FYM application @ 10 t ha^{-1} over all the treatments except control. This clearly emphasized the need for adequate nutrition for high yielding sorghum and suggested the use of organics with 100 per cent NPK. This is further substantiated by the results of Sonune *et al*. (2003) and Katkar *et al*. (2011). From the present study, it can be concluded that the balanced application of N, P and K significantly increased the productivity of sorghum as compared to imbalanced nutrition such as N, NP and no fertilizer application. The application of FYM @10 t ha^{-1} alone was found to be beneficial for improving physical, chemical properties of soil but could not sustain the sorghum yield in the long run.

Conclusion : The recommended dose of NPK fertilizers in combination with FYM was found to be beneficial in augmenting the fertility status of Vertisol as well as sustaining the productivity of sorghum in semi arid agro ecosystem of Maharashtara.

References

Acharya, C. L., Bisnoi, S. K., Yaduvanshi, H. S. 1988. Effect of long-term application of fertilizers and organic and inorganic amendments under continuous cropping on soil physical and chemical properties in an Alfisol. Indian J. Agric. Sci. 58, 509-516.

Bandyopadhyay, P. K., Subita Saha and Mallick, S. 2011. Comparison of soil physical properties between a permanent fallow and a long-term rice-wheat cropping with inorganic and organic inputs in the humid subtropics of eastern India. Commun. Soil Sci., and Pl. Anal. 42: 4,435-449.

Benbi. D. K., Biswas, C. R., Bawa, S. S. and Kumar, K. 1998. Influence of farmyard manure, inorganic fertilizers and weedcontrol practices on some soil physical properties in a long-term experiment. Soil Use Manage. 14, 52-54.

Bhattacharyya, R., Ved Prakash, Kundu, S., Srivastva, A. K. and Gupta, H. S. 2004. Effect of long-term manuring on soil organic carbon, bulk density and water retention characteristics under soybean-wheat cropping sequence in North-Western Himalayas. J. Indian Soc. Soil. Sci. 52(3): 23l8-242.

Bhatjacharyya, R., Kundu, S., Ved Prakash and Gupta, H. S. 2008. Sustainability under combined application of mineral and organic fertilizers in a rainfed soybean-wheat system of the Indian Himalyas. Europ. J. Agron. 28(1): 33-46.

Bhattacharyya, R., Ved Prakash, Kundu S, Srivastva A. K., Gupta, H. S. and Mitra, S. 2010. Long term effects of fertilization on carbon and nitrogen sequestration and aggregate associated carbon and nitrogen in the Indian Himalayas. Nutrient Cycling in Agroecosystem 86(1): 1-16.

Christensen, B. T. 1988. Effects of manure and mineral fertilizer on the total carbon and nitrogen contents of soil size fractions. Biol. Fertil. Soils 5, 304-307.

Garni, S. K., Ladha, J. K., Pathak, H., Shah, M. P., Pasuqn, E. Pandey, S. P., Hobbs, P. R., Joshy, D. and Mishra, R. 2001. Long term changes in yield and soil fertility in a 20 year rice-wheat experiment in Nepal. Biol. Fertil. Soils. 34: 73-78.

Jackson, M. L. 1967. Soil Chemical Analysis. Prentice Hall Publ. Pvt. Ltd., New Delhi, India.

Jamison, V.C., Weaver, H. A. and Reed, I. F. 1950. A hammer driven soil-core sampler. Soil. Sci. 69:487-496.

Katkar, R. N., Sonune, B. A. and Kadu, P. R. 2011. Long-term effect of fertilization on soil chemical and biological characteristics and productivity under sorghum-wheat system in Vertisol. Indian J. Agric. Sci. (8): 734-739.

Manna, M. C., Swarup, A., Wanjari, R. H., Ravankar, H. N., Mishra, B., Saha, M . N., Singh, Y. V., Sahi, D. K. and Sarap, P. A. 2005. Long-term effect of fertilizer and manure application on soil organic carbon storage, soil quality and yield sustainability under sub-

humid and semi-arid tropical India. Field Crop Res. 93(2-3): 264-80.

Manna, M. C., Swarup, A., Wanjari, R. H., Mishra, B. and Shahi, D. K. 2007. Long term fertilization, manure and liming effects on soil organic matter and crop yields. Soil ffiilLMs. 94(2): 397-409.

Olsen, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dept. of Agric. Circ. 939.

Richards, L. A. 1954. Diagnosis and Improvement of Saline and Alkali Soils. US Government Printing Office, Washington, D.C., USA.

Selvi, D., Santhy, P. and Dhakshinamoorthy, M. 2005. Effect of inorganics alone and in combination with farmyard manure on physical properties and productivity of *Vertic Haplustepts* under long-term fertilization. J. Indian Soc. Soil. Sci. 53(3): 302-307.

Sharma, M. P, Bali, S. V. and Gupta, D. K. 2001. Soil fertility and productivity of rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system in an Inceptisol as influenced by integrated nutrient management. Indian J. Agric. Sci. 71(2): 82-86.

Singh, J., Venugopalan, M. V. and Mannikar, N. D.2000. Soil fertility and crop productivity changes due to cotton based cropping systems under rainfed conditions. J. Indian Soc. Soil Sci. 48(2): 282-287.

Singh, Muneshwar, Sammi Reddy, K., Singh, V. P. and Rupa, T. R. 2007. Phosphorus availability to rice (*Oryza sativa* L.)- wheat (*Triticum aestivum* L.) in a Vertisol after eight years of inorganic and organic fertilizers additions. Bio. Res. Technol. 98: 1474-1481.

Singh, Y., Singh, Bijay, Ladha, J. K., Khind, C. S., Gupta, R. K., Meelu, O. P. and Pasuquin, E. 2004. Long-term effects of organic inputs on yield and soil fertility in the rice-wheat rotation. Soil Sci. Soc. Am. 68: 845-853.

Sonune, B. A, Tayade, K. B., Gabhane, V. V. and Puranik, R. B. 2003. Long term effect of manuirng and fertilization on fertility and crop productivity of Vertisols under sorghum-wheat sequence. Crop Res. 25(3): 460-461.

Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for the determination of available in soils. Curr. Sci. 25: 259-65.

Subehia, S. K., Verma, S. and Sharma, S. P. 2005. Effect of long-term use of chemical fertilizers with and without organics on forms of soil acidity, phosphorus adsorption and crop yields in an acid soil. J. Indian Soc. Soil Sci. 53(3):308-14.

Swarup, A., Manna, M. C. and Singh, G. B. 2000. Impact of land use and management practices on organic carbon dynamics in soils of India. In: Lal, R., Kimble, J.M., Stewart, B.A. (Eds.), Global Climatic Change and Tropical Ecosystem. Advances in Soil Science. CRC/Press, Boca Raton, New York, pp. 261-281.

Tolanur, S. I. and Badanur, V. P. 2003. Changes in organic carbon, available N, P and K under integrated use of organic manure, green manure and fertilizers on sustaining productivity of pearlmillet pigeonpea system and fertility of an Inceptisol. J. Indian Soc. Soil Sci. 51(1):254-57.

Vineela, C., Wani, S. P., Ch. Srinivasrao, Padmaja, B. and Vittal, K. P. R. 2008. Microbial properties of soils as affected by cropping and nutrient management practices in several long-term manorial experiments in the semi-arid tropics of India. Applied Soil Eco. 40: 165-73.

Walkley, A. and Black, C. A, 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of chromic acid titration method. Soil Sci. 37(1): 29-38.

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Effect of Different Foliar Spray of Nutrients on Growth, Yield and Quality of Summer Green Gram

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Abstract

The growth attributing characters like plant height, number of leaves, number of branches plant^{-1}, dry matter plant^{-1} and leaf area increased significantly due to application of foliar spray of 1.5 per cent urea + 1.5 per cent DAP before flowering over other treatments. However, it was on par with foliar spray of 1 per cent urea + 1 per cent DAP before flowering. Total flower drop plan^{-1} was significantly lowest in foliar spray 1 per cent urea + 1 per cent DAP before flowering over other treatments. Yield contributing characters *viz*., number of pods plant^{-1}, number of seeds pod^{-1}, test weight (g), grain (16.55 q ha^{-1}) and straw yield (32.75 q ha^{-1}) was increased significantly due to application of foliar spray of 1.5 per cent urea + 1.5 per cent DAP before flowering over other treatments. However, it was on par with foliar spray of 1 per cent urea + 1 per cent DAP before flowering.

Key words : Foliar spray, nutrients, yield, greengram.

Nutrients play a pivotal role in increasing the seed yield in pulses. Foliar application of major plant nutrients like nitrogen and potassium was found to be as good as soil application (Subramanian and Palaniappan, 1981). According to Kalita *et al*., (l994), supplementing urea at the reproductive stage significantly enhanced the seed yield by delaying leaf senescence in mungbean.

Application of fertilizers to soil and due to formation of certain soil complexes the uptake of necessary elements becomes difficult for the plants. The applied fertilizers are not fully utilized by the plants. In order to avoid or eliminate these situations foliar application of nutrients is important. (Velu and Srinivasan, 1984).

It is now well established fact that plants can utilize water soluble nutrients through their foliage, when applied in the form of foliar sprays. The nutrients enter in the cells by penetrating the cuticle of the leaf through stomata. When problems of excessive leaching of nutrients exist, foliar application constitutes the most effective means of fertilizer application. This practice may be useful to early maturing crops under rainfed conditions where moisture is limiting factor. Inorganic phosphatic fertilizers when added to soil undergo various reactions with soil constituents rendering some of the added phosphate unavailable to plants. Foliar applications of nutrients using water soluble fertilizer is one of the possible way to avoid such loss of phosphatic fertilizer (Pandrangi *et al*., 1991).

Materials and Methods

The field experiment was laid out in a randomized block design with three replications in summer, 2011. There were 8 treatment combinations formed with foliar spray of fertilizers on summer greengram. The treatments were absolute control, water spray,

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1 and 1.5 per cent urea spray, 1 and 1.5 per cent DAP spray, 1 per cent urea and DAP spray, 1.5 per cent urea and DAP spray. The foliar spray of nutrients were applied just before flowering at 42 DAS. The RDF-25:50:0 N:P:K kg ha^{-1} was applied uniformly to all treatments at the time of sowing.

The soil of experimental field was clayey in texture, neutral in reaction (pH 7.3) with low available nitrogen (211.33 kg ha^{-1}), slightly high available phosphorus (27.58 kg ha^{-1}), high available potassium (516.24 kg ha^{-1}) and low in organic carbon (0.48 per cent). The greengram crop was sown on 28th February, 2011 with spacing of 30 x 10 cm.

Results and Discussion

Plant height : The highest plant height (72.07 cm) was observed at harvest (Table 1) due to foliar spray of 1.5 per cent urea and DAP before flowering and it was on par with foliar spray of 1 per cent urea and DAP before flowering (70.93 cm). The lowest plant height was recorded in absolute control (63 cm). The plant height was increased due to proper application of nitrogen through foliar spray and adequate moisture supply through irrigations at 8-10 days interval. Similar results were observed by Patel and Patel (1994) and Verma *et al*. (2011).

Leaves plant^{-1} : The highest number of leaves plant^{-1} were due to foliar spray of 1.5 per cent urea and DAP before flowering and it was on par with foliar spray of 1 per cent urea and DAP before flowering. The lowest number of leaves plant^{-1} were recorded in absolute control treatment. Rest of the treatments were on par with each other. Nitrogen plays an important vital role in vegetative growth of the plant. The increase in number of leaves may be due to the promotive effect of foliar application of N in leaf growth. These resalts are in close conformity to findings of Verma *et al.* (2011).

Branches plant^{-1} : The highest number of branches plant^{-1} were observed due to foliar spray of 1.5 per cent urea and DAP before flowering and it was on par with foliar spray of 1 per cent urea and DAP before flowering. The lowest number of branches plant^{-1} was recorded in absolute control. Rest of treatments were on par with each other. The increase in number of branches plant^{-1} might be due to foliar application of nitrogen and phosphorus. Nitrogen plays an important role in vegetative growth of plant. Verma *et al*. (2011) also observed the same results.

Dry matter : The highest dry matter plant^{-1} was observed due to foliar spray of 1.5 per cent urea and DAP before flowering and it was on par with foliar spray of 1 per cent urea and DAP before flowering. The lowest dry matter plant^{-1} was recorded in absolute control. Rest of treatments were on par with each other. The increase in total dry matter production plant^{-1} may be ascribed to beneficial effect of foliar application of nitrogen and phosphorus on growth of plant. The sufficient amount of nitrogen accumulation in plant is essential for dry matter accumulation. The results are in close conformity to Chandrasekhar and Bangarusamy (2003), Selvi *et al*. (2004).

Leaf area plant^{-1} : The highest leaf area plant^{-1} was observed due to foliar spray of 1.5 per cent urea and DAP before flowering and it was on par with foliar spray of 1 per cent urea and DAP before flowering. The lowest leaf area plant^{-1} was recorded in absolute control treatment. Rest of the treatments were on par with each other. The increase in leaf area may be due to the promotive effect of foliar application of N in leaf growth and in turn on leaf area (Kalita *et al.*, 1994). Application of higher quantity of nitrogen has favoured rapid growth and enlargement of tissues resulting higher leaf area. Similar results were observed

by Srithara *et al*. (2005) and Mondal *et al*. (2011).

Days to 50 per cent flowering : The highest number of days required to 50 per cent flowering was recorded in treatment consisting foliar spray of 1.5 per cent urea and DAP before flowering (48.33) and it was on par with foliar spray of 1 per cent (47.67) and 1.5 per cent urea (48) and 1 per cent urea and DAP (48) before flowering. The mean number of days required to 50 per cent flowering were significantly lowest in treatments of absolute control (46) and water spray (46).The nitrogen increased the vegetative growth and delayed the reproductive growth of crop, so foliar spray of 1.5 per cent urea and DAP before flowering required more number of days to 50 per cent flowering.

Total flower drop plant^{-1} : The total number of flowers dropped plant^{-1} (Table 2) was significantly influenced by different foliar spray of nutrients. The mean total number of flower dropped plant^{-1} was 21.62. The foliar spray of 1.5 per cent urea and DAP before flowering recorded the lowest number of flower dropped plant^{-1} (19.32) and it was on par with foliar spray of 1 per cent urea and DAP before flowering (20.31). However, the highest number of flower dropped plant^{-1} was observed in absolute control (23.16). Foliar application of 1.5 per cent urea and DAP before flowering reduced flower drop by preventing abscission layer formation, which is responsible for flower drop. Similar results were observed by Ganapathy *et al.*, (2008).

Pods plant^{-1} : The mean number of pods plant^{-1} were 22.22 and it was significantly influenced by different foliar spray of nutrients. The foliar spray of 1.5 per cent urea and DAP before flowering recorded the highest number of pods plant^{-1} (24.73) and it was on par with foliar spray of 1 per cent urea and DAP before flowering (24.57). The lowest number of pods plant^{-1} were recorded in absolute control (20.03).

The increase in pod yield was due to more nutrient supply to crop through foliar spray of 1.5 per cent urea and DAP before flowering. This might have caused more number of pods and efficient translocation of photosynthates from source to sink (Kuttimani and Velayutham, 2011). The results are in close conformity to Patel and Patel (1994), Sarkar and Pal (2006), Mondal *et al.* (2011) and Verma *et al*. (2011).

Table 1. Effect of different foliar sprays on yield and its components in summer green gram.

Treatment	Plant height (cm)	Leaves plant^{-1}	Branches plant^{-1}	Dry matter plant^{-1} (g)	Leaf area plant^{-1} (dm^2)	Days to 50% flowering	Flower drop plant^{-1}	Pods plant^{-1}	Seeds pod^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})
Absolute control	63.00	32.73	6.27	15.27	8.10	46.00	23.16	20.03	8.43	39.77	11.25	25.28
Water spray	64.50	33.10	6.53	15.60	8.11	46.00	22.94	20.17	8.47	40.50	11.53	25.99
1% urea	67.53	35.80	6.47	16.30	8.28	47.67	22.21	21.27	8.53	41.33	12.64	26.34
1.5% urea	68.80	36.27	6.60	17.97	8.48	48.00	21.33	22.73	9.20	41.63	13.31	27.06
1% DAP	66.13	36.20	6.73	16.60	8.40	47.00	22.11	21.87	9.07	41.20	13.10	26.70
1.5% DAP	68.30	36.50	6.73	19.63	8.51	47.33	21.60	22.37	9.8	41.43	13.42	28.12
1% urea and DAP	70.93	37.80	7.13	21.87	9.07	48.00	20.31	24.57	10.27	42.33	15.70	30.97
1.5% urea and DAP	72.07	38.80	7.47	22.73	9.25	48.33	19.32	24.73	10.37	43.37	16.55	32.75
Mean	67.66	35.91	6.74	18.25	8.53	47.29	21.62	22.22	9.27	41.45	13.52	27.90
S.E.±	0.97	0.71	0.13	0.48	0.15	0.31	0.36	0.27	0.17	0.38	0.31	0.89
C. D. at 5 %	2.94	2.14	0.40	1.46	0.45	0.94	1.09	0.82	0.52	1.15	0.95	2.67

Seeds pod^{-1} : The mean number of seeds pod^{-1} were 9.27. This trait was significantly influenced by different foliar spray of nutrients. The foliar spray of 1.5 per cent urea and DAP before flowering recorded the highest number of seeds pod^{-1} (10.37) and it was at par with foliar spray of 1 per cent urea and DAP before flowering (10.27). The lowest number of seeds pod^{-1} was recorded in absolute control (8.43).

Test weight : The foliar spray of 1.5 per cent urea and DAP before flowering recorded the highest test weight (43.37 g) and it was on par with foliar spray of 1 per cent urea and DAP before flowering (42.33 g). The lowest test weight was recorded in absolute control (39:77 g). The size of seeds might be increased due to the foliar application of proper quantity of nitrogen. The finding confirms the results of Patel and Patel (1 994), Kalita *et al*. (1995) and Verma *et al.* (2011).

Seed yield : The mean seed yield was 13.52 q ha^{-1}. The seed yield ha^{-1} was significantly influenced by different foliar spray of nutrients. The foliar spray of 1.5 per cent urea and DAP before flowering recorded the highest seed yield (16.55 q ha^{-1}) and it was at par with foliar spray of 1 per cent urea and DAP before flowering (15.70 q ha^{-1}). The lowest seed yield was recorded in absolute control (11.25 q ha^{-1}). The yield was increased due to the increased dry matter production and efficient assimilate translocation to the developing sink leading to increased pods and higher seed yield (Dixit and Elamathi, 2007). It may be due to increased supply of nitrogen to leaf cells, which is essential for photosynthesis. The increase in yield was due to decrease in flower drop imparted by the foliar application of nutrients, Mungbean, though produces more number of flowers, most of them get abscised without forming pods. The retention of flowers and pod can be increased by foliar application of nutrients as reported by Chandrasekhar and Bangarusamy (2003) and Verma *et al*. (2011).

Straw yield : The mean straw yield was 27.90 q ha^{-1}. The straw yield plant^{-1} was significantly influenced by different foliar spray of nutrients. The foliar spray of 1.5 per cent urea and DAP before flowering recorded the highest straw yield (32.75 q ha^{-1}) and it was on par with foliar spray of 1 per cent urea and DAP before flowering (30.97 q ha^{-1}). The lowest straw yield ha^{-1} was recorded in absolute control (25.28 q ha^{-1}). The increase in straw yield might be due to increase in growth contributing characters like number of leaves, leaf area, dry matter etc. The nitrogen accumulation in sufficient amount in plant is essential for dry matter accumulation. There was increase in straw yield ha^{-1} which was due to increase in total dry matter production plant^{-1}. The research finding confirms the results of Patel and Patel (1994), Dixit and Elamathi (2007), Kuttimani and Velayutham (2011) and Verma *et al*. (211).

References

Chandrasekhar, C. N. and Bangarusamy, U. 2003. Maximizing the yield of mung bean by foliar application of growth regulating chemicals and nutrients. Madras Agric. J. 90(1-3). 142-145.

Dixit, P. M. and Elamathi, S. 2007. Effect of foliar application of .DAP, micronutrients and NAA on growth and yield of green gram (*Vigna radiata*). Legume Res. 30(4): 305-307.

Ganapathy, M., Baradhan, G. and Ramesh, N. 2008. Effect of foliar nutrition on reproductive efficiency and grain yield of rice fallow pulses. Legume Res. 31(2): 142-144.

Kalita, P., Dey, S. C., Chandra, K. and Upadhyaya, L. P. 1994. Effect of foliar application of nitrogen on morpho-physiological traits of pea (*Pisum sativum*). Indian J. agric. Sci. 64(12): 850-852.

Kuttamani, R. and Velayutham, A. 2011. Foliar application of nutrients enhances the yield attributes and nutrient uptake of greengram. Agric. Sci. Digest.31(3): 202-205.

Mondal, M. M. A., Rahman, M. A., Akter, M. B. and Fakir,

M. S. A. 2011. Effect of foliar application of nitrogen and micronutrients on growth and yield in mungbean. Legume Res. 34(3): 166-171.

Pandragi, R. B., Wankhede, S. G. and Nasre, R. A. 1991. Response of mung (*Phaseolus auras* L.) to soil and foliar application of phosphatic fertilizers. Legume Res. 14(4): 137-188.

Patel, J. R. and Patel, Z. G. 1994. Effect of foliar fertilization of nitrogen and phosphorus on growth and yield of summer greengram (*Phaseolus radiatus*). Indian J. Agron. 39(4): 578-580.

Sarkar, R. K. anda P. ML Pai. 2006. bffect of pre-sowing seed treatment and foliar spray of nitrarte salts on growth and yield of greengram (*Vigna radiata*). Indian J. agric. Sci. 16(1): 62-65

Selvi, R. V., Subramaniam, P. and Kalpana, R. 2004. Fertigation for greengram through microsprinklers. Legume Res. 27(2): 143-145.

Sritharan, N., Aravazhi, Anitha and Vanangamudi, Mallika. 2005. Effect of foliar spray of nutrients and plant growth regulators (PGRs) for yield maximization in blackgram. Madras Agric. J. 92(4-6): 301-307.

Subramanian, A. and Palaniappan, S. P. 1981. Effect of methods of planting, plant density and fertilization on yield of bfackgram in irrigated system. Madras Agric. J. 68(2): 96-99.

Velu, G. and Srinivasan, P. S. 1984. Efficiency of foliar application of potassium on growth and protein yield in blackgram var Co 4. Madras Agric. J. 71(9): 625-626.

Verma, C. K., Yadhav, D. D. and Singh, V. 2011. Effect on yield and quality of green gram (*Vigna radiata* L.) varieties by foliar spray of urea and seed rates. Plant Archives. 11(1): 289-291.

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Effect of Micronutrients and Silicon on Growth and Yield of Papaya cv. Red lady

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Abstract

Among the different levels of micronutrients, application of $ZnSO_4$ (0.25%) + Borax (0.1%) + $FeSO_4$ (0.5%) recorded maximum plant height (205.47 cm), stem diameter (113.59 mm), number of leaves (40.41 leaves^{-1} plant), petiole length (71.71 cm), plant spread (201.57 cm North-South and 198.70 cm East-West), reproductive parameters (53.13 flowers and 22.30 fruits plant^{-1}) and fruit yield (38.57 kg plant^{-1}). Among the micronutrient combinations, application of $ZnSO_4$ (0.25%) + Borax (0.1%) + $FeSO_4$ (0.5%) followed by $ZnSO_4$ (0.25%) + Borax (0.1%) and soluble Silicic acid at 5 ml L^{-1} were best treatment combinations with respect to vegetative and reproductive parameters.

Key word : Papaya, micronutrient,silica.

Papaya (*Carica papaya* L.) is one of the commercially important fruit crops of the tropics and is often considered as common man's fruit. The high productivity and ability to produce fruits throughout the year has added to gain popularity and commercial importance. Besides this, papaya is a wholesome fruit with high nutritive value and therapeutic value. It is rich in carotene, vitamin 'C' and minerals such as calcium, phosphorus and iron (Chadha,

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1992). It is used both as dessert fruit and in processed food. Productivity of papaya is 40.9 metric tonnes per hectare (Anon, 2011). Due to its continuous vegetative growth, flowering and fruiting habits, papaya requires high nutrients. The extent of nutrients removed by the whole plant at harvest would be 305 kg of N, 103 kg of P, 524 kg of K, 327 kg of Ca and 183 kg of Mg per hectare (Veerannah and Selvaraj, 1984).

Micronutrients play a major role in crop production due to their essentiality in plant metabolism and adverse effects that manifest due to their deficiency. Besides affecting plant growth, micronutrients also, play a major role in disease resistance in cultivated crop species. A hitherto lesser understood phenomenon is their role in determining quality and the post harvest life of harvested produce. In the Indian context, this situation has become alarming due to the widespread occurrence of micronutrient imbalance throughout the country. Though soil application of soluble forms of micronutrients has been widely practiced in the past, it calls for introspection, considering the nature of occurrence of micronutrient related maladies. Apart from micronutrients the element like silicon (Si) has also got specific role to play in the plant system (Korndorfer and Lepsch, 2001). However, soluble Si has enhanced the growth, development and yield of many plants. The content of silica in plants is equivalent to or more than the major nutrients N, P, K supplied through fertilizers. The exact role and requirement of silica are not identified even though it is found beneficial for crop growth, yield, pest and disease suppression (Epstein, 1999). However, information on effect of different micronutrients on growth and yield of papaya is very limited. Hence, keeping these ideas in view, an investigation was carried out to study the effect of micronutrients and silicon on growth and yield of papaya.

Materials and Methods

The study was carried out in Department of Fruit Science, KRCCH, Arabhavi (UHS, Bagalkot) during 2011-2012. The popular cultivar Red lady (F_1 hybrid) of papaya was used for the study.

The nutrients like Magnesium, Boron, Zinc, Iron and Silicon were applied as magnesium sulphate ($MgSO_4$), borax, zinc sulphate ($ZnSO_4$), ferrous sulphate ($FeSO_4$) and soluble Silicic acid respectively. The design adopted was randomised block design with ten treatments *viz*., T_1 - untreated control; T_2 - $MgSO_4$ @ 0.25%; T_3 - Borax @ 0.1%; T_4 - $ZnSO_4$ @ 0.5%; T_5 - $ZnSO_4$ @ 0.25% + Borax @ 0.1%, T_6 - Soluble silicic acid @ 0.5 %; T_7 - Soluble silicic acid @ 0.4%; T8 - Soluble silicic acid @ 0.3%; T_9 - $FeSO_4$ @ 0.5% and T_{10} - $ZnSO_4$ @ 0.25% + Borax @ 0.1% + $FeSO_4$ @ 0.5% with three replications. The above mentioned nutrient solutions were prepared separately by dissolving the required amount of salts in the water and four sprays were applied on the crop at one month interval after three months of planting. The uniform management practices with respect to nutrition and irrigation were adopted for experimental trees. Observations on growth parameters (plant height, stem diameter, number of leaves, petiole length, plant spread, number of flowers per plant and number of fruits plant^{-1}), fruit parameters (mean weight of fruits, fruit length, fruit diameter and volume of the fruits) and yield parameters (kg plant^{-1} and tonnes ha^{-1}) were recorded at nine months after transplanting. Stem diameter was recorded using digital vernier callipers, fruit length and diameter were measured using scale whereas, volume of the fruits was determined by water displacement method.

Results and Discussion

Regarding vegetative parameters, the values

for plant height were significantly higher when the plants were sprayed with T_{10} ($ZnSO_4$ + Borax + $FeSO_4$) with 205.47 cm, which was on par with all the treatment except T_8 and T_1. The same trend was observed for stem diameter where in the highest stem diameter (113.59 mm) was recorded in the plants which were treated with T_{10} ($ZnSO_4$+ Borax+ $FeSO_4$) however, this was on par with T_5, T_6, T_7 and T_9. Similarly number of leaves plant^{-1} and petiole length was found highest in the same treatment ($ZnSO_4$ + Borax + $FeSO_4$) with 40.41 and 71.71 cm respectively. Plant spread was also superior in T_{10} ($ZnSO_4$+ Borax + $FeSO_4$) with 201.57cm (North South) and 198.70 cm (East-West) followed by T_5 ($ZnSO_4$ + Borax) and soluble Silicic acid at 5 ml L^{-1} (Table 1).

The results were confirmed with earlier reports of Alila *et al.* (2005) who have studied the responses of papaya cv. Ranchi to micro nutrient application wherein B (0.1%, boric acid), Fe (0.1%, ferrous sulfate) and Zn (0.2%, zinc sulfate) were applied as foliar sprays on papaya at 2 and 4 months after planting. Growth parameters (plant height, basal diameter and number of leaves plant^{-1}) significantly increased under micronutrient treatments in comparison to the control. Prabu and Singaram (2001) reported that foliar application of 0.5 per cent $ZnSO_4$ with 0.2 per cent borax combination excelled in increasing the shoot length, number of internodes shoot^{-1} and number of leaves shoot^{-1} in Muscat grapes. Muhammad *et al*., (2010) reported that foliar application of Zn compound to severely Zn deficient citrus trees increased vigour, leaf size and shoot growth and recovery of sweet orange trees resulted in increased yield. According to Jeyakumar *et al*. (2002), the staggered foliar application of $ZnSO_4$ (0.05%) in combination with borax (0.1%) in 4 to 8 months after planting were associated with increase in plant growth of papaya cv. CO-5. Similarly Singh *et al*. (2000) reported that the application of borax at 0.50% + $ZnSO_4$ at 0.25 per cent was considered as the best which caused the maximum plant growth (39.74 cm girth) in papaya.

With respect to reproductive parameters, the plants treated with foliar spray of T_{10} ($ZnSO_4$ + Borax + $FeSO_4$) showed higher

Table 1. Effect of micronutrients and silica on growth parameters at nine months after transplanting.

Treatment	Plant height (cm)	Stem dia-meter (mm)	Leaves plant^{-1}	Petiole length (cm)	Plant spread (cm)		Flowers plant^{-1}	Fruits plant^{-1}
					North-South	East-West		
T_1 - Untreated control	164.47	87.19	31.67	60.33	156.83	149.34	38.57	17.67
T_2 - $MgSO_4$ (0.25%)	183.56	90.22	36.89	64.48	159.73	169.52	41.13	19.53
T_3 - Borax (0.1%)	192.92	98.37	38.30	63.22	162.40	162.30	51.80	22.30
T_4 - $ZnSO_4$ (0.5%)	182.78	90.18	36.74	58.78	164.12	165.63	41.87	19.60
T_5 - $ZnSO_4$ (0.25%) + Borax (0.1%)	201.08	105.93	39.11	64.33	184.67	190.89	52.23	22.67
T_6 - Soluble silicic acid (5 ml l^{-1})	198.94	103.00	37.26	67.93	181.36	172.67	44.53	20.67
T_7 - Soluble silicic acid (4 ml l^{-1})	189.14	101.78	34.70	67.00	157.25	167.86	41.60	19.83
T_8 - Soluble silicic acid (3 ml l^{-1})	177.03	99.81	33.81	66.26	165.05	165.67	41.40	20.23
T_9 - FeSO4 (0.5%)	196.00	102.04	36.93	66.00	175.02	171.37	40.30	20.87
T_{10} - $ZnSO_4$ (0.25%) + Borax (0.1%) + $FeSO_4$ (0.5%)	205.47	113.59	40.41	71.71	201.57	198.70	53.13	22.30
S. Em±	7.77	4.63	1.58	2.32	9.20	7.99	1.58	0.85
C. D. @ 5%	23.08	13.75	4.69	6.89	27.32	23.73	4.69	2.51

number of flowers plant^{-1} (53.13) which was on par with T_3 (borax) and T_5 ($ZnSO_4$ + Borax) with 51.80 and 52.23 flowers plant^{-1} at 9 months after transplanting (Table 1). The results are in conformity with earlier findings of Muhammad *et al.* (2010), who found that the application of borax and zinc as foliar spray hastened the flowering in sweet orange cv. Blood Red. Whereas, Alila *et al*. (2005) found that application of boron reduced the days taken for flower opening in papaya. The zinc induced more flowering in sweet orange trees (Garcia *et al*. 1984). Furthermore, the supply of boron needed for reproductive growth in many crops is more than needed for vegetative growth (Mengel and Kirkby, 1982, Marschner, 1986 and Hanson, 1991), and the same may be true in citrus.

Significantly highest number of fruits were recorded in T_5 (22.67) which was on par with treatments T_3 (22.30), T_{10} (22.30), T_9 (20.87), T_8 (20.23) and T_6 (20.27) whereas least number of fruits were found in T_2 (Table 1). The higher number of fruits plant^{-1} in T_{10}, T_5 and T_3 might be because, all these treatments have boron as one of the element in their formulation. Higher pollen germination percentage was observed in blossoms of plants receiving B, Ca, and B + Ca. B and Ca may have more influence on the ability of the stigma to stimulate pollen germination than on the germinability of pollen grains themselves (Youzhi and John, 1995). The results were compared with earlier reports of Robbertse *et al*., (1991 and 1 992) who were able to observe an increased fruit set of avocados substantially by foliar sprays of boron during floral development. It was also reported that fruit drop decreased as leaf Zn content increased (Garcia *et al*. 1984). Supplemental foliar sprays of micronutrients during flowering has showed to increase number of fruit in avocado (Whiley *et al*. 1996). Zinc stabilizes membrane permeability and B (by increasing the mobility of Ca to fruits) also plays a positive role by increasing photosynthesis and providing carbohydrates supply for good Ca uptake which ultimately increase the number of fruits (Edward, 2009).

The results showed highest values for mean weight of fruits (1.73 kg), fruit length (21.17 cm), fruit diameter (17.47 cm) and fruit volume

Table 2. Effect of micronutrients and silica on fruit and yield parameters of papaya.

Treatments	Mean weight of fruit (kg)	Fruit length (cm)	Fruit diameter (cm)	Volume of the fruits (ml)	Yield (kg plant^{-1})	Yield (t ha^{-1})
T_1 - Untreated control	1.13	17.60	13.97	1480.00	19.97	61.62
T_2 - $MgSO_4$ (0.25%)	1.14	18.77	14.50	1636.67	22.24	68.62
T_3 - Borax (0.1%)	1.12	18.87	16.50	2073.33	25.04	77.26
T_4 - $ZnSO_4$ (0.5%)	1.40	17.60	14.70	1700.00	27.09	83.59
T_5 - $ZnSO_4$ (0.25%) + Borax (0.1%)	1.51	20.47	17.50	2383.33	34.22	105.6
T_6 - Soluble silicic acid (5 ml l^{-1})	1.40	17.90	16.07	2016.67	28.57	88.16
T_7 - Soluble silicic acid (4 ml l^{-1})	1.33	17.87	15.00	1966.67	26.23	80.96
T_8 - Soluble silicic acid (3 ml l^{-1})	1.14	17.67	14.97	1858.33	23.09	71.24
T_9 - $FeSO_4$ (0.5%)	1.22	18.63	15.97	1800.00	25.35	78.24
T_{10} - $ZnSO_4$ (0.25%) + Borax (0.1%) + $FeSO_4$ (0.5%)	1.73	21.17	17.47	2446.67	38.57	119.04
S. Em±	0.13	0.79	0.78	187.20	2.44	7.54
C. D. @ 5%	0.38	2.35	2.30	556.19	7.26	22.39

(2446.67 ml) in the plants treated with $ZnSO_4$ + Borax+ $FeSO_4$ (T_{10}). However, weight of fruit was on par with T_4, T_5 and T_6, fruit length on par with T_5, T_3 and T_9, fruit diameter on par with T_3 and T_6 and fruit volume on par with T_5, T_3, T_6 and T_7. However, the lowest values were observed in control (Table 2). Similarly Khayyat *et al.* (2007) found the greater part of pulp weight, pulp seed^{-1} ratio, fruit length and diameter were resulted from boric acid (1500 ppm) in 'Shahany' date palm. Sharma *et al*. (2005) studied the effect of micronutrients spray on fruit set and quality of litchi and the results showed that application of zinc (100 ppm) was most effective for increase in fruit weight, fruit length and diameter.

The highest values for mean fruit yield per plant was recorded in T_{10} (38.57 kg) and T_5 (34.22 kg) which were on par with each other in the same way highest yield ha^{-1} was recorded in T_{10} (119.04 tonnes) and T_5 (105.60 tonnes) which were on par with each other whereas, significantly least values were recorded in control (Table 2). Micronutrient combination of $ZnSO_4$ + Borax + $FeSO_4$ (T_{10}) performed best with respect to all the vegetative parameters (plant height, stem diameter, number of leaves, petiole length and plant spread) and more number of flowers. More number of leaves and more plant spread have increased area for photosynthesis thus producing more photosynthates whereas more number of flowers increased the number of fruits which ultimately resulted in higher yield plant^{-1}. Similarly in papaya, maximum fruit yield (37.20 kg plant^{-1}) was observed by application of borax at 0.50 per cent + $ZnSO_4$ at 0.25 per cent as reported by Singh *et al*. (2000). The improved fruit set, yield and fruit physical characteristics (i.e. fruit weight, kernel weight, kernel fruit^{-1} ratio, kernel length, and kernel diameter and kernel shape index) can be achieved by 500 ppm boron and 50 ppm chelated zinc in almond (Sharkawy and Sha, 2004). Fe proved superior to the other micronutrients in terms of yield and yield attributes in papaya (Alila *et al*., 2005). Whereas, Singh *et al*. (1990) concluded that foliar spray of boric acid at 0.02 per cent was found significant for higher yield (8.25 kg tree^{-1}) in pomegranate. Bhavya (2010) reported that application of 4 and 6 ml l^{-1} foliar spray of salicylic acid at 10 days interval (6 sprays) and 6 ml l^{-1} foliar spray of silicic acid at 20 days interval (3 sprays) on Bangalore Blue grapes significantly influenced growth and yield parameters over control. Similarly application of borax (0.1%) has reported the maximum yield (121.20 kg plant^{-1}), highest TSS (37.6%) and total sugars (28.4%) and minimum fruit drop (86.40%) in bael (Saini *et al*., 2004).

The findings of the study indicated the importance of boron, zinc, iron magnesium and silicon to increase the plant vigour and yield in papaya.

References

Alila, P., Sanyal, D. and Akali, S. 2005. Responses of papaya cv. Ranchi to micro nutrient application. Hort. J., 18(2): 121-125.

Anonymous. 2011. Indian horticulture data bases, www.nhb.gov.in

Bhavya, H. K. 2010. Effect of foliar silicic acid and boron in Bengaluru blue grapes, M. Sc. thesis, Univ. Agric. Sci., Bengaluru, p. 95.

Chadha, K. L. 1992. Scenario of papaya production and utilization in India. Indian J. Hort., 49(2): 97-119.

Edward, R. M. 2009. Importance of micronutrients in changing horticultural scenario in India. J. Hort. Sci., 4(1): 1-27.

Epstein, E., 1999, Silicon. Annl. Rev. Plant Physiol. Plant Mol. Biol., 50:641-664.

Garcia, A., Haydar, N. E. and Ferrer, C. 1984. Influence of Zn and Mn on the physiological behaviour and yields of Valencia oranges. Center Agricola. Instt. Superior Agricola Ciego de Avila, Cuba, 10: 57-58.

Hanson, E. J. 1991. Movement of boron out of tree fruit leaves. J. Hort. Sci., 26: 271-273.

Jeyakumar, P., Durgadevi, D. and Kumar, N. 2002. Effects of zinc and boron fertilization on improving fruit yields in papaya (*Carcia papaya* L.) cv. Co5. Developments in Plant and Soil Sci., 92(5): 356-357.

Khayyat, E., Tafazoli, S., Eshghi and Rajaee, S. 2007. Effect of nitrogen, boron, potassium and zinc sprays on yield and fruit quality of Date Palm. American-Eurasian J. Agric. and Environ. Sci., 2(3): 289-296.

Korndorfer, G. H. and Lepsch, I. 2001, Effect of silicon on plant growth and crop yield. Elsevier, 8: 133-147.

Marschner, H. 1986. Mineral nutrition of higher plants. Acad. Press, San Diego, CA.

Mengel, K. and Kirkby, E. A. 1982. Principles of plant nutrition. Int'l Potash Instt. Bern, Switzerland.

Muhammad, S., Abdur, R., Nawab, A., Muhammad, A., Louise, F. and Masood, A. 2010. Effect of foliar application of zinc and boron on fruit production and physiological disorders in sweet orange cv. Blood Red. Sarhad J. Agric. 26(3):

Prabu, P. C. and Singaram, P. 2001. Effect of micronutrients zinc and boron on growth and yield of grapes (*Vitis vinifera* L.) Muscat. Madras Agric. J., 88(1-3): 213-215.

Robbertse, P. J., Coetzer, A. and Bessinger, F. 1991. The influence of solubor leaf spray on fruit production in avocado. South African Avocado Growers' Asso. Yearbook 14: 83-84.

Robbertse, P. J., Coetzer, L. A. and Janse, V. V., B. P. H. 1992. Boor-opname by vokado. South African Avocado Growers' Asso. Yearbook 15: 89-93.

Saini, R. S., Singh, S. and Deswal, R. P. 2004. Effect of micro nutrients, plant growth regulators and soil amendments on fruit drop, cracking, yield and quality of bael (*Aegle marmelos correa*) under rainfed conditions. Indian J. Hort., 62(2): 175-176.

Sharkawy, E. and Sha, M. M. 2004. Effect of boron and chelated zinc foliar sprays on fruit set, yield and fruit quality of almond trees. Egyptian J. Appl. Sci., 19(11B): 125-130.

Sharma, P., Singh, A. K. and Sharma, R. M. 2005. Effect of Plant bio-regulators (PBRs) and micro-nutrients on fruit set and quality of litchi cv. Dehradun. Indian J. Hort., 62(1): 24-26.

Singh, D. K., Ghosh, S. K., Paul, P. K. and Suresh, C. P. 2000. Effect of different micronutrients on growth, yield and quality of papaya (*Carica papaya* L.) cv. Ranchi. : II Internat. Symp. on Papaya. Acta Hort., 851.

Singh, R. P., Sharma, Y. P. and Awasthi, P. R. 1990. Influence of different cultural practices on pre-mature fruit cracking of pomegranate. Prog. Hort., 22(1-4): 92-96.

Veerannah, L. and Selvaraj, P. 1984. Studies on growth, dry matter partitioning and the pattern of nutrient uptake in papaya. Nat. Semi. on papaya and papain production, Tamil Nadu Agric. Univ., Coimbatore, pp. 76-78.

Whiley, I. E. A. W., Smith, B. N., Wolstenholme, J. B. and Saranah. 1996. Boron nutrition of Avocados, South African Avocado Growers' Asso., Yearbook, 19: 1-7.

Youzhi, C. and John, M. S. 1995. Effect of boron and calcium on in vitro and in vivo lowbush Blueberry pollen germination. Appl. Ecol. and Environ., Hort. Sci., 30(4), July.

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Nutrient Management for *Rabi* Onion under Micro-Sprinkler

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Abstract

The fertigation with urea phosphate (17:44:0) and 100 per cent recommended dose of fertilizers (RDF) level registered maximum values of dry matter, average bulb weight and total bulb yield. The maximum values of NPK availability and maximum uptake was due to urea phosphate (166.1, 28.50 and 359.2 kg ha^{-1}) followed by 18:18:18 and lowest values of NPK availability was observed in control treatment, where fertilizers were applied as band placement in soil. The fertilizer levels influenced the NPK availability and uptake. The maximum availability and uptake was observed in 100 per cent RDF followed by 80 and 60 per cent RDF. It was concluded from study that for production of rabi onion (N-2-4-1) cultivated on medium deep soil, application of 60 per cent recommended dose of fertilizer in water soluble form in 10 equal splits through micro- sprinkler was found appropriate for better growth, efficient nutrient use and nutrient availability and higher yield of rabi onion.

Key words : Onion, water soluble fertilizers, micro-sprinkler, yield, nutrient uptake and availability.

In recent years water soluble fertilizers are used as alternative for straight fertilizers as they are completely soluble in water and can be applied through pressurized irrigation system (micro-sprinkler) in many splits with an ease without any harm. Though water soluble fertilizers proved superior over conventional fertilizers, they are costly from economic point of view. With increasing prices of fertilizers it become necessary to save the fertilizers and reduce the cost of cultivation and to improve the fertilizer use efficiency for maintaining soil health (Mane and Khade, 1987). However, the information on nutrient availability and nutrient uptake by *rabi* onion under micro-irrigation system is lacking and hence present investigation was carried out.

Materials and Methods

The field experiment was conducted for three consecutive seasons from 2009-2012 at research farm of Interfaculty Department of Irrigation Water Management, Mahatma Phule Krishi Vidyapeeth, Rahuri. Agroclimatically, the area falls under the scarcity zone of Maharashtra with annual average rainfall of 520 mm which is mostly erratic and uncertain in nature. The experimental plot was uniformly leveled with well drained medium deep soil having pH of 7.8 and EC as 0.28 dS m^{-1}. The soil depth was 60 cm with infiltration rate and organic carbon content as 3.24 cm hr^{-1} and 0.63 per cent, respectively. The soil of experimental plot was low in available nitrogen (152.3 kg ha^{-1}), medium in available phosphorus (21.7 kg ha^{-1}) and high in potassium (360.0 kg ha^{-1}). The soil is well drained having moisture content at field capacity, permanent wilting point and available water content in soil was 38.20, 20.67 and 21.53 per cent, respectively. The experiment was laid out in a factorial randomized block design, involving ten treatments replicated

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thrice. The treatments were comprised of combinations of three fertigation sources *viz*.; urea phosphate, di-ammonium phosphate (DAP) and water soluble N:P:K grade (18:18:18) and three fertigation doses *viz*., 60, 80, 100 per cent RDF. The tenth treatment was included as control (micro-sprinkler with RDF applied conventionally i.e., full P_2O_5 and K_2O and half dose of nitrogen applied prior to transplanting and remaining half dose of nitrogen applied after one month).

The full grown onion seedlings (50-60 DAS) were transplanted during third week of December for three consecutive years from 2009-2011. The planting was done on flat bed of 4.2 x 6.0 m at spacing of 15 x 7.5 cm. The recommended dose of fertilizer for onion as 100:50:50, $N:P_2O_5:K_2O$ kg ha^{-1} was applied to all treatments in ten equal splits at an interval of seven days starting from transplanting. The water soluble fertilizers were applied through micro-sprinkler by injection pump (0.5 Hp) and small fertilizer tank in fertigation treatments. Adequate plant protection measures were adopted as and when required. The amount of water (litres day^{-1}) to be applied through micro-sprinkler at alternate days was calculated on the basis of cumulative pan evaporation. The reference evapotranspiration was estimated using Evapotranspiration Monitoring Unit (ICT International, Australia) installed at research farm. Considering the crop factor as per growth stages (Alien *et al*. 1988) and pan factor, the water requirement of the onion was computed.

The lateral lines of 16 mm diameter LDPE pipes were laid along the crop rows. Three laterals were provided within a plot at the spacing of 120 cm between two micro-sprinkler. The spacing between two adjacent laterals within plot was 2.4 m.

The crop was harvested at 110 days after transplanting when the bulbs matured. The soil samples were collected periodically (30, 60 and

Table 1. Yield and yield contributing characters of *rabi* onion as influenced by different treatments (Pooled means 2009-2012).

Treatments	Dry matter (g)	Bulb weight (g)	Bulb yield (t ha^{-1})			
			2009	2010	2011	Pooled mean
Fertigation sources :						
Urea phosphate + urea + MOP	13.13	90.86	47.33	33.37	39.18	39.93
DAP + urea + MOP	12.12	73.41	42.33	26.34	36.46	35.04
18:18:18 + urea	12.54	83.69	44.62	28.89	38.41	37.31
S.E.±	0.27	2.67	1.07	0.69	1.31	0.97
C.D. at 5%	0.80	7.99	3.20	2.07	NS	2.89
Fertigation doses :						
60% RDF	12.2	77.39	42.92	26.94	36.53	35.46
80% RDF	14.54	83.44	44.39	29.97	38.13	37.50
100% RDF	15.03	86.92	46.97	31.69	39.39	39.35
S.E.±	1.2	2.7	1.07	0.69	1.31	0.37
C.D. at 5%	NS	7.4	3.20	2.07	NS	NS
Interaction :						
C.D. at 5%	NS	NS	NS	NS	NS	NS
Control	12.01	75.51	39.44	25.57	33.57	33.86

Table 2. Water use by onion as influenced by different treatments. (Pooled means 2009-2012).

Treatments	Water depth (mm)	Effective rainfall (mm)	Total water requirement (mm)	WUE (kg ha^{-1} mm^{-1})
Fertigation sources :				
Urea phosphate + urea + MOP	397.41	4.99	402.40	98.24
DAP + urea + MOP	397.41	4.99	402.40	90.15
18:18:18 + urea	397.41	4.99	402.40	94.76
Fertigation doses :				
60% RDF	397.41	4.99	402.40	90.86
80% RDF	397.41	4.99	402.40	94.27
100% RDF	397.41	4.99	402.40	98.02
Control	397.41	4.99	402.40	82.75

90 DAT and after harvest of onion bulb) for nutrient availability. The plant samples like leaves and bulbs were used for nutrient analysis. The plant samples were digested (diacid mixture) as per the standard procedure given by Parkinson and Alien (1975). The uptake of major nutrients was worked by multiplying dry matter accumulation to N, P and K concentration (Jackson 1967).

Results and Discussion

Yield contributing characters : The maximum dry matter accumulation and average bulb weight (Table 1) was obtained due to urea phosphate source (17:44:0), which was (13.13 and 90.86 g, respectively) higher than the rest of the fertigation sources, but was at par with 18:18:18 and significantly superior over DAP.

A maximum dry matter accumulation (15.03 g plant^{-1}) with 100 per cent RDF and significantly higher and average bulb weight (86.92 g) was observed with application of 100 per cent RDF over 60 per cent RDF. However, it was at par with 80 per cent RDF level. These results are in conformity with those reported by Pandey and Kpko (1991) and Mallangonda *et al.* 1995. The interaction effect between fertigation sources and fertigation doses for dry matter accumulation and average bulb weight was found non significant.

Bulb yield : The onion bulb yield (Table 1) pooled over three years found to be ranged between 35.04 to 39.93 t ha^{-1}. The maximum total bulb yield of onion was obtained due to urea phosphate source (17:44:0), which was (39.93 t ha^{-1}) higher than rest of fertigation

Table 3. Total uptake of NPK (kg ha^{-1}) in bulb and leaves of onion as influenced by different treatments. (Pooled means 2009-2012).

Treatments	N uptake	P uptake	K uptake
Fertigation sources :			
Urea phosphate + urea + MOP	156.4	52.63	174.79
DAP + urea + MOP	126.2	39.35	138.09
18:18:18 + urea	126.56	43.80	152.93
S.E.±	0.62	0.29	0.70
C.D. at 5%	1.83	0.86	2.08
Fertigation doses :			
60% RDF	124.11	41.34	138.57
80% RDF	134.05	45.27	148.35
100% RDF	143.66	49.47	162.12
S.E.±	0.62	0.29	0.70
C.D. at 5%	1.83	0.86	2.08
Interaction :			
C.D. at 5%	NS	NS	NS
Mean	133.80	45.13	151.17
Control	121.72	39.48	140.04

sources, but was at par with 18:18:18 (37.31 t ha^{-1}) and significantly superior over DAP (35.04 t ha^{-1}).

The total bulb yield due to different fertilizer levels showed non significant effect. However, the maximum total bulb yield was obtained with application of 100 per cent RDF (39.35 t ha^{-1}) as compared to 80 and 60 per cent RDF. The lowest bulb yield was recorded in control treatment where micro sprinkler with RDF was applied conventionally. Chavan (2001) reported that the production potential of onion was found increased with increase in fertilizer application. The interaction effect between fertigation sources and fertigation doses for total bulb yield was found non significant.

Water use efficiency : The fertigation sources influenced the water use efficiency (Table 2). The maximum water use efficiency was due to urea phosphate (98.24 kg ha^{-1} mm^{-1}) while minimum water use efficiency observed with application of DAP (90.15 kg ha^{-1} mm^{-1}).

The maximum (98.02 kg ha^{-1} mm^{-1}) water use efficiency was recorded with application of 100 per cent RDF followed by 80 per cent RDF (94.27 kg ha^{-1} mm^{-1}). The lowest water use efficiency was recorded with application of 60 per cent RDF (90.86 kg ha^{-1} mm^{-1}).

Nutrient uptake : The maximum N uptake (156.4 kg ha^{-1}) was observed due to urea posphate source which was significantly higher over rest of the sources (Table 3). The minimum N uptake (126.2 kg ha^{-1}) was due to DAP. The water soluble fertilizers (urea phosphate and 18:18:18) resulted in higher N uptake than DAP, which may be due to higher solubility of nutrients in water soluble fertilizer than conventional sources of fertilizer.

The different fertilizer levels significantly

Table 4. Nutrient availability (kg ha^{-1}) as influenced by various treatments (Pooled means 2009- 2012).

Treatments	N availability				P availability				K availability			
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest
Fertigation sources :												
Urea phosphate + urea + MOP	158.7	161.1	166.1	163.1	18.3	22.3	28.50	19.50	346.9	353.3	359.2	353.6
DAP + urea + MOP	157.4	160.1	165.2	161.4	16.8	21.6	26.40	17.10	343.0	350.8	356.9	352.4
18:18:18 + urea	159.4	161.1	164.5	162.5	17.4	24.4	27.90	18.20	345.4	351.9	357.8	353.8
S.E.±	1.15	1.70	1.92	0.85	0.90	0.70	0.92	0.52	1.20	1.35	0.82	2.18
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fertigation doses :												
60% RDF	154.4	157.4	161.0	158.7	15.70	17.80	19.10	16.30	342.6	347.7	352.3	348.9
80% RDF	158.9	160.6	165.0	161.8	17.50	22.80	27.80	18.10	344.9	352.4	357.2	353.4
100% RDF	162.20	165.1	169.9	166.5	21.2	26.4	32.4	19.3	347.8	355.9	364.4	356.9
S.E.±	1.20	1.68	1.78	0.88	1.18	1.21	1.41	0.64	1.53	2.14	2.33	2.30
C.D. at 5%	3.60	5.10	5.35	2.61	3.50	3.60	4.22	1.92	4.60	6.40	7.00	6.95
Interaction :												
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control	157.5	155.4	161.5	156.5	15.30	20.6	24.06	14.20	338.2	351.5	350.1	354.2

influenced nitrogen uptake of onion at harvest. The maximum N uptake (143.66 kg ha^{-1}) was recorded with application of 100 per cent RDF treatment which was significantly superior over rest of the treatments. These observations indicated that higher dose of nitrogen was found beneficial to increase concentration and uptake of nitrogen by onion at harvest. These results are in conformity with those reported by Henriksen (1984) and Patel *et al*. (1992). The nitrogen uptake did not differ significantly due to interaction effects of sources and fertilizer levels.

The maximum P and K uptake (52.63 and 174.79 kg ha^{-1}, respectively) was observed due to urea phosphate which was significantly higher over rest of the sources (Table 3). The minimum P and K uptake (39.35 and 138.09 kg ha^{-1}) was due to DAP.

The different fertilizer levels significantly influenced the P and K uptake of onion bulb and leaves at harvest. The maximum P and K uptake (49.47 and 162.12 kg ha^{-1}) was recorded with application of 100 per cent RDF which was significantly superior over rest of the treatments. In general, the higher levels of fertilizers were advantageous for uptake of phosphorus and potassium by onion crop. These results are in agreement with those reported by Singh *et al*. (1997). The interaction effect of fertilizer sources and fertilizer levels for P and K uptake found non-significant.

The nitrogen availability was increased with period from transplanting upto 90 DAT in all the treatments and afterwards it decreased at harvesting stage may be due to higher N uptake by onion crop. The effect of sources of fertilizer on nitrogen availability was fond to be non significant. The maximum N availability was observed in urea phosphate as compared to other sources.

The level of fertilizer had influenced the N availability in soil to some extent. The maximum N availability was observed in 100 per cent RDF (169.9 kg ha^{-1}) and it was significantly superior over 60 per cent RDF (161.0 kg ha^{-1}) and at par with 80 per cent RDF (165.0 kg ha^{-1}) at 90 DAT. The interaction effect between fertigation sources and fertigation doses for periodical N availability in soil was found to be non significant.

The phosphorus availability was increased with period from transplanting upto 90 DAT in all the treatments and afterwards it decreased at harvesting stage may be due to higher P uptake by crop during the bulb development stage. The effect of sources of fertilizers on P availability was found to be non significant. The maximum P availability (28.50 kg ha^{-1}) was observed in urea phosphate followed by 18:18:18 and DAP at 90 DAT. The lowest P availability was in control treatment (24.06 kg ha^{-1}) where fertilizers were added as a basal dose.

The levels of fertilizer influenced the P availability in soil. The maximum P availability was observed in 100 per cent RDF (32.4 kg ha^{-1}) and it was significantly superior over 60 per cent RDF (19.10 kg ha^{-1}) and at par with 80 per cent RDF (27.8 kg ha^{-1}) at 90 DAT. The lowest P availability was observed in control treatment at harvest. The interaction effect between fertigation sources and fertigation doses for periodical P availability in soil was found non significant.

The potassium availability was increased with period from transplanting upto 90 DAT in all treatments and afterwards it decreased at harvesting stage, may be due to higher K uptake by crop during bulb development stage. The effect of fertigation sources on K availability was found to be non significant;

however, maximum K availability (359.6 kg ha^{-1}) was observed in urea phosphate followed by 18:18:18 and DAP.

The levels of fertilizers influenced K availability in soil. The maximum K availability was observed in 100 per cent RDF (364.4 kg ha^{-1}) and at par with 80 per cent RDF (357.2 kg ha^{-1}) at 90 DAT. The lowest K availability was observed in control treatment (350.1 kg ha^{-1}) where the fertilizers were added as a basal dose.

Conclusions :

The yield and yield contributing characters were found maximum in 17:44:0 source; however, it was at par with 18:18:18 source. The effect of levels on yield and yield contributing characters was non-significant except av. bulb weight. The nutrient uptake was found significantly superior in 17:44:0 source as compared to other sources. The levels of fertigation was significantly superior in nutrient uptake and availability of NPK.

It can be concluded that for production of rabi onion N-2-4-1 cultivated on medium deep soil, application of 60 per cent recommended dose of fertilizer in water soluble form in 10 equal splits through micro-sprinkler is found optimum for better growth, efficient nutrient use and nutrient availability and higher yield of *rabi* onion.

References

Alien, R.G., Perira. L. S., Raes, D. and Smith, M. 1998. Crop evapotranspiration. Guidelines for computing crop water requirements. FAO Irrigation and Drainage. Paper No. 5+, FAO, Rome, Italy. P. 300.

Chavan, S. G. 2001. Irrigation and fertilizer management in relation to yield target of *rabi* onion (*Allium cepa* L.) M.Sc. (Agri.) thesis, MPKV, Rahuri (M.S.) India.

Henriksen, K. 1984. Nitrogen fertilizing in seed onion (*Allium cepa* L.) at high soil moisture content. Tidsskrift for planteavel. 88(6): 621-631.

Jackson, M. L. 1967. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Mallangonda, B., Sulikeri, G. S., Murthy, B. G. and Pratibha N. C. 1995. Efect of NPK, FYM and companion crops on growth, yield and yield components of chilli (*Capsicum annum*). Adv. Agri. Res. India, 3: 58-59.

Mane, T. A. and Khade, K. K. 1987. Comparative performance of sprinkler and surface method of irrigation on yield of summer onion. Proc. of Sem. on drip and sprinkler irrigation method adoption, MPKV, Rahuri.

Pandey, U. C. and Kpko, U. 1991. Response of nitrogen on growth and yield of onion (*Allium cepa* L.) in maiduguri region of Borna state, Nigeria. Res. and Develop. Rep. 8(1): 5-9.

Parkinson, J. A. and Alien, S. E. 1975. A wet oxidation procedure for determination of N and other mineral nutrients in biological material. Common in soil sci. and plant Anal. 6: 1-11.

Patel, K. P., Patel, J. C., Patel, B. S. and Sadaria, S. G. 1992. Yield and nutrient uptake by onion (*Allium cepa* L.) as influenced by irrigation, nitrogen and phosphorus. Indian J. Agron. 37(2): 395-396.

Singh, K. P. Singh, S. and Singh, V. 1997. Evaluation of source phosphorus on alluvial soils with potato as test crop. J. Indian Soc. Soil. Sci. 45(3):594-596.

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Evaluation of Lilium (*Lilium* sp.) Cultivars for Growth and Yield Under Shadenet Conditions

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Abstract

Among the different cultivars studied, Elite, Courier, Tresor and Latoya performed better under shadenet conditions. Cultivar, Elite found significantly superior over all other varieties by recording early sprouting of bulb, highest plant height (93.61 cm), good number of leaves (90.39), stalk length (96.06 cm), number of flowers (4.21) and flowers with very attractive fire red color. While, Courier was found better next to cultivar Elite in terms of plant height (79.89 cm), stem girth (1.36 cm), number of flower buds (4.04), length of flower bud (8.18 cm), better stalk length (84.33 cm) with stalk thickness (1.37 cm) and having white color flower with highest number of flower stalks (50.75) per square meter. Next to these two cultivars, Tresor and Latoya also recorded the best performance in respect to growth and flower yield.

Key words : Lilium, evaluation, cultivars, shadenet, growth , flower yield.

Lilium (*Lilium* sp.) is one of the largest traded ornamental bulbous crops. Liliums are valued for their magnificently showy flowers, which are available in a variety of colours and widely used as cut flower, pot plant and garden perennial. Due to development of Asiatic hybrid, Oriental hybrids, Longiflorum hybrids and increasing demand in metropolitan cities, there is much scope for growing Lilium as a cut flower. Howerve, the preference should be given to the variety with prime characterics like plant height, growing period, buds per plant, stem sturdiness, keeping quality of flower and attractive colour (Mishra and Pathania, 2002). Earlier, cultivation of Lilium was restricted to temperate zone but now it is being grown successfully in subtropical regions like Pune, Bangalore, Hyderabad etc. Therefore, efforts were made to evaluate different varieties of Lilium under shadenet conations.

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Materials and Methods

The present investigation was conducted during the year 2009 at Hi-tech Floriculture Project, College of Agriculture, Pune under shadenet conditions. The experiment was laid out in a randomized block design with four replications and eight varieties (Table 1). The uniform size and proper resting bulbs of these varieties were planted on raised beds prepared from mixture of red soil and FYM under shade net house (75% shade net) conditions. Before planting, bulbs were treated with Bavistin (0.2%) for 10 min. Planting was done at spacing 15 x 10 cm with 15 to 25 cm depth. The observations were recorded for different growth and yield parameter on five randomly selected plants. The growth observation in respect of height of plant, number of leaves plant^{-1}, stem girth were recorded at an interval of 15, 30, 45 and 60 days after planting and data after 60 days was considered evaluation the performance under shednet obtained. While, data for days to flower initiation, flowering and harvesting was recorded and

yield attributing characters like number of flowers plant^{-1} and number of bulbs m^{-2} was also recorded after harvesting of flowers and drying of leaves. Data were analyzed statistically as per the procedure given by Panse and Sukhatme (1985).

Results and Discussion

Lilium cultivars varied significantly for vegetative growth and flower yield. The data pertaining to growth and yield are presented in Table 1.

Growth parameters : All the growth parameters were differed significantly among all the Lilium cultivars under study. Among the different cultivars studied cv. Elite required significantly the lowest number of days (10.53) for sprouting over all the cultivars under study and it was followed by the cv. Sareda. The highest number of days for sprouting observed in cv. Tresor (14.92 days). The variation in number of days required for sprouting of bulb after planting due to genetic composition of cultivar, climatic conditions, size of bulbs as well as storage of food in bulb. Similar variation was reported by Sindhu (2006). Significantly highest plant height at all the stages was also recorded by the cultivars Elite and the cultivar Novano recorded the lowest plant height as compared to all other cultivars. The plant height is correlated with bulb size of cultivars and also might be due to storage food and favorable growing conditions. Similar trend in increase plant height have been reported by Dhiman (2003), Janakiram and Srinivas (2006) and Sindhu (2006) in lilium at various location of India.

The next important character is number of leaves and the cultivar Elite produced significantly highest number of leaves plant^{-1} (90.39) throughout growth period overall the cultivar. It was followed by cultivar Novano. The cultivar Brindisii recorded the lowest number of leaves plant^{-1} at all the stages. Leaves plant^{-1} was influenced by genetic constitution of varieties and physiological parameters of the plants like carbohydrate, plant height etc. These results are in agreement with those reported by Dhiman (2003) Janakiram and Srinivas (2006). However, the cultivar Latoya showed the highest stem girth (1.37 cm) and was at par with cultivar Courier and Brindisii. The variation among the cultivars might be due to genetic makeup of cultivars as well as

Table 1. Comparative performance of different cultivars of lilium for growth.

Cultivars	Days to sprouting	Plant height (cm)	Number of leaves	Stem girth (cm)	Days to bud initiation	Days to first flowering	Days to harvest	Number of flower bud plant^{-1}	Number of flower m^{-2}	Bulb m^{-2}
Serrada	12.93	70.00	74.85	1.27	57.33	68.88	78.40	2.95	49.50	44.0
Elite	10.53	93.61	90.39	1.13	53.28	66.64	76.20	4.21	46.50	40.5
Brunello	13.09	73.73	71.77	1.30	53.94	65.88	75.38	2.36	49.00	46.25
Tresor	14.92	77.84	77.20	1.31	42.69	56.31	62.13	3.08	49.00	46.50
Latoya	13.57	79.22	72.83	1.37	52.44	68.25	76.09	3.80	50.50	45.0
Novano	14.17	54.37	81.98	1.15	48.53	59.26	70.86	3.94	47.75	41.50
Brindisii	14.14	79.10	50.29	1.33	51.25	66.56	77.56	2.81	48.50	41.25
Courier	14.38	79.89	71.41	1.36	51.81	68.69	76.22	4.04	50.75	47.00
Mean	13.47	75.97	73.84	1.28	51.41	65.06	74.10	3.40	48.94	44.00
SE. m±	0.26	1.65	0.89	0.02	0.42	0.59	0.49	0.17	0.63	0.97
CD at 5%	0.76	4.86	2.62	0.035	1.24	1.73	1.43	0.51	1.84	2.83
CV%	3.83	4.35	2.41	0.02	1.64	1.80	1.31	10.16	0.03	0.04

number of leaves and plant height.

Flowering and yield parameters : The cultivar Tresor was found significantly earliest (42.69 days) for bud initiation after planting while Serrada required more days (57.33) to bud initiation. Variation for bud initiation differed significantly among all the cultivars under study. Similar results were also reported by Dhiman (2003) and Sindhu (2006) at solan and Delhi conditions. Similarly, significantly the earliest flowering was also reported in cultivar Tresor (56.31 days) and was superior over all the cultivars. The highest days required for flowering in Serrada (68.88). Early or late flowering behavior is a varietal characteristic, which was with of genetically base. These results are similar to the findings reported by Thakur *et al.* (2010), Kumar and Tewari (2003). Another important flowering character is duration of flowering and the lowest days taken for complete harvesting by cv. Tresor (62.13) and the highest in cv. Serrada (78.40 days) This might be due to early bud initiation which was observed in cv. Tresor and late in Serrada. Similar findings were also reported by Singh (2006).

Yield attributes like number of flower buds plant^{-1}, flower m^{-2} and number bulb m^{-2} were important during evaluating performance of cultivars. Among eight cultivars, Elite had produced significantly the highest number of flower buds (4.21) plant^{-1} and was par with Courier (4.04). The lowest number of flowers buds was Brunello (2.36). Such variation due to cultivars also reported by Sindhu (2006), Ranpise *et al*. (2007) and Singh *et al*. (2010) at various locations of India. The Courier was produced significantly the highest flower stalks (50.57) m^{-2} and was significantly higher than rest of the cultivars. Similar Courier also was produced significantly highest number of bulb (47.00) square^{-1} meter area and was at par with Tessor (46.50) and Brunello (46.25) while the lowest number of bulb m^{-2} was observed in cv. Elite (40.50). Yield potentials supported to be varietal characters and with climatic conditions and agro techniques The variation due to cultivars potential to produce flower stalks and bulb depends on the density of planting, growth media and environments.

Considering overall performance lilium cultivars for growth and flower yield, cv. Elite, Courier, Tresor and Latoya performed better under shadenet house having 75 per cent shade.

References

Dhiman, M. R. 2003. Studies on evaluation of Lilium hybrids under Kullu conditions. J. of Ornamental Horti. New Series, 6(2): 154-155.

Kumar, Dhiraj and Tewari, G. N. 2003. Response of cultivars and planting time on growth and flowering behavior of Asiatic hybrid lily. J. Ornamental Hort. 8(2): 264-267.

Janakiram T. and Sriniwas, Meenakshi. 2006. Studies on performance of lilium genotypes under low cost polyhouse. National Sym of Ornamental Bulbous Crops held at SUBPVA and T Merrut, Abst. Book, 1. 33.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical Method for Agricultural Workers. ICAR Pub. New Delhi.

Ranpise, S. A., Patil, M. T., Gurav, S. B. and Chougule, A. A. 2007. Studies on comparative performance of Lilium under shade house and polyhouse conditions. National sym. on recent advances in floriculture held at NAU, Navsari Abst. Book, 2-6 : 44.

Sindhu, S. S. 2006. Evaluation of lilium cultivars under North Indian conditions. Haryana J. Hort. Sci., 35(3-4): 270.

Singh, M. K., Kumar, Sanjay and Mahajan, Arpana. 2010. Evaulation of Asiatic hybrid lily under conditions of Lahaul valley and Palampur, Himachal Pradesh. Nat. Sym. on Lifestyle Floriculture, Challenges and Opportunities held at Dr. Y. S. Parmar Univ.of Horti. and Forestry, Nouni, Solan. Abstract Book, pp. 2. 13: 16.

Thakur, Priyanka, Dhiman, S. R., Gupta, Y. C. and Bhalla, Rajesh. 2010. Performance of lilium germplasm under mid hill conditions of Himachal Pradesh. Nat. Sym. On Lifestyle Foriculture. Challenges and Opportunities, held at Dr. Y. S. Parmar Univ. of Hort. and Forestry, Nauni Solan, Abst. Book pp. 2-24: 23.

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Response of Bt. Cotton (*Gossypium hirsutum* L.) to Plant Densities and Fertilizer Levels Under Different Irrigation Methods

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Abstract

Drip irrigation along with 125 per cent general recommended dose of fertilizer (125:62.5:62.5 kg N, P_2O_5 and K_2O ha^{-1} + 10 t FYM ha^{-1}), coupled with nitrogen fertigation upto 60 days recorded significantly maximum growth and yield attributes and seed cotton yield (43.22 q ha^{-1}) as compared to lower level of fertilizer dose and surface irrigation. The high plant density of 18,518 plants ha^{-1} (180 x 30 cm) recorded significantly higher seed cotton yield than low plant densities (11, 111 and 12, 345 plants ha^{-1}). Significantly higher uptake of nitrogen, phosphorus and potassium by Bt. cotton was registered with application of 125 per cent general recommended dose of fertilizer. The maximum water use efficiency was observed in drip irrigation method than surface irrigation method.

Key words : Bt. cotton, plant density, fertigation, nutrient uptake, water use efficiency.

Cotton (*Gossypium hirsutum* L.) is an important fibre crop in India. The productivity of cotton is low in India, therefore, efforts has to be made to increase the productivity of cotton by adapting improved technology alongwith improved varieties. The Bt. cotton is introduced in the country and it is widely adapted by the farming community due to its higher yield level, minimum plant protection cost and higher net returns. However, the information on Bt. cotton related to nutrient management and plant density under drip irrigation is very meager. Looking to the success of Bt. cotton and its productivity, the present investigation was undertaken to assess the nutrient requirement, optimum plant density and water requirement of Bt. cotton.

Materials and Methods

The field experiment was conducted at All India Co-ordinated Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during the summer season of 2009. The soil of the experimental field was clayey in texture, slightly alkaline in reaction (pH 7.86), low in available nitrogen (225.24 kg ha^{-1}), medium in available phosphorus (17.58 kg ha^{-1}) and high in available potassium (482.80 kg ha^{-1}). The values of bulk density, field capacity and permanent wilting point were 1.25 g cm^{-3}, 35.49 per cent and 17.53 per cent, respectively. The experiment was laid out in split plot design and replicated three times. The treatments consisted of two irrigation methods *viz*., drip irrigation (T_1) and surface irrigation method (T_2) and three plant densities *viz*., S_1 : 12,345 (90 x 90 cm), S_2 : 11,111 (150 x 60 cm) and S_3 : 18,518 (180 x 30 cm) plants ha^{-1} as main plot treatments and three fertilizer levels *viz*., F_1 : 75 per cent GRDF, F_2 : 100 per cent GRDF and F_3 : 125 per cent GRDF as subplot treatments. The general recommended dose of fertilizer was 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} + 10 t FYM ha^{-1}. In drip irrigation treatment, the recommended dose of phosphorus and potassium was applied at sowing as a basal dose and only nitrogen was applied by fertigation at every alternate day

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commencing from 7 days after sowing upto 60 DAS in different splits (from 7 DAS to 30 DAS - 12 splits and from 31 DAS to 60 DAS - 15 splits). In surface irrigation method, 20 per cent recommended dose of nitrogen and 100 per cent recommended dose of phosphorus and potassium was applied at sowing as a basal dose and 40 per cent nitrogen at square formation and 40 per cent at flowering stage by ring method. The irrigation was applied at 75 mm CPE with 7.5 cm depth at each irrigation turn in surface irrigation method, while in drip irrigation method irrigation was applied at every alternate day on the basis of cumulative pan evaporation (CPE) and crop coefficient (kc).

Results and Discussion

Irrigation methods : Scheduling of irrigation through drip method exhibited significantly higher values of growth and yield attributes and seed cotton yield (39.19 q ha^{-1}) than surface irrigation method (Table 1). This might be due to irrigation water was applied as per the need of the crop and the soil remains always at field capacity in drip irrigation method, resulting in maximum utilization of soil moisture and nutrients by plant. This favours for increasing growth and yield attributes of plant. Similar findings were reported by Hodgson *et al.* (1990) and Kashid (2002).

The uptake of nitrogen, phosphorus and potassium by Bt. cotton was significantly higher in drip irrigation than surface irrigation method. This is due to split application of nitrogen trough drip increasing the use efficiency of added nutrient as reported by Singh *et al*., (2007). After harvest of crop the nutrient status in respect of nitrogen, phosphorus and potassium was significantly more in surface irrigation than drip irrigation method. Comparatively higher water use efficiency was recorded in drip irrigation method than surface irrigation method. This might be due to maximum yield obtained with minimum quantity of water under drip irrigation method as reported by Cetin and Bilgel (2002), Halemani *et al*. (2003).

Table 1. Seed cotton and stalk yield of Bt. cotton as influenced by different treatments.

Treatments	Seed cotton yield (q ha^{-1})	Stalk yield (q ha^{-1})
A. Irrigation methods :		
T_1 : Drip	39.19	54.50
T_2 : Surface	30.50	49.72
SE(m)±	0.82	0.61
C.D. at 5%	2.60	1.92
B. Plant densities :		
S_1 : 12,345 plants ha^{-1} (90 cm x 90 cm)	34.23	45.12
S_2 : 11,111 plants ha^{-1} (150 cm x 60 cm)	33.03	41.24
S_3 : 18,518 plants ha^{-1} (180 cm x 30 cm)	37.27	69.98
SE(m)±	1.01	0.75
C.D. at 5%	3.18	2.35
C. Fertilizer levels :		
F_1 : 75 % GRDF	30.02	51.06
F_2 : 100% GRDF	34.66	52.26
F_3 : 125% GRDF	39.85	53.02
SE(m)±	0.77	0.35
C.D. at 5 %	2.57	1.16
Interactions :		
A x B	N.S.	N.S.
B x C	N.S.	N.S.
A x C	N.S.	N.S.
A x B x C	N.S.	N.S.
Mean	34.84	52.11

Plant densities : Growth and yield attributes were influenced significantly due to different plant densities. The cotton sown at higher plant density of 18,518 plants ha^{-1} (180 x 30 cm) registered significantly higher plant height (125.92 cm) than lower plant densities of 12,345 plants ha^{-1} (90 am x 90 cm) and

Table 2. Interaction effect between irrigation method and fertilizer levels on seed cotton yield (q ha^{-1}).

Fertilizer levels Irrigation methods	Seed cotton yield (q ha^{-1})			
	75% GDRF	100% GDRF	125% GDRF	Mean
Drip irrigation	36.40	37.95	43.22	39.19
Surface irrigation	23.64	31.37	36.49	30.50
Mean	30.02	34.66	39.85	34.84
Source	S.E.(m)±		C.D. at 5 %	
Between levels of 'A' at the same level of 'C'	1.21		3.62	
Between levels of 'C' at the same level of 'A'	1.09		3.19	

11,111 plants ha^{-1} (150 x 60 cm). This might be due to more competition for interception of light in higher plant density resulted in increasing the plant height as compared to lower plant densities. There was a genera] trend of increasing monopodial and sympodial branches per plant with decreasing plant densities. This might be due to very close intra row spacing leading to a limited space for monopodial and sympodial growth. These results are in confirmity with those reported by Narayana *et al*. (2008) and Pendharkar *et al*. (2010).

The plant density of 12,345 plants ha^{-1} (90 x 90 cm) recorded significantly higher seed cotton weight per boll (4.53 g) as compared to plant densities of 11,111 and 18.518 plants ha^{-1}, however, the plant density of 18,518

Table 3. Nutrient uptake and soil available nutrients after harvest of Bt. cotton as influenced by different treatments.

Treatments	Nutrient uptake (kg ha^{-1})			Soil available nutrients (kg ha^{-1})		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
A. Irrigation methods :						
T_1 : Drip	199.35	28.34	97.26	189.78	16.71	481.56
T_2 : Surface	185.54	26.38	84.34	201.97	17.79	498.65
SE(m)±	4.29	0.59	1.70	1.13	0.25	0.40
C.D. at 5%	13.50	1.86	5.36	3.55	0.78	1.27
B. Plant densities :						
S_1 : 12,345 plants ha^{-1} (90 x 90 cm)	168.46	24.39	79.57	197.37	17.31	490.31
S_2 : 11,111 plants ha^{-1} (150 x 60 cm)	157.52	22.14	71.77	195.99	17.50	490.06
S_3 : 18,518 plants ha^{-1} (180 x 30 cm)	251.37	35.54	121.06	194.25	16.94	489.94
SE(m)±	5.25	0.72	2.08	1.38	0.30	0.49
C.D. at 5%	16.54	2.28	6.56	N.S.	N.S.	N.S.
C. Fertilizer levels :						
F_1 : 75 % GRDF	158.22	25.99	84.39	190.94	15.93	487.20
F_2 : 100% GRDF	200.20	27.22	91.56	197.55	17.25	490.00
F_3 : 125% GRDF	218.92	28.86	96.45	199.13	18.56	493.11
SE(m)±	6.47	0.60	1.58	1.22	1.16	0.39
C.D. at 5 %	21.59	1.99	5.27	4.06	3.87	1.31
Interactions :						
A x B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
B x C	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
A x C	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
A x B x C	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
General Mean	192.45	27.36	90.80	195.87	17.25	490.10

plants ha^{-1} recorded significantly higher seed cotton yield (37.27 q ha^{-1}) and stalk yield (69.98 q ha^{-1}) than 11,111 plants ha^{-1} and 12,345 plants ha^{-1}. Though, the yield attributes per plant in higher plant density were less as compared to lower plant densities, but the higher number of plants per unit area suppressed the higher yield of lower plant densities. These results are in accordance with those reported by Ramana *et al.* (2000) and Buttar and Singh (2006).

Maximum uptake of nitrogen (199.35 kg ha^{-1}), phosphorus (28.34 kg ha^{-1}) and potassium (97.26 kg ha^{-1}) by Bt. cotton was observed in higher plant density than lower plant density. These results are in conformity with Ghadage (2003) and Sisodia and Khamparia (2007). The soil available nutrient status after harvest of Bt. cotton was not influenced significantly due to different plant densities because the Bt. cotton is heavy nutrient feeding crop, therefore, all applied nutrients were removed from the soil by the plants.

The water use efficiency was increased from lower plant densities to higher plant densities in both irrigation methods. Similar findings were reported by Tekale *et al*. (1999) and Aujla *et al*. (2005).

Fertilizer levels : Application of 125 per cent general recommended dose of fertilizer registered significantly higher plant height (128.52 cm) and number of sympodial branches per plant (30.61) than 75 and 100 per cent general recommended dose of fertilizer. The higher dose of fertilizer meet the nutritional requirement of the crop as reported by Brar *et al*. (1992) and Maitra *et al*. (2000).

The seed cotton yield (39.85 q ha^{-1}) and stalk yield (53.02 q ha^{-1}) was significantly maximum at 125 per cent recommended dose of fertilizer (Table 2) and it was significantly superior over 75 and 100 per cent recommended dose of fertilizer. This might be due to overall improvement in growth and yield contributing characters with increasing levels of fertilizers was reflected in higher seed cotton yield as Bt. cotton is a fertilizer responsive crop.

Table 4. Soil moisture studies as influenced by different treatments.

Treatments	Water depletion (mm)		Water applied (mm)		Effective rainfall (mm)		Consumptive use (mm)		Yield (kg ha^{-1})		WUE (kg ha^{-1} mm^{-1})	
	Drip	Surface	Drip	Surface	Drip	Surface	Drip	Surface	Drip	Surface	Drip	Surface
Plant densities :												
S_1 : 12345 plants ha^{-1} (90 x 90 cm)	260.20	447.62	260.20	450.00	53.4	111.5	313.6	559.12	3844.7	3001.3	12.25	5.36
S_2 : 11111 plants ha^{-1} (150 x 60 cm)	260.20	423.31	260.20	450.00	53.4	111.5	313.6	534.71	3792.6	2813.9	12.09	5.26
S_3 : 18518 plants ha^{-1} (180 x 30 cm)	260.20	468.37	260.20	450.00	53.4	111.5	313.6	579.87	4118.9	3335.2	13.13	5.75
Fertilizer level :												
F_1 : 75 % GRDF	260.20	446.40	260.20	450.00	53.4	111.5	313.6	557.90	3639.6	2363.9	11.60	4.24
F_2 : 100% GRDF	260.20	446.40	260.20	450.00	53.4	111.5	313.6	557.90	3795.0	3137.3	12.10	5.62
F_3 : 125% GRDF	260.20	446.40	260.20	450.00	53.4	111.5	313.6	557.90	4321.6	3649.2	13.78	6.54

The maximum uptake of nitrogen (218.92 kg ha^{-1}), phosphorus (28.86 kg ha^{-1}) and potassium (96.45 kg ha^{-1}) by Bt. cotton was recorded with 125 per cent recommended dose of fertilizer (Table 3) and which was significantly higher than 75 and 100 per cent general recommended dose of fertilizer. Similar results were reported by Biradar *et al*. (2010). Significantly more nitrogen, phosphorus and potassium was remained in soil after harvest of crop where higher level of fertilizer was applied which was also reported by Ravankar and Deshmukh (1994).

Water use efficiency was found to be increased with increasing fertilizer levels (Table 4) in both drip and surface irrigation methods. The increasing water use efficiency may be due to increasing yields with increasing levels of fertilizers with the same quantity of moisture.

References

Aujala, M. S., Thind, H. S. and Buttar, G. S. 2005. Cotton yield and water use efficiency at various levels of water and N through drip irrigation under two methods of planting. Agril. Water Managt. 71: 167-169.

Biradar, V., Rao, S. and Hosamani, V. 2010. Nutrient uptake in late sown Bt. cotton (*Gossypium hirsutum* L.) as influenced by plant spacings, fertilizer levels and NAA application under irrigation. Int. J. Agric. Sci. 6(1): 357-358.

Brar, A. S., Singh, R., Tiwana, V. S. and Singh, T. H. 1992. Response of cotton cultivars to nitrogen application at two population level. J. Indian Soc. Cotton Improv. 17(2): 119-125.

Buttar, G. S. and Singh, P. 2006. Performance of Bt. cotton hybrids at different plant populations in south western region of Punjab. J. Cotton Res. Dev. 20(1): 97-98.

Cetin, O. and Bilgel, L. 2002. Effects of different irrigation methods on shedding and yield of cotton. Agric. Water Managt. 54: 1-15.

Ghadage, H. L. 2003. Effect of planting patterns, irrigation techniques and mulching on growth, yield and quality of irrigated cotton (cv. NHH-44). Ph.D. thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.), India.

Halemani, H. L., Hallikeri, S. S., Hooger, C. I. and Khadi, B. M. 2003. Response of hybrid cotton to drip irrigation. J. Indian Soc. Cotton Improv., December. pp. 173-178.

Hodgson, A. S., Constable, G. A., Duddy, G. R. and Daniells, I. G. 1990. A comparison of drip and furrow irrigated cotton on a cracking clay soil. Irri. Sci. 11: 145-148.

Kashid, N. V. 2002. Response of cotton to irrigation methods, fertilizer levels and green manuring. Ph.D. thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.), India.

Maitra, S., Mondal, A. K., Roy, D. K., Ray, A. and Samui, S. K. 2000. Effect of spacing and fertility levels on upland cotton (*Gossypium hirsutum*) in Sundarbans. Indian J. Agric. Sci. 70(5): 323-24.

Narayana, E., Hema, K., Srinivasulu, K., Prasad, N. V. V. S. D. and Rao, N. H. P. 2008. Performance of Bt. cotton hybrid (NCS-145 Bt.) to varied spacing and fertilizer levels in vertisol under rainfed conditions. J. Indian Soc. Cotton Improv. April. pp. 33-36.

Pendharkar, A. B., Solunke, S. S., Lambade, B. M., Nawale, S. S. and Dalvi, N. D. 2010. Response of Bt. cotton hybrids to different plant spacings under rainfed condition. J. Cotton Res. Dev. 24(2): 216-218.

Ramana, M. V., Narayanamma, M. and Bapireddy, T. 2000. Influence of plant population and nitrogen levels on rainfed cotton. J. Res. ANGRAU. 28(4): 16-18.

Ravankar, H. N. and Deshmukh, V. A. 1994. Study on nutrient uptake pattern in H-4 cotton under different agronomic management. PKV Res. J. 18(1): 60-62.

Singh, M., Cumber, R. K., Brar, A. S. and Singh, M. 2007. Efficacy of fertilizer application in cotton under drip and flood irrigation system. Proc. World Cotton Res. Conf. held at Civil Centre in Lubbock, Texas, USA during September 10-14, pp. 1-8.

Sisodia, R. I. and Khamparia, S. K. 2007. American cotton varieties as influenced by plant densities and fertility levels under rainfed conditions. J. Cotton Res. Dev. 21(1): 35-40.

Tekale, D. D., Patil, R. K., More, M. R., Nadre, R. G. and Vaishnav, V. G. 1999. Yield response of cotton cv. NHH-44 to varying depths of irrigation through drip under differential planting geometry. J. Soils and Crops. 9(2): 174-177.

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Water Productivity and Economic Feasibility of Integrated Farming System under Irrigated Conditions

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Abstract

The cropping system used was highly remunerative and fexible for utilizing the variable resources. The crop production component of IFS gave maximum gross monitory returns (Rs. 167911/-), net monitory returns (Rs. 65319/-) and B:C ratio of 1.73, followed by dairy farming (Rs. 109444/-, Rs. 28821/- and 1.31). The fishery component recorded maximum B:C ratio of 1.90. Amongst the different components crop production utilizes maximum water (1182 m^{-3}) while poultry component utilizes very less quantity of water (17 m^{-3}). The water productivity of IFS reached to Rs.6.25 m^{-3} of water used. The integrated farming system gives year round employment to the farm families which turn out to 713 man days per year. IFS proved farming business suslainable through increased crop production, profitability, employment generation through efficient use of organic material and available water.

Key words : Integrated farming system, water resources, crop production, horticulture, fisheries, dairy farming, energy recycling.

Water is a prime natural resource of all living things. Sustainable management of water resources like rain, ground water and water stored in dams both in quality and quantity of its availability its management requires an integrated approach. It is imperative that conservation, recycle, reuse and efficient use of water both for sustainability as well as water productivity.

Integrated farming system approach gives better opportunity for efficient utilization and reutilization of available water, which reflects into higher productivity per unit of available water, results into improving the economic status as well as productivity and quality of production for better sustainability (Rangasami et al. 1996). Thus main objectives of the study were to generate the integrated farming system model for efficient use of available water resources, water budgeting of ground and surface water with maximum productivity of integrated farming system and to assess the impact of integrated farming system model on employment generation, recycling of energy and get regular income.

Materials and Methods

Integrated farming system model consisted five different components as given in Table 1 at water management project (WMP), M.P.K.V., Rahuri during 2007-2009.

The region comes under semiarid tropical zone with an average rainfall of 520 mm. Most of the rainfall receives from South-West monsoon during the months from June to September. The rainfall is erratic and unevenly distributed in 15 to 45 rainy days. Agro-climatically, the area comes under the drought prone area of Maharashtra. The maximum and minimum weekly temperature during the study period ranged from 26.1 to 40.8 and 7.8 to 23.9°C, respectively. Mean weekly morning

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Table 1. Component wise area and its per cent allocation in IFS.

Component	Area (ha) alloted	% of area alloted
Crop production	1.50	75.00
Horticulture	0.40	20.00
Dairy farming Poultry farming	0.05	2.50
Fishery	0.05	2.50
Total	2.00	100.00

Table 2. Physico chemical properties of soil.

Properties	Composition
Physical properties :	
Particle size analysis :	
Coarse sand	26.0(%)
Silt	34.9 (%)
Clay	38.4 (%)
Texture class	Clay loam
Field capacity	30.18 (%)
Permanent wilting point	19.16 (%)
Available soil moisture	11.02 (%)
Bulk density	1.10 (g cm^{-3})
Chemical properties :	
Soil pH	7.9
EC	0.29 (dSm^{-1})

relative humidity ranged from 44 to 90 per cent and evening humidity ranged from 13 to 74 per cent, respectively. The mean pan evaporation was 4.39 mm with maximum pan evaporation of 12.4 mm in month of May.

The physico chemical properties of soil were determine by adopting standard methods. The details of the physico-chemical properties of the experimental plot are given in Table 2. The soil of experimental field was clay loam, 150 cm deep with moderate moisture retension capacity.

The crop production component consisted of cash crops, grain crops, pulses, oilseeds and fodder crops for fulfilling the needs and generate employment as well as economic upliftment of farm family so as to rise the quality of life of rural poor. The cropping system consist of sugarcane (*Saccharum officinarum*), wheat, soybean (*Glysine max*). pigeon pea (*Cajanus cajan*) - banana (*Musa paradicica*). The vegetable component of crop production consists of okra (*Ambelmoscus esculantus*), chilli (*Capsicum annum*), Onion (*Allium cepa*), sweet corn etc. While the fodder component consists of lucerne (*Medicago sativa*), hybrid napier and maize (*Zea mays*).

The horticulture component consisted of pomegranate orchard as a cash crop. Pomegranate Var. *Bhugwa* was planted on an

Table 3. Component details of integrated farming system.

Component	Area (ha)	Details
Crop production	1.50	Cash crops :- Sugarcane (Co-86032). Banana (Grand naine) Grain crops:- Sorghum (M 35-1), Wheat (HD-2189), Soybean (JS-335), Pigeon Pea (ICPL -87) Vegetable crops :- Brinjal (Krishna Hybrid), Okra (Phule utkarsha). Pea (Arkel), Chilli (Pluile Jyoti), carrot (New kuroda Hy.) Fodder crops :- Lucerne (RL-88), Maize (African tall), Hybrid Napier (Jaiwant)
Horticulture	0.40	Pomegranate (Bhagwa)
Dairy farimg	0.05*	2 Phule Triveni Cows
Poultry farming	0.05*	200 Poultry bird/batch (Rhode Island Red)
Fisheries	0.05	250 fingerlings (Katla ,Rohu, Mrugal)
Total	2.00	

*Area under cow byre, poultry shed and farmstead. (Dairy farming and poultry farming both on 0.05 ha area)

Table 4. Crop yields obtained during the year 2007-08.

Crop	Area (ha)	Yield (q) main produce
Grain crops :		
Soybean (JS-335)	0.20	5.0
Pigeon pea (ICPL-87)	0.20	3.0
Maize (African Tall)	0.30	5.0
Wheat (HD-2189)	0.40	12
Vegetable crops :		
Okra (Phule Utkarsha)	0.10	3.05
C'arrot (New Kuroda Hybrid)	0.05	6.09
Chilli (Phule Jyoti)+	0.15	Chilli seed : 0.16
		Green chili : 0.016
Marigold (Double orange) -		Chilli powder : 0.36
		Flower : 1.82
Rajmabean (Varun)		Rajma seed : 0.50
Fodder crops :		
Lucerne (RL-88)	0.10	Seed 0.36 kg
Lucerne (RL-88)	0.10	154.40
Hybrid Napier grass (Phule Jaiwant)	0.05	56.05
Maize (African Tall)	0.05	31.00

area of 0.40 ha at a distance of 4.5 x 3 m^2 under drip irrigation system. The dairy component consisted of two cross bred cow (Phule Triveni a triple cross breed of MPKV, Rahuri). The feed and fodder requirement was partially fulfilled from crop production component while concentrate feed was purchased from local market to improve milk productivity. In poultry component 200 birds were reared for chicken purpose on commercial basis. The fishery component with polyculture farming of species Katla, Rohu and Mrugal in ponded water. The pond served as protective irrigation to crops and for fish farming. This component of integrated farming system was on an area of 0.05 ha. The integrated culture of Rohu, Katla and Mrugal was reared in the pond.

The crops selected in crop production component were highly remunerative and fullfill the needs of farm family. Most of the crops selected in crop production component were irrigated with the help of pressurized irrigation system i.e. drip and sprinkler depending upon the nature of crop.

Irrigation were scheduled at alternate day for the crops irrigated by drip irrigation and in case of sprinkler cumulative pan evaporation reaches to 25 mm. The irrigation water requirement of crops taken under drip and sprinkler were calculated with the help of following formula.

Net irrigation requirement (NIR)=CPE x Kp x Kc x Wa x Es x Ls.... For drip

Gross irrigation requirement (GIR) = NIR/Uc

Time of operation (Ti) = GIR/discharge x efficiency

Table 5. Crop yields obtained during the year 2008-09.

Crop	Area (ha)	Yield (q) main produce
Cash crops :		
Sugarcane (Co-86032) +	0.30	29.78 (t)
chickpea (Virat)		3.00
Banana (Grand naine)	0.40	30.35 (t)
Grain crops :		
Pigeon pea (ICPL-87)	0.35	8.00
Sorghum (SPV-829	0.20	4.50
Maize (sweet corn Sagar-75)	0.10	(cobs) 2348
Vegetable crops :		
Onion (Phule Samartha)	0.10	15.00
Bund and border of crops :		
Drum stick (Co-I)	On bund	0.32
Papaya (Cinta Hy. Fl)	and	2.23
Fenugreek (Local)	border of crops	3.71
Fodder crops :		
Lucerne (RL-88)	0.10	173.70
Hybrid Napier grass (Phule Jaiwant)	0.05	66.00
Horticultural crop :		
Pomegranate (Bhagava)	0.40	16.19

Where, CPE = cumulative pan evaporation (mm), Kp = pan factor (0.7), Kc = crop factor according to growth stage, Wa = wetted area, Es = emitter spacing, m, Ls = lateral spacing, m, Uc = uniformity coefficient, Ppt = average rate of precipitation, Q = average emitter discharge (lph). The economics of individual crops and component was calculated by following standard procedure for calculating cost and economics.

The amortization cost of pomegranate orchard was calculated with the help of following formula

$$A = P.\ r.(1+r)n/(l+r)^{n-1}$$

Where, A = Amortization cost, P = Annualized establishment cost, r = rate of interest, n = expected economic life of the orchard (years). In case of water productivity (Rs. ha^{-1} cm) was calculated by using followinig formula Wp = Net returns (Rs.)/Quantity of water utilized (m^2).

The total employment generated in conducted model was calculated with help of actual labour requirement (man days) of the each component.

Unless the IFS is compared with the conventional cropping system (CCS) one cannot have an idea how the IFS has come over with superiority in aspects *viz*., gross income, employment, generation and water use. Therefore sugarcane and soybean- wheat these two farmers practices were compared with Integrated farming system model.

Results and Discussion

Water productivity : The crop production component utilized maximum water to the extent of 18.20 ha cm. per year (Table 3). The productivity of crop production component was turned out to Rs. 337.88 ha^{-1} cm. by utilizing all the possible means efficient water

Table 6. Yield of dairy farming during the year 2005-06 to 2008-09.

Item	Quantity	
	2007-08	**2008-09**
Milk (lit.)	5776.00	6635.5
Manure (t)	13.50	49.16
Feed gunny bags	55.00	45
Calf	1	2
Heifer	1	1
Poultry farming :		
Chicken (kg)	880.10	1012.60
Manure (kg)	1000	1150
Empty Feed bag	34	37
Fishery :		
Fish (kg)	81.00	101.10
Prawns (kg)	25kg	-

Table 7. Economics of various components in integrated farming system (mean of two years.)

Year	Gross income (Rs.)	Cost of production (Rs.)	Net income (Rs.)	B:C ratio
Crop production	167911	112854	55057	1.73
Horticulture	32380	39108	7815	0.66
Dairy farming	109444	80623	28821	1.35
Poultry farming	49701	43348	6353	1.14
Fisheries	21375	12187	9189	1.90
Total	380810	288118	107236	1.29
Average ha^{-1}	190405	144059	53618	1.29

Table 8. Water productivity of various components through integrated farming system (mean of two year).

Component	Quantity of water used (ha cm)	Net income (Rs.)	Water productivity (Rs. ha^{-1} cm)
Crop production	118.20	39938	337.88
Horticulture	12.61	7815	619.74
Dairy farming	25.36	43940	1732.65
Poultry farming	0.17	6353	37370.59
Fisheries	14.42	9189	637.24
Total	171.39	107236	625.68

*0.20 ha area was considered for estimation of water productivity of dairy farming.

Table 9. Employment generation through integrated farming system.

Component	Hired human labour (man days)	Family labour (man days)	Total (man days)
Crop production	372	126	498
Horticulture	181	32.5	214
Dairy farming*		319.5	319.5
Poultry farming		69	69
Fisheries		62.5	62.5
Overall supervision of farm		103	103
Total	553	712.5	1265.75

utilization *viz*., drip irrigation, sprinkler irrigation, land configuration, ridges and furrow irrigation. The dairy exnterprise utilized 25.26 ha.cm. It was mainly utilized for consumption and growing green fodder. The water productivity of dairy enterprise gives rise to 1732.65 ha^{-1} cm, the poultry enterprise utilises very small quantity (0.17 ha cm) of water which gives rise to Rs. 37370.59 ha^{-1} cm of water productivity which was highest amongest the other components. Fishery component utilizes 14.42 ha cm of water gives ris to water productivity of Rs. 637.24 ha^{-1} cm of water used.Overall the whole system utilizes 171.39 ha cm of water per year, with average water productivity of Rs. 625.68 ha^{-1} cm of water used.

Employment generation : Integrated farming system gives good opportunity for employment generation to the tune of 1265.75 man days per year. The crop production component shows good opportunity for the farm family (126) as well as hired human labour (572 man days) comprise of 498 man days per year. It is followed by dairy component (319.5 man days) which was good opportunity for the farm family (100%). Though horticulture component was its initial stage of establishment stage but generated employment for both family (32.5) as well as hired labours (181 man days) which required skilled works to perform special practices like training, pruning and provided year round employment (Table 4). Poultry and fishery gave employment and monetary income to farm family.

Overall the IFS with these five enterprises gives year round employment to the farm family and help to reduce the cost of production of the enterprises run on the farm by involvement of the family labour with increased productivity. Kalyan Singh *et al.* (2007), Singh *et al*. (2004) also discussed the benefits of IFS.

Integrated farming system model : Basis on the findings of the IFS model laid on 2.00 ha area at WMP MPKV., Rahuri. The proper allocation of the area, choice of enterprise, proper area, choise of enterprise,

Table 10. Economics, water productivity and employment generation of integrated farming system (IFS) and conventional cropping system (CCS).

Particulars	Gross income (Rs.)	Cost of production (Rs.)	Net income (Rs.)	B:C ratio	Water utilized (ha-cm)	Net income (Rs.)	Water productivity (Rs. ha^{-1}-cm)	Hired labout (man days)	Family labour (man days)	Total (man days)
IFS	520983.00	376167.50	144815.5	1.38	188.86	144815.5	766.78	539.5	730	1289.5
CCS										
1) Sugarcane	191336.00	130632.00	60704.00	1.46	250	60734	134.96	408	210	618
2) Soybean-Wheat	81754.00	83310.00	-1556.00	0.98	160	-1556		154	156	310
CCS-Total	273090.00	213942.00	59148.00	1.27	410	59178	134.96	562	366	928

poor utilization of natural resources available with the farmer gave the profitable way of farming. Further it suggested that IFS provided an opportunity to increase the economics per area and time by identification of cropping and integration of allied enterprises. It also offers enough scope to increase the profitability, employment generation, nutrient recycling within the system to improve the ivelihood of the farmer and sustainability of ecosystem. The interdependence of the one component on another reduces the cost of production such as fodder from crop to dairy component. The manurial need of crop horticulture and fishery component was fulfilled from dairy and poultry component as own source.

Economics : During the period of investigation the cost incurred on running different components of IFS was Rs.144059/- ha^{-1} $year^{-1}$. Total gross return received Rs. 190405/- ha^{-1} $year^{-1}$ with net returns Rs. 53618/- and B:C ratio turned out to 1.29 indicating stable income over the period of investigation (Table 7). The share of crop production to the total income was higher Rs. 167911/- (44.09%) followed by dairy component Rs. 109444 (28.72%). The share of crop and dairy component was higher in total net returns Rs. 55057/- and Rs.28821/- respectively. It might he due to the inter dependency of these components, such as fodder need for dairy component and manure needs for crop production. This minimizes the cost of production of these two interdependent enterprises. The share of horticulture component was low it mainly because of the crop was in establishment stage. While in case of poultry it is because of the fluctuating prices of chicken during the year and the fear of disease like 'bird flu'. However, the share of fishery was minimum but the B:C ratio 1.90 was recorded highest Kalyan Singh *et al*. (2007) also noticed IFS is ideal model for year round income and self employment.

Comparison of IFS and conventional cropping system (CCS) : The net income from IFS for the year 2008-09 though seems to be little higher (i.e. Rs. 144815/-) over the CCS. The IFS gave Rs.766.78 ha^{-1} cm of water used where as CCS given only Rs. 134.96 ha^{-1} cm of water with considerable amount of water saving over an area of 2.00 ha. In case of employment generation, it was clear that the total employment generation in IFS was too higher (i.e. 1289.5 man days) than the CCS wherein the employment generated was 928. man days only.

Integrated farming system gave opportunity to the production, profitability employment generation, recycling of organic material, efficient utilization of water resources. Shrivastava *et al*. (2204) also reported the efficient water utilization through IFS.

References

Kalyan Singh, Bothra, J. S., Singh, T. K., Singh, J. P., Yogeshwar Singh and Singh, C. S. 2007. Productivity and economics of integrated farming system in irrigated agro ecosystem of eastern. Uttar Pradesh. Indian J. Agron 52(1): 11-12.

Rangasami, A., Venkitaswami, R., Purushothaman, S. and Palaniappan, S. P. 1996. Rice, Poultry, Fist, Mushroom integrated farming system for low land of Tamilnadu. Indian J. Agron. 41(3): 344-348.

Shrivastava, R. C., Singhandhupse, R. B., and Mohanty, R. K. 2004. Integrated farming approach for runoff recycling systems in humid plateau areas of eastern India. Agricultural Water Management 64: 197-212.

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Evaluation of Chickpea Genotypes for Drought Tolerance

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Abstract

The genotypes, PG 95333 and PG 03110-1 were found to be promising under stress as well as non-stress condition for yield and yield contributing characters. In addition to this, the genotypes, JG 315 under non-stress and Vijay under stress were also promising for yield and yield contributing characters. The genotypes Vijay, Vishal and PG 03110-1 had low reduction for yield and yield contributing characters due to moisture stress. The genotypes PG-95333, Vijay, JG 315 exhibited higher drought tolerance efficiency (DTE), proline content, chlorophyll content, minimum drought susceptibility index (DSI) and low magnitude of membrane injury index indicating their drought tolerance behaviour. Therefore, these genotypes can be used as sources of drought tolerance in further breeding programme for evolving the drought tolerant genotypes in chickpea.

Key words : Drought tolerance, chickpea, morpho-physiological traits, DTE, DSI, yield and yield contributing characters.

Chickpea forms an important component of cropping system under varying soils and climatic conditions. It is not only a rich source of protein, minerals and vitamins in human diet but also enriches soil fertility through symbiotic nitrogen fixation. Its grain protein content ranges between 22-23 per cent. The major constraints for low productivity are abiotic stresses like water, temperature, nutrients and salts. Among them water stress and temperature stress are the most important abiotic stresses for growth and productivity. In chickpea, biotic and abiotic stresses collectively cause up to 50 per cent yield losses (Dua *et al*., 2003). Moisture stress is one of the most prevalent in environmental stress factor limiting plant growth, survival and productivity (Bohnart and Jensen, 1995). Water sress causes deletrious physiological effects like membrane damage (Deshmukh *et al*., 2000), concomitant organelles disarray impairment of stomatal function (Willmer and Pantoza, 1992), reduction in root growth (Blum and Johnson, 1992) and yield (Lutfor and Meshab-Uddin, 2000).

Materials and Methods

Fifteen chickpea genotypes were evaluated under moisture stress and irrigated conditions at MPKV, Rahuri during *rabi* 2008-09 in RBD with two replications. One irrigation was given to moisture stress condition for good germination and additional two irrigations were given to irrigated plot at pre-flowering and 50 per cent pod formation stage. The gross and net plot sizes were 2.00 x 2.40 m^2 and 1.80 x 2.10 m^2, respectively. The spacing was 30 x 10 cm. Soil moisture status was monitored 20 days interval starting from sowing at 0-15 cm and 15-30 cm depth. The observations on Relative Leaf Water Content (RLWC) membrane injury index (Blum and Ebercon, 1981), chlorophyll content (Dhopte and Phadanwis, 1989), chlorophyll stability index

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Table 1. The soil moisture content (%) under water stress and irrigated conditions during crop growth period.

Soil depth (cm)	0-15		15-30	
Days after sowing	I_1	I_0	I_1	I_0
At sowing	32.0	30.8	33.4	31.7
40	33.6	26.5	34.3	30.4
60	29.0	21.9	29.2	25.0
80	28.8	20.0	30.4	21.8

(Dhopte, 2002) and proline content (Bates *et al.*, 1973) was recorded at 50 per cent flowering and 50 per cent pod formation stages. Yield and yield contributing characters were recorded and the influence of moisture stress worked out by assessing per cent reduction, drought tolerance efficiency (DTE) and drought susceptibility index (DSI).

Results and Discussion

The moisture levels were equal at the time of sowing however, it was depleted by around 4 per cent between 0-15 and 15-30 cm depth at 40 DAS. Soil moisture content reduced with the advancing age of crop under moisture stress condition. At 60 DAS, moisture percentage was reduced by 7.1 and 3.9 per cent to the depth of 0-15 and 15-30 cm, respectively. At 80 DAS, it depleted by 8.8 and 8.6 per cent to the depth of 0-15 and 15-30 cm (Table 1).

The perusal of data presented in Table 1 revealed that, the genotype Vijay was earlier for initiation of flowering under irrigated (34.50 days) and moisture stress condition (33.50 days) followed by Phule G 95333 (43.00 and 42.00 days) and Phule G 0110 (43.50 and 42.50 days). Therefore, these genotypes

Table 2. Initiation of flowering and drought parameters as influenced by chickpea genotypes under irrigated and moisture stress condition.

Genotype	Initiation of flowering		RLWC % (at flowering)		MII (at flowering)		Proline content	
	I_1	I_0	I_1	I_0	I_1	I_0	I_1	I_0
Phule G-9758	50.50	49.50	57.90	46.75	0.378	0.445	0.992	7.951
Phule G-00110	43.50	42.50	39.73	40.13	0.258	0.461	1.002	8.001
Phule G-03110-1	45.50	44.50	60.44	65.47	0.408	0.466	0.772	7.644
JG-11	48.00	46.00	56.72	54.04	0.295	0.394	0.707	8.047
PG-95333	42.00	43.00	41.52	40.15	0.224	0.466	0.913	9.074
PG-03203	44.00	45.00	59.60	54.00	0.326	0.462	1.008	7.647
Vijay	34.50	33.50	55.65	53.04	0.179	0.383	0.714	8.914
Vishal	40.50	39.50	60.32	59.03	0.179	0.342	0.990	7.678
Virat	51.00	50.00	64.08	63.05	0.145	0.259	0.821	6.910
Digvijay	50.00	49.00	52.25	55.05	0.220	0.326	0.760	7.063
PG-5 (Ch.)	51.50	50.00	65.80	60.12	0.206	0.268	0.938	6.760
Phule G-6102	46.50	47.50	62.84	60.09	0.331	0.483	0.771	8.587
JG-315	47.00	46.00	52.37	57.45	0.209	0.304	1.423	8.080
Pusa-256	49.50	48.50	60.30	58,90	0.178	0.270	0.834	8.084
Saki-9516	48.00	49.50	50.61	52.03	0.202	0.246	0.866	6.816
Mean	46.10	44.13	56.68	55.01	0.255	0.373	0.901	7.810
S.E.±	0.297	1.198	0.188	0.069	0.004	0.004	0.004	0.028
CD at 5 %	0.900	3.635	0.571	0.209	0.012	0.011	0.013	0.085

I_1 : Irrigated condition, I_0 : Moisture stress condition, RLWC : Relative leaf water content, MII : Membrane injury index.

Table 3. Chlorophyll content and chlorophyll stability index (CSI) as influenced by chickpea genotypes at 50 per cent flowering under irrigated and moisture stress condition.

Genotype	Chl. 'a'		Chl. 'b'		Total chlorophyll		CSI	
	I_1	I_0	I_1	I_0	I_1	I_0	I_1	I_0
Phule G-9758	0.39	0.55	0.47	0.52	0.98	1.09	0.420	0.297
Phule G-00110	0.82	0.68	0.81	0.66	1.76	1.20	0.385	0.253
Phule G-03110-1	0.46	0.78	0.56	0.73	1.28	1.11	0.397	0.340
JG-11	0.83	0.86	0.79	0.84	1.71	1.35	0.323	0.269
PG-95333	0.99	0.98	1.00	0.72	1.87	1.94	0.515	0.415
PG-03203	0.42	0.73	0.36	0.60	1.69	1.04	0.332	0.226
Vijay	0.65	0.64	0.67	0.71	1.66	1.60	0.345	0.236
Vishal	0.47	0.44	0.54	0.58	1.17	1.08	0.405	0.290
Virat	0.75	0.62	0.69	0.61	1.28	1.24	0.546	0.412
Digvijay	0.65	0.43	0.61	0.42	1.65	1.20	0.392	0.351
PG-5 (Ch.)	0.62	0.62	0.54	0.60	1.07	1.04	0.360	0.352
Phule G-6102	0.55	0.45	0.54	0.42	1.27	1.03	0.411	0.344
JG-315	0.47	0.54	0.58	0.64	0.99	1.07	0.358	0.311
Pusa-256	0.59	0.66	0.50	0.68	1.27	1.29	0.417	0.310
Saki-9516	0.73	0.72	0.60	0.67	1.55	1.68	0.449	0.321
Mean	0.63	0.63	0.60	0.65	1.40	1.34	0.404	0.314
S.E.±	0.018	0.007	0.006	0.009	0.022	0.006	0.014	0.004
CD at 5 %	0.053	0.021	0.017	0.027	0.066	0.018	0.042	0.013

I_1 : Irrigated condition, I_0 : Moisture stress condition,

Table 4. Yield and yield contributing characters as influenced by chickpea genotypes under irrigated and moisture stress condition.

Genotype	Pods plant^{-1}		Yield (q ha^{-1})		100 grain weight		Harvest index (%)	
	I_1	I_0	I_1	I_0	I_1	I_0	I_1	I_0
Phule G-9758	58.00	36.00	15.20	10.07	30.00	27.00	50.06	48.35
Phule G-00110	67.00	51.00	10.50	6.19	20.00	19.00	49.00	49.59
Phule G-03110-1	121.00	104.00	11.12	8.48	19.00	17.00	49.33	44.46
JG-11	55.00	32.50	17.14	10.01	22.00	21.00	41.15	36.93
PG-95333	56.50	41.00	22.13	16.51	40.00	38.00	47.64	36.45
PG-03203	90.50	72.50	10.68	7.12	21.00	20.00	45.64	44.52
Vijay	81.00	57.50	16.68	12.83	20.00	18.00	41.85	37.77
Vishal	45.00	31.00	17.17	10.12	27.00	25.00	50.95	54.40
Virat	71.00	51.00	16.01	11.23	30.00	28.00	49.98	45.17
Digvijay	82.00	64.00	18.52	12.27	25.00	23.00	49.47	45.54
PG-5 (Ch.)	82.00	66.00	13.34	9.97	29.00	27.00	50.85	42.69
Phule G-6102	70.00	56.00	10.03	6.55	21.00	20.00	45.02	40.34
JG-315	95.00	76.00	17.34	12.19	16.00	15.00	52.75	50.07
Pusa-256	62.00	40.00	10.07	6.33	20.00	19.00	49.38	47.48
Saki-9516	72.00	43.00	13.56	8.20	27.00	24.00	43.04	44.60
Mean	73.93	54.83	13.90	9.60	23.00	22.00	47.74	44.56
S.E.±	0.41	1.26	0.95	0.79	0.001	0.001	0.02	0.09
CD at 5 %	1.25	3.82	2.72	2.27	0.002	0.004	0.06	0.18

exhibited the drought escaping mechanism which completes their vegetative growth before serious soil moisture deficit condition. Salim and Saxena (1993) noticed that early flowering under severe drought condition.

Yadav *et al*. (1991) reported that, the higher rate of stomatal resistance, sugar content and proline accumulation with a lower rate of transpiration and CSI were considered to be important parameters and could be used successfully for rapid screening of germplasm/ cultivars for drought tolerance. The genotypes, PG-5 (65.80%) and Virat (64.08%) recorded highest RLWC under irrigated condition, whereas, under moisture stress condition Phule G-03110-1 (65.47%) and Virat (63.05%) recorded highest RLWC. The genotypes, Virat (0.145), Pusa-256 (0.178), Vijay (0.179) and Vishal (0.179) recorded least amount of membrane injury index (MII) under irrigated condition, whereas, under moisture stress conditions, the genotypes SAKI-9516 (0.246) and Virat (0.259) maintained significantly less membrane injury index. The maximum proline content was recorded by the genotypes Phule G 95333 (9.074) and Vijay (8.914) under moisture stress condition. From above data, it revealed that the genotypes Virat, Phule G 95333 and Vijay exhibited the higher desiccation tolerance against moisture stress (Table 2). Gupta *et al*. (2000) noted reduction in osmotic potential probably helps the genotypes in maintenance of RLWC under stress condition. Sharma *et al*. (2007) recorded that the reverse moisture stress and mild stress environment reduced the RLWC and negative relative water content at full bloom in different genotypes of chickpea.

The genotype Phule G 95333 recorded the highest chlorophyll 'a' content under irrigated (0.99 mg g^{-1}) as well as moisture stress condition (0.98 mg g^{-1}), chlorophyll 'b' content under irrigated (1.00 mg g^{-1}) and total chlorophyll content under irrigated (1.87 mg g^{-1}) and moisture stress (1.94 mg g^{-1}) condition (Table 3). In addition to this, JG 11 recorded

Table 5. Per cent reduction and DSI influenced by chickpea genotypes for yield and yield contributing characters due to moisture stress.

Genotype	Per cent reduction				Drought susceptibility index (DSI)			
	Pods $plant^{-1}$	Yield ha^{-1}	100 grain weight	Harvest index	Pods $plant^{-1}$	Yield ha^{-1}	100 grain weight	Harvest index
Phule G-9758	37.93	33.77	10.00	3.41	0.38	1.10	2.32	0.57
Phule G-00110	23.88	41.02	5.00	-	0.92	1.35	1.14	-
Phule G-03110-1	14.05	23.62	10.53	9.88	0.57	0.92	2.39	0.37
JG-11	40.91	41.60	4.54	10.24	1.57	1.35	1.03	1.57
PG-95333	27.43	25.41	5.00	11.18	1.07	0.81	1.08	1.14
PG-03203	19.89	33.38	4.76	24.51	0.76	1.06	2.27	0.42
Vijay	29.01	23.08	10.00	9.75	1.15	0.78	1.68	1.42
Vishal	31.11	25.29	7.40	9.62	1.23	1.32	1.51	-
Virat	28.17	29.73	6.66	7.86	1.11	0.96	1.82	1.42
Digvijay	21.95	33.72	8.00	7.94	0.84	1.09	1.57	1.14
PG-5 (Ch.)	19.51	25.25	6.89	16.05	0.77	0.81	1.08	2.28
Phule G-6102	20.00	34.75	4.76	10.39	0.76	1.13	1.14	1.57
JG-315	20.00	29.69	6.25	5.08	0.76	0.96	1.13	0.86
Pusa-256	35.48	37.13	5.00	3.85	1.38	1.10	1.13	0.57
Saki-9516	40.28	39.49	11.11	-	1.57	1.27	2.53	0.42
Mean	31.62	31.79	7.06	10.02	0.99	1.06	1.58	0.98

high amount chlorophyll 'a' (0.86 mg g^{-1}) and chlorophyll 'b' (0.84 mg g^{-1}) content under moisture stress and Vijay maintained high amount of total chlorophyll under irrigated (1.66 mg g^{-1}) and moisture stress (1.60 mg g^{-1}) condition. The genotypes PG 03203 recorded minimum CSI under irrigated (0.332) and moisture stress (0.226) condition followed by Vijay (0.345 and 0.236), Phule G 00110 (0.385 and 0.253) and JG 11 (0.323 and 0.269).

The genotypes, Phule G 03110-1 (121 and 104) and JG 315 (95 and 76) produced higher number of pods $plant^{-1}$ under irrigated as well as moisture stress condition, however, the smaller seed size and less seeds pod^{-1}, they does not performed well in terms of yield ha^{-1}. In contrast, the kabuli genotype, Phule G 95333 (22.13 and 16.51 kg ha^{-1}) and desi genotype Digvijay (18.52 and 12.27 kg ha^{-1}) recorded highest seed yield ha^{-1}, respectively. It might be due to bold seed size and number of seeds pod^{-1}. The genotype, Vishal had maintained highest harvest index under irrigated (50.95%) and moisture stress condition (54.40%), respectively (Table 4).

Salim and Saxena (1993) reported that the drought response index was used to quantify tolerance or susceptibility of a cultivar independently to drought escape (early flowering) and yield potential. In the present investigation (Table 5), genotypes, Phule G 03110-1 (143.05%) and PG 5 (19.51%) had minimum per cent reduction for pods $plant^{-1}$ due to moisture stress condition alongwith less drought susceptibility index (0.57 and 0.77). Widely adopted variety Vijay (23.08%) and genotype Phule G 03110-1 (23.62%) recorded minimum reduction for yield ha^{-1} due to moisture stress condition. The variety JG 11 (4.54%), identified at national level maintained minimum reduction for 100 grain weight followed by Phule G 03203 and genotype Phule G 6102 (4.76%). However, JG 11 (1.03), Phule G 95333 (1.08) PG 5 (1.08) had least drought susceptibility index.

In general, the varieties PG-95333, JG-315, JG-03110 found promising under irrigated condition and Phule G-95333, Phule G-03110-1, Vijay found promising under moisture stress condition. The genotypes Vijay, Vishal, Phule G-03110-1 indicated less yield reduction due to moisture stress and as such found to be stable. The high yielding genotypes Phule G-95333, JG-315, Vijay, Vishal are found to be superior in seed $plant^{-1}$, seed pod^{-1}, yield $plant^{-1}$ and harvest index.

Therefore, the high yielding genotypes Phule G-95333 and Digvijay and less reduction for yield and yield contributing characters for Vijay, PG 5 and JG-315 exhibited better performance for various drought parameters *viz*., proline content, chlorophyll content, CS1, RLWC, membrane injury index considered as sources for drought tolerance in further breeding programme for evolving the drought tolerant genotypes in chickpea.

References

Bates, L. S., Waldren, R. P. and Teare, L. D. 1973. Rapid determination of free proline for water stress studies. Plant Soil. 39: 205-207.

Blum, A. and Ebercon, A. 1981. Cell membrane stability as a measure of drought and heat tolerance in wheat. Crop Sci. 21: 43-47.

Blum, A. and Johnson, J. W. 1992. Transfer of water from roots into dry soil and the effect on wheat water relations and growth. Plant and Soil. 145: 141-146.

Bohnert, H. J. and Jensen, R. G. 1995. Strategies for engineering water stress tolerance in plants. Trends in Biotechnol. 14: 89-97.

Deshmukh, P. S., Sairam, R. K., Kumari, S., Kushwaha, S. R. and Kumar P. 2000. Physiological traits for yield improvement of chickpea in moisture stress prone environments. In: Nat. Sem. on Plant Physiol. at Interface of Agri-horticulture and Industry held at 20th Dec., 1999 to 1st Jan., 2000, RAU, Udaipur, India, pp. 104.

Dhopte, A. M. 2002. Chlorophyll stability index for

drought tolerance in plants in useful techniques for plant scientists. Publ. of Forum for Plant Physiol. pp. 102-103.

Dhopte, A. M. and Phadnawis, B. N. 1989. Quantitative analysis of chlorophyll in useful techniques for plant scientists. Publ. of Forum for Plant Physiol. pp. 247.

Dua, R. P., Chaturvedi, S. K. and Kumar, S. 2003. Managing biotic and abiotic stresses in chickpea through genetic options. Internat. Chickpea Conf., Raipur, India Jan., 20-22. Chickpea Res. for millennium. 217-226.

Gupta, S. C., Rathore, A. K., Sharma, S. N. and Saini, R. S. 2000. Response of chickpea cultivars to water stress. Indian J. Plant Physiol. 5(3): 274-276.

Lutfor, S. M. and Mesbah-Uddin, A. S. M. 2000. Ecological adaptation of chickpea to water stress-2. Grain yields, harvest index, flowering and maturity studies. Leg. Res. 23(1): 1-8.

Salim, S. N. and Saxena, M. C. 1993. Adaptation of spring sown chickpea to Mediterranean basin. II. Factors influencing drought. Field Crop Res. 34(2): 137-146.

Sharma, K. D., Punnu, R. K. and Singh, D. P. 2007. Water use efficiency and yield of chickpea genotypes as influenced by soil moisture availability. Indian J. Pl. Physiol. 12(2): 168-172.

Willmer, C. and Pantoza, O. 1992. The plasma membrane and tonoplast of guard cell membranes, Kluwer Acad. Press.

Yadav, R. B. R., Ehatt, R. E. and Katiyar, D. S. 1991. Physiological evaluation of fodder sorghum genotypes for drought tolerance. Sorghum Newslett. pp. 32-39.

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Variability Studies for Grain Quality Characters in Upland Rice (*Oryza sativa* L.)

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Abstract

Analysis of variance revealed that there were significant differences among the 22 genotypes of rice for grain quality characters *viz*., L:B ratio, relative density, water absorption, gel consistency, amylose content and protein content. The genotypes, PBNR 03-07, PBNR 03-10, PBNR 03-11, PBNR 03-20, PBNR 04-23, PBNR 08-01, PBNR 08-04 and PBNR 08-06 were having more preferred level of grain quality parameters *viz*., intermediate amylose content and soft gel consistency. The maximum protein content was recorded in genotypes PBNR 03-11, PBNR 04-37 and PBNR 03-10. High phenotypic and genotypic coefficient of variation was recorded for water absorption and gel consistency. High heritability coupled with high to moderate expected genetic advance was observed for water absorption and gel consistency indicating scope for selection in these characters.

Key words: Rice, variability, quality characters, heritability

Rice is the most important staple food among the cereals consumed by more than half of the world's population. India has largest area under rice in world and rank second in rice production. Good quality rice fetches premium price due to its excellent aroma, cooking quality test, and preferred for export in domestic as well as international market. Therefore intensive efforts are needed to improve grain quality of rice to earn more foreign exchange.

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The quality desired in rice vary from one geographical region to another and consumer demand certain varieties and favours specific quality traits of milled rice for home cooking (Juliano *et al*. 1964; Azeez and Shafi, 1966). For instance, in Japan, low amylose, short grain type is preferred since after cooking it become soft and sticky. However, in India, long grain with intermediate amylose content and soft gel consistency is preferred since it become soft and fluffy after cooking (Hossain *et al*. 2009). Because of different consumer preferences the world rice market is not homogenous.

Thus, the critical assessment of nature and magnitude of genetic variability is one of the important prerequisite in formulating effective breeding methods. Since estimate of genetic parameters are useful to breeder for designing an effective breeding programme. Hence, in present investigation, attempts have been made to estimate genetic variability for different grain quality characters in available genotypes of rice.

Materials and Methods

The experimental material consisted of 22 promising genotypes of upland rice along with two checks *viz*., 'Parag' and 'Avishkar'. This material was collected from Upland Paddy Research Scheme, Marathwada Krishi Vidyapeeth, Parbhani. These 22 genotypes along with two checks were evaluated using randomized block design with 3 replications on experimental field at Upland Paddy Research Scheme, during *kharif* 2011. A plot of 4.5 x 3 m^2 was assigned to each genotype with 30 cm spacing between two rows. The recommended agronomic practices were adopted timely to raise the healthy crop. Five randomly selected plants of each genotype in each replication were used for recording observations on grain quality characters *viz*., L:B ratio, relative density, water absorption, gel consistency, protein content and amylose content. The analysis was done to estimate the genetic variability, according to Burton (1952) and Hanson *et al*. (1956).

Results and Discussion

Analysis of variance was worked out to assess the variation in the genotypes for grain quality characters. The results of analysis of variance are presented in Table 1. The analysis of variance showed that the differences among the genotypes in respect of grain quality characteristics *viz*., L:B ratio, gel consistency, relative density (g ml^{-1}), water absorption, protein content and amylose content were significant. These results are in conformity with the findings of Deosarkar (1985).

Based on L:B ratio, all genotypes (Table 2) had recorded slender grains except PBNR 03-10. The genotype PBNR 08-01 (1.333 g ml^{-1}) had highest relative density as compared to check 'Avishkar' (1.310 g ml^{-1}). Among all genotypes, the genotype PBNR 03-20 (1.192 mg) had recorded highly significant water absorption followed by PBNR 04-23 (1.185

Table 1. Analysis of variance for grain quality parameters.

Source	d.f.	L:B ratio	Gel consistancy (mm)	Relative density (g ml^{-1})	Water absorption (mg)	Protein content (%)	Amylose content (%)
Replication	2	0.0283	12.3889	0.0059	0.0000	0.6239	1 .5000
Treatments (genotypes)	23	0.8047**	358.4831**	0.0166**	0.1456**	0.7365**	12.9176**
Error	46	0.1424	18.7802	0.0069	0.0039	0.2623	17982

*, ** significant at 5 and 1 per cent probability level respectively.

mg), PBNR 04-28 (1.160 mg), PBNR 04-36 (1.150 mg) and PBNR 08-01 (1.132 mg) as compare to check Avishkar (1.022 mg). The most preferred level of grain quality parameters like intermediate amylose content and soft gel consistency was recorded in genotypes PBNR 03-07, PBNR 03-10, PBNR 03-11, PBNR 03-20, PBNR 04-23; PBNR 08-01, PBNR 08-04 and PBNR 08-06. The genotypes PBNR 03-11, PBNR 04-37 and PBNR 03-10 had recorded highest protein content. These results are in conformity with findings of Das *et al*. (1989) and Binod *et al*. (2006).

The extent of variability (Table 3) with respect to six quality characters in 24 rice genotypes is measured in terms of range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and expected genetic advance (Table 3) and showed considerable variations. In the present investigation PCV was higher than GCV for all characters indicating environmental factors influenced their expression. The GCV and PCV were high for water absorption, gel consistency, L:B ratio and amylose content. Remaining characters had low genotypic and

Table 2. Mean values of 24 rice genotypes for some grain quality characters.

Genotype	L:B ratio	Relative density (g ml^{-1})	Water absorption (mg)	Gel consistancy (mm)	Protein content (%)	Amylose content (%)	Grain translu-cency	Aroma
PBNR 03-02	3.67	1.235	0.976	47.33	7.50	25.03	Translucent	Mild
PBNR 03-07	3.94	1.192	0.78	57.00	6.54	24.33	Translucent	Strong
PBNR 03-10	2.86	1.134	0.800	55.33	8.26**	20.94	Translucent	Mild
PBNR 03-11	3.10	1.150	0.930	54.33	8.32**	21.88	Translucent	Mild
PBNR 03-19	3.56	1.101	0.762	43.00	7.95	18.69	Translucent	Strong
PBNR 03-20	3.32	1.141	1.192**	59.00	7.40	24.80	Translucent	Strong
PBNR 04-23	3.76	1.207	1.185**	56.66	6.70	21.77	Translucent	Mild
PBNR 04-24	3.33	1.162	0.922	46.33	8.12	24.23	Translucent	Strong
PBNR 04-26	3.43	1.225	1.025	64.00	7.49	25.04	Translucent	Mild
PBNR 04-27	3.59	1.070	0.910	42.33	7.92	21.43	Translucent	Mild
PBNR 04-28	4.27	1.292	1.160**	65.33	6.84	24.67	Translucent	Strong
PBNR 04-30	3.70	1.225	0.943	44.66	7.72	24.07	Translucent	Strong
PBNR 04-32	3.40	1.287	1.022	70.66	7.85	22.61	Translucent	Mild
PBNR 04-36	3.75	1.212	1.150**	67.33	7.05	24.96	Translucent	Strong
PBNR 04-37	3.26	1.152	0.755	47.66	8.29**	18.98	Translucent	Mild
PBNR 08-01	4.00	1.333	1.132**	55.33	7.48	22.17	Translucent	Mild
PBNR 08-02	3.52	1.127	0.870	43.00	7.11	21.00	Translucent	Strong
PBNR 08-03	3.01	1.243	0.712	72.33	7.78	24.66	Translucent	Mild
PBNR 08-04	3.75	1.222	1.065	60.66	8.04	20.53	Translucent	Mild
PBNR 08-05	3.44	1.119	0.972	45.33	7.41	21.97	Translucent	Strong
PBNR 08-06	3.60	1.115	0.874	77.66	7.82	23.82	Translucent	Mild
PBNR 08-07	3.61	1.131	0.130	44.00	7.20	19.40	Translucent	Mild
Parag (ch)	4.48	1.302	0.942	68.00	7.39	21.09	Translucent	Mild
Avishkar (ch)	5.37	1.310	1.022	70.00	7.45	24.89	Translucent	Strong
Mean	3.658	1.194	0.926	56.55	7.57	22.62	-	-
S.E.±	0.217	0.047	0.036	2.50	0.29	0.77	-	-
CD at 5%	0.619	0.135	0.103	7.11	0.84	2.20	-	-
C.V.	10.31	6.927	6.768	7.66	6.76	6.92	-	-

Table 3. Parameters of genetic variability in 24 rice genotypes.

Characters	Range	General mean	PCV (%)	GCV (%)	Heritability (%) in b.s.	EGA (%)
L:B ratio	2.86-5.37	3.65	16.47	12.84	60.79	20.62
Relative density	1.070-1.333	1.194	8.41	4.77	32.18	5.57
Water absorption	0.130-1.192	0.926	24.40	23.44	92.30	46.40
Gel consistency	42.33-77.66	56.55	20.31	18.81	85.77	35.89
Protein content	6.54-7.32	7.57	8.56	5.25	37.60	6.63
Amylose content	18.69-25.04	22.62	10.36	8.50	67.33	14.38

GCV= Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, EGA= Expected genetic advance.

phenotypic coefficient of variation. Similar results in some important traits were reported by Durai *et al.* (2001) and Chaudhari *et al*. (2007). Wide variation between phenotypic and genotypic coefficient of variations in rice crop indicated their susceptibility to environmental fluctuations and narrow difference showed less environmental interference on the expression of these traits. The traits which showed high GCV and PCV are of economic importance and there is scope for improvement of these traits through selection.

The heritability in broad sense ranged from 32.18 to 92.30. High value of heritability was recorded for water absorption (92.30%), gel consistency (85.77%), amylose content (67.33%) and L:B ratio (60.79%). Remaining characters showed moderate heritability. High heritability for above characters clarified that they were least affected by environmental modifications and selection based on phenotypic performance would be reliable. Similar findings have been reported by Kumari *et al*. (2003) and Selvaraj *et al.* (2011). The heritability estimates along with genetic advance are more useful than the heritability value alone for selecting the best genotype. From the present investigation, the expected genetic advance as per cent of mean ranged from 5.57 to 46.40. High estimates of expected genetic advance was showed by water absorption (46.40%) followed by gel consistency (35.79), L:B ratio (20.62), amylose content (14.38), protein content (6.63) and relative density (5.57). High values of heritability, GCV and genetic advance as per cent of mean were observed for water absorption and gel consistency suggesting that these traits are genetically controlled by additive gene action indicating scope for selection of these characters. High heritability coupled with high genetic advance as per cent of mean was observed for above characters suggesting that these characters were governed by additive gene action. These findings are in consonance with observation of Carrers (1982) and Deosarkar (1985).

In the present study significant differences were observed among the genotypes for protein content, range was from 6.54 to 8.32 per cent. Similar, results were also reported by Dalai *et al*. (2003).

References

Azeez, M. A., Shafi, M. 1966. Quality in rice. Dept of Agric West Pakistan Technol. Bull. 13 pp. 50-54.

Binod, K. Ashish., Kalayarasi, R., Thiyagarajan, K. and Manomani, S. 2006. Physico-chemical and cooking quality characteristics of promising varieties and hybrids in rice (*Oryza sativa* L.). Indian J. Genet. 66(2): 107-112.

Burton, G. W. 1952. Quantitative inheritance in grasses. Proc. 6th Jan. Int. Grassland Cong. 1: 227-283.

Carrers, R. 1982. Study of quality in seven rice varieties and two, breeding lines. Communications INIA, Prod.

Vegetal. 46(28): 40-42.

Chaudhari, M., Motirmani, N. K. and Pravin, J. 2007. Variability and genetic divergence of aromatic rice. (*Oryza sativa* L.). Ann. Agric. Res. New Series. 28(3 and 4): 268-272.

Dalai Sunita, Dhillon Santosh, Chugh, L. K. and Singh, Randhir. 2003. Protein content and protein pattern of some rice varieties on Sds-Polyacrylamide Gels. Internat. J. of Tropical Agric. 21(4): 79-83.

Das, P. K., Miah, N. M. and Loresto, G. C. 1989. Genetic variability in root and shoot character of selected rice genotypes. Int. Rice Res. Newslett. 16(5): A65-67.

Deosarkar, D. B. 1985. Variability studies for grain yield, yield components and quality characters in some breeding lines of rice. M.Sc. (Agri.) thesis, submitted to Marathwada Krishi Vidyapeeth, Parbhani.

Durai, A. A., Ngachan, S. V., Pattanayak, A. and Sarma, B. K. 2001. Comparative study of heritability, genetic advance and association of characters in conventionally bred and doubled haploid lines of rice (*Oryza sativa* L.). Indian J. of Hill Farm. 14(2): 71-75.

Hanson, G. W., Robinson, H. F. and Comstock, R. E. 1956. Biometricar studies of yield in segregating population of Koreon lespedeza. Agron. J., 48: 268-272.

Hossain, M. S., Singh, A. K. and Fasih-uz-Zaman 2009. Cooking and eating characteristics of some newly identified inter sub-specific (*indica/japonica*) rice hybrids. Sci. Asia. 35: 320-325.

Juliano, B. O., Bautista, G. M., Lugay, J. C. and Reyes, A. C. 1964. Studies on physico-chemical properties of rice. J. Agril. Food Chem. 12: 131-138.

Kumari, R. U., Rangasamy, P. and Gomez, S. M. 2003. Phenotypic differentiation in indica-japonica wide campatible varieties in rice (*Oryza sativa* L). Plant Archives. 3(1): 141-142.

Selvaraj, C. I., Pothiraj Nagrajan, Thiyagarajan, K., Bharathi, M. and Rabindran, R. 2011. Genetic parameters of variability, correlation and path-coefficient studies for grain yield and other yield attributes among rice blast disease resistant genotypes of rice (*Oryza sativa* L.). African J. of Biotecnol. 10(17): 3322-3334.

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Diallel Analysis of Sugar and Sugar Contributing Characters in Sweet Sorghum [*Sorghum bicolor* (L.) Moench]

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Abstract

Additive gene action has been found to be predominant for sugar and sugar contributing traits in sweet sorghum (*Sorghum bicolor* (L.) Moench). Hence, selection followed by selfing will help in fixing the relevant traits. RSSV-21-2 has been identified as the best general combiner. It can be used in breeding programme for the incorporation of desired traits for enhancing sugar yield. NAR1-SS-35-1 x NSS-218 and NARI-SS-83 x NSS-221-2 have been identified as the best specific combinations.

Key words : Sweet sorghum, half-diallel, general combining ability, specific combining ability.

Sweet sorghum has shown potential as a raw material for fuel-grade ethanol production due to its rapid growth rate, early maturity, high water use efficiency, limited fertilizer requirement and wide adaptability. The stalk

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juice sugar content is positively correlated with ethanol yield. The feasibility of converting stalk sugars to ethanol by fermentation prompted researchers to evaluate the potential of sweet sorghum as an alternative crop for ethanol production. Ratnavathi *et al*. (2010) studied genotypic variation for ethanol production from sweet sorghum juice. To breed new cultivars of sweet sorghum with high sugar content in combination with other desirable agronomic traits is an achievable task, which is expected to be a boon to the farmers in India due to its extensive potential in the ethanol industry (Prasad *et al*. 2007).

The research related to sweet sorghum in India is in its infancy. Moreover, references on the genetic studies in sweet sorghum are scanty. Hence, there is an urgent need to characterize the existing material for breeding purposes so as to have an efficient hybridization programme for sweet sorghum improvement. Keeping this in view, an attempt has been made to identify the good general combiners and specific cross combinations and some suggestions are offered for the adoption of breeding methodology for the improvement of sweet sorghum. This may help in breeding superior genotypes of sweet sorghum.

Materials and Methods

The research was carried out at the Nimbkar Agricultural Research Institute, Phaltan, Maharashtra. Material comprised of 10 sweet sorghum (*Sorghum bicolor*) parents *viz*., Keller, NARI-SS-35-1, NARI-SS-83, NSS-216, NSS-218, NSS-221-2, RSSV-15-2, RSSV-21-2, RSSV-34-2 and RSSV-49 crossed in a half-diallel fashion during *rabi* 2006-07. Forty-five hybrids thus obtained and their 10 parents were grown in a randomized block design with three replications during *kharif* 2007. Plants were raised at a spacing of 15 x 45 cm. The recommended cultural practices were followed to raise a good crop. Five plants were randomly selected for recording observations on 12 characters as given in Table 1. Analysis for total reducing sugar and reducing sugar was done as per Lane and Eynon (1923). Non-reducing sugar was calculated as per Rao *et al*. (1983).

Recorded data was subjected to the combining ability analysis according to model 1, method 2 of Griffing (1956).

Results and Discussion

Analysis of variance (Table 1) revealed the significance of both GCA and SCA effects except for the non-significance of SCA for stem diameter, total reducing sugar, non-reducing sugar and total sugars thus indicating the importance of both additive and non-additive gene actions. However, GCA/SCA ratio indicated the preponderance of additive and

Table 1. Analysis of variance for combining ability.

Source	df	Plant height	Stem diameter	Biomass	Stripped stalk yield	Juice extraction	Juice yield	Brix	Reducing sugar	Total reducing sugar	Non-reducing sugar	Total sugars	Total sugar index
GCA	9	2812.429**	0.032**	31.272**	24.297**	91.667**	5.139**	7.132**	0.260**	5.306**	5.686**	4.864**	96.308**
SCA	45	739.627**	0.013	9.122**	5.752**	13.689**	1.176**	1.740*	0.130**	1.051	1.106	0.929	16.245**
Error	108	117.249	0.010	2.896	1.725	5.137	0.277	1.010	0.061	0.951	1.062	0.883	5.149
GCA/ SCA		3.80	2.46	3.43	4.22	6.70	4.37	4.10	2.00	5.05	5.14	5.23	5.93

**, *: Significant at 1 and 5% level, respectively.

additive x additive gene action for all the traits under study. Hence, selfing followed by progeny selection would be rewarding for these traits. Similar results have also been reported by Ramalingam and Rangasamy (1987). On the contrary, Indhubala *et al*. (2010) and Sandeep *et al*. (2010) have reported the preponderance of non-additive gene action for quality traits in sweet sorghum.

The success of any plant breeding programme largely depends on the appropriate choice of parents. Hence, parents chosen for the present study were assessed based on combining ability effects. No single parent was a good general combiner for all the characters. The parents showing high GCA status for each character (shown as bold value in Table 2) can be used in crossing programme. This is likely to result in superior progenies which in turn may provide the raw material for the selection of superior lines. However, when all the characters were considered together, RSSV-21-2 was the best general combiner followed by Keller, NAR1-SS-35-1 and RSSV 15-2. These parents appear to transmit genes to their progeny for maximum number of traits responsible for enhancing sugar yield. However, highest *per se* performance did not point to the best performer on the basis of GCA effects hence indicating no correspondence between the GCA effects and *per se* performance. On the contrary, Ramalingam and Rangasamy (1987) have reported correspondence between *per se* performance and the GCA effects.

The SCA is a useful index to determine usefulness of a particular cross combination for the exploitation of heterosis. Perusal of data revealed that there was correspondence between the *per se* performance and SCA effects for most of the cross combinations.

Table 2. Estimates of general combining ability effects of parents.

Parent	Plant height	Stem diameter	Biomass	Stripped stalk yield	Juice extra-ction	Juice yield	Brix	Reducing sugar	Total reducing sugar	Non-reducing sugar	Total sugars	Total sugar index
Keller	-11.227**	-0.003	-1.615**	-1.245**	**4.789****	0.019	**1.048****	-0.186**	**0.601***	**0.859****	**0.673***	1.023
NAR1-SS-35-1	4.087	-0.107**	0.918	**0.967****	**1.614***	**0.717****	-0.318	**0.208****	-0.123	-0.383	-0.175	**2.258****
NARI-SS-83	2.837	0.049	-1.042**	-1.092**	-3.944**	-1.002**	0.115	-0.143*	-0.100	0.061	-0.078	-3.577**
NSS-216	-18.338**	-0.056*	-0.645	-0.371	0.903	-0.041	0.082	**0.247****	0.255	-0.012	0.233	0.125
NSS-218	-2.680	0.023	**1.280****	**0.945****	1.060	**0.610****	0.465	0.066	0.508	0.384	0.450	**2.815****
NSS-221-2	-0.791	0.003	-0.449	-0.481	1.032	-0.054	-0.368	-0.062	-0.303	0.299	-0.363	-0.967
RSSV-15-2	**11.948****	0.053	**1.039***	**0.886***	-0.073	**0.351***	-0.177	-0.008	0.051	0.109	0.099	**1.245***
RSSV-21-2	**29.245****	**0.057***	**2.530****	**2.239****	-4.929**	0.243	**1.132****	-0.162*	**0.874****	**0.974****	**0.812****	**2.092****
RSSV-34-2	-23.394**	-0.024	-2.899**	-2.624**	-0.581	-1.265**	-1.493**	0.025	-1.537**	-1.458**	-1.433**	-6.107**
RSSV-49	**8.314****	0.004	0.833	**0.774***	0.130	**0.421****	-0.485	0.015	-0.225	-0.235	-0.219	1.093

*, **: Significant at 1 and 5% level, respectively.

Table 3. Best specific combinations in sweet sorghum.

Cross	Plant height	Stem diameter	Biomass	Stripped stalk yield	Juice extraction	Juice yield	Brix	Reducing sugar	Total reducing sugar	Non-reducing sugar	Total sugars	Total sugar index
NARI-SS-35-1 x NSS-218	23.839**	0.075	6.693**	-3.514	1.822**	-0.258	2.270**	1.541	1.750*	1.490	9.219**	5.347**
NARI-SS-83 x NSS-221-2	18.200*	0.202*	3.785**	-0.081	0.997*	-0.085	0.170	0.154	0.212	0.144	3.803*	2.339*
Keller x NARI-SS-83	48.236**	0.055	6.551**	-3.621	1.871**	0.046	0.053	0.087	-0.195	-0.117	6.249**	5.253**
NSS-218 x RSSV-15-2	28.378**	0.096	3.958**	-2.290	1.130*	-0.456*	1.628	0.443	0.774	0.320	4.273*	3.225**

**, *: Significant at 1 and 5% level, respectively.

Table 4. Estimates of specific combining ability effects and *per se* performance of best crosses.

Character	No. of F_1S with significant SCA effect in desired direction	Crosses with maximum SCA effects	SCA effect	*Per se* performance	GCA status of the parents involved in cross combination
Plant height (cm)	14	Keller x NARI-SS-83	48.236**	355.9	L x L
		Kellerx RSSV-21-2	43.695**	377.7	L x H
		Keller x RSSV-49	40.493**	353.6	L x H
Stem diameter (cm)	3	NARI-SS-83 x NSS-221-2	0.202*	1.96	L x L
		Keller x RSSV-49	0.186*	1.89	L x L
		NSS-221-2 x RSSV-15-2	0.182*	1.58	L x L
Biomass (T ha^{-1})	7	NARI-SS-35-1 x NSS-218	6.693**	63.65	L x H
		Keller x NARI-SS-83	6.551**	52.55	L x L
		Keller x NARI-SS-35-1	5.224**	53.95	L x L
Stripped stalk yield (T ha^{-1})	8	NARI-SS-35-1 x NSS-218	5.347**	48.85	H x H
		Keller x NARI-SS-83	5.253**	39.20	L x L
		Keller x NARI-SS-35-1	3.654**	40.22	L x H
Juice extraction (%)	5	Keller x RSSV-15-2	5.738**	56	H x L
		NARI-SS-83 x RSSV-21-2	5.633**	42.31	L x L
		Keller x RSSV-34-2	5.499**	55.25	H x L
Juice Yield (T ha^{-1})	12	Keller x NARI-SS-83	1.871**	16.76	L x L
		NARI-SS-35-1 x NSS-218	1.822**	21.78	H x H
		Keller x NARI-SS-35-1	1.795**	20.41	L x H
Brix	5	NARI-SS-35-1 x NSS-218	2.270**	21.17	L x L
		Keller x NSS-221-2	2.036**	21.50	H x L
		NSS-216 x RSSV-34-2	1.928*	19.33	L x L
Reducing sugar (%)	5	NSS-216 x NSS-218	0.759**	2.97	H x L
		NARI-SS-35-1 x RSSV-21-2	0.725**	2.66	H x L
		NARI-SS-83 x RSSV-21-2	0.475*	2.06	L x L
Total reducing sugar (%)	2	Keller x NSS-221-2	2.740**	18.86	H x L
		NSS-216 x RSSV-34-2	1.801*	16.34	L x L

Table 4. Contd.

Character	No. of F_1S with significant SCA effect in desired direction	Crosses with maximum SCA effects	SCA effect	*Per se* performance	GCA status of the parents involved in cross combination
Non-reducing sugar (%)	4	Keller x NSS-221-2	2.514**	16.37	H x L
		NSS-216 x RSSV-34-2	1.900*	13.73	L x L
		RSSV-15-2 x RSSV-49	1.855*	11.32	L x L
Total sugars (%)	2	Keller x NSS-221-2	2.360**	17.86	H x L
		NSS-216 x RSSV-34-2	1.630*	15.62	L x L
Total sugar index (q ha^{-1})	9	NARI-SS-35-1 x NSS-218	9.219**	36.87	H x H
		NSS-216 x RSSV-21-2	6.776**	31.57	L x H
		Keller x NARI-SS-83	6.249**	26.27	L x L

**, *: Significant at 1 and 5% level, respectively.

NARI-SS-35-1 x NSS-218 and NAR1-SS-83 x NSS-221-2 were the best cross combinations on the basis of SCA effects, as these cross combinations have excelled for maximum number of traits contributing to high sugar yield (Table 3). However, none of the cross combinations in the present investigation were good for all the yield attributes simultaneously.

It was observed that cross combinations giving high SCA effects for different traits belong to the parents exhibiting H x H, H x L, L x H and L x L GCA status, with most of them involving at least one parent with high GCA status (Table 4). This result is in agreement with Sandeep *et al*. (2010).

The H x H GCA effects can be attributed to the additive type of interaction between the parents. In view of the considerable importance of the additive effects and possibility of their fixation, single plant selections may be carried out in segregating generations to evolve superior inbreds. On the other hand, high SCA-effects in crosses involving parents with H x L and L x H GCA status may be attributed to their dominant x recessive interactions. In such cases, biparental mating between two sweet stalk F_2 derivatives and advancing the cross to subsequent generations would be more effective than following pedigree selection. This may break the undesirable linkages and through recombination can produce transgressive segregants in the subsequent generations thus providing an opportunity for obtaining more desirable selections. These findings are in agreement with the reports of Audilakshmi *et al*. (2010). Further, epistatic interactions seem to be responsible for cross combinations which exhibit high SCA effects even though the concerned parents are of low GCA status.

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References

Audilakshmi, S., Mall, A. K., Swarnalatha, M. and Seetharama, N. 2010. Inheritance of sugar concentration in stalk (brix), sucrose content, stalk and juice yield in sorghum. Biomass and Bioenergy, 34: 813-820.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. Aust. J. Biol Sci., 9:463-493.

Indhubala, M., Ganesamurthy, K. and Punitha, D. 2010.

Combining ability studies for quality traits in sweet sorghum [*Sorghum bicolor* (L.) Moench.]. Madras Agric. J. 97: 17-20.

Lane, J. H. and Eynon, L. 1923. Determination of reducing sugars by means of Fehling's solution with methylene blue as internal indicator. J. Soc. Chem. Ind. Trans. 17: 32-36.

Prasad, S., Singh, A., Jain, N. and Joshi, H. C. 2007. Ethanol production from sweet sorghum syrup for utilization as automotive fuel in India. Energy Fuels, 21: 2415-2420.

Ramalingam, A. and Rangasamy, S. R. S. 1987. Genetic analysis of sugar content and its components in sorghum. Ind. J. Agri. Sci., 57: 289-293.

Rao, H. K. G., Veerabhadraiah, A. M., Patil, S. G., Srinivasa Murthy, C. A., Revana Gowd, G. and Viswanath Shetty, Y. 1983. Chemistry of plant and plant products. Dep. of Chemistry and Soils, Agric. College, Hebbal, UAS, Bangalore 560024, pp. 32.

Ratnavathi, C. V., Suresh, K., Vijay Kumar, B. S., Pallavi, M., Komala, V. V. and Seetharama, N. 2010. Study on genotypic variation for ethanol production from sweet sorghum juice. Biomass and Bioenergy, 34: 947-952.

Sandeep, R. G., Gururaja Rao, M. R., Ramesh, S., Chikkalingaiah and Shivanna, H. 2010. Parental combining ability as a good predictor of productive crosses in sweet sorghum. [*Sorghum bicolor* (L.) Moench]. J. of Applied and Natural Sci. 2: 245-250.

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Response of Arbuscular Mycorrhizal Fungi and Phosphate Solubilizing Bacteria on *Rabi* Sorghum Var. Phule Vasudha

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Abstract

Inoculation of sorghum with vesicular arbuscular mycorrhiza i.e. *Glomus mosseae* and phoshate solubilizing *Bacillus polymyxa* along with different levels of phosphate fertilizer *viz*., 10,20,30 and 40 kg P_2O_5 ha^{-1} had profound effect on growth parameters *viz*., plant height, stem girth, root length, dry root weight and grain yield compared to uninoculated control treatment. The significantly higher yield obtained with application of 30 kg P_2O_5 ha^{-1} conjugated with *Glomus mosseae* + PSB (34.46 q ha^{-1}). The application of 40 kg P_2O_5 ha^{-1} along with inoculation of VAM (*Glomus mosseae*) + PSB was found beneficial for enhancing the total uptake of nitrogen and phosphorus. These findings clearly indicated that there is a possibility of saving fertilizer phosphate to the extent of 10 kg P_2O_5 ha^{-1}. All the inoculants significantly improved total N and P uptake at all the four levels of fertilizer phosphate. The per cent VAM root colonization was also found to be diminishing with each increase in the level of P.

Key words : Sorghum, VAM, PSB and colonization

Sorghum (*Sorghum bicolor* L. Moench) is a major cereal crop of dryland agriculture. Sorghum is a drought resistant crop and can be grown throughout the year. In Maharashtra it is cultivated during *kharif* and *rabi* season

Arbuscular mycorrhiza are known to improve the plant growth, nutrient, water and phosphate uptake, resistance to root pathogen and improves the activity of N fixing organisms in the root zone (Owusu-Bennoach and Mosse

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1979). Phosphorus is highly reactive element. When it is in nature it exist in the phosphate form, when four molecules of oxygen reacts with it, it forms phosphate ions that can be taken by plants not the phosphorous as such. The mycorrhizal fungus is a specialized member of rhizosphere or root region microorganisms. Mycorrhizal plants contain higher concentration of P in their tissues than control. Phosphorus is the most essential nutrient which stimulate the root development, ripening and disease resistance. It is added through soluble phosphatic fertilizer which is not fully utilized by a crop as most of parts get fixed in the soil. In view of the above facts efforts are being made to study the effect of dual inoculation of arbuscular mycorrhizal fungi and phosphate solubilizing bacteria on growth, nutrient uptake and yield of *rabi* sorghum.

Materials and Methods

A field experiment was conducted during the *rabi* season of 2009-10 at Post Graduate Farm, Department of Plant Pathology and Agricultural Microbiology, Mahatma Phule Krishi Vidyapeeth, Rahuri. The rhizospheric soil of guinea grass (*Panicum maxicum* Jacq.) containing extrametrical chlamydospores (680-800 spores ml^{-1}) and root segments of guinea grass infected with VA-mycorrhizal fungus from VA-mycorrhizal nursery. The lignite based inoculants of phosphate solubilizing bacteria was obtained from Biofertilizer Production Unit, M.P.K.V., Rahuri.

VAM isolation : Isolation of VA-mycorrhizal spores was carried by wet sieving and decanting Technique (Gerdemann and Nicolson, 1963).

Colonization : A commonly used root slide technique was used to identify VA-mycorrhizal infection. Twenty five root segments were collected at random for each experimental treatment and the root per cent colonization was calculated as VA-mycorrhial colonization (%) = Number of VAM positive root segments / Total number of root segments observed x 100

Inoculum production : The guinea grass was kept in nursery upto flowering stage. At this stage successful colonization of VA-mycorrhizal fungi i.e. *Glomus mosseae* species in roots of guinea grass was found. These root cuttings and rhizospheric soil of guinea grass were mixed thoroughly and used as inoculum for sorghum seeds.

Sorghum roots : The root samples of sorghum crop were analyzed for VA-mycorrhizal colonization by staining with 0.05 per cent trypan blue in lactophenol and counting of VA-mycorrhizal percentage by roots slide technique (Phillips and Hayman, 1970). The experiment was started in October 2009 in a split plot design with three replications and 16 treatment combination The treatment comprised of four phosphate levels, *viz*., 10, 20, 30 and 40 kg P_2O_5 ha^{-1} as a main plot and sub plot treatments were with and without culture (Arbuscular mycorrhizal fungi and phosphate solubilizing bacteria PSB). The recommended nitrogen @ 80 kg N ha^{-1} and muriate of potash @ 40 kg ha^{-1} each were applied prior to sowing where as phosphate was given in 4 split doses. *Glomus mosseae* fungus obtained from VA-mycorrhizal nursery, Dept. of Plant Pathology and Agril. Microbiology, MPKV, Rahuri.

Results and Discussion

Plant height : The height of rabi sorghum was significantly increased due to VAM + PSB inoculation. The maximum plant height was obtained in P_4 level (237.95 cm) however, it did not differ significantly from the treatment P_3 (237.78 cm) level. The combined inoculation of *Glomus* + PSB (237.38 cm) was found significantly superior over the rest of

inoculation treatments. Interaction effects were non significant. The results are inconformity with those reported by Banerjee *et al.* (2006) who reported that application of phosphate solubilizing bacteria and phosphorus sources increases the growth, chlorophyll and yield of maize. Sukhada (1988) had shown inoculation of papaya plants with VA-mycorhizal fungi *viz*., *G. fasciculatum* and *G. mosseae* significantly increased height, dry matter, phosphorus content of roots and leaves of seedlings.

Stem girth : The results of stem girth of plant (Table 1) recorded at harvesting reveled that an increase in dose of phoshate application along with inoculation enhanced the stem girth up to P_4 (40 kg P_2O_5 ha^{-1}) level. The maximum stem girth was obtained in P_4 (7.25 cm) level of phosphate fertilizer followed by P_3 (6.85 cm). Thus, both these levels had equal effect and were superior to P_2 and P_1 level. The combined inoculation of *Glomus mosseae* and PSB was, found significantly superior to rest of all

Table 1. Effect of *Glomus mosseae* and PSB inoculation under graded levels of fertilizer phosphate on growth and yield of sorghum.

Inoculation	P-levels (kg ha^{-1})				Mean	P-levels (kg ha^{-1})				Mean
	10(P_1)	20(P_2)	30(P_3)	40(P_4)		10(P_1)	20(P_2)	30(P_3)	40(P_4)	
	Height at 90 days of sowing (cm) :					**Dry wt. of shoots (g $plant^{-1}$) :**				
Control (C_0)	23.60	233.30	236.50	236.70	234.78	41.24	43.57	47.43	48.74	45.25
Glomus mosseae (C_1)	233.78	234.40	237.78	237.95	235.98	45.33	47.27	51.11	52.22	48.98
PSB (C_2)	233.50	234.40	237.40	237.80	235.78	44.70	46.81	50.78	51.91	48.55
Glomus + PSB (C_3)	235.10	235.90	239.30	239.20	237.38	50.29	52.43	58.92	57.44	54.77
Mean	233.78	234.40	237.78	237.95	235.98	45.39	47.52	52.06	52.57	49.38
	Stem girth at 90 days of sowing (cm) :					**Dry wt. of roots (g $plant^{-1}$) :**				
Control (C_0)	4.20	4.90	6.60	7.00	5.60	9.22	10.31	13.37	14.29	11.79
Glomus mosseae (C_1)	4.47	5.15	6.85	7.25	5.93	12.44	13.24	16.17	16.33	14.54
PSB (C_2)	4.40	5.10	6.80	7.20	5.80	11.82	12.74	15.89	16.91	14.34
Glomus + PSB (C_3)	4.70	5.40	7.10	7.50	6.10	16.28	19.39	20.42	21.59	19.42
Mean	4.47	5.15	6.85	7.25	5.93	12.44	13.92	16.46	17.28	15.03
	Length of root at 90 days of sowing (cm) :					**Yield (q ha^{-1}) :**				
Control (C_0)	29.60	30.5	35.30	36.20	32.90	27.60	28.91	29.82	30.50	28.20
Glomus mosseae (C_1)	31.03	32.10	36.90	37.90	34.50	29.42 (6.59)	30.52 (5.56)	31.48 (5.56)	32.62 (6.95)	31.01
PSB (C_2)	30.70	31.00	36.60	37.50	34.20	28.52 (3.33)	29.45 (1.86)	30.50 (2.28)	31.71 (3.96)	30.5
Glomus + PSB (C_3)	32.60	33.60	38.40	39.50	36.10	31.42 (13.84)	32.80 (13.80)	34.46 (13.34)	35.50 (16.39)	33.40
Mean	31.03	32.10	36.90	37.90	34.50	29.24	30.42	31.56	32.58	30.93

	S.E.±			CD at 5%			S.E.±			CD at 5%		
	a	b	c	a	b	c	a	b	c	a	b	c
P-levels (P)	0.39	0.04	0.45	1.35	0.14	1.56	0.42	0.43	0.05	1.45	1.47	1.06
Innoculations (T)	0.27	0.05	0.48	0.79	0.16	1.41	0.43	0.44	0.09	1.27	1.27	1.15
Interaction (P x T)	0.54	0.11	0.96	NS	NS	Ns	0.87	0.87	0.17	NS	NS	NS
	0.61	0.10	0.95	NS	NS	NS	0.86	0.87	0.15	NS	NS	NS

Parentheses indicate per cent increase over control, N.S. - Non significant.

inoculation treatments. The individual inoculation treatments i.e. *Glomus mosseae* (5.9 cm) and PSB (5.8) were at par with each other. The results of P_4C_3 treatment recorded maximum stem girth (7.5 cm) while the least stem girth was recorded by P_1C_0 (4.2 cm) treatment. Similar results were also reported by Suresh *et al*. (2010) who studied the efficacy of phosphate solubilizing microorganism (PSM) and VA-Mycorrhizal biofertilizer with graded levels of phosphorus (P_2O_5) at 50, 100, 150 and 200 g on growth, nutrient uptake of papaya. Maximum plant height girth were observed in VAM + 200 g (P_2O_5). The present results are therefore in close agreement with these reports.

Length of root : The maximum root length was obtained with P_4 level (37.9 cm) however, it did not differ significantly from the treatment P_3 (36.9 cm) level but those treatment were significantly superior over P_2 and P_1 level. The combined inoculation of *Glomus mosseae* + PSB (36.1 cm) was found significantly superior to rest of all inoculation treatments. The single inoculation treatment i.e. *Glomus mosseae* (34.5 cm) and PSB (34.2 cm) were at par with each other. The results of

Table 2. Effect of *Glomus mosseae* and PSB inoculation under graded levels of fertilizer phosphate on N, P uptake and root colonisation in sorghum.

Inoculation	**P-levels (kg ha^{-1})**				**Mean**
	10(P_1)	**20(P_2)**	**30(P_3)**	**40(P_4)**	
N uptake (kg ha^{-1}) :					
Control (C_0)	90.19	94.47	99.83	103.58	97.02
Glomus mosseae (C_1)	101.13	106.30	113.18	117.38	109.49
PSB (C_2)	95.23	99.38	105.37	110.52	102.63
Glomus + PSB (C_3)	111.09	115.47	122.13	130.32	119.75
Mean	99.41	103.91	110.13	115.45	107.23
P uptake (kg ha^{-1}) :					
Control (C^0)	15.20	19.86	24.80	29.76	22.41
Glomus mosseae (C_1)	18.26	23.40	27.41	34.58	25.91
PSB (C_2)	16.47	21.41	26.60	32.01	24.12
Glomus + PSB (C_3)	20.95	26.64	32.75	39.86	30.05
Mean	17.72	22.83	27.89	34.05	25.63
% VAM root colonization :					
Control (C_0)	47.68	57.22	53.13	49.20	51.81
Glomus mosseae (C_1)	54.74	65.42	62.48	58.06	60.18
PSB (C_2)	49.82	58.05	55.55	49.95	53.35
Glomus + PSB (C_3)	55.56	68.59	63.45	59.69	61.83
Mean	51.95	62.32	58.66	54.23	56.79

	S.E.±			**CD at 5%**		
	a	**b**	**c**	**a**	**b**	**c**
P-levels (P)	056	0.49	0.20	1.94	1.70	0.70
Innoculations (T)	0.77	0.31	0.39	1.27	0.91	1.16
Interaction (P x T)	1.55	0.62	0.80	NS	NS	Ns
	1.46	0.73	0.72	NS	NS	NS

N.S. - Non significant.

P_4C_3 treatment recorded the maximum root length (39.5 cm) while the least root length was recorded by P_1C_0 (29.6 cm) treatment.

These results are in consonance with those of Krishna *et al*. (1985) in pearl millet, they reported that the maximum plant height, stem girth and root length were observed in VAM + 200 g P_2O_5.

Dry shoot weight : The maximum dry shoot weight was registered by P_4 (52.57 g) level of phosphatic fertilizer which was closely followed by P_3 (52.06 g) level which did not differ significantly from each other showing equal effect but superior to P_2 and P_1 levels. The combined inoculation of *Glomus mosseae* + PSB (54.77 g) was found significantly superiqr to rest of inoculation treatments and gave maximum dry shoot weight. The single inoculation treatment of *Glomus mosseae* (48.98 g) and PSB (48.55 g) were at par with each other. The results of interaction were non significant. These findings are similar to those reported by Leader *et al*. (1998) studied the phosphorus effect and VAM on maize resulted into accumulation of grater shoot dry weight (13%), root P concentration (15%) and protein concentration (30%) than non VAM roots.

Dry root weight : It was observed that maximum dry root weight was registered by P4 (17.28 g) level of phosphatic fertilizer which was closely followed by P_3 (16.46 g) level which did not differ significantly from each other. Thus both these levels were at par with each other and had equal effect in superior to P_2 and P_1 levels. The combined inoculation of *Glomus mosseae* + PSB (19.42 g) was found significantly superior to rest of inoculation treatments and gave maximum dry root weight. An individual inoculation treatment of *Glomus mosseae* (14.54 g) and PSB (14.34 g) were at par with each other. The result of interaction were non-significant. These findings are similar to those reported by Parra *et al*. (1990) who conducted an experiment on two months seedlings of coffee, inoculated with *Glomus manihols*, *Entraphosphora colombiana* and *Acaulospora myriocarpa*. After five months, plants showed increase dry matter content, leaf area, root colonization, foliar content of NPK, Ca and Mg in coffee seedlings.

Grain yield : The result of sorghum grain yield recorded at harvesting were significant for P-levels and inoculation treatment. However, their interaction were non-significant. An increase in dose of P-application upto P_4 level (40 kg P_2O_5 ha^{-1}) along with inoculations enhanced the grain yield of sorghum. All the P-levels studied differed significantly from each other and P_4 level registered the highest value of grain yield (32.58 qha^{-1}) which was at par with P_3 (31.56 q ha^{-1}) followed by P_2 (30.42 q ha^{-1}) and P_1 (29.24 q ha^{-1}). The combined inoculation of *Glomus mosseae* + PSB (33.40 q ha^{-1}) was found significantly superior to rest of all inoculation treatments. The least grain yield was noticed in uninoculated control (28.20 q ha^{-1}). These findings are similar to those reported by Yadav (2008) in pea who showed application of phosphorus in combination with PSB was found higher yield. Mehraban *et al*. (2009) reported the effect of VAM on yield of sorghum cultivars and showed increase in height, no. of seeds splike and root biomass colonization. *G. masseae* were best mycorhizoal strain among the spices studied. VAM colonization improved most of the characters of sorghum in semi arid lands.

N uptake : All the P-levels (Table 2) studied differ significantly from each other and P_4 level registered the highest value of total N uptake kg ha^{-1} (115.45 kg ha^{-1}) than other levels of P. The least total N-uptake kg ha^{-1} was noticed in uninoculated control (97.02 kg ha^{-1}). The results of interaction were non-significant. The

present results were in line with those reported by Singh and Kapoor (1997) who worked on inoculation with PSM and VAM fungus, improved dry matter yield and nutrient uptake by wheat grown in sandy soil and also concluded that combined inoculation of PSM + VAM along with MRP amendment can improve crop yield in nutrient deficient soils.

P uptake : All the total P-levels (Table 2) studied differed significantly from each other and P_4 registered the highest value of total P-uptake (34.05 kg ha^{-1}) than other levels of P. The least total P-uptake was noticed in uninoculated control (22.41 kg ha^{-1}). The results of interaction were non-significant. The results of total P uptake of plant are in conformity with those reported by Ricardo *et al*. (2009) in maize who studied the mycorrhizal effect of P uptake from rock phosphate and superphosphate in maize. The inoculation of *Gigaspora margarita* resulted in better root colonization (55%), increase in P uptake and 27 per cent increase in shoot growth.

VAM colonization : Results of per cent VAM root colonization (Table 2) indicated that an increase in dose of P-application from 10 to 40 kg P_2O_5 ha^{-1} along with inoculation increased the VAM root colonization of plant upto P_2 (20 kg P_2O_5 ha^{-1}) level and decreased with further increase in the level of P. However, the P_2 (62.32%) level was found significantly superior to rest of all phosphate levels The combined inoculation of *Glomus mosseae* + PSB recorded the highest VAM root colonization (61.83%) and found at par with *Glomus mosseae* (60.18%) alone. However, these two inoculants were found significantly superior to PSB and no culture. The results of interaction were non-significant. Barea *et al*. (1975) found that maize inoculated with endogyne plus PSB recorded marginal increase in mycorrhizal infection than those observed in the other treatments. Azcon *et al*. (1986) also found that the amount of mycorrhizal infection was increased by PSB at all the levels of added phosphate the results are in close agreement with those report.

References

Azcon, A. C., Gianiazzi, P. V., Fardeau J. C. and Gianinazzi S. 1986. Effect of VAM and PSB on growth and nutrition of soybean in a neutral calcareous soil amended with 32p45ca-tricalcium phosphate., Pl. Soil. 96(1): 3-15.

Banerjee, M., Rai, R. K., Srivastava, G. C., Debtanu Maiti and Shiva Dhar. 2006. Influence of nitrogen and phosphate solubilizing bacteria and phosphorus sources on growth, chlorophyll and yield of maize. Indian J. Pl. Phys. 11(4): 124-126.

Gerdemann, J. W. and Nicolson, J. H. 1963. Spores of mycorrhizal Endogyne species extracted from soil by wet sieving and decanting. Trans. Br. Mycol. Soc. 46(2): 235-244.

Leadir, L. M. Fries, Raymond, S. P., Gene, R. and Safir Joao Kaminski. 1998. Phosphorus effect on phosphatase activity in Endomycorrhizal maize. 2 Ed. Black. C.A. Ame. Soc. Agron. Inc. Publ. Madison, USA. 1965. pp. 1035-1048.

Owusu-Bennoah, E. and Mosse, B.1 979.Plant growth responses to vesicular arbuscular mycorrhiza XI. Field inoculation responses in barley lucern and onion, New Phytol. 83(3): 671-679.

Mehraban, A. Vazan S., Naroui, M. R. and Ardakany, A. R. 2009. Effect of VAM on yield of sorghum cultivars. J. of Food Agric. and Envirn. 45(4): 461-463

Parra, M., Sanchez De Prager M. and Sieverding, E. 1990. Effect of VA-mycorrhiza on coffee (*Coffee arabica* L.) cultivar. Colombia in nursery. Acta Agronomica. 40 (1-2) 88-99.

Phillips, J. M. and Hayman, D. S. 1970. Improved procedure for clearing roots and staining parasitic and vesicular arbuscular mycorrhizal fungi for rapid assessment of infection. Trans. Br. Mycol. Soc. 55(1): 158-161.

Ricardo, R. and Betty Mendoza Jon. I. Lizaso. 2009. Mycorrhiza effect on Maize P uptake from phosphate rock and superphosphate. Comm. in Soil Sci. and Plant Anal. 40(3): 13-14.

Sukhada, M. 1988. Response of papaya (*Carica papaya* cv. Coorgh Honey Dew) to inoculation with mycorrhizal fungi. In : Mycorrhizae for Green Asia, Proc. First Asian Conf. of Mycorrhizal held at Univ. of Madras, Madras, India Jan. 29-31. (Eds. Mahadevan,

A., Raman, N and Natarajan, K.) pp. 260-261.

Suresh, C. P., Nath, S., Poduval, M. and Sen, S. K. 2010. Studies on the efficacy of phosphate solubilizing microbes and VAM fungi with graded levels of phosphorus on growth, yield and nutrient uptake of papaya. Acta Hort. No.: 851.

Yadav, S. S. 2008. Studies on the integrated response of phosphorus, phosphorus solubilizing bacteria on the vegetable pea. Bhartiya Krishi Anusandhan Patrika. 23(3): 124.129.

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Effect of Leaf Supplementation with Secondary Metabolites on Cocoon Parameters of Mulberry Silkworm

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Abstract

The higher cocoon shell ratio was recorded in lower concentrations of pectin (21.97%), amino acid mixture (21.46%) followed by proline (20.95%) than the higher concentrations. Weight of shell and cocoon was noticed lower in high concentration of pectin, amino acid mixture and proline as compared with higher and lower concentrations. In respect of effective rearing rate by number, no significant difference was noticed, but effective rearing rate by weight was significantly higher in pectin T_1 (27.30 kg); amino acid mixture T_5 (26.65 kg) and proline T_3 (23.80 kg) than the higher concentrations of amino acid mixture T_6 (22.75 kg); proline T_3 (22.30 kg) and pectin T_2 (21.90 kg). The cocoon parameters found to be superior in T_1 and T_5 which showed significantly improved silk production and that can be recommend for increasing farmers' income.

Key words : Fortifications, complementary additives, cocoon parameters, silkworm.

Nutrition plays an important role in improving the growth and development of *Bombyx mori* L. It is stated that silk production is dependent on the larval nutrition and nutritive value of mulberry leaves, which plays a very effective role in producing good cocoons (Legay, 1958). Significant seasonal variations occur in the nutritional value and composition of mulberry leaves depending on factors *viz*., weather, pests and disease as well as crop package of practices (Ito, 1978). leaf supplementation with secondary metabolites is one of the important role by which cocoon and silk productivity can be increased and quality can be enhanced and maintained. Sengupta *et al.*, (1972) revealed that *Bombyx mori* L. requires specific essential sugars, amino acids, proteins and vitamins for its normal growth of silkworm, survival and also for improvement in the growth of silkgland. Good quality cocoons can obtained when silkworms fed on nutritionally supplemented leaves (Seki and Oshikane, 1959). In silkworms, silk fibroin is derived mainly from 4 amino acids: alanine, serine, glycine and tyrosine (Kirimura, 1962) which come from their dietary source of protein and amino acids (Ito, 1983). Silkworms obtain 72-86 of their amino acids from mulberry leaves and more than 60 per cent of the

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absorbed amino acids are used for silk produclion (Lu and Jiang, 1988).

The amino acid plays an important role in glucose, tryptophan and organic acid metabolism. Few studies have been conducted on amino acids supplementation, which improved the silk production (Etebari and Malindoost, 2005). Thus, in the present study a comprehensive effort was made to determine whether secondary metabolites supplementation influences the growth and development along with the cocoon parameters.

Materials and Methods

Silkworm rearing : Eggs of Kolar Gold (PM x CS2) were reared in the Sectional Laboratory. Agriculture College. Pune under standard conditions of 29°C with a RH of 75 ± 5% and a photoperiod of 16 L: 8D as described by Harjzanis (2004). Fresh mulberry leaves were used for feeding the silkworms.

Amino acids was dissolved in distilled water and diluted to lower and higher concentrations of three amino acids *viz*., pectin T_1 (0.5%) and T_2 (1.0%), proline T_3 (1%) and T_4 (2%) and amino acid mixture T_5 (0.01%) and T6 (0.02%) along with tv natural diet. Silkworms led on supplemented leaves to all larval in stars. Fresh leaves were dipped in different solution concentration and then after, drying within 15 minutes under fan were then fed to the silkworm larvae four times in a day. 100 larval batches were fed with untreated leaves in five replications using a completely randomised design. One week after pupation, the cocoon, pupa and shell weights were recorded as advocated by Rahmathulla *et al.* 2007 and calculated with the following formulae.

Cocoon parameters : The male and female cocoons @ 10/replication were randomly selected and observations were recorded on mean of single cocoon weight, pupal weight, shell weight, shell ratio, ERR by number and weight; the details of which are given below.

Cocoon weight : Single cocoon weight was worked out by the formula. Cocoon weight (g) = (male 10 cocoon weight + female 10 cocoon weight) / 20 x 100.

Shell weight : Single shell weight was estimated by the formula. Shell weight (g) = (male 10 shell weight + female 10 shell weight) / 20 x 100

Shell ratio : Calculated by the following formula. Shell ratio (%) = (Single shell weight / Single cocoon weight) x 100

Effective rearing rate by number : Calculated by the formula. ERR (by number) = (Total harvested cocoons / Total number of larvae retained after last moult) x 100.

Effective rearing rate by weight (kg) : Estimated as quantity of cocoons harvested for 10,000 larvae retained after last moult that was calculated by the following formula. ERR (by weight in kg) = (Weight of harvested cocoons / Total number of larvae retained after last moult) x 100.

Results and Discussion

Effect of secondary metabolites with amino acids on cocoon parameters is shown in Table 1. It seems positive effects of pectin (0.5%) and amino acid mixture (0.01%) were noticeable as compared to untreated natural diet and other amino acid concentrations. The feeding of larvae with leaf supplementation along with lower and higher concentrations of amino acids. In the natural diet significantly lowest weight of single-cocoon (1.736 g), shell weight (0.305 g), shell ratio (17.56%). effective rearing rate by number (9386) and effective rearing rale by weight (17.02) were observed. Significantly

higher single cocoon weight was noticed in T_1 (1.930 g). Next higher cocoon weight in order of statistically significance was observed in T_6 (1.908 g) and T_5 (1.899 g), next group of promising treatments was T_2 (1.864 g), T_3 (1.847 g) and T_4 (1.817 g). Single shell weight was recorded significantly higher in T_1 (0.424 g) that was followed by T_5 (0.408 g) followed by T_2 (0.390 g), T_3 (0.387 g), T_6 (0.382 g) and T_4 (0.363 g). Significantly higher shell ratio was recorded in T_1 (21.97%), which was found at par with T_5 (21.46%) followed by T_3 (20.95%) and T_2 (20.94%) followed by T_6 (20.02%) and T_4 (19.99%). Amongst test treatments, effective rearing rate by number ranged from 9386 to 9950. Significantly lower in natural diet and higher in T_2, T_3, T_5 and T_6 in respect of effective rearing rate by number recorded 9950. which followed by T_1 and T_5 (9900). However, effective rearing rate by weight in order of statistically significance was exhibited as T_1, (27.30 kg); T_5 (26.65 kg); T_2 (23.80 kg): T_6 (22.75 kg); T_3 (22.30 kg) and T_1 (21.90 kg). Findings reported that cocoon parameters were found to be superior in T_1 and T_5.

The present findings were in conformity with the findings of Chapman (1998) who reported that, in order to have best larval growth, insect needs optimum level of amino acids, bemg used for structural purposes such as enzymes and transport-receptors. Under the studies, lower concentration of each of pectin and amino acid mixture were found promising than their higher concentration. Also Kirimura (1962) reported that silk fibroin derived mainly from four amino acids *viz*., alanine, serine, glycine and tyrosine have positive effect on cocoon characteristics. Kabila *et al.* (1994) reported that aspartic acid increased cocoon characteristics. Tazima (1978) reportec that alanine played important role in glucose, tryptophan and organic acid metabolism wherein, aspargine was used as aspartic acids, constituting two groups of essential amino acids and its deficiency leads to growth retardation. Radjabi (2010) observed that lower concentration of aspargine and alanine recorded positive effect of effective rearing rate and had negative effect on shell ratio, therefore not be recommended for commercial silk production. However, Joshi (1985) and Radjabi (2009) found encouraging results with their higher concentration. In the present investigations, aspartic acid and aspargine were not incorporated however, pectin and amino acid mixture were found to be promising: at their lower concentration, effective rearing rate both by number and weight; shell ratio were found comparatively higher depicted better silk quality.

In conclusion, supplementation of silkworm with selected amino acids at certain levels may be effective for improved growth, but a higher level of supplementations doesn't have a positive effect on silkworm growth and

Table 1. Effect of secondary metabolites on cocoon parameters.

Treatment	Cocoon wt. (g)	Shell wt. (g)	Shell ratio (%)	ERR by	
				Number	Kg
T_1	1.930	0.424	21.97 (27.90)	9900	27.30
T_2	1.864	0.390	20.94 (27.20)	9950	23.80
T_3	1.847	0.387	20.95 (27.20)	9950	22.30
T_4	1.817	0.363	19.99 (26.56)	9900	21.90
T_5	1.899	0.408	21.46 (27.63)	9950	26.65
T_6	1.908	0.382	20.02 (26.56)	9950	22.75
Natural diet	1.736	0.305	17.56 (24.73)	9386	17.02
SE±	0.016	0.003	0.24	87.13	0.21
C.D. at 5 %	0.048	0.010	0.69	252.55	0.60

Figures in parenthesis are the mean arcsin transformed values.

development. Supplementations of dietary nutrients with the aforesaid promising complementary additives increased content of leaf moisture that might have lead to higher consumption rate. This might have proportionately increased apparent digestibility that in turn resulted into enhanced digestion, absorption, assimilation and utilization of food energy into larval bio mass and thereby the cocoon. This might have induced upgrading cocoon parameters as suguested by Rahmathulla (2007). Further, conversion rate of leaf into silk was also found to be promising depicting higher silk content that represented superiority of silk quality as pointed out earlier by Trivedy *et al*. (2003).

References

Chapman, R. F. 1998. The Insect Structure and Function. Cambridge Univ. Press. Cambridge.

Etebari, K. and Matindoost, L. 2005. Application of multivitamins as supplementary nutrients on bio-economical characteristics of *Bombyx mori* J. Asia Pacific Ent. 8(1): 1-6.

Harizanis, C. P. 2004. Manual of Sericulture Silkworm Rearing and Mulberry Cultivation. Athens. pp: 22.

Ito, T. 1978. Silkworm nutrition: Silkworm an Imporlant Laboratory Tool. Tazima. Y. edn Kodansha Ltd., Tokyo., 121-157.

Ito, T. 1983. Nutrition of silkworm and the artificial diet (In Japanese). Jpn. Scric. J. Press, Tokyo. Jpn., pp. 292.

Kabila, V., Subburathinan, K. M. and Chetty, J. S. 1994. Growth and economic characters of *Bombyx mori* on feed enriched with neutralized aspartic acid. Ind. J. Seric., 33: 80-81.

Kirimura, J. 1962. Studies on amino acid composition and chemical structure ot silk protein by microbiological determination. Bull. of Scric. Expt. Sin., 17: 447-522.

Legay, J. M. 1958. Recent advances in silkworm nutrition. Ann. Rev. Ent. 3: 75-86.

Lu, S. L. and Jiang, Z. D. 1988. Absorption and utilization of amino acids in mulberry leaves by *Bombyx mori* L. Actu Scricologia Sanela., 14: 198-204.

Radjabi, R., Ebadi, R., Mirlioseini, S. and Nair, S. 2009. Effects of feeding alanine enriched leaves on economic characters of *Bombyx mori* Formosan Entomologist. 29: 73-78.

Radjabi, R., Ebadi, R., Mirlioseini, S. and Nair, S. 2010. Effect of leaves enrichment with amino acid supplementary nutrients on *Bombayx mori* L. Acad. J. of Ent., 3(1): 45-51.

Rahmathulla, V. K., Priyabraia, D. S., Ramesh, M. and Rajan, R. K. 2007. Growth rate pattern and economic traits of *Bombyx mori* under influence of folic acid administralion. J. Appl. Sci. Envn. Manage., 11(4): 81-84.

Seki, K. and Oshikane, K. 1959. Res. Repl. Fac. Text. and Seric., Shinshu Univ., China.

Sengupta, K., Singh, B. D. and Mustafi. 1972. Nutrition of *Bombyx mori*. Studies on enrichment of leaf with sugars, proteins, amino acids and vitamins for vigorous growth of silkworm and increased cocoon crop production, Ind. J. Seric., 11: 11-27.

Tazima, Y. 1978. Silkworm: An Important Laboratory Tools. Kondansha Ltd., Tokyo.

Trivedy, K., Nair, K. S., Ramesh, M., Gopal, N. and Kumar, S. N. 2003. New semi-synthetic diet "Nutrid" - A technology for rearing young instar silkworm in India. Ind. J. Seric., 42(2): 158-161.

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Effect of Dietary Vitamins Supplementations on Reeling Parameters of *Bombyx mori* L.

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Abstract

Maximum improvement in filament length (1194 and 1184 m), reelability (87.79 and 86.74%) and renditta (6.11 and 6.57 kg) was observed in folic acid (0.5%) and ascorbic acid (1.5%) concentrations dose when fed at 6 am. 11 am. 14 pm. 18 pm and 22 pm in the initial three instars and four times a day at 6am. 13pm. 17 pm and 22 pm for later two instars. It is economically feasible and recommendable to rear the cocoons to get better raw silk reeling properties.

Key words : Folic acid, ascorbic acid, *Bombyx mori*. L., reeling parameters.

Nutrition and nutritive additives have_direct and positive correlation with quantity and quality of cocoon yield (Trivedy and Nair. 1999). Nutritive value and palatability of leaves vary with type of variety of mulberry, crop cultivation, harvesting method, storage duration, fertilizer- irrigation schedules, season and afflication by pests and disease incidence (Radjabi *et al*. 2010). By means of supplementated food constituents they get transformed into body elements. Balanced nutritional feeding of silkworm larva supplies it with the energy for normal growth, development and larval physiology. Quantity and quality of silk depends on food intake, digestion, assimilation, absorption and utilization of the energy from food (Rahmathulla *et al*. 2004).

Good larval management practices during rearing younger instars always achieved economical cocoon yield moreover, supplementation of dietary additives renders into better shell ratio. Scientists and researchers have worked out that nutritional status of the mulberry leaves could be improved by enriching them with different nutrients. Effect of mulberry leaf supplemented with various nutritional compounds on different developmental aspects of the silkworm. *Bombyx mori* L. has been well established (Etebari *et al.* 2004). Dietary supplementation of silkworm with vitamin C has been carried out by many research workers using different time of application but no attempt has been made regarding different recommended doses of different vitamins. It has been found that mulberry leaves supplemented with vitamin C does not show any marked influence on silkworm when fed from initial stages compared to the later stages. (Chauhan and Singh 1992). Due to metabolic activities later instars are more responsive to the treatments because of most significant phases. The present study was undertaken to evaluate the effect of dietary supplementation on reeling parameters of silkworm with due emphasis on the determination of effective doses of different vitamins supplemented to all the silkworm larvae.

Materials and Methods

Silkworm, *Bombyx mori* E. (PM x CSR2) was used for the present investigation. Rearing

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was conducted as per rearing standard method. The larvae were reared on leaf supplementations with vitamins along with untreated control in a group up of seven treatments including natural diet (untreated leaves).

Each group consisted of five replications of 100 larvae. The experiment was carried out by preparing six treatments of different vitamins dissolved in distilled water *viz*., T_1 - B-complex (0.5%). T_2 - niacin (1.0%), T_3 - pyridoxine (0.1%), T_4 - folic acid (0.5%). T_5 - ascorbic acid (1.5%) and T_6 - multivitamins (2.5%) were compared with T_7 - natural diet.

Leaf dipping method was adopted and were kept under fan dry for 15 minutes to evaporate the excess water and fed to all the instar larvae at different time schedules, *viz*., for initial three instars five times a day at 6 am, 11 am, 14 pm, 18 pm and 22 pm and for later two instars four times a day at 6 am, 13 pm, 17 pm and 22 pm till to the onset of spinning activity. On 6^{th} day of mounting, the cocoons were harvested. Data on filament length, non-breakable filament length, renditta. denier and raw silk recovery were recorded and statistically analyzed in completely randomized design as suggested by Cochran and Cox (2000).

Results and Discussion

The data of effect of six different vitamin doses along with natural diet as influenced by leaf supplementation to *Bombyx mori* L. is presented in Table 1. The results of vitamin doses on reeling traits of the silkworm *Bombyx mori*. L. Perusal of the results revealed that folic acid (0.5%) and ascorbic acid (1.5%) supplementation was capable of bringing out significant improvement in silkworm reeling traits and quality of silk.

Average filament length : The results revealed that significantly longest length to the extent of 1194 m was recorded in T_4 treatment that was followed by T_5 (1184 m), T_3 (1081 m), T_6 (1066 m) and natural diet (919 m). Whereas, significantly shortest length was noticed in T_1 (900 m).

Non-breakable filament length : highest breaks were noticed in natural diet (2.0) followed by T_1 (0.3%). This was followed by T_3, T_6 and T_2 treatment with 0.1 breaks of filament length which were found to be at par. No breaks were found in T_4 and T_5.

Reelability : Significantly highest reelability was observed in T_4 (87.79%), which was at par with T_5 (86.74%) followed by T_2 (86.59%), T_3

Table 1. Effect of vitamins on reeling parameters.

Treatment	Avg. filament length (m)	No. of breaks	NBFL (m)	Reela-bility (%)	Denier	Renditta (kg)	Raw silk (%)	Raw silk recovery (%)
T_1	900	0.3	873	80.11	2.74	8.44	6.30 (14.54)	35.43 (36.51)
T_2	911	0.1	862	86.59	2.68	8.03	7.06 (15.45)	37.77 (37.94)
T_3	1081	0.1	1032	86.51	2.55	7.68	4.33 (11.97)	22.15 (28.11)
T_4	1194	0.0	1194	87.79	2.40	6.11	8.50 (16.95)	39.04 (38.65)
T_5	1184	0.0	1184	86.74	2.47	6.57	8.91 (17.36)	43.97 (41.55)
T_6	1066	0.1	1017	86.48	2.57	7.82	7.45 (15.89)	38.84 (38.53)
Natural diet	919	2.0	621	86.40	2.50	8.54	7.14 (15.45)	40.66 (40.66)
SE±	9.22	0.007	8.72	0.534	0.02	0.07	0.217	0.333
C.D at 5%	26.73	0.020	25.29	1.57	0.07	0.20	0.628	0.965

(886.51%), T_6 (86.48%) and natural diet (86.40%) respectively.

Denier and renditta : The filament length was significantly influenced by the treatment T_4 (2.40 and 6.11 kg) and T_5 (2.47 and 6.57 kg), which was followed by T_3 (2.40 and 6.11 kg), multivitamins T_6 (2.57 and 7.82). T_2 (2.68 and 8.03) and natural diet (2.50 and 8.54). Similar trend was noticed on denier values. It shows a significant decreased value was observed in T_4 and T_5 comparing with other test treatments and natural diet. This indicated that T_4 and T_5 performed superior over all the treatments.

Raw silk and silk recovery : The results revealed that significantly highest silk recovery was recorded in T_5 (43.97%) followed by natural diet (40.66%), T_4 (39.04%), T_6 (38.84%) and T_1 (35.43%) and significantly lowest recovery was noticed in (22.15%). Same trend in the improvement was noticed in raw silk per cent in T_4 and T_5 followed by other treatment and natural diet.

Better performance was exhibited in all reeling parameter by 0.5 per cent folic acid and 1.5 per cent ascorbic acid. Longest average filament length with less breakage of filament, highest relability and raw silk recovery along with lowest denier and renditta pointed out the superiority of these two vitamins over other vitamins and natural diet. The findings in respects of folic acid are in agreement with Chakraborty (2006) and Rahmatulla *et al*. (2007) who observed that it acted as growth promoter that significantly increased growth rate pattern of silk glands and thereby improved in cocoon yield and reeling traits, Results in respect of ascorbic acid are in conformation with Rai *et al*. (2002), Etebari (2002) and Tantray *et al*. (2009).

It is clear that filament length, non-breakable filament length, reelability. raw silk percentage and raw silk recovery neatness percentage of Kolar Gold has improved significantly at T_4 and T_5 treatment. The renditta is expressed in the weight of the cocoons required to produce one kilogram of raw silk. Hence higher shell ratio indicated better reeling traits. Ascorbic acid has been introduced by many authors as feeding stimulatory factor and antioxidant in many insects (Singh and Reddy 1981 and Matsuda (1981). Some authors have worked the effects of different concentration of ascorbic acid on wide range and various results have been achieved (El-Karaksy and Idriss 1990). But there are no reports available regarding the effect of vitamins on reeling parameters of silkworm with due emphasis on supplementations. In the present investigations, exhibition of significant improvement in the reeling traits was noticed in this leaf supplementation experiments. Dietary supplementation of folic acid and ascorbic acid to all the larval instars has noticeable impact on silkworm compared to natural diet. Researcher have observed that supplementation of vitamins to advanced stages enhanced metabolic activities are more responsive to the treatment. Further final instar has been considered as the most significant phase for vitamin C supplementation (Rahman *et al.* 1990).

Thus the present findings in respect of reeling parameters, folic acid (0.5%) and ascorbic acid (1.5%) performed better than other treatments and natural diet. This findings are supported with the findings of Rai *et al*. (2002) who showed significant increase in the filament length and weight.

References

Chakrabarty, S. 2006. Effect of ascorbic acid on the economic characters of *Bombyx mori*. L. MSc. thesis. Dept. Seric., Univ. of Mysore. India. Central Seric. Res. and Traing. Inst., Mysore.

Chauhan, T. and Singh, K. 1992. Effect of ascorbic acid on

fecundity in mulberry silkworm. Sericologia. 32: 567-574.

Cochran and Cox. 2000. Experimental Design Procedures for the Behavioural Sciences. Cole Pub. Comp., pp. 319-380.

El. Karaksy, LA. and Idriss, M. 1990. Ascorbic acid enhances silk yield of *Bombyx mori* L. J. Appl. Ent., 109: 81-86.

Etebari, K. 2002. Effect of leaf (*Morus alba*) enrichment with some vitamins and nitrogenous compounds on economic traits and physiological characters of *Bombyx mori* L. MSc thesis. Isfahan Univ. of Tech., Iran, pp. 150.

Etebari, K., Ebadi, R. and Matindoost, L. 2004. Effect of feeding enriched mulberry leaves with ascorbic acid on some biological biochemical and economical characteristics of silkworm. Int. J. Indust. Ent., 8: 81-87.

Matsuda, K. 1981. Feeding stimulation of nutrient chemicals in *Gastrophysa atrocyanea* M. (Coleoptera: Crysomelidae). Jpn. J. App. Entomol. 2001. 25:84-88.

Radjabi, R., Ebadi, R., Mirhoseini, S. Z. and Nair, S. 2010. Effect of leaves enrichment with amino acid supplementary nutrients on *Bombyx mori* L. Acad. J. of Ent., 3(1): 45-51.

Rahmathulla, V. K., Himantharaj, M. T., Srinivasa, G. and Rajan, R. K. 2004. Association of moisture content in mulberry leaf with nutritional parameters of bivoltine *Bombyx mori* E. Acta Ento. Sinica. 47(6): 701-704.

Rahmathulla. V. K.; Priyabrata. D. S.; Ramesh, M. and R. K. Raj an. 2007. Growth rate pattern and economic traits of *Bombyx mori* under influence offolic acid administration. J. Appl. Sci. Envn. Manage.. 11(4); 81-84.

Rai, M. M., Rathod, M. K., and Khurad, A. M. 2002. Improvement iit economic characters of *Bombyx mori* by folic acid administration. Entomon., 27(1): 99-104.

Rahman, S. M., Khanam, L. A. M. and Ferdoud, J. 1990. Effect of various concentrations of ascorbic acid on the oviposition and hatchability of silkworm. (*Bombyx mori* L.) Bull. Sericult. Res., 1:47-50.

Singh, T. and Reddy, G. P. 198E Feeding behavior of castor semilooper. *Achoea janata*. Linn. to sterols. ascorbic acid and castor leaves. Indian J. Entomol., 50: 530-532.

Tantray, A. K., Trivedy, K. and Sangappa. 2009. Studies on the effect of dietary vitamin C supplementation on reeling traits of the silkworm, *Bombyx mori* L. J. of Textile Asso. pp. 103-107.

Trivedy, K., and Nair, K. S. 1999. Feed conversion efficiency of improved multivoltine hybrids of *Bombyx mori* L. Ind. J. Seric., 38: 30-34.

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Genetic Divergence for Blast Resistance in Rice (*Oryza sativa* L.)

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Abstract

Wide variation was found in 65 rice genotypes for all the five blast resistance characters studied. These genotypes were grouped into seven clusters. The study differentiated the genotypes as resistant, moderately susceptible and highly susceptible into different clusters. The characters per cent disease intensity (PDI) and lesion density contributed maximum towards genetic divergence. Six landraces and three local selections were identified as resistant or moderately resistant to blast, indicating independent sources for blast resistance.

Key words : Rice, blast, genetic diversity, D^2.

Rice is subjected to attack by large number of pests and serious diseases, which under epidemic conditions become epiphytotic and thereby causing serious losses. Among several diseases, blast caused by *Magnaporthe grisea* (Hebert) Barr. (anamorph: Pyricularia oryzae) is one of the most devastating and destructive diseases of rice worldwide (Zeigler *et al*. 1994). The use of resistant rice cultivars is a powerful tool to reduce the use of environmentally destructive pesticides. Using classical plant breeding techniques, plant breeders have developed a number of blast resistant cultivars adapted to different rice growing regions worldwide. However, the rice industry remains threatened by blast disease because of the instability of the rice blast fungus.

With the advent of modern cultivars, farmers are replacing the traditional landrace cultivars. Such landraces could be potential genetic resources, with respect to resistance to blast disease causing significant loss in rice growing countries (Yang *et al*. 2009). Genetic improvement mainly depends on the amount of genetic diversity present in different genotypes in the population. The estimation of genetic diversity between different genotypes is the first and foremost process in plant breeding. However, assessment of genetic diversity in rice land races has not been given much thrust (Rajesh *et al*. 2010).

In view of this fact, basic work on breeding resistance and screening of different genotypes at hot spot is the long term solution to avoid the outbreak and endemic spread of this blast disease. Identification of genetically diverse accessions with desired genes is essential for better utilization in crop breeding programme. Hence the present study was undertaken to evaluate 65 rice genotypes for genetic divergence for blast disease.

Materials and Methods

Sixty five diverse genotypes of rice including landraces, local genotypes and some released varieties maintained at Agricultural Research Station, Radhanagari, District Kolhapur, MS, India (Table 1) were evaluated during *kharif* 2010 in a Uniform Blast Nursery (UBN) in a

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randomized block design with two replications at Agricultural Research Station, Lonavala, MS, which is a "hot spot" for blast disease. Each entry was represented by single row of 60 cm length (~3 g seeds per row) with spacing of 10 cm between rows having high density sowing. A bed of the susceptible check was planted after every bed of the test entries. Similarly two rows of susceptible check were sown after every ten entries providing uniform inoculam load of the pathogen. Disease reaction was recorded by adopting Standard Evaluation System (SES) scale having 0-9 score (Anonymous 2002) at 8 days interval starting from 15th day after sowing (DAS) till 45th DAS. Recommended agronomic practices were followed to grow the crop successfully. Number of susceptible lesions and their size was measured on five plants per replication from which per cent diseased leaf area was calculated. Per cent disease intensity (PDI) was calculated following Wheeler (1969).

The data was analyzed following Panse and Sukhatme (1985). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated following Burton (1952), whereas heritability was calculated following Burton and DeVane (1953) and the genetic advance was estimated as per Johnson *et al*. (1955) using Windostat Genetic analysis software. The genetic divergence was estimated using D^2 statistics of Mahalanobis (1936) as described by Rao (1952). The D^2 values were used to make clustering pattern by Tocher's method.

Results and Discussion

The screening of rice genotypes under "hot spot" conditions reported significant variation in the expression of various blast resistance traits (Table 1). The range of infection type among the genotypes varied from 1.0 to 9.0 with the mean of 5.4. Earlier significant variation for the blast score with higher mean blast infection score was reported by Ghaley *et al*. (2012) in the evaluation of Bhutan rice landraces at hot spot locations. Telebanco-Yanoria *et al*. (2008) also reported wide range in blast infection that varied from 0.8 to 3.8 (0 to 5 scale) while, classifying world rice genotypes. In the present study significant variation was also observed for other blast resistance characters viz., diseased leaf area (0.41 to 81.71%), lesion density (0.00 to 5.77 per cm^2), lesion size (0.20 to 16.82 mm2) and per cent disease intensity (11.11 to 98.42%).

The analysis of variance of mean values for all the pathological characters revealed that mean squares among the sixty five genotypes were highly significant for all the pathological traits under study. This indicated that there were significant differences in all the pathological characters of rice genotypes selected for the study. The present material therefore, could serve as a pool for selection of suitable material in breeding programme. Sixteen genotypes recorded infection type < 3 indicating the non-sporulating type of lesions with almost all of them showing less than 10 per cent disease intensity indicating that these genotypes may have allelic combinations showing resistant or moderately resistant reaction to blast.

The data in Table 2 revealed that the character lesion size showed highest GCV (75.6%) and PCV (77.8%) followed by lesion density (73.70 and 74.00%) whereas, infection type showed lowest GCV (39.05%) and PCV (40.8%). The highest difference between GCV and PCV values was observed between lesion size (2.25), followed by infection type (1.76). Diseased leaf area had the lowest (0.30) difference between the GCV and PCV values.

The proportion of genetic variability which is transmitted from parent to progeny is reflected by heritability. According to

Table 1. Mean performance of rice genotypes for blast resistant characters.

Name of genotype	Infection type	Diseased leaf area (%)	Lesion density (cm^{-2})	Lesion size (mm^2)	Per cent disease intensity
Heera	3.00	5.74	0.00	0.20	35.19
Halvi Sal 17	6.00	12.59	2.97	3.93	65.87
RDN 185-2	7.50	16.85	2.97	4.32	75.40
Phule Radha	6.50	11.64	2.40	4.46	71.94
RTN 1	8.00	22.84	2.43	9.19	83.87
Ratna	5.00	4.02	0.55	5.60	48.15
Phule Samruddhi	3.00	10.18	0.00	0.20	33.33
Jaya	6.50	19.80	2.97	6.46	74.34
Phule Maval	8.50	26.27	3.40	7.03	84.92
Pawana	5.50	4.82	0.90	2.82	52.12
Indravani	3.00	6.89	0.00	0.33	36.00
Bhogavati	3.00	2.26	0.64	0.45	31.75
Basmati 370	4.50	3.82	0.00	5.41	52.12
Pusa Basmati 1	4.50	4.49	1.13	3.47	50.53
Ambemohar 157	8.00	45.20	3.80	11.68	84.67
Ghansal	5.50	5.71	1.37	3.05	59.00
Kalajirga	5.00	4.73	0.54	4.42	52.38
Vivek Dhan 82	3.00	9.74	0.00	0.20	33.33
Badshabhog	6.00	8.94	1.30	4.28	56.35
Kothimbire	5.50	10.18	1.53	3.65	59.79
BPT 5204	6.50	17.52	2.10	5.99	71.16
RDN 98-2-3-5-14	2.00	2.26	0.00	0.20	16.14
RDN 01-2-10-9	6.50	15.86	1.70	7.90	64.81
KJT2	3.00	2.52	0.00	0.20	32.54
EK70	9.00	81.71	5.77	14.65	98.42
Patni	4.50	5.74	0.74	5.76	46.03
Diwani	6.00	12.21	1.27	8.21	63.23
Shyam Jeer	7.00	12.62	1.80	6.56	70.11
Juhibengal	3.50	3.75	0.10	2.43	36.51
Improved Pusa Basmati 1	3.50	7.83	0.04	1.60	38.89
Kasturi	6.50	12.05	1.07	10.39	67.72
Karnal Local	5.00	4.96	0.30	9.10	45.24
SD. 7	5.50	9.00	0.97	7.48	61.64
SD. 17	6.50	12.53	1.37	5.58	67.73
Sugandhmati	8.50	40.04	3.47	12.58	91.54
Basmati 386	2.50	1.88	0.07	1.55	26.46
MC. 4	5.00	9.81	0.54	7.94	51.59
Haryana Basmati	3.00	5.61	0.00	0.20	28.17
Mahisugandha	3.00	9.87	0.00	0.20	30.69
Khalibagh	5.50	9.48	0.94	8.72	57.14
Jagatpuri	8.50	57.16	4.55	12.33	91.54
Vikram	3.00	9.24	0.00	0.20	33.33
Velkat	8.50	46.79	3.20	14.21	92.59

Table 1. Contd.

Name of genotype	Infection type	Diseased leaf area (%)	Lesion density (cm^{-2})	Lesion size (mm^2)	Per cent disease intensity
Tulshi tall	8.00	25.72	1.80	13.88	88.36
Champakali	8.00	23.41	2.83	8.10	84.66
Siddhagiri	6.00	11.46	0.90	10.60	60.59
RDN 97-2	1.00	1.52	0.00	0.20	11.11
RDN 99-12	3.00	20.28	0.00	0.20	26.19
RDN 99-14	4.00	8.38	0.14	1.22	49.20
RTN purple	6.50	16.82	2.94	5.41	72.75
Taraori Basmati	5.00	8.99	0.93	6.83	52.38
RDN 99-18	7.00	19.72	2.44	7.57	78.04
RDN 02-80	1.00	1.48	0.00	0.20	11.91
Ajara Local 1	7.00	16.38	1.60	8.66	62.44
Ajara Local 3	8.00	36.17	2.57	9.23	83.73
IGT 13857	4.50	5.91	0.50	9.35	44.44
Pavsal	7.50	25.62	2.84	9.03	78.57
Kunchi	8.00	35.89	3.33	10.07	87.30
Ambemohar 102	9.00	39.03	4.54	7.87	94.44
Antersal	8.50	56.07	3.34	16.82	92.59
Nalabhat	3.00	5.44	0.00	0.20	30.69
Sonsali	5.50	8.53	1.30	5.59	62.44
Pinjarwadi local	5.50	7.04	0.87	4.43	55.55
L. K. 248	1.00	0.41	0.00	0.20	11.11
Pomendi local	4.00	3.44	0.30	6.40	42.86
Range	1.00-9.00	0.41-81.71	0.00-5.77	0.20- 16.82	11.11-98.42
Mean	5.40	15.46	1.41	5.65	57.01
S.E.(±)	0.45	1.23	0.15	0.74	2.41
C.D. at 5%	1.28	3.48	0.43	2.09	6.79
C.D. at 1%	1.70	4.62	0.57	2.78	9.03
C.V. (%)	11.83	11.26	15.12	15.12	5.97

Robinson's (1966) classification, heritability obtained in the present investigation for all the characters could be classified as very high. The highest heritability was observed for the character diseased leaf area (98.78%) followed by per cent disease intensity (97.85%) and for infection type (91.59%). The genetic advance was highest for per cent disease intensity (46.78) followed by diseased leaf area (23.55) and lowest for infection type (4.16). However, when expressed as the percentage of mean, it was highest in lesion size (151.29) followed by lesion density (147.38). As heritability in broad sense includes both additive and non additive gene effects, heritability estimates should be considered in conjunction with genetic advance (Johnson *et al*. 1955).

Genetic divergence measured as per Mahalanobis's D^2 statistics (Table 3), grouped 65 genotypes of rice into 7 clusters following Tocher's method as described by Rao (1952). Cluster I had highest (27) genotypes, followed by cluster II (26 genotypes) and cluster IV (8

genotypes). The clusters III, V, VI and VII had single genotype.

Intra and inter cluster D^2 and D values worked out using D^2 values from divergence analysis (Table 4) showed maximum inter-cluster distance between cluster I and VII (D^2 = 1273.78), followed by cluster VI and VII (D^2 = 1094.29), cluster II and VII (D2 = 882.09) and cluster V and VII (D^2 = 634.03). The minimum inter-cluster distance was observed in the cluster III and V (D^2 = 35.28), followed by cluster II and V (D^2 = 68.23), cluster II and III (D^2 = 73.45) and cluster III and IV (D^2 = 74.30). The minimum intra-cluster distance was found in cluster II (D^2 = 32.38), followed by cluster I (D^2 = 33.52) and cluster IV (D^2 = 37.95). The cluster III, V, VI and VII with single genotype,

Table 2. Variability parameters of rice genotypes.

Character	GCV (%)	PCV (%)	Heritability % (BS)	Genetic advance	GA as % of mean
Infection type	39.04	40.80	91.59	4.16	76.98
Diseased leaf area (%)	54.37	54.67	98.78	23.55	110.81
Lesion density (cm^{-2})	73.70	74.00	97.73	8.14	147.38
Lesion size (mm^2)	75.62	77.86	94.32	8.54	151.29
Per cent disease intensity	40.27	40.71	97.85	46.78	82.06

GCV = Genotypic coefficient of variation; PCV = Phenotypic coefficient of variation; BS = broad sense; GA = Genetic advance

Table 3. Distribution of rice genotypes into different clusters.

Cluster numer	Number of genotype	Name of genotype	Remarks
I	27	RDN 97-2, RDN 02-80, L.K. 248, RDN 98-2-3-5-14, Basmati 386, Haryana Basmati, Nalabhat, KJT-2, Bhogavati, Heera, Juhibengal, Indrayani, Vikram, Mahisugandha, Vivek Dhan 82, Improved Pusa Basmati-1, Phule Samruddhi, RDN 99-14, Pomendi local, Basmati 370, Kalajirga, Patni, Pawana, Ratna, Pusa Basmati-1, Pinjarwadi local, MC-4	Resistant and moderately resistant genotypes with few moderately susceptible having score of 4-5
II	26	RDN 01-2-10-9, Ajara local-1, Diwani, Shyamjeer, Kasturi, Siddhagiri, Khalibagh, SD-7, Sonsali, SD-17, Taroari Basmati, Badshabhog, Kothimbire, Gliansal, BPT-5204, Phule Radha, RDN 99-18. Halvi Sal 17, RTN purple, RDN 185-2, Jaya, RTN-1, Champakali, Pavsal, IGT 13857, Karnal local	Susceptible and moderately susceptible (Score 5-8)
III	1	Phule Maval	Highly susceptible with low lesion density and PDI
IV	8	Sugandhamati, Kunchi, Ambemohar 157, Velkat, Ambemohar 102, Ajara local 3, Antersal, Jagatpuri	Highly susceptible, score 8-9
V	1	Tulsi tall	Susceptible with high lesion density and low PDI
VI	1	RDN 99-12	Moderately resistant (score 3), but high PDI
VII	1	E.K. 70	Highly susceptible; more lesion size and high PDI

had intra-cluster distance of 0.0. The present results are in accordance to the report of Telebanco *et al*. (2008) who classified 922 rice genotypes collected mainly from Asia into six clusters based on Ward's hierarchical classification.

Cluster means for five characters revealed wide range of variability among the clusters for all the pathological characters (Table 5). Cluster I, having highest 27 genotypes reported moderately resistant mean performance for infection type (3.41), diseased leaf area (36.21%), lesion density (2.08 per cm^2), lesion size (0.24 mm^2) and per cent disease intensity (5.29%). The genotypes from this cluster were mostly resistant or moderately resistant to blast indicating presence of one or more genes for blast resistance and can be used as sources of resistance for further breeding programme. This cluster includes six landraces (Nalabhat, Juhibengal, Vikram, Patni, Pomendi local and Pinjarwadi local), three local selections (L.K.248, Kalajirga and Haryana Basmati) and 18 improved varieties. The landraces and local selections were originated from different geographical regions and therefore, may have different genetic background for resistance.

Cluster II, containing twenty six genotypes showed moderately susceptible to susceptible reaction to blast with moderate to high mean performance for infection type (6.29), diseased leaf area (65.23 %), lesion density (6.94 per cm^2), lesion size (1.76 mm2) and per cent disease intensity (13.52 %). The widely adapted popular genotypes with quality attributes (*viz*., Phule Radha, Taroari Basmati, BPT 5204, and Jaya) from this cluster can be used for further breeding programme for improvement. Cluster III, IV, V and VII reported higher mean performance for all the observations for blast, indicating the genotypes from these clusters were susceptible to highly susceptible for blast. Cluster VI, having single genotype, RDN 99-12 had moderately resistant reaction of infection

Table 4. Average intra and inter cluster D^2 values of 7 clusters formed from 65 genotypes of rice.

Cluster number	I	II	III	IV	V	VI	VII
I	33.52	118.37	277.89	478.30	260.50	82.81	1273.78
II		32.38	73.45	219.93	68.23	216.97	882.09
III			0.00	74.30	35.28	353.06	541.96
IV				37.95	104.04	470.46	275.56
V					0.00	347.82	634.03
VI						0.00	1094.29
VII							0.00

Table 5. Mean performance of clusters for blast resistance traits in rice.

Character	Cluster number						
	I	II	III	IV	V	VI	VII
Infection type	3.41	6.29	8.50	8.38	8.00	3.00	9.00
Diseased leaf area (%)	36.21	65.83	84.92	89.90	88.36	26.19	98.42
Lesion density (cm^{-2})	2.08	6.94	7.03	11.85	13.88	0.20	14.65
Lesion size (mm^2)	0.24	1.76	3.40	3.60	1.80	0.00	5.77
Disease intensity (%)	5.29	13.52	26.27	44.54	25.72	20.28	81.71

type (3.00), very low lesion density (0.20 per cm^2) and all non-sporulating lesions. However, this genotype had higher number of non-sporulating lesions indicated by higher lesion density (26.19 %) and per cent disease intensity (20.28 %). This genotype may contain one or few resistant genes and can be used as diverse source in breeding programme.

The per cent contribution of the five characters studied towards total divergence (Table 6), indicated that the per cent disease intensity had contributed highest (35.24%) towards total divergence, followed by lesion density (32.88%) and diseased leaf area (21.15 %). Infection type contributed least (0.39%) to the divergence, followed by lesion size (10.34%). This suggested that per cent disease intensity, lesion density and diseased leaf area should deserve the consideration while choosing parents for breeding programme for blast resistance in rice.

The resistant and moderately resistant cultivars were grouped in cluster I and VI, moderately susceptible and susceptible cultivars into cluster II and highly susceptible cultivars into cluster III, IV, V and VII. The inter-cluster distances reveal the variation in expression of blast resistant characteristics between the genotypes from different clusters. The inter-cluster distances were maximum between the resistant and susceptible clusters, cluster I and VII (D^2 - 1273.78) and between VI and VII (D^2 = 1094.29) whereas, it was least between the susceptible clusters i.e. cluster III and V, II and III and III and IV (D^2 = 35.28, 73.45 and 74.30, respectively) and between resistant clusters; clusters I and VI (D^2 = 82.81). Genotypes of distinct clusters separated by high genetic distances would be utilized in breeding programme for obtaining a wide range of variability in the segregating generations. The breeding lines from cluster I (RDN 97-2, RDN 02-80) with resistance to blast are good sources for blast resistance. The improved varieties from cluster I (KJT 2, Improved Pusa Basmati, Bhogavati and Indrayani) showing moderately resistant reaction to blast and having better agronomic features can be further utilized in breeding programme. The improved line RDN 99-12 reported moderately resistant reaction and clustered separately indicates the unique combinations of alleles in it and can be used for further breeding programme.

Table 6. Per cent contribution of blast resistance traits for divergence in rice.

Character	No. of times appearing 1st in ranking	Per cent contribution
Infection type	8	0.39
Diseased leaf area (%)	440	21.15
Lesion density (cm^{-2})	684	32.88
Lesion size (mm^2)	215	10.34
Disease intensity (%)	733	35.24
Total	2080	100.00

The present investigation has enabled the identification of six landraces and three local selections as resistant or moderately resistant to the pathogen. These lines can be used as donor for resistance into the widely cultivated popular rice varieties The resistant landraces can also be used for more efficient further detailed studies of actual gene mapping, mining of new resistant genes for subsequent introgression into other rice materials.

References

Anonymous. 2002. Standard evaluation system (SES) for rice. 4th edn. Internat. Rice Res. Inst., Manila, Philippines.

Burton, G. W. 1952. Quantitative inheritance in grasses. Proceed. of 6th Internat. Grassland Cong. 1: 227-283.

Burton, G. W and DeVane, E. M. 1953. Estimating heritability in tall fescue (*Festuca aurundinacea*) from replicated clonal material. Agron. J. 45: 478-481.

Ghaley, B. B., Christiansen, J. L. and Andersen, S. B.

2012. Genetic diversity for blast resistance of Bhutan rice iandraces. Euphytica. 184: 119-130.

Johnson, H. W., Robinson, H. E. and Comstock, R. E. 1955. Estimation of genetic and environmental variability in soybean. Agron. J. 47: 314-318.

Mahalanobis, P. C. 1936. On the generalized distance in statistics. Proceed. of Nat. Inst. of Sci. India. 2: 35-39.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical Methods for Agricultural Workers, ICAR, New Delhi. pp. 359.

Rajesh, T., Paramasivam, K. and Thirumeni, S. 2010. Genetic divergence in land races of rice. Electr. J. Pl. Breed. 1(2): 199-204.

Rao, C. R. 1952. Advanced Statistical Methods in Biometrical Research. John Wiley and Sons. Inc., New York.

Robinson, H. F. 1966. Quantitative genetics in relation to breeding on the centennial of Mendelism. Genetics. 40: 45-60.

Talebanco - Yanoria, M. J., Ohsawa, R., Senoo, S., Kobayashi, N. and Fukata, Y. 2008. Diversity analysis for resistance of rice (*Oryza sativa* L) to blast disease (Magnaporthe grisea (Hebert) Barr.) using different isolates from the Philippines. Plant Breed. 127: 355-363.

Wheeler, B. J. J. 1969. An introduction to plant diseases, Wiley and Sons Ltd. London. pp. 301.

Yang, Q. Z., Lin, F., Wang, L. and Pan, Q. H. 2009. Identification and mapping of Pi41,a major gene conferring resistance to rice blast in *Oryza sativa* subsp. Indica reference cultivar. Theor. Appl. Genet. 118: 1027-1034.

Zeigler, R. S., Tohme, J., Levy, M. and Correa, F. 1994. Linking blast population analysis to resistance breeding: a proposed strategy for durable resistance, (eds) Zeigler R S, Leong S, Teng P S. Rice blast disease, CAB Internat. Wallingford, UK. pp. 267-292.

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Adoption of Post Harvest Technology by Pomegranate Growers

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Abstract

Majority (62.50 per cent) of the respondents had medium level of adoption about post harvest technology of pomegranate, followed by low (20%) and high (17.50%)

Key words : Adoption, pomegranate growers, post harvest technolog.

Pomegranate (*Punica granatum*) is most important fruit crop grown in tropical. subtropical and temperate regions of the world. It is a non-climacteric fruit and one of the drought resistant horticultural crops, has proved to be the best profitable crop under dryland conditions. India ranks first in pomegranate cultivation with an area of 1.25 lakh ha. Maharashtra ranks first in the country in pomegranate production. In the state nearly 93,500 ha. area with production of 6,01,500 MT. Though, the agricultural production is increased, the studies report proved that 25 to 30 per cent losses in horticultural crops which occur after harvesting of the crops, summing the value loss of Rs. 4000/- crores annually.

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Table 1. Demographic characteristics of the pomegranate growers.

Characteristics	Category	Frequency	Per cent
Farming experience	Less (up to 10)	16	20.00
	Medium (11 to 30)	48	60.00
	More (Above 30)	16	20.00
Education	No literacy	09	11.25
	Primary schools	27	33.75
	Secondary school	25	31.25
	Higher secondary school	14	17.50
	Graduate	05	06.25
Land holding	Small (1.1 to 2 ha.)	26	32.50
	Semi-medium (2.1 to 4 ha.)	41	51.25
	Medium (4.1 to 10 ha.)	11	13.75
	Big (Above 10 ha.)	02	02.50
Annual income	Low (up to Rs. 1,00,000/-)	13	16.25
	Medium (Rs. 1,00,000/- to 2,40,000/-)	58	72.50
	High (Above Rs. 2,40,000/-)	09	11.25
Area under pomegranate	Small (up to 0.40 ha.)	35	43.75
	Medium (0.41 to 1.00 ha.)	38	47.50
	Large (Above 1.00)	07	08.75
Social participation	Low (up to 2 score)	14	17.50
	Medium (3 to 4 score)	41	51.25
	High (Above 4 score)	25	31.25
Use of sources of information	Low (up to 35 score)	15	18.75
	Medium (36 to 45 score)	51	63.75
	High (Above 45 score)	14	17.50
Risk orientation	Low (up to 12 score)	24	30.00
	Medium (13 to 16 score)	35	43.75
	High (Above 16 score)	21	26.25
Market orientation	Low (up to 11 score)	18	22.50
	Medium (12 to 16 score)	55	68.75
	High (Above 16 score)	07	08.75

The main reason behind this is inadequate adoption of post harvest technology, lack of knowledge and acceptance of post harvest technology on the part of farmers. Bearing in mind an importance of adoption of pomegranate growers about post harvest technology, the present study was undertaken with the object!ves to assess the extent of adoption of the pomegranate growers about post harvest technology and to find out farmers responsible for doption about post harvest technology.

Materials and Methods

The multistage sampling technique was used to select district, tahsil, village of pomegranate growers. The study was conducted in purposively selected Latur district of Marathwada region (M.S.) on the basis of availability of area and market. The sample was comprised of 80 respondents. The data were collected with the help of structured interview

Table 2. Distribution of the pomegranate growers according to their level of adoption about post harvest technology of pomegranate (n=80).

Adoption level	Frequency	Percentage
Low (up to 44 A.I.)	16	20.00
Medium (45 to 54 A.I.)	50	62.50
High (55 and Above A.I.)	14	17.50

schedule and analyzed by using suitable statistical techniques like frequency, percentage, correlation coefficient and multiple regressions. The level of adoption of post harvest technology of pomegranate was measured by computing adoption score. In all 23 practices regarding the post harvest technology of pomegranate were included in the structured schedule. The 1-3 score system was adopted as 1-no adoption, 2-partially adoption and 3-complete adoption of the post harvest technology of pomegranate. Total score of every pomegranate grower was worked out and the adoption was measured with the help of Adoption Index.

Results and Discussion

It is revealed from Table 1 that 60 per cent of the pomegranate growers had medium farming experience, 72.50 per cent of them were found in medium annual income group and 43.75 per cent of them had medium degree of risk orientation. These findings are in line with the findings of Dandnaik (2009). It is also observed from the table that 33.73 per cent of the pomegranate growers were educated up to primary education and higher percentage (51.25%) of pomegranate growers were found in medium land holding category.

Majority (68.75%) of the respondents had medium level market orientation. These findings were supported by Surwase (2008). The 47.50 per cent of the pomegranate growers had undertaken pomegranate crop on an area of 0.41 to 1 ha., 51.25 per cent of them pomegranate growers had medium social participation and nearly two third (63.75%) of the pomegranate growers had used medium sources of information. These findings were supported by Bhosale, (2004).

It is revealed from Table 2 that majority (62.5%) of the pomegranate growers were in the medium level of adoption of post harvest technology while, 20.00 and 17.50 per cent of them were in the low and high level of adoption, respectively. Similar findings were reported by Badale (2007).

A perusal of data in Table 3 vividly presented the fact that the independent

Table 3. Relationship of demographic characteristics with their adoption about post harvest technology.

Independent variables	**Correlation coefficient ('r') adoption**	**Calculated t' value**
Farming experience	0.606	6.799**
Education	0.547	5.74**
Land holding	0.633	7.24**
Annual income	0.707	8.83**
Area under pomegranate	0.594	6.44**
Social participation	0.696	8.57**
Use of sources of information	0.744	9.80**
Risk orientation	0.852	14.48**
Market orientation	0.593	6.65**

**Significant at 1 % level of probability.

Table 4. Multiple regression analysis between demographic characteristics of pomegranate growers and their adoption about post harvest technology.

Independent variables	**Regression coefficient of 'Bi' value**	**Standard error**	**Calculated 't' value**
Farming experience	-0.201	0.075	-2.651**
Education	-0.448	0.601	-0.744NS
Land holding	0.389	0.568	0.686NS
Annual income	0.029	0.015	1.864NS
Area under pomegranate	0.591	2.331	0.253NS
Social participation	0.215	0.514	0.419NS
Use of sources of information	0.621	0.198	3.129**
Risk orientation	1.144	0.1706	710**
Market orientation	-1.092	0.351	-3.108**

R^2 = 0.836, F-value = 39.654 , NS - Non-significant.
Significant at 1 % level of probability.

variables namely farming experience, education, land holding, annual income, area under pomegranate, social participation, use of sources of information, risk orientation and market orientation of pomegranate growers were positively and significantly related with the level of adoption of post harvest technology.

It is conspicuous from Table 4 that the nine independent variables namely farming experience, education, land holding, annual income, area under pomegranate, social participation, use of sources of information, risk orientation and market orientation have explained 83.60 per cent of total variation in the dependent variable adoption. It could be observed further from the data that risk orientation, use of sources of information, market orientation and farming experience had exhibited significant impact on adoption of post harvest technology of pomegranate.

The findings of the study leads to conclude that majority (62.50%) of the respondents had medium level of adoption followed by low and high level of adoption about post harvest technology.

References

Bhosale, S. S. 2004. Knowledge and adoption of post harvest technology in Sangola tahsil of Solapur district. M.Sc. (Agri.) thesis, submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri.

Badale, N. S. 2007. Knowledge and adoption of recommended soybean production technology by the farmers of Latur district in Marathwada region. M.Sc. (Agri.) thesis, submitted to Marathwada Krishi Vidyapeeth. Parbhani.

Dandnaik, A. B. 2009. Adoption of improved cultivation practices of pigeonpea. M.Sc. (Agri.) thesis, submitted to Marathwada Krishi Vidyapeeth. Parbhani.

Surwase, B. D. 2008. Technological gap in grape production practices. M.Sc. (Agri.) thesis, submitted to Marathwada Krishi Vidyapeeth. Parbhani.

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Studies on Preparation and Evaluation of Beverages from Fruit of Kokum (*Garcinia indica* Choisy)

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Abstract

The beverages *viz*., R.T.S., squash and the syrup prepared from ripe kokum fruits were organoleptically acceptable upto 8 months of storage period. However, amongst all these three beverages the amrit kokum (prepared by crushing and pressing rind) recorded the highest organoleptic score (8.48), followed by the *amrut* kokum (prepared by rind softening) while minimum was recorded by squash prepared by rind softening (7.58). The syrup prepared from all the genotypes was organoleptically acceptable. Among the different genotypes, the maximum yield of amrut kokum (83.12%) was obtained from the genotype No. KK-66 and the minimum genotype No. 201 (64.66%). All the kokum beverages were acceptable on the basis of their organoleptic evaluation. The average organoleptic score declined slightly during storage period. The T.S.S. and pH of the kokum products increased slightly during storage, whereas acidity was found to decline in all the kokum product i.e. *Amrit*, squash and R.T.S. throughout the storage period at ambient storage conditions.

Key words : Kokum, amrit kokum, syrup, squash, R.T.S.

The kokum is being traditionally used as an acidulant in Konkan region. The fresh ripe fruit rind with sugar makes an excellent *sharbat* and is useful in fever as cooling refreshing drink and also as an antidote against bilious affections. Sun drying of rind is also practised to prepare dried kokum of commerce. The rind is repeatedly soaked in juice of the pulp during sun drying. A salted product, wherein common salt is used during soaking and drying of the rind. This product '*Amsol*' is used as condiment in a traditional fish curry of the Konkan coast and the Goa. An acid drink "*Solkadhi*" prepared from "*Amsol*", which serves as a substitute for the butter milk.

As the kokum fruits are utilized for many household purposes, value added commercial products and the medicinal products, now a days it is deemed to be the most commercial crop, next to mango and cashew. The demand for the kokum products, within the county as well as from other countries, the standardization for preservation and processing of kokum fruits is an urgent need, for the preparation of quality products on large scale. These fruits could be used at the fullest extent for processing them into suitable kokum products, since the taste of this fruit is relished only after processing.

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Materials and Methods

Kokum syrup osmosis method (Fig. 1)

Selection of fruits : Fresh, sound and riped fruits were selected from each genotype separately. The fruits were washed with water. The fruit stalks were removed.

Preparation of fruits : The fruits were cut into four pieces by quartering. The pulp along with seeds was removed. The pieces of rind were mixed with sugar in 1:2 (Rind : Sugar) proportion by weight. This mixture from each

genotype was kept separately in the glass jars. The mixture was well stirred every day. After 7 days whole juice from kokum rind was extracted due to osmosis. The whole quantity of sugar was dissolved in it. The syrup was strained through 1 mm stainless steel sieve to separate out rind portion. The preservative sodium benzoate was added at the rate of 610 mg kg^{-1} of finished The syrup was filled in presterilized glass bottles. The bottles were then crown corked, labelled and kept in a cool and dry place at the ambient conditions.

Kokum syrup by crushing and pressing the fruit rind

Selction of fruits : Fresh, sound and ripe fruits of kokum were selected and washed with water.

Preparation of fruits : The fruits were cut into four pieces, pulp and seeds were removed. The pieces of rind were crushed in the mixer. The homogenous pulp was collected in a steel vessel. The juice was obtained by squeezing, pressing the crushed rind. The clear juice was obtained by straining it through muslin cloth. From the extracted juice, syrup was prepared. Quantity of sugar was added to raise its T.S.S. to 70°B. The preservative sodium benzoate was added @ 610 mg kg^{-1} of finished product. Product was then heated for 5 minutes to dissolve the sugar. The product was filled in presterilized glass bottles. The bottles were then crown corked, immediately, lebelled and store at cool and dry place at ambient temperature.

Kokum syrup by softening the rind

Selection of fruits : Fresh, sound and riped fruits of kokum were selected and washed with water.

Preparation of fruits : The fruits were cut into two pieces, pulp and seeds were removed. They were cooked in a pressure cooker by adding water in 1:1 (rind:water) proportion by weight. After cooking juice was obtained by pressing. It was strained through muslin cloth. From the extracted juice syrup was prepared by adding sugar and citric acid to raise the T.S.S. to 70°B and acidity to 1.5 per cent. The product was heated for 5 minutes to dissolve the sugar. Sodium benzoate was added @ 610 mg kg^{-1} of the finished product and the product was filled in presterilized glass bottles. The bottles were crown corked, labelled and stored at a cool and dry place at ambient temperature

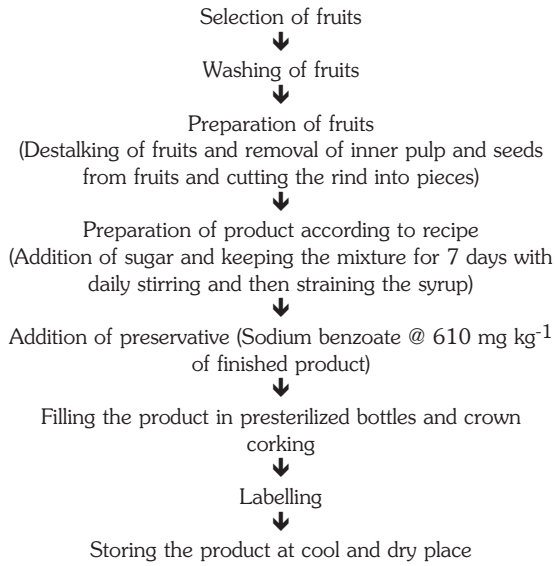

Fig. 1. Kokum syrup (*Amrit* kokum by sugar osmosis method)

Kokum squash by crushing and pressing the rind : Selection, preparation of fruits and extraction of juice was same as described in syrup prepation. The T.S.S. and acidity of juice was 12°B and 1.0 per cent required quantity of acid and sugar was added to raise the T.S.S. to 45°B and acidity to 1.2 per cent. Finally the product contained 12 per cent pulp, 45 per cent T.S.S. and 1.2 per cent acidity.

After adding the required quantity of sugar and citric acid, sodium benzoate was added @ 610 mg of finished product. The product was stirred and just heated (not boiled) till the sugar dissolved and immediately filled in presterilized glass bottles. The bottles were crown corked immediately then eurized for 30 minutes. After that they were cooled, labelled and stored at cool and dry place at ambient temperature.

Kokum squash by rind softening : The selection and preparation of the fruits and juice extraction was the same as describe in syrup prepation by rind softening. The T.S.S. and acidity of juice was 70°B and 1 per cent respectively. The required quantity of sugar and acid was added to raise the T.S.S. and acidity to 45°B and 1.2 per cent respectively. Finally the product contained 25 per cent juice, 45 per cent T.S.S. and 1.2 per cent acidity. Further procedure was the same as described in syrup prepation by rind softening

Kokum R.T.S from fruits by crushing and pressing the rind : Fruit selection, preparation and juice extraction procedure was the same as described in syrup by crushing and pressing the rind The T.S.S. and acidity of the juice was 12°B and 1.5 per cent respectively. The required quantity of sugar was added to raise the T.S.S. to 20°B. Finally the product contained 8 per cent pulp, 20 per cent total

Table 1. Changes in chemical composition of kokum (*Garcinia indica* Choisy) products during storage at ambient temperature (28.6-31.8°C) and 76% relative humidity.

Kokum products	Storage period (in days)	Chemical constituents		
		T.S.S.	pH	Acidity
Amrit kokum :				
i) Osmosis method	0	70.00	2.3	2.0
	120	70.63	2.5	1.87
	240	71.20	2.63	1.83
ii) Crushing and pressing of rind	0	70.00	2.35	2.00
	120	70.70	2.59	1.89
	240	71.30	2.69	1.82
iii) By rind softening	0	70.00	2.33	2.00
	120	70.63	2.59	1.89
	240	71.42	1.70	1.85
Squash :				
i) Crushing and pressing of rind	0	45.00	2.50	1.50
	120	45.90	2.77	1.47
	240	47.20	2.83	1.42
ii) By rind softening	0	45.00	2.60	1.50
	120	46.30	2.74	1.43
	240	47.60	2.84	1.40
R.T.S. :				
i) Crushing and pressing of rind	0	20.00	3.42	0.30
	120	21.50	3.47	0.28
	240	21.90	3.52	0.27
ii) By rind softening	0	20.00	3.40	0.30
	120	21.40	3.46	0.29
	240	21.60	3.56	0.27

T.S.S. and 0.3 per cent acidity. Further sodium benzoate was added @ 200 mg kg^{-1} of finished product. The product was heated just for 5 minutes and then immediately preserved in presterilised glass bottles. The bottles were cooled, labelled and stored at ambient temperature.

Kokum R.T.S. by rind softening : The selection, preparation of fruits and juice extraction was the same as described in syrup by rind softening. The T.S.S. and acidity of juice was 7°B and 1 per cent respectively. The required quantity of sugar and acidity was added to raise the T.S.S. to 20°B and acidity to 0.3 per cent. Finally the product contained 20 per cent juice, 20 per cent T.S.S. and 0.3 per cent acidity. Addition of preservative, pasteurization, labelling and storage was the same as in syrup by rind softening.

Organoleptic evaluation of kokum products : All the kokum products were evaluated organoleptically for their colour, flavour, texture by a panel of 5 judges with score of 1-9 hedonic scale (Amerine and Pangbom, 1965). The beverages were evaluated twice just after preparation and 8 months after storage. The sample of syrup was required to be diluted in 1:5 and that of squash with 1:4 proportion with water before organoleptic evaluation.

The data recorded in various experiments conducted during the present investigation were analysed statistically as per the method described by Panse and Sukhatme (1995).

Results and Discussion

T.S.S. : The data presented in Table 1, 2 all the products increased T.S.S. slightly. The storage period was not found to exert much influence on T.S.S. of anyone of these products. The T.S.S. of syrup ranged from 70.00 to 71.42 per cent during storage period

Table 2. Changes in chemical constituents of Amrit kokum (*Garcinia indica* Choisy) of different genotypes stored at ambient temperature (28.6-31.8°C and 76% relative humidity).

Genotype (Tree No.)	Storage period (in days)	Chemical constituents		
		T.S.S.	pH	Acidity
KK-27	0	70.70	2.37	1.99
	120	70.70	2.45	1.87
	240	71.20	2.89	1.85
KK-66	0	70.00	2.32	1.73
	120	70.20	2.49	1.69
	240	70.60	2.52	1.62
KK-76	0	70.00	2.19	1.59
	120	70.40	2.25	1.34
	240	71.4	2.27	1.49
KK-87	0	70.00	1.87	1.92
	120	70.50	1.85	1.84
	240	71.00	2.09	1.79
KK-100	0	70.00	1.82	2.03
	120	70.20	1.91	1.77
	240	71.20	1.96	1.75
KK-122	0	70.00	1.91	1.82
	120	70.40	1.95	1.79
	240	71.40	1.87	1.73
KK-149	0	70.00	2.27	1.72
	120	70.60	2.32	1.74
	240	71.50	2.41	1.69
KK153	0	70.00	2.39	1.79
	120	70.30	2.47	1.81
	240	71.60	2.51	1.79
KK-155	0	70.00	1.74	2.00
	120	70.43	1.75	1.91
	240	71.60	1.84	1.87
KK-157	0	70.00	1.82	1.83
	120	70.32	1.87	1.72
	240	71.47	1.91	1.69
KK-166	0	70.00	1.84	1.95
	120	70.57	1.87	1.93
	240	71.34	1.92	1.89
KK-191	0	70.00	2.10	1.82
	120	70.62	2.39	1.79
	240	71.47	2.43	1.74
KK-192	0	70.00	2.29	2.00
	120	70.72	2.35	1.95
	240	71.35	2.47	1.85
KK195	0	70.00	1.84	1.94
	120	70.52	1.95	1.87
	240	71.22	2.30	1.79
KK-196	0	70.00	1.87	2.18
	120	71.27	2.13	1.85
	240	71.53	2.19	1.67
KK-197	0	70.00	2.29	2.17
	120	70.62	7.34	2.03
	240	71.45	2.39	1.67
KK-201	0	70.00	1.88	1.97
	120	70.73	1.92	1.83
	240	71.69	1.95	1.78

of 8 months. The T.S.S. of syrup prepared from different genotypes ranged from 70.00 to 71.69. The T.S.S. of products are presented in Table 2. The storage period was not found to excert much influence on T.S.S. of any one of the product. Similar observations were also recorded by Shinde (1994) and Joshi in sapota and kokum products respectively.

pH : It is seen from the data that the pH values of the products increased at ambient storage condition. An increase in pH value of the product appeared to be due to the corresponding decrease in titrable acidity of the products. Observations analogous to these findings were reported by Garande (1992) in jamun and Joshi (1994) in kokum.

Table 3. Organoleptic evaluation and the colour of different products prepared from kokum (*Garcinia indica* Choisy) fruits.

Name of the product	Storage period (in days)	Organoleptic score			Colour
		Colour	Flavour	Avg.	
Amrit kokum :					
i) Osmosis method	0	8.27	8.25	8.26	Red
	120	8.23	8.25	8.24	Red
	240	7.99	8.27	8.13	Red
	Avg.	8.16	8.25	8.21	-
ii) Crushing and pressing of rind	0	8.25	8.91	8.58	Red
	120	8.49	8.23	8.29	Red
	240	8.32	8.83	8.17	Red
	Avg.	8.35	8.99	8.48	-
iii) Rind softening	0	8.00	8.10	8.50	Red
	120	7.90	8.09	8.30	Red
	240	8.20	7.94	8.07	Red
	Avg.	8.03	8.04	8.29	-
Squash :					
i) Crushing and pressing of rind	0	8.30	7.81	8.055	Red
	120	8.40	7.61	8.005	Red
	240	8.04	7.42	7.73	Red
	Avg.	8.24	7.60	7.93	-
ii) Rind softening	0	7.90	7.50	7.70	Red
	120	7.80	7.20	7.50	Red
	240	7.50	7.60	7.55	Red
	Avg.	7.73	7.43	7.58	-
R.T.S. :					
i) Crushing and pressing of rind	0	8.50	7.82	8.16	Faint Red
	120	8.50	7.59	8.045	Faint Red
	240	8.40	7.42	7.91	Faint Red
	Avg.	8.46	7.61	8.038	-
ii) Rind softening	0	8.50	7.70	8.10	Faint Red
	120	8.30	7.60	7.95	Faint Red
	240	8.20	7.40	7.80	Faint Red
	Avg.	8.33	7.76	7.95	-

Acidity : It is seen from the data that acidity of the syrups and the squashes ranged frorn 2.18 to 1.49 and 1.5 to 1.40 respectively during storage period of 8 months. It is evident from the data that the acidity was found to reduce during the storage of all the products. The reduction in acidity during storage could be attributed to the utilization of acids for inversion of non-reducing sugars into reducing sugars. Similar observations were also reported by Asagekar (2002) in pineapple and Sawant (2000) in jackfruit.

***Amrit* kokum :** The data presented in Table 3 indicate that '*Amrit* kokum' was found to be organoleptically acceptable. The organoleptic score was found to be maximum (8.58) for the syrup prepared by crushing and pressing the fruit rind. This was the same for the fresh *Amrit* kokum.

It could be noticed that organoleptic score of the product remained more or less same throughout the storage period. The organoleptic score for colour remained the same throughout the storage period. Nair (1986), Joshi (1994) also reported the similar results with respect to kokum syrup.

Squash : The data indicated the organoleptic score of the paltability of ripe kokum squash, it could be observed that this product was found to be acceptable. The average organoleptic score for colour and flavour was 8.24, 7.60 and 7.73, 7.43 for the squash prepared from crushing and pressing the rind and rind softening respectively. The data also indicated that the product was organoleptically acceptable throughout the storage period. The changes in organoleptic score during the storage period were due little changes taking place in chemical composition and colour. Joshi (1994) prepared kokum fruits squash successfully.

Table 4. Organoleptic evaluation of Amrit kokum prepared from the fruits of different genotypes.

Geno-type	Storage period (in days)	Organoleptic score			Colour
		Colour	Flavour	Avg.	
KK-27	0	8.53	7.51	8.02	Red
	120	8.50	7.64	8.07	Red
	240	8.52	7.29	7.86	Red
	Avg.	8.51	7.48	7.98	-
KK-66	0	8.37	7.35	7.86	Dark Red
	120	8.63	7.27	7.95	Dark Red
	240	8.45	7.09	7.77	Dark Red
	Avg.	8.48	7.23	7.86	-
KK-76	0	8.52	7.63	8.07	Dark Red
	120	8.49	7.52	8.00	Dark Red
	240	8.34	7.34	7.85	Dark Red
	Avg.	8.45	7.50	7.97	-
KK-87	0	8.66	7.59	8.125	Red
	120	8.54	8.64	8.09	Red
	240	8.39	7.56	7.97	Red
	Avg.	8.53	7.59	8.06	-
KK-100	0	8.58	7.55	8.065	Red
	120	8.46	7.49	7.97	Red
	240	8.38	7.39	7.89	Red
	Avg.	8.47	7.47	9.97	-
KK-122	0	8.50	7.73	8.11	Red
	120	8.40	7.68	8.04	Red
	240	8.40	7.49	7.94	Red
	Avg.	8.43	7.63	8.031	-
KK-149	0	8.62	7.48	8.05	Dark Red
	120	8.75	7.61	8.18	Dark Red
	240	8.59	7.39	7.99	Dark Red
	Avg.	8.653	7.493	8.073	-
KK-153	0	8.72	7.37	8.045	Red
	120	8.43	7.95	8.19	Red
	240	8.44	7.83	8.13	Red
	Avg.	8.53	7.71	8.12	-
KK-155	0	8.51	7.45	7.98	Red
	120	8.46	7.36	7.91	Red
	240	8.48	7.69	7.88	Red
	Avg.	8.48	7.36	7.92	-
KK-157	0	8.93	7.30	8.11	Red
	120	8.34	7.60	7.97	Red
	240	8.05	7.40	7.25	Red
	Avg.	8.44	7.43	7.93	-
KK-166	0	8.47	7.72	8.095	Red
	120	8.38	7.43	7.90	Red

Ripe kokum R.T.S. : The data presented in Table 3 indicated that R.T.S. drink prepared from both the methods was organoleptically acceptable. The average maximum organoleptic score for colour (8.46) and the flavour (7.61) with an average of 8.03 was recorded by R.T.S. prepared by crushing and pressing the rind. The score was the maximum for the fresh R.T.S. prepared by both the methods.

It could be seen from the data that there is slight decrease in organoleptic score of the product during storage, which could be due to slight degradation of the colour, flavour and other chemical constituents of the product, during storage. The observations similar to these findings were also reported by Joshi (1994) in ripe kokum nector.

***Amrit* kokum from the fruits of different genotypes :** The organoleptic score (Table 4) and the yield (Table 5) for the Amrit kokum prepared from the fruits of different genotypes are presented. The data indicate that the Amrit kokum prepared from the fruits of all the genotypes was acceptable. It could be noticed that the organoleptic score of the product remained more or less the same, throughout the storage period in almost all the genotypes.

It could be revealed from Table 5 that the maximum (83.12%) yield of Amrit kokum was obtained from the genotype No. 66 and the minimum (64.66%) from the genotype No. 201. The differences in the yield of Amrit kokum obtained from the fruits of different genotypes may be due to differences in the juice percentage of the fruits.

The T.S.S. and pH of the kokum products increased slightly during storage, whereas acidity was found to decline in all the kokum product i.e. Amrit, Squash and R.T.S. throughout the storage period at ambient storage condition.

Table 4. Contd.

Geno-type	Storage period (in days)	Organoleptic score			Colour
		Colour	Flavour	Avg.	
	240	8.09	7.91	8.02	Red
	Avg.	8.31	7.68	8.00	-
KK-191	0	8.54	7.30	7.90	Dark Red
	120	8.36	7.27	7.75	Dark Red
	240	8.62	7.31	7.79	Dark Red
	Avg.	8.50	7.29	7.81	-
KK-192	0	8.49	7.23	7.86	Red
	120	8.37	7.14	7.75	Red
	240	8.36	7.47	7.91	Red
	Avg.	8.40	7.28	7.84	-
KK-195	0	8.79	7.41	8.10	Red
	120	8.69	7.37	8.03	Red
	240	8.38	7.35	7.86	Red
	Avg.	8.62	7.37	7.99	-
KK-196	0	8.34	7.42	7.88	Dark Red
	120	8.72	7.32	8.02	Dark Red
	240	8.49	7.59	8.04	Dark Red
	Avg.	8.51	7.44	7.64	-
KK-197	0	8.71	7.33	8.02	Dark Red
	120	8.67	7.29	7.98	Dark Red
	240	8.09	7.43	7.76	Dark Red
	Avg.	8.49	7.35	7.92	-
KK-201	0	8.59	7.35	7.97	Dark Red
	120	8.52	7.52	8.02	Dark Red
	240	8.49	7.32	7.90	Dark Red
	Avg.	8.534	7.39	7.965	-

All the kokum products were acceptable on the basis of their organoleptic evaluation. The average organoleptic score declined slightly during storage period.

The beverages *viz*., R.T.S., squash and the syrup prepared from ripe kokum fruits were organoleptically acceptable upto 8 months of storage period. However, amongst all these three beverages the *amrit* kokum (prepared by crushing and pressing rind) recorded, the highest organoleptic score (8.48), followed by

Table 5. Yield parameters of *Amrit* kokum prepared from the fruits of different genotypes.

Genotype number	Percentage of Amrit kokum obtained	Percentage of rind residue
KK-27	63.33	36.37
KK-66	83.12	16.88
KK-76	75.12	24.88
KK-87	69.78	30.22
KK-100	70.45	29.55
KK-122	77.56	52.44
KK-149	63.12	36.88
KK-153	77.78	22.22
KK-155	73.34	26.66
KK-157	80.44	19.55
KK-166	64.22	35.78
KK-191	58.66	41.34
KK-192	53.55	26.66
KK-195	74.45	25.56
KK-196	72.45	27.55
KK-197	64.88	35.12
KK-201	64.66	35.34

the *amrut* kokum (prepared by rind softening) while minimum was recorded by squash prepared by rind softening (7.58). The syrup prepared from all the genotypes was organoleptically acceptable.

Among the different genotypes, the maximum yield of *amrut* kokum (83.12%) was obtained from the genotype No. KK-66 and the minimum from genotype No. 201 (64.66%).

References

Amerine, M. A. and Pangbom, R. M. 1965. Principles of sensory evalution of fopd. Acad. Press London, 1665.

Asgekar, M. A. 2002. Studies on physico-chemical composition, some aspects of post harvest handling and processing of pineapple (*Ananas comosus* L. Merr.) cv. Kew fruits. M.Sc. (Agri.) Hort., thesis submitted to Dr. B.S.K.K.V,. Dapoli.

Garande, V. K. 1992. Studies on maturity indices, storage and processing of Jamun (*Syzygium cumini* Skeels.) fruits. A M.Sc. (Agri.) Hort., thesis submitted to Dr. B.S.K.K.V., Daopli, Ratnagiri.

Joshi, A. B. 1994. Studies on some aspects of post harvest handling and processing of kokum (*Garcinia indica* Choisy) fruits. A M.Sc. (Agri.) thesis submitted to the Konkan Krishi Vioyapeeth, Dapoli, Dist. Ratnagiri (M.S.).

Nair, G. R. 1986. Studies on maturity indices and post harvest technology of kokum (*Garcinia indica* Choisy). A M.Sc. (Agri.) Hort., thesis submitted to Dr. B.S.K.K.V., Dapoli, Ratnagiri, M.S.

Panse, V. G. and Sukhatme, P. V. 1995. Statistical Methods for Agricultural Workers. I.C.A.R. Rev. Ed. by Sukhatme P. V. and Amble V. N. pp. 145-146.

Sawant, S. B. 2000. Studies on maturity indices and some aspects of post harvest handling and processing of jackfruit (*Artocarypus heterophyllus* Lam.). A M.Sc. (Agri.) Hort., thesis submitted to Dr. B.S.K.K.V., Dapoli, Ratnagiri.

Shinde, V. S. 1993. Studies on some aspects of post harvest handling and processing of sapota (*Manilkara achras* (Mill) Forsberg) fruit var. Kalipatti. A M.Sc. (Agri.) thesis submitted to the Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, M.S.

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Evaluation of Dehydration Methods, Storage Period and Acceptability of Dehydrated Onions and Beetroots in Recipe Form

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Abstract

The highest dehydration temperature at 56.08°C was attained when beetroots were dried in uncovered condition in solar cooker. Oh an average 15-25°C higher temperature was noted inside the solar cooker than that of atmospheric temperature. In respect to evaporation rate per unit area, solar cooker dehydration method was significantly efficient over the open sun drying. Organoleptic score for colour, aroma, taste, texture and overall acceptability was significantly high till six months of storage period.

Key words : Dehydration, onions, beetroots and drying of vegetables.

Onions and beetroots are most important vegetables from roots and tubers category used for making curries, salads, sauces, pickles, preserves, juice, powder, flakes, sweet meats and soups. Various processing methods such as radiation, freezing, canning, pickling ana dehydration are used for making different products and to extend the shelf life. Among them dehydration is preferred to be better because it reduces the cost of packaging, storage and transportation by reducing both, weight and volume of the end product (Brackett, 1987).

Materials and Methods

The present study was undertaken to investigate the potential of preservation of onions and beetroots by means of sun drying and solar cooker drying, which can be useful for urban as well as rural areas to store onions and beetroots for long period Dehydration of onions and beetroots was carried out in three conditions i.e. open sun drying and drying in solar cooker in covered and uncovered condition. For covered condition of dehydration in solar cooker black coloured cotton cloth was used for the experiment. Domestic type solar cooker recommended by MEDA (Maharastra Energy Development Association, Pune) were selected for the experiment. All the solar cookers were of similar size i.e. 49 x 49 x 16.5 cm with one reflector consisted of rectangular enclosures insulated at the sides and bottom and two glass covers on top. Solar radiation entered through top and heated up the enclosures in which onions and beetroots were placed for dehydration.

The selected vegetables used in the study were procured from the local market of Parbhani city. Beetroots were washed with running tap water and kept for draining for 10 min. peeled with stainless steel knife and grated with the help of stainless steel grater. Onions were cut into thin slices. Grated beetroots and onions slices, each 300 g were evenly spread on stainless steel trays. Trays were kept for dehydration in three conditions i.e. open sun drying, in solar cooker covered and uncovered condition. The dehydration was done to reduce moisture content up to 8-10 per cent from initial moisture content. The dehydrated onions

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and beetroots were packaged in LDPE pouches (400 gauges) with the help of sealing machine and stored in stainless steel and plastic containers at ambient temperature. The moisture content of fresh onions and beetroots was determined by standard oven drying method (AOAC 1985). Temperature of open drying was measured. Weight of onions and beetroots was measured by digital top pan balance. At the end moisture content was measured by using infrared moisture balance. Moisture evaporation per cent was calculated by difference in initial and final moisture content. Evaporation rate, moisture removed per unit area and evaporation rate per unit area were calculated by using formulas (Nawle 1992).

The dehydrated onions and beetroots were stored for six months and the sensory evaluation was done by the intervals of 2 months. Sensory evaluation of onions and beetroots was done in recipe form i.e. in the form of vegetable and salad respectively. For sensory evaluation panel consisting 10 semi trained members from staff and students of the department were selected and evaluated for colour, aroma, taste, texture and overall acceptability. Five-point scale was used for the evaluation, where 5 represents, highly acceptable and 1 represents not acceptable (Patel, 1994). The samples were served to the similar panelists in random order for evaluation after each interval of 2 months. The data was evaluated statistically.

Results and Discussion

Dehydration of onions flakes was carried out in solar cooker and direct sunlight in winter and summer season. Results indicated (Table 1) that the dehydration temperature attained in solar cooker was significantly more than the atmospheric temperature when onions flakes were dehydrated in covered and uncovered

Table 1. Observations of various criteria of dehydration of onions flakes in different conditions during summer and winter season.

Treatments	Temperature (°C)	Water after drying (g)	Moisture evaporation (%)	Final moisture content (%)	Evaporation rate (g ha^{-1})	Moisture removed per unit area (g cm^{-2})	Evaporation rate per unit area (g cm^{-2} hr^{-1})
Winter :							
T_1	31.39	51.11	81.51	8.7	7.40	0.180	0.016
T_2	46.03	48.32	80.39	8.8	13.40	0.178	0.029
T_3	44.49	49.44	80.67	9.31	13.43	0.179	0.029
F value	979.95**	7.8*	NS	785.94**	6972.8 **	NS	1561.0**
SE±	2.56	5.01	0.309	0.0113	0.0415	0.004	0.0001
CD	8.87	1.73	1.071	0.039	0.143	0.0021	0.0006
Summer :							
T_1	31.83	50.49	81.48	8.66	7.40	0.180	0.0160
T_2	53.89	49.76	81.33	8.86	13.55	0.180	0.0296
T_3	56.08	50.45	80.40	9.36	13.39	0.178	0.0290
F value	6846.6**	NS	NS	39.00**	5642.4**	2.85	1603.0**
SE±	0.162	0.361	0.372	0.057	0.046	0.00086	0.00019
CD	0.560	1.24	1.28	0.199	0.161	0.0029	0.00066

T_1 - Open air drying, T_2 - Covered condition in solar cooker, T_3 - Uncovered condition in solar cooker. **-* Significant at 5 and 1% level of significance respectively. NS - Non significant

condition (15°-25°C more). Naik and Chavan (1992) worked on solar drying of onions and concluded that for drying, the temperature requirement was 45 to 60°C. Final moisture content of dried samples was least (8.7%) in case of open air-drying method in both the seasons. Statistically results were highly significant. With respect to evaporation rate and evaporation rate per unit area, solar cooker dehydration method was significantly efficient method over the open air-drying in both the seasons. The whole dehydration of onions was in lower rate. In the initial stage all the samples showed faster rate of evaporation and it was declined in the later stage. During falling rate period, the surface is dry and the risk of spoilage is much smaller. For the best quality dried foods, it is essential to reach the falling rate period as quickly as possible as this minimizes the potential for spoilage. Hence, drying process of onions flakes in solar cooker was found to be appropriate as the falling rate period was achieved quickly. Further, it was noted that variations in relative humidity inside the solar cooker was not responsive to the changes in evaporation rate. Based on the selected parameters such as least weight after drying and higher evaporation rate, it can be said that dehydration of onions flakes were found to be more efficient under covered condition in solar cooker than in uncovered and open air-drying condition. Overall acceptability of dehydrated onions flakes in recipe form was higher in case of the three drying conditions such as open air-drying and solar cooker drying with covered and uncovered conditions.

The results obtained by Kolawole *et al*. (2011) revealed that, there was no significant difference between the mean temperatures attained in solar drying device due to light frequencies of different colour fabric throughout the period of drying.

It is clear from the Table 2 that on an

Table 2. Observations of various criteria of dehydration of beetroots flakes in different conditions during summer and winter season.

Treatments	Tempe-rature (°C)	Water after drying (g)	Moisture evaporation (%)	Final moisture content (%)	Evapo-ration rate (g ha^{-1})	Moisture removed per unit area (g cm^{-2})	Evaporation rate per unit area (g cm^{-2} hr^{-1})
Winter :							
T_1	26.28	24.41	77.85	9.25	12.05	0.172	0.0265
T_2	44.85	24.43	77.65	9.20	19.47	0.172	0.0430
T_3	44.35	24.28	77.85	9.25	19.46	0.172	0.0430
F value	238.17**	NS	NS	NS	161.05**	NS	130.68**
SE±	0.685	0.06	0.242	0.117	0.337	0.00055	0.00083
CD	2.368	2.087	0.836	0.407	1.165	0.00190	0.0028
Summer :							
T_1	38.28	28.76	76.90	9.45	15.38	0.170	0.0335
T_2	51.12	28.29	76.85	9.50	25.84	0.170	0.0563
T_3	50.87	28.79	76.90	9.45	25.66	0.170	0.0565
F value	123.70**	NS	NS	NS	2744.0**	NS	1890.7**
SE±	0.660	0.230	0.044	0.239	0.114	0.001	0.0003
CD	2.280	0.796	1.533	0.826	0.395	0.007	0.00105

T_1 - Open air drying, T_2 - Covered condition in solar cooker, T_3 - Uncovered condition in solar cooker, **,* Significant at 5 and 1% level of significance respectively. NS - Non significant

average 44 to 50°C temperature was noted in the solar cooker that was 13°-18°C higher than ambient temperature. Baig and Chakravorti (2002) reported that the drying air temperature of 50°C appeared to be beneficial for drying of carrot slices. Weight of the beetroots samples after drying ranged from 24 to 28 g in case of all the three selected drying conditions. Statistically, there was no significant difference in three methods of drying when weight after drying was considered. Similar results were obtained in both the seasons in case of moisture evaporation and final moisture content. Highest evaporation rate of 25.84 g hr^{-1} was noted in case of covered condition of dehydration in solar cooker in summer season. Statistically evaporation rate was significantly higher in case of solar cooker drying than open air-drying. Similar results were obtained in case of evaporation rate per unit area. Moisture removed per unit area was not significantly different in case of dehydration of beetroots in solar cooker and open air-drying. During drying, samples were drawn at intervals of one hour and their moisture contents were determined. Drying time data showed that solar cooker drying took much lesser time as compared to open air drying and whole dehydration took place in falling rate. It was found that variation in the relative humidity does not affect the evaporation rate in solar cooker drying of beetroots.

It can be said that the dehydration of beetroots with maximum evaporation rate was possible in solar cooker with black cloth covered condition. It signifies that solar cooker is suitable device for dehydration of beetroots flakes in both the seasons i.e. winter and summer. It was found that dehydrated beetroots flakes could be stored for six months; because after storage rehydrated beetroots flakes in salad form were highly acceptable for all the attributes of sensory evaluation.

There was no effect of storage on the acceptability of rehydrated beetroots flakes and dehydrated onion flakes in recipe form. Solar cooker drying and open air-drying methods were at par with regard to dehydration of beetroots and flakes. In conclusion, it can be said that dehydrated onions and beetroots could be stored for six months.

References

AOAC. 1985. Official Methods of Analysis. Association of Agricultural Chemists, Washington. U.S.A.

Baig, M. S. and Chatravarty, A. 2002. Development of dehydration system for carrot slices. Indian Food Packer, May-June. pp. 66-68.

Brackett, R. E. 1987. Microbial consequence of minimally processed fruits and vegetables J. Food Quality. 10: 195-206

Kolawole, O. M., Ajiboye, A. E., Aturu, E. E. and Anibijuwon, I. I. 2011. Effect of solar drying on the proximate and microbial composition of *Abelmoschus esculentus*. J. Microbiol. Biotech. Res., 1(1): 71 -81.

Naik. and Chavan. 1992. Feasibility of single and double-glazed solar air heating system for onions drying. B. Tech (Food Science and Technology). A project report submitted to MAU, Parbhani.

Nawale, F. M. 1992. Solar energy utilization for khoa production, M.Sc. thesis. (Dept. of Animal Husbandry and Dairying) submitted to M.A.U. Parbhani.

Patel, S. P. 1994. Feasibility of solar cooker for dehydration of selected vegetables, M.Sc. thesis, College of Home Science, M.A.U. Parbhani.

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Association of Sociopersonal and Communicational Factors on Bank Loan Repayment Capacity of Raipur District Farmers in Chhattisgarh*

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Abstract

Cooperative Bank loan repayment study undertaken at Raipur district of Chhattisgarh state indicated that as the age of respondents increases, defaulter in repayment also increases. However, if the extent of contact with extension agent increases, the loan repayment performance is also increase. Further, 83.33 per cent of the respondents said that the major constraint in timely and regular repayment of bank loan was low outcome from the produce. To overcome the problems, 76.25 per cent respondents suggested that, the rate of interest in loan should be decreased to get better repayment performance followed by increase in duration and number of installments.

Key words : Sociopersonal, communicational, loan, repayment, respondent.

India is a developing country and about 65 per cent population depends on agriculture. The present trend of agriculture will shift from subsistence to commercial farming exploring new vistas which would require modernization and standardization of its various activities. Now a days, agriculture sector requires massive capital. As such majority of Indian farmers in general and farmers of Chhattisgarh in particular does not possess sufficient owned funds and they depend on the borrowed money. In this direction co-operative banks play major role especially in village areas to meet the agricultural demands of the society farmers. However, the progress of co-operative bank strengthening in respect of agriculture credit is very much poor in the state due to no repayment behavior of the farmers. The present study was carried out considering the situation as a burning issue and factors associated to recycle of the loan.

Materials and Methods

The study was carried out in a well established largest district Central Cooperative Bank under the jurisdiction of Indira Gandhi Agricultural University. College of Agriculture, Raipur in Chhattisgarh. Out of 57 Cooperative bank branches, four branches namely Arang , Mandir Hasaud, Dharsiwa and Abhanpur were randomly selected for this study. Randomly selected 20 farmers from each branch who had already taken loan constituted the universe. Thus total 80 borrowers were considered as respondents.

The independent variables i.e., sociopersonal (age. education, caste, family size and social participation) and communicational (source of information and extension contact) factors as well as dependent variable (loan repayment performance of borrowers) was included at the time of interview. The instruments utilized for the measurement of independent variables are given in Table 1. However, the dependent variable is classified into three categories i.e., regular (score-2),

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irregular (score-1) and defaulter (score-0). All the information was collected during interview by a developed suitable interview schedule.

Results and Discussion

Age : The 43.75 per cent (Table 2) respondents belonged to middle age group (36-55 years) while 38.75 per cent belonged to old age group (above 55 years). Only 17.50 per cent were recorded under young age group (up to 35 years). This shows that middle age groups are more enthusiastic, enterprising and willing to explore new heights by taking risk. Similar findings have been reported by Yanger *et al*. (2005).

Education : The majority of respondents (27.50%) were under the read only group followed by 23.75 per cent in two categories (read and write only and primary level). However, 13.75 per cent had middle level of education, whereas, 8.75 per cent respondents had education up to high school and higher secondary. Only 2.50 per cent respondents were having college and above level of

Table 1. Independent variables as well as communicational factors category and score value of the respondents.

Score	Sociopersonal variables category						Communicational variables category	
	Age	**Education**	**Caste**	**Family size**	**Social participation in organization**	**Personal group**	**Mass media information source (monthly)**	**Extension activities of respondents**
0	-	Illiterate	-	-	No member in any organisarion	-	Never	Low level of extension contact ($\bar{X}$ - S.D.)
1	Young group (< 35 years)	Can read only	Scheduled caste (SC)	Small (up to 5 members)	Member of one organization	Low (1-3 sources)	1-3 times	---- " ---
2	Middle group (36 - 55 years)	Can read and write	Scheduled tribes (ST)	Middle (6-10 members)	Member of more than one organization	Medium (4-6 sources)	4-6 times	---- " ---
3	Old group (55< years)	Primary	Other backward caste (OBC)	Large (above 10 members)	Office bearer in any organization	High (more than 65 sources)	7-9 times	---- " ---
4	-	Middle	General				9<	Medium level of extension contact ($\bar{X}$ - S.D.)
5		High school and Higher secondary						
6		College and above						---- " ---
7<								High level of extension contact ($\bar{X}$ - S.D.)

education.

Caste : Majority of the respondents (40%) were dominated by scheduled tribe and 23.75 per cent were under both schedule caste and other backward caste. Only 12.50 per cent respondents belonged to general category.

Size of family : Maximum number of the respondents (50%) had small size of the family (up to 5 members) followed by medium size of family (6 to 10 members) with 30 per cent. However, rest of 20 per cent respondents had large size of family (more than 10 members).

Social participation : In the social participation, maximum numbers of respondents (30%) did not have membership in any organization followed by 28.75 per cent of respondents having membership in more than one organization. Further. 26.25 per cent had membership in one organization and only 13.75 per cent of the respondents were working as office bearer in the organization.

Overall use of information source : The 66.25 per cent respondents (Table 3) were using the medium number of sources of information (4-6) followed by 17.50 per cent (more then 6 sources), whereas, 16.25 per cent respondents were using the low number of information sources (1-3).

Contact with extension agent : The majority of the respondents (48.75%) had medium level of extension contact (4-6 score) followed by 28.75 per cent had high level (Table 4). Only 22.50 per cent respondents had low extension contacts (up to 3 score). Similar results were shown by Singh *et al*. (2001).

Repayment performance : From entire four branches there were only 32.50 per cent of the respondents who regularly repaid their loan. Whereas, 18.75 per cent respondents did not repay even a single installment. There were a large number of respondents (48.75%) who repaid certain initial installments and then

Table 2. Distribution of respondents according to sociopersonal characteristics.

Characteristics	Frequency (n=80)	Percentage
Age :		
Young (up to 35 years)	14	17.50
Middle (36 to 55 years)	35	43.75
Old (above 55 years)	31	38.75
Education :		
Illiterate	0	0.00
Can read only	22	27.50
Can read and write	19	23.75
Primary	19	23.75
Middle	11	13.75
High school and Higher Secondary	7	8.75
Graduate and above	2	2.50
Caste :		
Scheduled caste (SC)	19	23.75
Scheduled tribes (ST)	32	40.00
Other backward caste (OBC)	19	23.75
General	10	12.50
Size of family :		
Small (up to 5 members)	40	50.00
Middle (6-10 members)	24	30.00
Large (above 10 members)	16	20.00
Social participation :		
No member in any organization	24	30.00
Member of one organization	21	26.25
Member of more than one organization	23	28.75
Office bearer in any organization	12	15.00

Table 3. Respondents distribution on the basis of overall use of information sources.

Overall use of information sources	Frequency (n=80)	Per cent	Other
Low (1-3 sources)	13	16.25	Mean = 8.46
Medium (4-6 sources)	53	66.25	
High (more than 6 sources)	14	17.50	S.D. = 5.66
Total	80	100.00	

stopped the repayment due to economic and social reasons (Table 5). The data indicates that the proportion of regular payers were less which means that the recycling of loan to other needy person by the Co-operative Bank becomes limited for advancing of loan. Almost similar results reported by Prakash (2001) that a large majority of the loantakers were defaulters and did not repay even a single installment, or repaid their loan partly.

Repayment with reference to age : The young age group respondents (42.86%) were regular in bank loan repayment followed by 35.71 irregular and 21.43 per cent defaulters. Further, 51.43 per cent respondents of the middle age group were irregular in repayment followed by regular (25.71%), whereas, only 22.86 per cent were found to be defaulter. However, 51.62 per cent of old age group respondents were found to be irregular in repayment followed by 35.48 per cent regular and 12.90 per cent defaulter. The percentage of irregular group is higher than the regular in middle and old age group. However, regular percentage is more under young age group of respondents (Table 6). The results are in agreement with the results of Das (2001).

Repayment with reference to extension contact : Out of total 52 respondents, 38 (73.08%) belonged to low extension contact category and found irregular followed by 12 respondents were defaulters (23.08%) and only 2 respondents (3.84%) were regular in repayment of loan. Further, majority of respondents 10 (76.92%) belonged to medium extension contact category and were found to be regular in bank loan repayment followed by 02 defaulter (15.38%) and 01 irregular (7.69%) categories, respectively. However, 14(93.33%) respondents were belonging to high category and found regular in their repayment of loan and rest 01 (6.67%) of them was defaulter (Table 7). These results are getting support from the findings of Singh *et al*. (2001).

Constraint : The data were collected to

Table 4. Respondents distribution on the basis of their overall contact with extension agents.

Overall use of information sources	Freq-uency (n=80)	Per cent	Other
Low (up to 3 score)	18	22.50	Mean = 3.41
Medium (4-6 score)	39	48.75	
High (more than 6 score)	23	28.75	S.D. = 2.56
Total	80	100.00	

Table 5. Distribution of respondents according to their loan repayment performance categories.

Category	Frequency (n=80)	Per cent
Regular	26	32.50
Irregular	39	48.75
Defaulter	15	18.75
Total	80	100.00

Table 6. Repayment performance of respondents with reference to age group.

Age	Repayment (No. and per cent of respondents)			Total
	Regular	Irregular	Defaulter	
Young	6 (42.86)	5 (35.71)	3 (21.43)	14 (100)
Middle	9 (25.71)	18 (51.43)	8 (22.86)	35 (100)
Old	11 (35.48)	16 (51.62)	4 (12.90)	31 (100)

Table 7. Repayment performance of respondents with reference to extension contact.

Exten-sion contact	Repayment (No. and per cent of respondents)			Total
	Regular	Irregular	Defaulter	
Low	2 (3.84)	38 (73.08)	12 (23.08)	52 (100)
Medium	10 (76.92)	1 (7.69)	2 (15.38)	13 (100)
High	14 (93.33)	0 (0.00)	1 (6.67)	15 (100)

find put the constraints faced by the respondents which affect the repayment of their loan. It was interesting to observe that those who were paying their loan regularly (32.50%) did not face any problem in repayment; remaining (67.50%) respondents reported multiple problems in repaying their loan. It can be seen that 83.33 per cent of the respondents said that the major constraints was low outcome from the produce. The second important constraint was non-reasonable price to agricultural produce as pointed out by 64.81 per cent respondents. Next constraint was natural calamities such as crop failure as expressed by 46.29 per cent of the respondents. Further, mismanagement of income due to improper planning (33.33%), non willingness to repay the loan (31.48%) attack of insect and pests (27.77%), pressing family needs (25.92%), marketing problems such as regulated marketing facilities are not available in the area (24.07%), poor health of the respondents (20.37%), short repayment period (14.82%), death of milch animals (12.96%) and less income sources (9.26%) constraints were reported by the respondents (Table 8). These findings are similar as reported by Gopalakrishnan (1998) and Yanger *et al*. (2005) who concluded that the possible factors which affect the loan repayment performance were low outcome from the produce and crop failure due to natural calamities.

Suggestions to overcome the constraints : Majority of respondents (76.25%) suggested that the rate of interest in loan should be decreased to get better repayment performance followed by increase in duration and number of installments (70%), support price for agricultural produce should be increased (52.50%), timely and adequate loan to be supplied (40%), marketing facilities should be increased (31.25%), adequate rapport of bank employees with borrowers should be enhanced (21.25%) and only 17.50 per cent respondents suggested that cooperative bank should provide consumption loan. Similar finding were drawn by Viswanath (1999).

References

Das, D. 2001. A study on repayment performance of sample.borrowers of Arunanchal Pradesh State Cooperative Apex Bank Ltd. Ind. Co-opt. Rev. 39(2): 139.

Gopalakrishnan, B. K. 1998. Recovery camp - an effective tool. Fin. Agri. 30(1): 10-12.

Prakash, B. 2001. Performance of primary agricultural cooperative credit societies in India. Ind. J. Agri. Eco. 56(30): 487-488.

Singh, R. P., Pandey, A. K. and Singh, S. K. 2001. Rural credit and participation of credit agiencies- An analysis. Ind. Co-opt. Rev. 38(4): 211-220.

Viswanath, A. R. 1999.An analysis of the performance of agricultural credit cooperatives and their overdue problems on India. Ind. Co-opt. Rev. 26(3): 271.

Yanger, L., Godara, A. K., Singh, S. P. and Kundu, K. K. 2005. A study on cooperative bank loan repayment behavior of farmers in Nagaland. Ind. Eco. Pano. Jan (14): 46-53.

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Farmers Perception Towards the Attributes of Sugarcane Variety CoM-0265*

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Abstract

The data regarding overall perception of farmers towards attributes of CoM-0265 revealed that 70.83 per cent of the respondents had medium level of perception followed by 15.00 per cent with low level of perception. Only 14.17 per cent of them had high level of perception. Thus, majority of the sugarcane growers had medium level of perception towards the attributes of CoM-0265.

Key words : Perception, attributes, CoM-0265, sugarcane.

Predominance of desired attributes from the point of view of farmers ensure wide acceptance of innovations within a short period of time. The intrinsic qualities for attributes of agricultural innovations influence farmers' perception. The present investigation was therefore, aimed to ascertain the perception of farmers about the attributes of CoM-0265 variety and the suggestions to overcome the constraints.

Materials and Methods

The present study was carried out in the jurisdiction of Vighnahar Co-operative Sugar Factory Ltd., Junnar and Bhimashankar Co-operative Sugar Factory Ltd., Ambegaon of Pune district of Maharashtra state. These locations were purposively selected for the study since the area under CoM-0265 variety of sugarcane was high in this area. A descriptive and diagnostic design of social research was used for the present investigation. List of villages having maximum area under sugarcane with CoM-0265 variety was obtained from both sugar factories. In all. twelve villages from the jurisdiction of two sugar factories were selected randomly. The list of sugarcane growers cultivating the variety CoM-0265 was prepared from each selected village in consultation with Cane Development Officers of both sugar factories. From this list, the selection of 10 respondents from each village was made by random sampling. Thus, 120 respondents constituted as a sample for present investigation. The independent and dependent variables were selected as per the objectives along with their empirical measurements. An interview schedule was designed with relevant questions in accordance with the objectives. Perception about attributes of CoM-0265 variety of sugarcane by the respondents was measured with the help of schedule developed in consultation with experts. The statements of the schedule were developed taking into account the attributes of CoM-0265 variety. Finally the data was collected and analyzed with the help of appropriate statistical tools.

Results and Discussion

Perception towards the attributes :

Drought tolerance : Root system of CoM-

*Part of M.Sc.(Agri.) thesis submitted by second author to MPKV, Rahuri.

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0265 variety of sugarcane is deep as compared to other varieties of sugarcane. Hence, its roots can absorb the water and nutrients from deep layer of soil. It is observed from Table 1 that 28.3, 25.84, 17.50 and 12.50 per cent of the respondents were undecided, agreed, strongly agreed, disagreed and strongly disagreed to the attribute that CoM-0265 is tolerant to drought, respectively. Majority of the respondents were undecided towards this attribute because they could not judge the drought tolerance capacity of this variety as good irrigation sources are available throughout the year. Surprisingly more than one fourth respondents disagreed to this attribute of this variety.

Ratoonability : It is observed from Table 1 that a large majority (93.34%) of the respondents strongly agreed or agreed with the attribute of better ratoonability of this variety. Large eyebuds, excellent tillering and deep root system are mainly responsible for better ratoonability of this variety.

Tillering : Further it was observed from

Table 1. Distribution of the sugarcane growers by their perception towards the attributes of CoM-0265 variety.

Statement	Strongly agree	Agree	Un-decided	Disagree	Strongly disagree
Tolerant to drought	21 (17.50)	31 (25.84)	34 (28.33)	19 (15.83)	15 (12.50)
Better ratoonability	62 (51,67)	50 (41.67)	5 (4.16)	3 (2.50)	-
Excellent tillering ability	80 (66.67)	38 (31.67)	1 (0.83)	1 (0.83)	-
Resistant to diseases	30 (25.00)	75 (62.50)	5 (4.16)	10 (8.34)	-
Leaf sheath spines are absent	47 (39.17)	60 (50.00)	7 (5.83)	6 (5.00)	-
Easy de-trashing	44 (36.67)	59 (49.17)	9 (7.50)	8 (6.66)	-
Better for suru planting	50 (41.67)	63 (52.50)	2 (1.67)	5 (4.16)	-
Better for pre seasonal planting	55 (45.84)	58 (48.33)	4 (3.33)	3 (2.50)	-
Better for adsali planting	60 (50.00)	53 (44.17)	3 (2.50)	4 (3.33)	-
Suitable for salt affected soils	62 (51.67)	50 (41.67)	4 (3.33)	4 (3.33)	-
Pest susceptibility	33 (27.50)	71 (59.17)	9 (7.50)	7 (5.83)	-
Sparse flowering	13 (10.83)	21 (17.50)	19 (15.83)	64 (53.34)	3 (2.50)
Maturity period :					
Suru - 12 months	90 (75.00)	27 (22.50)	2 (1.67)	1 (0.83)	-
Preseasonal - 14 months	83 (69.16)	33 (27.50)	2 (1.67)	2 (1.67)	-
Adsali - 16 months	94 (78.34)	24 (20.00)	1 (0.83)	1 (0.83)	-
Non lodging	39 (32.50)	73 (60.84)	5 (4.16)	3 (2.50)	-
Pithiness absent	50 (41.67)	58 (48.33)	5 (4.17)	7 (5.83)	-
Internode splits absent	40 (33.34)	72 (60.00)	3 (2.50)	5 (5.83)	-
Dark green leaves and arrows	94 (78.34)	20 (16.67)	5 (4.16)	1 (0.83)	-
Good for fodder purpose	89 (74.17)	29 (24.17)	1 (0.83)	1 (0.83)	-
Weight loss	35 (29.17)	70 (58.33)	8 (6.67)	7 (5. 83)	-
Weight loss by bursting of eyebuds	32 (26.67)	65 (54.17)	13 (10.83)	10 (8.33)	-
Thick and solid stem	78 (65.00)	34 (28.34)	3 (2.50)	5 (4.16)	-
Large and swallow eyebuds	84 (70.00)	30 (25.00)	3 (2.50)	3 (2.50)	-
Bursting of eyebuds	30 (25.00)	80 (66.67)	6 (5.00)	4 (3.33)	-
Less sugar recovery	22 (18.33)	38 (31.67)	13 (10,.83)	30 (25.00)	17 (14.17)
Jaggery quality - Excellent	27 (22.50)	38 (31.67)	28 (23.33)	20 (16.67)	7 (5.83)
Average yield 161 MT ha^{-1}	101 (84.17)	19 (15.83)	-	-	-

pooled data that 98.34 per cent respondents strongly agreed or agreed about the excellent tillering ability of CoM-0265 variety of sugarcane. Due to deep root system, good response to fertilizers and manure application on an average 15-20 tillers plant^{-1} were observed.

Disease resistance : It is peculiar varietal character. It is observed that 62.50, 25.00, 8.34 and 4.16 per cent of the respondents were agree, strongly agree, disagree and undecided to this attribute, respectively.

Spinelessness : It is observed that 50.00, 39.17, 5.83 and 5.00 per cent of the respondents were agree, strongly agree, undecided and disagree towards the attribute, respectively that leaf sheath spines are absent.

Easy de-trashing : It was noticed that 85.84 per cent of respondents strongly agreed or agreed towards the attribute of easy de-trashing of this variety.

Planting season : It was observed that 52.50, 41.67, 4.16 and 1.67 per cent of the respondents were agree, strongly agree, disagree and undecided towards suru planting attribute, respectively. Further, 48.33, 45.84, 3.33 and 2.50 per cent of the respondents were agree, strongly agree, undecided and disagree towards personal planting attribute, respectively. Similarly, 50.00, 44.17, 3.33 and 2.50 per cent of the respondents were strongly agree, agree, disagree and undecided towards the attribute, respectively as better for adsali planting.

Salt tolerance : CoM-0265 variety has good nutrient and water uptake in salt affected and saline soils. Also productivity is good as compared to other varieties of sugarcane in such soils. It was observed from pooled data that 93.34 per cent of the respondents strongly agreed or agreed that this variety is suitable for saline and salt affected soils.

Pest tolerance : Fiber percentage is high in this variety and leaves are medium thick which cause hindrance to pests to attack. It was observed that 59.17, 27.50, 7.50 and 5.83 per cent of the respondents were agree, strongly agree, undecided and disagree towards this attribute, respectively.

Flowering : This variety comes under the sparse flowering group of sugarcane varieties. Hence, sparse flowering is observed. But in contrast it was observed that 55.84 per cent of the respondents disagreed this attribute.

Maturity : It was observed that 75.00, 22.50, 1.67 and 0.83 per cent of the respondents were strongly agree, agree, undecided and disagree towards the attribute that maturity of this variety for suru sugarcane is 12 months, respectively. Similarly, 69.16 and 27.50 per cent of the respondents were strongly agree and agree, while, equal proportion (1.67%) of the respondents were undecided and disagree towards the attribute that maturity of this variety for preseasonal sugarcane is 14 months. It was also observed that 78.34 and 20.00 per cent of the respondents were strongly agree and agree, while, equal proportion (0.83%) of the respondents were undecided and disagree towards the attribute that maturity of this variety for adsali sugarcane is 16 months.

Lodging : This variety is erect and has deep

Table 2. Distribution of respondents' sugarcane growers according to their perception level.

Category	No. of respondents (n=120)	Per-centage
Low	18	15.00
Medium	85	70.83
High	17	14.17
Total	120	100.00

root system. Hence, non lodging is observed. It lodges if luxuriant growth without nodal breakage. It was observed that 60.84, 32.50, 4.16 and 2.50 per cent of the respondents were agree, strongly agree, undecided and disagree towards this attribute, respectively.

Pithiness : It is peculiar varietal character. It was observed that 48.33, 41.67, 5.83 and 4.17 per cent of the respondents agree, strongly agree, disagree and undecided towards this attribute, respectively.

Internode splits : Internode joints of this variety are strong. Hence, internode splits are absent. Hence, 93.34 per cent of the respondents agreed or strongly agreed towards this attribute.

Greenness of leaves and arrows : It was observed that 78.33, 16.67, 4.17 and 0.83 per cent of the respondents were strongly agree, agree, undecided and disagree towards this attribute, respectively.

Palatability : As leaf sheath spines are absent in this variety and due to dark green leaves, broad leaf it is good for fodder purpose. Respondents reported that leaves remain green for long time. Hence, majority (98.34%) of the respondents reported to agreed and strongly agreed to this attribute.

Harvesting : This variety is drought tolerant, leaves remains green for long time and less percentage of arrows are observed. Hence, no loss in cane weight and sugar recovery is reported if harvested late. It was observed that 58.33, 29.17, 6.67 and 5.83 per cent of the respondents were agree, strongly agree, undecided and disagree towards this attribute, respectively.

Eye bud bursting : This variety is good adopter of environmental changes, non lodging is observed and it lodges if luxuriant growth occure. Hence, bursting percentage of eyebuds is very low. Hence, no loss in cane weight and sugar recovery is reported due to bursting of eyebuds. It was observed that 54.17, 26.67, 10.83 and 8.33 per cent of the respondents were agree, strongly agree, undecided and disagree towards this attribute, respectively.

Thick and solid stem : It is peculiar varietal character. It was observed that 65.00, 28.34, 4.16 and 2.50 per cent of the respondents were strongly agree, agree, disagree and undecided towards this attribute, respectively.

Eyebuds : As stem of this variety is thick and solid, eyebuds are large and swallow. It was observed that 70.00 and 25.00 per cent of the respondents were strongly agree and agree towards the attribute, while, equal proportion (2.50%) of the respondents were undecided and disagree towards this attribute.

Bursting of eyebuds : Leaf sheath on eyebuds are easily trashed. Hence, eyebuds burst when exposed to sunlight. It was noticed that 66.67, 25.00, 5.00 and 3.33 per cent of the respondents were agree, strongly agree, undecided and disagree towards this attribute, respectively.

Sugar recovery : The observations from Table 1 indicated that 39.17 per cent respondents disagreed or strongly disagreed about less sugar recovery of CoM-0265 as compared to Co 86032 variety of sugarcane, while, 10.83 per cent respondents were undecided about this attribute.

Jaggery quality : It was noticed that 54.17 per cent of the respondents agreed or strongly agreed towards the attribute that jaggery quality of this variety is excellent.

Yield : It was noticed that cent per cent respondents strongly agreed or agreed towards

the attribute of high average yield of this variety. More number of tillers, dark green leaves, hence, high rate of photosynthesis, total biomass is high, gives good response to cultural management and fertilizer application. Hence, high average yield is obtained.

These findings are in line with those of Kharde (1994), Solanki *et al.* (2004), Thorat *et al.*(2004), Sasane *et al*. (2008), Mande and Thombre (2009) and Anonymous (2010).

References

Anonymous. 2010. Sugarcane Chapter, *Krishi Darshani* MPKV, Rahuri (M.S.) : 62.

Kharde, P. B. 1994. A study of adoption of improved practices of sugarcane cultivation and problems faced by the members of Padmashri Dr. Vitthalrao Vikhe Patil Sahakari Sakhar Karkhana Ltd., Pravaranagar. M.Sc. (Agri.) thesis. MPKV, Rahuri.

Mande, J. V. and Thombre, B. M. 2009. Adoption of cultivation practices by sugarcane growers. Agric. Sci. Digest. Vol. XXIX (3): 35-38.

Sasane, G. K., Jagdale, U. D., Khule, R. P. and Patil, R. G. 2008. Study of knowledge and adoption of sugarcane water management practices recommended by MPKV, Rahuri. Research Rev. Committee Report, MPKV, Rahuri : 22-49.

Solanki, G. K., Phalke, D. H., Pawar, S. M. and Bhoi, P. G. 2004. Extent of adoption of improved sugarcane technology by the sugarcane growers in Satara district. Res. Rev. Committee Report, MPKV, Rahuri : 55-60.

Thorat, D. R., Shirke, V. S., Bodhale, D. A., Jagdale, U. D. and Patil, P. R. 2004. A study on technology of sugarcane cultivation generated by university considering attributes of the innovations as perceived by the farmers. Research Rev. Committee Report, MPKV, Rahuri : 50-60.

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Impact of Participatory Irrigarion Management Programme in Western Ghat Region (MS)

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Abstract

The foregoing analysis indicated that, there was significant difference in crop productivity on beneficiary farms over non-beneficiary farms which was accrued due to increase in inputs, facilitated by irrigation management and increase in area under wheat and gram in *rabi* season. The per hectare quantity of main produce and byproduee in terms of paddy equivalents was 32.64 q. and 22.60 q. respectively for beneficiary and non beneficiary farms which was 44.42 per cent over non-beneficiary farms, respectively. The total gross return for beneficiary, farms and non-beneficiary farms in terms of paddy equivalents were Rs. 52,430 and Rs. 35,552 respectively which were higher by 47.47 per cent in beneficiary farms over non-beneficiary farms. The farm business income, family labour income and net income were higher by 61.43, 71.49 and 133.75 per cent respectively over non-beneficiary farms. The per farm total employment was 253.24 man days in beneficiary farms over and 88.99 man days in non-beneficiary farms. The per cent change in employment in beneficiary farms over non-beneficiary farms was 174.28 per cent. The per capita change in employment to working members in the family was on higher (105.95 man days) in beneficiary farms side than in non-beneficiary farms (38.19 man days). The employment per hectare of net cropped area was higher by 14.06 per cent for beneficiary farms over non-beneficiary farms. The increase in productivity and input use in case of beneficiary farms was major effect of participatory irrigation management programme. The per quintal cost of different crops on the beneficiary farms was reduced to Rs. 181 for rice, followed by Rs.159 for jowar, Rs. 125 for groundnut and Rs. 272 for gram over non-beneficiary farms. This positive influence of cost reduction has definite advantage towards profit generation for beneficiary farmers through saving in cost of producation.

Key words : Production, employment, income and saving in cost of production.

The watershed programme endeavours to improve and sustain production and productivity of all categories of land at higher levels. The specific objectives of watershed management programme to design a sustainable resource use in order to provide optimum production potential of the agro-ecosystem, promotion of *in-situ* soil and water conservation, proper management of non-arable land to conserve soil, moisture and store run-off for recharging groundwater and optimal use of land to minimise risk in rainfed farming, increase productivity of land and better returns to the farmers on sustainable basis through adoption of better technology and cropping patterns and diversification of sources of income.

Materials and Methods

Patan taluka of Satara district lies under these Western Ghat region. The watershed receives about 1200 to 1500 mm rainfall during June to September. However, there was no any irrigation system for the crops. The crops like paddy were grown but due to shortage of water during flag leaf and grain filling stage, yield decreases because there is no protective irrigation source for this paddy crop. To overcome this problem, watershed programme was started under "Western Ghat

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Table 1. Impact on farm economy.

Particular	Beneficiary	Non-beneficiary	Change over	
			Quantity	Percentage
Net cropped area	1.44	0.55	-	-
Gross cropped area	1.77	0.63	-	-
Cropping intensity (%)	122.91	114.54	-	7.31
Investment in assets (Rs.)	367335	257141	110194	42.85
Productivity of crops (q ha^{-1}) :				
Rice	31.88	22.12	9.76	14.12
Jowar	30.02	21.21	8.81	41.53
Groundnut	18.20	15.26	2.94	19.26
Maize	34.90	-	34.90	-
Wheat	34.74	-	34.74	-
Gram	15.01	8.58	6.43	74.94

Development Programme" in 2002. Under this programme, water harvesting structures like nala bunding (2 no.), gully plugging (104), terracing (14 ha.) and diversion bandhara (1) were completed. With these agriculture development works, the water shortage was over.

Kolgewadi village of Patan taluka was selected for the study where the gravitational irrigation project was carried out. From the list of beneficiaries and non-beneficiaries in the village, the beneficiaries were grouped under three heads *viz*., upper middle and end reach. From each category, ten farms were selected. A sample of thirty non-beneficiary farms not covered under irrigation management programme from the adjacent area was selected randomly to compare the impact of irrigation management programme. The data were collected during 2010-11 by survey method through personal interviews with the selected beneficiaries and non-beneficiaries. The data were analyzed by using simple statistical tools like arithmetic averages, frequency distribution, percentages, and ratios to document impact of irrigation management programme.

Results and Discussion

Impact on farm economy : It could be seen from Table 1 that, cropping intensity on beneficiary farms was higher (122.91%) than the non-beneficiary farms (114.54%). There was 7.31 per cent change in cropping intensity of beneficiary over non-beneficiary farms. The investment in assets was higher by Rs. 1,10,194 (42.85%) in beneficiary farms non-beneficiary farm. It was observed that, the productivity of all crops was higher in beneficiary than non-beneficiary farm. The productivity per hectare was higher by 9.76 q. (14.12%) for rioe, 8.81 q. (41.53%) for jowar,

Table 2. Impact on production and income grneration per hectare of gross cropped area in terms of paddy equivalents.

Particulars	B	NB	Change over	
			Quantity	Percentage
Gross cropped area (ha)	1.77	0.63	1.14	180.95
Cropping intensity (%)	122.91	114.54	8.37	7.30
Production (q) :				
Main produce	32.64	22.60	10.04	44.42
By-produce	23.02	23.25	-0.23	0.99
Gross Returns (Rs.) :				
Main produce	48975	32090	16884	52.61
By-produce	3455	3462	-7	-0.21
Total	52430	35552	16877	47.47
Gross expenditure (Rs.) :				
Cost-A	21755	16551	5204	31.44
Cost-B	31494	23344	8150	34.91
Cost-C	36935	28924	8012	27.70
Cost of production quintal^{-1}	1026	1127	101	8.96
Profit at :				
Cost-A (Farm buissness income)	30675	19002	11673	61.43
Cost-B (Family labour income)	20935	12208	8727	71.49
Cost-C (Net income)	15494	6629	8865	133:75
Benefit-cost ratio	1.42	1.23	-	-

Production and returns are compared in terms of paddy equivalents.

Table 3. Groupwise per farm employment generation.

Particulars/ Crop	Employment generation (man days)		Per cent change over
	Beneficiary	Non-beneficiary	
Net cropped area (ha)	1.44	0.55	261.81
Rice	101.43	61.47	65.01
Jowar	36.60	9.02	305.76
Groundnut	52.06	5.23	895.41
Maize	14.65	-	-
Wheat	18.00	-	-
Gram	30.50	13.27	129.84
Per farm total employment	253.24	88.99	184.57
Per capita employment	105.95	38.19	174.28
Employment ha^{-1} of net cropped area	175.86	161.80	14.06

2.94 q. (19.26%) for groundnut and 6.43 q. (74.94%) for gram in beneficiary farm over non-beneficiary farm. This may be due to use of more inputs by beneficiaries coupled with direct effect of participatory irrigation management.

Further Table 1 clearly indicated that, the per cent change in productivity, cropping intensity, investment in assets was higher and positive over non- beneficiaries which could be attributed to adoption of participatory irrigation management programme. The foregoing analysis indicated that, there was significant difference in crop productivity on beneficiary farms over non-beneficiary farms which was accrued due to increase in inputs facilitated by irrigation management and increase in area under wheat and maize in *rabi* season.

Production and income realization : It is seen from the Table 2 that, the hectare^{-1} quantity of main produce and by produce in terms of paddy equivalents was 32.64 q. for beneficiary and 22.60 q for non-beneficiary farms which was higher by 44.42 per cent over non-beneficiary farms. The per hectare cost of production has considerably increased to the extend of 27.70 per cent for beneficiary farms. This increment was mainly attributed mostly to increase in use of critical inputs for crops grown and additional labour use. Though total cost of production has increased on beneficiary farms, it had negative influence over quintal^{-1} cost of production. The quintal^{-1} cost of production was reduced to the extent of Rs. 101 over non beneficiary farms.

Table 4. Unit cost reduction due to participatory irrigation management programme (figures in Rs.).

Particulars	Rice		Jowar		Groundnut		Maize		Wheat		Gram	
	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB
Output q ha^{-1}	31.88	22.12	30.02	21.21	18.20	15.26	34.90	-	34.74	-	15.01	8.58
Increase in output (%)	44.12	0	41.53	0	19.26	0	-	-	-	-	74.94	0
Cost hectare^{-1} :												
Cost-A	21410	17157	23069	18508	24873	22013	22004	-	19940	-	15101	9135
Cost-B	31257	24298	33624	26156	33249	29064	30752	-	31653	-	23363	14149
Cost-C	37709	30174	38005	30221	39395	34932	33621	-	3610-2	-	29399	19138
Cost quintal^{-1} :												
Cost-A	672	776	768	873	1367	1443	630	-	574	-	1006	1065
Cost-B	980	1098	1120	1233	1827	1905	881	-	911	-	1556	1649
Cost-C	1183	1364	1266	1425	2165	2289	963	-	1039	-	1959	2231
Unit cost reduction :												
Cost-A	104	0	104	0	76	0	-	-	-	-	59	0
Cost-B	118	0	113	0	78	0	-	-	-	-	93	0
Cost-C	181	0	159	0	125	0	-	-	-	-	272	0

In terms of value, return from main produce and byproduce for beneficiary farms terms of paddy equivalents were Rs. 48,975 and Rs. 3,455 respectively and Rs. 32,090 and Rs. 3,462 for non-beneficiary farms. Thus, total gross returns were higher by 47.47 per cent for beneficiary farms (Rs. 52430) over non-beneficiary farms (Rs. 35552) in terms of paddy equivalents.

The benefit cost ratio was 1.42 for beneficiary farms and 1.23 for non-beneficiary farms which was on higher side. The farm business income, family labour income and net income were higher by 61.43 per cent, 71.49 per cent and 133.75 per cent, respectively over non-beneficiary farms. The findings on income level and economics of crop production are in conformity with Kanan *et al*. (2006). On whole the zero cost of conveyance for irrigation and higher production increased returns to beneficiary farm substantially. This has clearly revealed gain in income generation through the participatory irrigation management programme for uplifting economic conditions of beneficiary farms.

Employment : Since, the farm income level has improved significantly on account of irrigation management; the farmers were greatly benefited by a way of gainful employment generation in crop production. The crop wise per farm employments generation is given in Table 3.

The per farm employment was higher by 65.01 per cent in rice, 305.76 per cent in jowar, 895.41 per cent in groundnut and 129.84 per cent in gram for beneficiary farm over non-beneficiary farm which may be due to the increase in productivity and high levels of input use by beneficiaries of participatory irrigation management. The per farm total employment was 253.24 man days in beneficiary farm and 88.99 man days in non-beneficiary farm. The per cent change in per capita employment in beneficiary farm over non-beneficiary farm was 174.28 per cent. The per capita employment to working members in the family was on higher side (105.95 man days) in beneficiary group than non-beneficiary group (38.19 man days). The employment hectare^{-1} of net cropped area was higher by 14.06 per cent for beneficiary farms over non-beneficiary farms. These observations are similar to those reported by Naik (2009) and Jobpaul and D. Shreenivasa Rao (2011).

Varietal shift : Farmers started using new improved varieties of different crops. Local rice varieties of mid-late duration were replaced by high yielding early duration rice varieties like Khamang, RH-10 and Suruehi. There was change in jowar varieties from local (mid-late) to CSH-5, CSH-9 improved (early). Also there was change in groundnut varieties from local to JL-24, TG-26 etc. improved (early). Also wheat varieties like NIAW-301 and HD-2189 in midlate category were sown by farmers. The gram varieties like chafa and annegiri was sown by farmers before irrigation management programme which were susceptible to wilt disease. Farmers replaced these varieties by adding new improved varieties like Vijay and Digvijay. The adoption of early varieties by the farmers enabled them to take one more crop in *rabi* season. These changes had influenced agricultural crop production practices as reported by Prabhakar *et al*. (2010).

Unit cost reduction : The crop wise per farm cost of cultivation was further analysed for estimating reductions in unit cost/saving in cost due to participatory irrigation management programme. It is clearly observed from the Table 4, that the adoption of irrigation through Kolgewadi participatory irrigation management programme, the quintal^{-1} cost of different crops on the beneficiary farms was reduced to Rs. 181 for rice, followed by Rs. 159 for jowar, Rs.

125 for groundnut and Rs. 272 for gram over non-beneficiary farms. This positive influence on cost reduction has definite advantage towards profit generation for beneficiary farmers by saving in cost of cultivation.

References

Jobpaul, K. D. L. and Sreenivasa Rao, D. 2011. Impact of watershed development on equitable distribution of income and employment-A study in drought prone district of Kadapa in Andhra Pradesh. Internat. Res. J. of Agril. Econ. and Stat. 2(2): 262-268.

Kannan, K., Srivastava, R. C., Mohanty, S., Sahoo, N., Das, M., Mohanty, R. K. and Nanda, P. 2006. Impact evaluation of micro level water resource development and improved agricultural practices on crop productivity and economics. Indian J. Soil Cons. 34(1): 55-69.

Naik, P. K. 2009. Impact of national watershed development programme for rainfed agriculture- A case study. Indian J. Soil Cons. 37(3): 230-235.

Prabhakar, K., Lavanya Latha, K. and Papa Rao, A. 2010. Watershed programme: Impact on socio-agricultural and socio-economic spheres of the farmers. Indian J. of Agril. Sci. 1(1): 31-37.

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Bank Loan Repayment Capacity of the Chhattisgarh Farmers as Influenced by Socioeconomic Factors

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Abstract

Bank loan repayment capacity study at Raipur district of Chhattisgarh state indicated that the respondent with higher annual income showed better repayment performance. A majority of the respondents with low to medium socio economic status were found defaulter in repayment of their loans. However, only few of them were found to be regular. Study also showed that there was no impact of number of earners in the loan repayment performance.

Key words : Socioeconomic, loan, repayment, farmer, respondent.

India is a developing country and about 65 per cent population depends on agriculture. The present trend of agriculture will shift from subsistence to commercial farming exploring new vistas which would require modernization and standardization of its various activities. Now a days, agriculture sector requires massive capital. As such majority of Indian farmer in general and farmers of Chhattisgarh in particular does not possess sufficient owned funds and they depend on the borrowed money. In this direction co-operative banks play major role especially in village areas to meet the agricultural demands of the society farmers. However, the progress of co-operative bank strengthening in respect of agriculture credit is very much poor in the state due to no repayment behavior of the farmers. Considering the situation as a burning issue, socioeconomic factors associated to recycle of the loan, the present study was carried out.

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Materials and Methods

The study was carried out in a well established largest district Central Co-operative Bank under the jurisdiction of Indira Gandhi Agricultural University, College of Agriculture, Raipur in Chhattisgarh. Out of 57 Co-operative Bank branches, four branches namely Arang , Mandir Hasaud. Dharsiwa and Abhanpur were randomly selected for this study. Randomly 20 farmers who had already taken loan from selected each branches constituted the universe. Thus total 80 borrowers were considered as respondents.

The socioeconomic characters (occupation, annual income, land holding size, house type, material possession and farm power, number of earners in the family, loan its purpose and type as wdl as availability time and utilization along with socio- economic status) were included at the time of interview. However, the socio-economic status is classified into three categories i.e., low level (score - up to 10). middle level (score - 11 to 18) and high level (score - 19 <). All the information was collected during interview by developed a suitable interview schedule.

Results and Discussion

Occupation : The majority of the respondents (35%) were involved in farming, followed by farming + labour (31.25%). Whereas 21.25 per cent respondents were engaged in farming + animal husbandry, 8.75 per cent did farming + business, whereas 2.50 per cent respondents were devoted in farming + service. Only 1.25 per cent respondents had farming + other occupations. Similar findings have been reported by Gopalakrishnan (1998).

Annual income : The maximum number of the respondents (47.50%) were under low annual income group followed by middle group (35.00%) while 11.25 per cent respondents were under high group. Only 6.25 per cent respondents were under very high annual income group. Similar findings have been reported by Viswanath (1999).

Land holding : Maximum number of the respondents (35%) had small size followed by marginal size (28.75%) land holding, whereas 16.25 per cent of the respondents were under the category of medium size. Only 20 per cent of the respondents had big size of land holding (above 4.0 ha). Similar findings have been reported by Despande and Nandapurkar (1999).

Type of house : The 50 per cent of respondents were living in kachcha type followed by 27.50 per cent respondents in pacca house. Whereas, 22.50 per cent respondent were living in the hut/thatches. Similar findings have been reported by Lal (1999).

Material possession and farm power : The 36.25 per cent respondents had two farm animals or materials such as bullock cart and radio, followed by 23.75 per cent respondents

Table 1. Repayment performance of respondents with reference to annual income.

Annual income group	Repayment category, No. and per cent			Total
	Regular	Irregular	Defaulter	
Low (up to Rs. 25,000)	10 (26.32)	20 (52.63)	8 (21.05)	38 (100)
Medium (Rs. 25,001 to Rs.50,000)	08 (28.57)	16 (57.14)	4 (14.29)	28 (100)
High (Rs. 50,001 to Rs. 75,000)	05 (55.56)	02 (22.22)	2 (22.22)	09 (100)
Very high (above Rs. 75,000)	03 (60.00)	01 (20.00)	1 (20.00)	05 (100)

having three farm animals or materials such as improved farm implements. However, 17.50 per cent respondent had one farm animal or material such as bullock, buffalo, cow and cycle, whereas, 11.25 per cent respondent had five to ten farm animals or materials such as gas, pump set, motorcycle and exactly same category respondents were having more than ten animals or materials such as tractor, automobile, television etc. Similar findings have been reported by Das (2001).

Number of earners in the family : Out of 80 farmer's family, 45 per cent belonged to medium earners group followed by 35 per cent in high and 20 per cent in low earners category.

Purpose of loan : Survey indicated that majority of the respondents (81.25%) had taken loan for agricultural purpose followed by 11.25 per cent for other purpose. However. 7.50 per cent of the respondents had taken loan for subsidiary business purpose. Similar findings have been reported by Prakash (2001).

Type of loan : The maximum number of the respondents (60%) had taken short-term (up to 6 months) loan, followed by 30 per cent who had taken medium-term (six months to 5 years) loan. While only 10 per cenl of the respondents taken long-term (above 5 years) loan. Similar observations were made by Afolabi (2008).

Timely availability of loan : It was seen that 27.50 per cent respondents reported that they have not obtained the loan in time while 16.25 per cent respondents said that they obtained loan late from the cooperative bank. Further 18.75 per cent respondents replied that they can't say anything about availability of loan. But 21.25 per cent respondents reported that they could get loan very much in time. However, 16.25 per cent said that they obtained loan in time. Similar findings have been reported by Singh *et al*. (2001).

Utilization of loan : It was evident that 37.50 per cent respondents partially utilized loan amount for productive purpose followed by 35.00 per cent who fully utilized their loan amount in specific purpose. However, 16.25 per cent fully utilized in other purpose whereas 11.25 per cent respondents fully misutilized their loan amount. Similar findings have been reported by Mazumdar and Baruah (1999).

Socio-economic status : Majority of the respondents (66.25%) were under medium socio-economic status followed by 17.50 per cent under high and 16.25 per cent under low socio-economic status. The results are in agreement with the results of Yanger *et al*. (2005).

Table 2. Repayment performance of respondents with reference to socio-economic status.

Socio-economic status	Repayment category, No. and per cent			Total
	Regular	Irregular	Defaulter	
Low	2 (15.38)	5 (38.46)	6 (46.16)	13 (100)
Medium	15 (28.30)	27 (50.95)	11 (20.75)	53 (100)
High	9 (64.29)	4 (28.57)	1 (7.14)	14 (100)

Table 3. Repayment performance of respondents with reference to earners in the family.

Earners in the family	Repayment category, No. and per cent			Total
	Regular	Irregular	Defaulter	
Low	6 (37.50)	5 (31.25)	5 (31.25)	16 (100)
Medium	12 (33.33)	19 (52.78)	5 (13.89)	36 (100)
High	8 (28.57)	15 (53.57)	5 (17.86)	28 (100)

Repayment behavior : The 52.63 per cent respondents (Table 1) of low annual income group were found irregular followed by 26.32 per cent of them regular repayers and rest (21.05%) were defaulters. Further, 57.14 per cent respondents from medium annual income were found to be irregulars in their repayments and 28.57 per cent of them were regular. The 55.56 per cent respondenta from high and 60 per cent from very high annual income were found to be regular in repaying their loan. However, 22.22 and 20.00 per cent were found defaulters under these two categories, respectively. The similar findings were reported by Yanger *et al*. (2005).

Repayment performance and socio-economic status : A perusal of data given in Table 2 revealed that 64.29 per cent respondents having high socio-economic status were regular in repayment of loan followed by 28.57 per cent irregular. However, only 7.14 per cent of the respondents of high category were found to be defaulters. A majority of respondents (50.95%) from medium category were irregular in repayment followed by 28.30 per cent were regular in repayment of their loan and only 20.75 per cent respondents were defaulter. Further. 46.16 per cent respondents of low category were found defaulter, while 38.46 per cent were irregular and only 15.38 per cent were regular in repayment of loan. Thus, the higher socio-economic status played significant role in the repaying performance. These findings are in line with the findings of Yanger *et al.* (2005).

Repayment performance and earners percentage : Data of Table 3 revealed that 37.50 per cent of the respondents from low earners categories were regular in repayment of loan. However, 31.25 per cent respondents were found to be irregular and also defaulter. A majority (52.78%) of the respondents belonged to medium earners category and were found to be irregular in repayment of loan followed by regular (33.33%) and defaulter (13.89%). More than half (53.57%) of the respondents were belonging to high category and were found to be irregular while 28.57 per cent were regular and only 17.86 per cent were defaulters in their repayment.

Repayment performance and timeiiy availability of loan : It is evident from the Table 4 that 47.06 per cent of the respondents who had obtained loan very much in time and

Table 4. Repayment performance of respondents with reference to timely availability of loan.

Timely availability of loan	Repayment category, No. and per cent			Total
	Regular	Irregular	Defaulter	
Very much in time	8 (47.06)	7 (41.18)	2 (11.76)	17 (100)
In time	2 (15.38)	10 (76.93)	1 (7.69)	13 (100)
I can't say	5 (33.33)	6 (40.00)	4 (26.67)	15 (100)
Not in time	7 (31.82)	8 (36.36)	7 (31.82)	22 (100)
Vary late	4 (30.77)	8 (61.54)	1 (7.69)	13 (100)

Table 5. Repayment performance of respondents with reference to utilization of loan.

Utilization of loan	Repayment category, No. and per cent			Total
	Regular	Irregular	Defaulter	
Fully utilized in specific purpose	8 (28.57)	13 (46.43)	7 (25.00)	28 (100)
Fully utilized in other purpose but productive	9 (30.00)	16 (53.33)	5 (16.67)	30 (100)
Partially utilized for productive purpose	6 (46.15)	6 (46.15)	1 (7.70)	13 (100)
Fully misutilized	3 (33.34)	4 (44.44)	2 (22.22)	9 (100)

found regular followed by 41.18 per cent respondents irregular while, 11.76 per cent found to be defaulter. Majority of respondents (76.93%) who had obtained loan in time and found irregular in their loan repayment. However, 15.38 per cent were regular in loan repayment and only 7.69 per cent were defaulter respondents who had obtained loan in time and found to be irregular in loan repayment. Maximum respondents (40.00%) who were not sure about the time period of loan availability were irregular in repayment followed by 33.33 per cent respondents were regular, whereas, 26.67 per cent of the respondents were found to be defaulter. Further, 31.82 per cent respondents who obtained their loan not in time were found to be irregular as well as defaulter followed by 27.50 per cent respondents who were regular in repayment of their loan. More than half of the respondents (61.54%) who had obtained loan very late were irregular followed by 30.77 per cent and 7.69 per cent respondent were regular and defaulter, respectively. Similar observations were made by Enoma (2010).

Repayment performance and utilization of loan : It can be concluded from the Table 5 that majority (46.43%) of the respondents who have fully utilized their loan in specific purpose and found irregular in their loan repayment followed by 28.57 per cent were regular respondents, while 25.00 per cent were defaulter. However, 53.33 per cent respondents who fully utilized their loan in some other productive purpose and found irregular, followed by 30.00 per cent regular and only 16.67 per cent defaulter. A significant majority (46.15%) of the respondents who partially utilized their loan for productive purpose and found to be regular and irregular in their loan repayment, while only 7.70 per cent of them were found defaulter. Further, majority of the respondents (44.44%) fully misutilized their loan and found irregular followed by regular (33.34%) and rest of them (22.22%) were defaulter. The similar observations were made by Nawai and Shariff (2010).

Repayment performance and type of loan : The majority (39.58%) of the respondents obtained short term loan were found both regular and irregular in their loan repayment, followed by defaulter (20.82%). With reference to medium term loan majority of the respondents (62.50%) were irregular followed by regular (20.83%) and defaulter (16.67%). Further, 62.05 per cent respondents who had taken long term loan and found irregular, followed by one fourth (25.00%) regular and rest of them (12.50%) were defaulter. Similar observations were made by Oboh and Ekpebu (2011).

References

Afolabi, J. A. 2008. Analysis of loan repayment among small scale farmers in south western Nigeria - a discriminant approach. J. Soc. Sci., 17(1): 83-88.

Das, D. 2001. A study on repayment performance of sample borrowers of Arunanchal Pradesh State Coop. Apex Bank Ltd. Ind. Co-opt. Rev. 39 (2): 139.

Deshpande, S. D. and Nandapurkar, G. G. 1999. Relation of socio- economic profile with repayment and utilization of bank loan by rural women. J. Maharashtra agric. Univ. 23(2): 151-153.

Enoma, A. 2010. Agricultural credit and economic growth in Nigeria: An empirical analysis. Bus. Econ. J. (BEJ), 14(7): 1-7.

Gopalakrishnan, B. K. 1998. Recovery camp - an effective tool. Fin. Agri. 30(1): 10-12.

Lal, Roshan. 1999. Utilization and repayment pattern of beneficiaries under DRDA- Scheme. Ph. D. thesis, CCSHAU, Hisar.

Mazumdar, D. K. and Baruah, H. K. 1999. An analysis of repayment performance of agriculture credit in Nagaon district of Assam. J. Agril. Sci. Soc. of N E India. 12(2): 158-163.

Nawai, N. and Shariff, M. N. M. 2010. Determinants of Repayment Performance in microcredit programs: A review of literature. Int. J. Bus. Soc. Sci., 1(2): 152-161.

Oboh, V. U. and Ekpebu, I. D. 2011. Determinants of

formal agricultural credit allocation to the farm sector by arable crop farmers in Benue State, Nigeria. African J. Agric. Res., 6(1): 181-185.

Prakash, B. 2001. Performance of primary agricultural cooperative credit societies in India. J. Agri. Eco. 56 (30): 487-488.

Singh, R. P., Pandey, A. K. and Singh, S. K. 2001. Rural credit and participation of credit agiencies - an analysis. Indian Co-opt. Rev. 38(4): 211- 220.

Viswanath, A. R. 1999. An analysis of the performance of agricultural credit cooperatives and their overdue problems on India. Indian Co-opt. Rev. 26(3): 271.

Yanger, L., Godara, A. K., Singh, S. P. and Kundu, K. K. 2005. A study on cooperative bank loan repayment behavior of farmers in Nagaland. Indian Eco. Pano. Jan (14): 46-53.

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Socio-Economic Profile of the Suicide Prone Farmers Families of Vidarbha

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Abstract

Among the 60 families over one fourth (28.33%) were illiterate, more than half of them (51.66%) were from OBC caste group, mostly the *Kunbis* and having small to medium family size. More than half of the families possessed upto 1.00 ha land and have moderately fertile land (55.00%). Majority (83.33%) of the families did not have any access to source of irrigation and have crop-crop (83.66%) farming system. Over half (58.33%) of them were engaged seasonally in crop cultivation on their own farm plus farm labour for wage earning as a supportive endeavor to farming. More than half (51.67%) of the families have 120-211 mean man days employment in a year. Labour/wage earning contributed 56.87 per cent share in their total mean man days and 46.67 per cent families have income in the range of Rs. 20,001 to 40,000. The average income of the selected families was Rs. 33,450/-. The farming and wage earning were found contributory income sources. In majority (85.00%) of the families income gap was noted. Over three fourth (76.67%) families have availed loans from institutional sources out of them 45.65 per cent families were found defaulters and 35.00 per cent families having debt in the range of Rs. 15001 to 30.000. Near about half (48.33%) of the families were having medium morale strength and not recovered from the suicide shock of the family head.

Key words : Socio-economic, livelihood, distress-prone, subsidiary occupation, income liability gap.

In six distress districts of Vidarbha, Yavatmal, Buldana, Amravati, Akola, Washim and Wardha during January 2001 to December 2011 about 8220 farmers committed suicide, out of which 2854 (35%) cases were compensated at Government level (Anonymous, 2007). These suicides have happened, by and large, due to yield, price, credit, income and weather uncertainties (Mishra, 2006). Though family head left due to severe agrarian crisis, it is very difficult for his family members to survive the livelihood in Vidarbha. The Vidarbha farmers, who committed suicide, were mostly the family

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heads and the main bread earner of the family members. For many victims spouse or many widows and their family members, suicide is not about the dead, it is about the living and for them they soldiers on. Every moment of life has been a struggle for them. The central and state government has implemented various relief packages for development of the farmers in distress districts of Vidarbha.

The present field survey was planned with a specific objective to study the existing socio-economic and livelihood profile of the households of suicide victim farmers of Vidarbha after suicidal death of the family head.

Materials and Methods

The present investigation was carried out in distress districts namely, Akola, Buldana, Washim. Amravati. Yavatmal and Wardha of Vidarbha region of Maharashtra. Exploratory design of social research design was used. In this study respondents were the households of selected victims who committed suicide during 1st January 2001 to 31st December 2011 and had declared as legal victims by district level committee headed by Collector of the respective district, for allotting compensation of Rs. 1 lakh and received it. From each district 10 families were interviewed who lost their family head during 2001 to 2011. Thus total 60 families of suicide victim farmers were selected randomly from 46 villages for this study, it covered total 9 tehsils of 6 distress districts of Vidarbha. A structured interview schedule was prepared and used for data collection. Data were collected by personal interview method with the help of structured interview schedule.

Results and Discussion

Socio-economic profile of the families:

Age : It is observed from Table 1 that 35.00 per cent of the immediate family heads of

Table 1. Distribution of the immediate family head of selected suicide victim farmers according to socio-economic profile.

Category	Percentage
Young (Up to 35)	35
Middle (36-50)	33.33
Old (above 50)	31.67
Total	100
Educational level :	
Illiterate	28.33
Primary school	20.00
Middle school	18.33
High school	21.67
Higher secondary school	1 1 .67
Total	100
Caste category :	
Schedule Caste (SC)	18.33
Schedule Tribe (ST)	8.33
Vimukta Jati (VJ-A)	6.67
Nomadic Tribe (NT-B)	5.00
Nomadic Tribe (NT-C)	1.67
Nomadic Tribe (NT-D)	1.67
Other Backward Classes (OBC)	51.66
Special Backward Class (SBC)	5.00
Open	1.67
Total	100
Family size :	
Small (Upto3)	58.33
Medium (4 to 6)	30.00
Large (7 to 9)	10.00
Very large (Above 9)	01.67
Total	100
Holding group :	
Marginal (Upto 1.00 ha.)	51.67
Small (1.01 to 2.00 ha.)	36.66
Semi-medium (2.01 to 4.00 ha.)	06.67
Medium (4.01 to 10. 00 ha.)	05.00
Total	100.00
Status of soil :	
Very deep	6.67
Deep	11.67
Moderately deep	55.33
Shallow	28.33
Very shallow	00.00
Total	100.00

selected victim farmers were under young age category i.e. upto 35 years. It was followed by one third (33.33%) of family head who were found in middle age category i.e. 36 to 50 years and remaining 31.67 per cent were found under old age category i.e. above 50 years. The age profile analysis of the selected families of the victims indicated that more or less in all age group respondents were covered under the study.

Educational level : It is observed that out of the total respondents, over one fourth i.e. 28.33 per cent were illiterate and remaining 71.67 per cent were literates. Within the literates 21.67 per cent family head were educated up to high school level, followed by 20.00 per cent of the family head having education up to the primary, 18.33 per cent have middle school and remaining 11.67 per cent had higher secondary school level education and not a single family head possessed college level education. Thus the overall education level of the selected families was low.

Caste : Over half (51.66%) of the respondents were belonged to OBC category, mostly the Kunbi's from six distress districts. Kunbi caste is the dominant caste and they mostly depends on farming business in study area. This was followed by SC category (18.33%), schedule tribe 8.33 per cent and Vimukta Jati (VJ-A) category (6.67%). Three families each (5.00%) from Nomadic Tribe (NT-B) and SBC category. Whereas one (3.33%) each of the family from Nomadic Tribe-C (NT-C), Nomadic Tribe-D (NT-D) and Open category. The data revealed that over half of the families were from OBC group.

Family size : The data revealed that over half (58.33%) of the selected families were concentrated in small size family having up to 3 family members. This was followed by 30.00 per cent families under medium (4 to 6) family size. While 10.00 per cent victims having large family size (7 to 9 members). Whereas 1.67 per cent respondents having very large family size (above 9 members). Thus, it is inferred that

Table 1. Contd.

Category	Percentage
Type of soil :	
Rich fertile	05.00
Moderate fertile	55.00
Poor/Warkas	40.00
Total	100.00
Irrigation sources :	
No source	83.33
Well	16.67
Total	100.00
Farming system :	
Crop-crop	83.33
Crop-dairy	16.67
Total	100.00
Livelihood sources :	
Agriculture + Labor	58.33
Agriculture + Labour + Niradhar allowances	13.33
Agriculture (only farming)	05.00
Agriculture + Labour + Milch animals	16.67
Agriculture + Anganwadi Service	06.67
Total	100.00
Mean man days :	
120-211	51.67
212 and Above	48.33
Total	100.00

Table 2. Share of each livelihood sources in total mean man days employment.

Livelihood sources	% Share in total mean man days
Farming	31.93
Labour	56.87
Milch animals	06.45
Service	04.75
Total	100.00

majority of the families were having small to medium family size.

Land holding : Data showed that over half (51.67%) of the families come under marginal land holding group i.e. having land up to 1.00 ha. This was followed by small (36.66%) land holder (1.01 to 2.00 hectares) group. Whereas 6.67 per cent having semi-medium (2.01 to 4.00 ha) and 5.00 per cent have medium (4.01 to 10.00 ha.) land holding. Out of the total 60 families, 5 (8.33%) families lease out their land to others.

Type of land and soil type : The data regarding the type of land of the selected families revealed that over half (55.33%) of the families were having moderately deep type of land, followed by over one fourth (28.33%) respondents having shallow, 11.67 per cent having deep and 6.67 per cent were having very deep type of land. Over half (55.00%) of the selected families were having moderate fertile soil, followed by 40.00 per cent families with poor fertile soil and 5.00 per cent have rich fertile type of soil.

Irrigation facilities : It is observed that majority (83.33%) of the families did not have any access to source of irrigation. They solely depended on monsoon rains. While 16.67 per cent families were having open welll as irrigation source. Out of the 10 wells, 7 (70.00%) wells were dug after suicidal death of family head by the respondents under Govt. scheme. These group of the families now needs electric connections. Thus it is revealed that majority (83.33%) selected families were not having any source to access the irrigation. They were mostly depends on monsoon rains only.

Farming system : The data revealed that majority (83.66%) of the families of suicidal farmers were adopting crop-crop farming system and crop-dairy system adopted by 16.67 per cent families.

Livehood scources : The data indicated that over half (58.33%) of the selected families were engaged in agriculture plus farm labour for wage earning as a supportive endeavor to farming. Followed by 16.67 per cent were engaged in their own farm plus farm labour and milch animals. This milch animals they got from Prime Minister Package. While 13.34 per cent families receiving Niradhar allowance Rs.600/- per month plus agriculture and wage earning.

Table 3. Distribution of the victims' families according to their annual income and their sources (2011-12).

Category	Percentage
Annual income (Rs.) :	
Up to 20,000	31.67
20,001 to 40.000	46.67
40,001 to 60,000	18.33
Above 60,000	3.33
Total	100
Livelihood sources :	
Farming	44.79
Labour	38.30
Service on *Anganwadi*	08.63
Milch animals	05.41
Govt. Niradhar Allowance	02.87
Total	100.00

Table 4. Annual expenditure pattern of the victims' families on different items (2011-12).

Items	Total	
	Amount Rs.	Percentage
Food	1380700	40.68
Clothing	139500	04.11
Housing	40000	01.18
Education	167950	04.95
Health	310500	09.15
Festivals	171400	05.05
Lighting	93920	02.77
Marriage	30000	00.88
Agriculture	7,42,000	21.86
Repayment of debts	3,18,000	9.37
Total	33,93,970	100.00

Whereas 6.67 per cent were engaged in agriculture plus *Anganwadi* service got after the suicidal death of the family head and 5.00 per cent were have only farming as the livelihood source.

Employment generation (in mean man days) : The minimum man days (Table 2) were noted 120 days in one family. As per the Government of India norm 212 mean man days is required for achieving sustainable livelihood. Hence the results about the mean man days of all selected families were grouped in two groups. The results clearly indicated that over half (51.67%) of the respondents were have 120-211 mean man days employment in a year. Whereas 48.33 per cent of the families were having 212 and above mean man days employment in a year. Hence this result clears that over half (51.67%) of the selected families were not having sustainable rural livelihood.

The results about the share of each livelihood source in total mean man days employment of selected families showed that labour wages earning occupied more than half (56.87%) share, followed by farming (31.93%). milch animals (6.45%) and service (4.75%).

Annual income : Income is a major determinant of the economic status of an individual. Every individual's style of living is decided to a great extent by his income. Low income creates very difficulty for an individual to manage affairs of the family (Madan, 1980). From Table 3, it is observed that 46.67 per cent of the families had annual income between Rs. 20,001 to Rs. 40.000. Whereas 31.67 per cent having upto Rs.20.000. This was followed by 18.33 per cent belonging to income group with annual income between Rs. 40.001 to Rs. 60.000 and remaining 3.33 per cent families had annual income above Rs. 60,000.

The average annual income of all families was computed Rs. 33,450/-. Thus it is observed that majority of families were concentrated having annual income upto Rs.20, 000 (31.67%) and between Rs. 20.001 to Rs. 40.000 (46.67%).

The farming contributed 44.79 per cent share followed by labour wage earning (38.30%), anganwadi service (8.63%). milch animals (5.41%) and Govt. Niradhar allowance contributed 2.87 per cent share in total annual income of the selected families. Thus the results revealed that farming with wage earning were the major contributing sources of income of the selected families.

Expenditure pattern : It could be observed from Table 4 that out of total expenditure of overall families, the expenditure on food had higher share contributing 40.68 per cent and expenditure on crop cultivation (agriculture) contributed 21.86 per cent share. Expenditure on repayment of debts (9.37%). health contributed 9.15 per cent, festivals (5.05%), education (4.95%), and clothing (4.11%). The share of housing and lighting have very negligible share. The average expenditure of all selected families computed to Rs. 56.S66/-. From the data it was revealed that these families have no other options only for survival they are living.

Gap between income and expenditure: It is evident from Table 5 that, among 9 (15.00%) families there was no gap between

Table 5. Distribution of selected victims' families according to their identified gap between annual livelihood income and expenditure.

Gap range in Rs.	Percentage
No Gap	15.00
Upto 6000	10.00
600 1 to 12000	10.00
12001 to 24000	30.00
Above 24000	35.00
Total	100.00

annual livelihood income and expenditure which means their livelihood income is enough to fulfill the essential expenditure. While among rest of them 85.00 per cent families gap was observed. The gap was noted, upto Rs. 6000 and Rs. 6001 to 12000 among each of the 10.00 per cent families. Whereas. Rs. 12001 to Rs. 24000 among 30.00 per cent families and above Rs. 24000 with 35.00 per cent families. The average gap was observed Rs. 28161/- with the 51 (85.00%) families.

Indebtedness : It can be seen from the Table 6 that over three fourth (76.67%) families were found indebted, it means they have availed the institutional credit facilities and remaining 23.33 per cent were free from debt. Whereas out of the total families sizable group (45.65%) of the families were defaulters from last two-three years and they were not eligible for availing the loan facility during 2011-12.

The data indicated the credit sources availed by the selected families. It gives clear idea about type of credit sources utilized by the selected families. It was observed that majority (68.33%) of the families availed the loans of institutional credit sources. Whereas, 15.00 per cent have taken loan from their relatives.

Out of the 60 families 46 (76.67%) families had outstanding debt of institutional sources. When the investigator went through the above mentioned four classes, it was observed that out of the total, over one third (35.00%) families having debt in the range of Rs. 15001 to 30,000. This was followed by Rs. 30.001 to 60.000 with 16.67 per cent families, upto Rs. 15000 with 15.00 per cent families and above Rs. 60.000 with 10.00 per cent families. The average debt computed to Rs. 26,833/-

Morale strength : The 48.33 per cent of the families were having medium morale strength, followed by 45.00 per cent families struggling very hard after suicidal death and have stronger morale strength. For these group suicide is not about the dead, it is about the living and for them they soldiers on. Whereas 6.67 per cent families withdraw their attention from farm, family, economic and social issues after suicidal death of the family head.

The present study revealed that more than half (51.66%) of the families were from OBC caste group, mostly the Kunbi's and having small to medium family size. More than half of the families possessed upto 1.00 ha land (51.67%) and have moderately fertile land (55.00%). Majority (83.33%) of the families did not have any source to access irrigation and have crop-crop (83.66%) farming system. Over half (58.33 %) of them were engaged

Table 6. Distribution of selected victims' families according to their indebtedness, credit sources and moral strength.

Indebtedness	Percentage
Indebtedness :	
Indebted families	16.61
Free from debts	23.33
Defaulter	45.65
Total	100.00
Sources :	
Institutional :	
Co-operatives (Socities and co-op. banks)	53.33
Commercial banks	15.00
Non-institutional :	
Relatives	15.00
Volume of debts Rs. :	
Free from debts	23.33
Upto 15,000	15
15,001-30,000	35
30,001-60,000	16.67
Above 60,000	10.00
Total	1 00.00
Morale strength index :	
Weaker (Upto 33.33)	6.67
Medium (33.34-66.66)	48.33
Stronger (Above 66.66)	45
Total	100.00

seasonally in crop cultivation on their own farm plus farm labor for wage earning as a supportive endeavor to farming. More than half (51.67%) of the families have 120-211 mean man days employment in a year as against GOI norm 212 mean man days for achieving sustainable livelihood. Labour wage earning contributed 56.87 per cent share in their total mean man days and 46.67 per cent families have income in the range of Rs. 20,001 to 40,000. The average income of the selected families were Rs. 33,450/-. The farming and wage earning were found contributory income sources. The expenditure on food had contributed 40.68 per cent share and average yearly expenditure was estimated Rs. 56,566/. In majority (85.00%) of the families income gap was noted. Over three fourth (76.67%) families have availed loans from institutional sources out of them 45.65 per cent families were found defaulters and 35.00 per cent families having debt in the range of Rs. 15001 to 30,000. The average outstanding debts computed to Rs. 26,833/-. Near about half (48.33%) of the families were having medium morale strength and yet not recovered from the suicide shock of the family head. This research study revealed that these families were living in very pathetic condition and not have sustainable livelihood. For improving this situation there is a need to increase the income level of the families for increasing their paying capacity, increase the employment opportunities, debts availability, raise educational level, increase the irrigation sources for profitable crop grown for raising their rural livelihood sustainabilky. Secondly diversify the livelihood sources of the families by promoting agro based subsidiary livelihood options like dairy, goatary, poultry, etc. Declare the remunerative prices for all crops of the farmers. More focus should be given on increasing the rural infrastructure by stepping up public investment in agriculture for increasing the farmers' income generating capabilities, because infrastructure facilities are very negligible in these six districts of Vidarbha.

References

Anonymous. 2007. Report of the Expert Group on Agricultural Indebtedness. Ministry of Finance, Govt. of India.

DFID. 2004. Sustainable livelihoods guidance sheets, Department for International Development, United Kingdom.

Madan, G. R. 1980. Indian Social Problems, Volume-I. New Delhi, Allied Publ. Pvt. Ltd.

Mishra, Srijit. 2006. Farmers suicides in Maharashtra. Economic and political weekly, April 22 : 1538-1545.

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Agricultural Credit Policy and Institutional Financing in India

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Abstract

The share of institutional credit was increased and remarkable decline in the share of non-institutional credit during the same period. The share of commercial banks was hardly 0.90 per cent in 1950, it increased to 25.10 per cent in 2010. Up to the end of March 2010, total Kisan Credit Card (KCC) issued in India were 1009.18 lakh, which were 7.84 lakh in the year 1998-99. Out of the total KCC issued, the co-operative banks issued 40.32 per cent where as the RRB and commercial banks issued 15.06 per cent and 44.62 per cent, respectively. In case of RRB for period of 26 year, the CGR of working capital, deposits, loan advanced and share capital was found satisfactory. All the public sector banks have been advised to reduce their lending rate for agriculture to a single digit rate of not more than 9 per cent per annum on crop loans upto a ceiling of Rs.50,000. Hence, there is need to promote micro finance more vigorously on a widespread basis.

Key words : Agril credit policy, financing, policy initiatives.

Agriculture plays a crucial role in the development of the Indian economy. It accounts for about 19 per cent of GDP and about two thirds of the population is dependent on the sector. Recognizing the importance of agriculture sector in India's development, the Government and the Reserve Bank of India (RBI) have played a vital role in creating a broad-based institutional framework for catering to the increasing credit requirements of the sector. Agricultural policies in India have been reviewed from time to time to maintain pace with the changing requirements of the agriculture sector. Credit, as one of the critical non-land inputs, has two-dimensions from the viewpoint of its contribution to the augmentation of agricultural growth *viz*., availability of credit and the distribution of credit. In this paper, the trends in agricultural credit (Sale *et al*., 1998) are analyzed in Section I; Section II covers State wise position of institutional credit in India; Section III deals with recent policy initiatives.

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Section I: The trends in agricultural credit

Agricultural credit is disbursed through a multiagency network consisting of Commercial Banks (CBs), Regional Rural Banks (RRBs) and Cooperatives. According to report of National Federation of State Cooperative Banks Ltd, New Mumbai, there are approximately 94,647 village-level Primary Agricultural Credit Societies (PACS), 372 District Central Cooperative Banks (DCCBs) with 13181 branches and 31 State Cooperative Banks (SCBs) with 1015 branches providing primarily short- and medium term agricultural credit in India. The long-term cooperative structure consists of 19 State Cooperative Agricultural and Rural Development Banks (SCARDBs), with 2609 operational units as on 31 March 2010 comprising 788 branches and 772 Primary Agricultural and Rural Development Banks (PA and RDBs) with 1049 branches.

The policy of agricultural credit is guided

mainly by the considerations of ensuring adequate and timely availability of credit at reasonable rates through the expansion of institutional framework. Over time, spectacular progress has been achieved in terms of the scale and outreach of institutional framework for agricultural credit. Some of the major discernible trends are as follows:

The percentage share of institutional and non-institutional credit in agriculture w.e.f. 1950 to 2010-11 is depicted Table 1. The share of institutional credit, which was little over 7.30 per cent in 1950, increased manifold to over 68.80 per cent in 2010, reflecting a remarkable decline in the share of non-institutional credit from around 92.70 per cent to about 29.70 per cent during the same period.

One of the major achievements in the post-independent India has been widening the spread of institutional machinery for credit and decline in the role of non-institutional sources. The share of co-operative banks was 3.30 per cent in 1950, it increased to 24.99 per cent in 2010, while the share of commercial banks was hardly 0.90 per cent in 1950, it increased to 25.10 per cent in 2010 (Annonymous, 2010).

Agency wise flow of institutional credit to agriculture in India during 1985-86 to 2010-11 indicated in Table 2. Commercial banks and RRBs were clubbed together upto 1990-91. The credit flow to agriculture in India during 1985-86 was only Rs. 7601 lakh which increased to Rs. 446779 lakh during 2010-11 and percentage change over base year was 5778. The share of commercial banks has increased from 41.19 per cent to 74.47 per cent and the share of cooperative banks has reduced from 50.97 per cent to 15.69 per cent from the year 1985-86 to 2010-11.

Table 1. Percentage share of credit in agriculture (1950-51 to 2010-11).

Source	1950	1960	1970	1980	1990	2000	2010
Institutional of which	7.30	18.70	31.70	63.20	66.30	61.30	68.80
Co-operative banks	3.30	2.60	22.00	29.80	23.60	30.20	24.99
Commercial banks	0.90	0.60	2.40	28.80	35.20	26.30	25.10
Non-institutional of which	92.70	91.00	68.30	36.80	30.60	38.90	29.70
Money lenders	69.70	49.20	36.10	16.10	17.50	26.80	21.90
Other	23.00	41.80	32.20	20.70	13.10	12.10	7.80
Total	100	100	100	100	100	100	100

Source : Annual Report of NABARD, 2011.

Table 2. Agency wise flow of institutional credit to agriculture in India during 1985-86 to 2010-11 (Rs. crore).

Agency	Period		Change (%)	CGR (%)		
	1985-86	2010-11		Period I (1985-2000)	Period II (2001-2011)	Entire period (1985-2010)
Co-operative banks	3874 (50.97)	70105 (15.69)	1709	12.68	13.38	12.83**
Regional rural banks (w.e.f. 1991)	596 (7.84)	43968 (9.84)	7277	101.07	28.12	57.37**
Scheduled commercial banks	3131 (41.19)	332706 (74.47)	10526	15.43	30.95	21.83**
Total	7601	446779	5778			

** - 1 % level of significance. Source : Economic surcey and NABARD, various issues.

In order to study agency wise status of KCC issued in India, the secondary data was collected, analyzed and presented in Table 3. Up to the end of March 2010, total KCC issued in India were 1009.18 lakh, which were 7.84 lakh in the year 1998-99. Out of the total KCC issued, the Co-operative banks issued 406.93 lakh (40.32%) whereas the Regional Rural Banks and Commercial banks issued 151.95 lakh and 450.30 lakh (15.06% and 44.62%), respectively. For the Co-operative banks and Commercial banks lot of variations has been seen in issuing KCC on the other hand the Regional Rural Banks have shown a steady growth in issuing KCC. The compound growth rate for total KCC issued in India was 9.04 per cent per annum. The Co-operative banks showed 1.72 per cent annual compound growth rate where as the Regional Rural Banks and Commercial banks registered 33.34 per cent and 12.70 per cent (both significant at 1 per cent) annual compound growth rate.

Table 3. Agency-wise status of kisan credit card issued in India (lakh numbers).

Year	Coope-rative banks	RRBs	Comm-ercial banks	Total
1998-99	1.56 (19.90)	0.06 (0.77)	6.22 (79.34)	7.84 (100.00)
2001-02	54.36 (58.19)	8.34 (8.93)	30.71 (32.30)	93.41 (100.00)
2005-06	25.98 (32.42)	12.49 (15.60)	41.65 (51.98)	80.12 (100.00)
2010-11	28.10 (38.71)	17.80 (24.52)	26.70 (36.77)	72.60 (100.00)
Total	406.93 (40.32)	151.95 (15.06)	450.3 (44.62)	1009.18 (100.00)
CGR	1.72	33.34	12.70	9.04

Source : Annual report - NABARD, 2011.

Section II : Statewise position of cooperative loan in India

The Statewise position of cooperative loan in India as on March-2010 stated in Table 4. It is observed that maximum loan issued in the Kerala state i.e. Rs. 2615277 lakh and it was followed by Tamilnadu (Rs. 954878 lakh) Punjab, (Rs. 625309l lakh) and Maharashtra (Rs. 528417 lakh.) The loan demanded was maximum in the state of Maharashtra i.e Rs. 285317 lakh followed by Kerala (Rs. 185247 lakb), Punjab (Rs. 717563 lakh), Tamilnadu (Rs. 710196 lakh) and Haryana (Rs. 631034 lakh). The loan outstanding was highest in Kerala state i.e. Rs. 2240547 lakh followed Maharashtra (Rs. 965743 lakh), Tamil Nadu (Rs. 852896 lakh), Haryana (Rs. 483279 lakh). The overdue was higest in Maharashtra state as on March 2010.

The progress of RRB in India during 1985-86 to 2010-11 is indicated in Table 5. The working capital, deposits, loan advanced and share capital of RRB in India were increased by 48301, 10929, 5533 and 328 per cent, respectively over period of 26 years. The CGR for entire period of working capital, depositsy loan advanced and share capital were found satisfactory i.e. 32.86, 21.03, 17.52 and 18.51 per cent, respectively.

Section III : Recent policy initiatives

There are many rural infrastructure projects which have been started but are lying incomplete for want of resources. They represent a major loss of potential income and employment to rural population. Rural Infrastructure Development Fund (RIDF) was set up in NABARD under the initiative of the Government of India in 1995-96 with an initial corpus of Rs. 2,000 crore to provide loans to State Governments for financing rural infrastructure projects. Since then, 11 tranches of allocations have been made towards the fund. Commercial banks make contributions towards the fund on account of the shortfalls in their priority/agriculture sector lending. The scope of RIDF has been widened to enable utilization of loan by Panchayati Raj Institutions

(PRIs), Self-Help Groups (SHGs), Non-Government Organizations (NGOs), etc., since 1999-2000. The fund has continued with additional corpus being announced every year in the union budget. The RIDF XI was announced in the union budget for 2005-06 with an allocation of Rs. 8,000 crore making a total corpus of Rs. 78,300 crore.

Special rehabilitation package for the districts severely affected by farmers'

Table 4. State wise position of cooperative loan as on March, 2010 (Rs. lakh).

States/ Union territories	Laon issued	Laon demanded	Loan outstanding	Overdues
South Zone				
Andhra Pradesh	333920.78	376565.76	457585.01	145770.05
Karnataka	326742.90	334609.24	407155.78	84614.72
Kerala	2615277.27	1852647.89	2240547.75	469386.64
Tamil Nadu	954878.75	710196.93	852896.73	104126.91
Pondicherry	3826.08	2662.55	3279.01	258.60
West Zone				
Goa	977.10	1609.25	2657.65	766.29
Gujarat	391727.18	435360.56	393860.04	142770.36
Maharashtra	528417.00	2835317.00	965743.00	2080612.00
North Zone				
Haryana	431664.36	631034.35	483279.50	242770.91
Himachal Pradesh	2667.00	2611.00	3442.00	632.00
Jammu & Kashmir	1288.41	3136.86	3713.41	2451.30
Punjab	625309.99	717563.58	443193.13	90225.27
Rajasthan	307424.02	379538.16	303760.63	129793.64
Uttar Pradesh	79747.00	121663.94	163175.54	51586.94
Urtarakhand	32346.26	38996.49	34754.37	8017.43
Central Zone				
Madhya Pradesh	249648.14	382276.56	251293.67	174823.12
Chhattisgarh	62752.64	90052.82	61257.24	23743.12
East Zone				
Bihar	35252.75	55101.71	43248.00	27719.64
Jharkhand	100.00	2379.65	1384.87	2246.60
Orissa	360199.40	385349.12	346719.17	96157.73
West Bengal	147184.13	186560.28	179470.33	70166.99
North-East Zone				
Arunanchal Pradesh	0.00	0.00	0.00	0.00
Assam	794.25	319.88	594.43	42.27
Manipur	310.00	305.92	470.78	294.28
Meghalaya	342.65	777.48	1025.63	682.98
Mizoram	65.95	85.68	85.33	36.87
Nagaland	204.73	663.98	937.09	602.38
Pondicherry	3826.08	2662.55	3279.01	58.60
Sikkim	323.50	0.06	93.17	0.06
Tripura	12.68	2151.70	2044.88	2044.88

Source : Annual report - NABARD, 2011.

suicide : The incidents of suicide by farmers have been mainly reported from the States of Andhra Pradesh, Karnataka, Maharashtra, and Kerala. To mitigate the distress of farmers, the Government of India decided to launch a special rehabilitation package in 31 districts in the States of Maharashtra, Andhra Pradesh, Karnataka, and Kerala. The 31 districts were identified based on the severity and magnitude of the incidence of farmers' suicide, as reported by the State Governments. The intent is to initially solve the problem and correct the situation in those areas reporting high number of suicides so that an effective dent on the problem is made and the incidence of farmers' suicide which is of national concern could be curbed. The package aims at establishing a sustainable farming system through debt relief to farmers, improved supply of institutional credit and subsidiary income opportunities through horticulture, livestock, dairying, fisheries. During June, 2004 Advisory Committee on Flow of Credit to Agriculture and Related Activities from the Banking was set up under the Chairmanship of Prof. V. S. Vyas. The Government of India announced a host of measures in June 2004 to double the flow of agricultural credit during the period 2004-05 to 2006-07 by all the financial institutions. The Reserve Bank has undertaken several policy initiatives in pursuance of the objective set to achieve a doubling of flow of credit to agriculture. On the issue of farmers' suicide in the country, the Government has realized that indebtedness is one of the major reasons for suicide by farmers in the country. To prevent and save the farmers from the clutches of private money lenders, several measures were taken. Banks were advised in particular as follows:

i) To increase the agricultural credit flow at the rate of 30 per cent per year.

ii) To restructure the outstanding debt of the farmers.

iii) To grant a one-time settlement (OTS) including partial waiver of interest or loan to the small and marginal farmers who have been declared as defaulters and have become ineligible for fresh credit.

iv) In some parts of the country, farmers face acute distress because of the heavy burden of debt from non-institutional lenders (e.g., moneylenders). Banks have been permitted to advance loans to such farmers to provide them relief from indebtedness.

v) All the public sector banks have been advised to reduce their lending rate for agriculture to a single digit rate of not more than 9 per cent per annum on crop loans upto a ceiling of Rs. 50,000.

Table 5. Progress of Regional Rural Banks in India (1980-81 to 2010-11) (Rs. Crore).

Particulars	Period		Change (%)	CGR (%)		
	1985-86	2010-11		Period I (1985-2000)	Period II (2001-2011)	Entire period (1985- 2010)
RRBs (No.)	188	82	-56.38	0.30	-9.01	-2.3 1NS
Share capital	46	197	328.26	16.58	-15.00	18.51***
Deposits	1315	145034	10929.20	23.42	17.34	21.03***
Working capital	164	79379	48301.83	24.88	52.49	32.86***
Loan advanced	1405	79157	5533.95	17.86	24.75	17.52***

Source : Annual Report-NAB ARD, 2010-11.

References

Anadam, M. A. and Namsivayam, N. 1988. Cooperative overdues- the influence of socio-economic factors of borrowing: A case study. Indian Coop. Review 25(3): 293.

Anonymous. 2010. NABARD State Focus Paper, 2009-10.

Balishter, A. K. and Shiv Kumar. 1991. Overdues of loans in agriculture-A study. Agric. Banker. 14(1): 13-16 pp.

Dawar Ram. 1989. Overdues in agricultural advances cause and remedies. Indian Coop. Review. 27(1): 69-87 pp.

Derashri, S. D. 1968. Co-operative financing for agricultural development - some essentials for its success. Role of co-operative credit in agricultural development. Faculty of Commerce, Univ. of Jodhpur, pp. 8.

Goyal, Pramila. 1983. The menacing problems of overdues of credit cooperatives- Indian Coop. Review. 21(3): 260-265 pp.

Sale, D. L., Shlnde, H. R. and Inamke, N. M. 1998. Agricultural Credit System in India- A brief review. Indian J. of Aric. Econ. 5(3): 522.

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Utility and Impact of Supplemental Irrigation from Water Harvesting Tanks in Malwa Region

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Abstract

The study revealed that storing excess rainwater in dugout farm ponds for utilization during the dry spells of monsoon season or for raising a subsequent crop was a promising way to improve the cropping intensity and crop productivities and to stabilize the farming in the Malwa region. The activity of excavation of farm ponds on the individual farmer's field was extremely useful in turning the mono-cropped area into multi-cropped/crop diversified area and improving the farmer's income and, thus, his standard of living.

Key words : Water harvesting tanks, black soil, runoff.

In Malwa region, the topography is such that two types of the tanks can be constructed in the' farmers fields (i) excavated tanks suited for flat topography and (ii) excavated cum embankment type tanks particularly in degraded or gullied portion. In most of the cases, use of flexible structure is necessary for this condition even at lower cost than tanks with cemented inlet and outlet (Ranade *et al*. 2001). Though various studies have been made at, other parts of country (Singh, 1983), but not scientific and specific information particularly on use of stored water and its effect on *rabi* crops is available in Malwa region. Keeping these points in view, a study was carried out during 2005-2008 mainly for rainwater management through assessing the economic feasibility of the water harvesting tanks constructed in the portion of the land of the farmers in Malwa region to facilitate for better rainwater management and improving crop productivity in the region and to determine to what extent the system of construction, storage and utilization of stored water in the water

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Table 1. Cost of construction of various tanks under the scheme.

Name of owner of field	Storage capacity (cu. m.)	Year of construction	Cost of construction	Utilization
Manohar	7457	2005	263000/-	Irrigation
Sandeep	3054	2005	161100/-	Irrigation
Prasanna	2937	2005	161820/-	Irrigation
Abhyankar	2723	2005	200000/-	Irrigation
Chain Singh	2396	2006	161820/-	Irrigation

harvesting tank would ffi increase the crop productivity.

Materials and Methods

Five suitable sites were finalized for the construction of excavated water harvesting tanks in the farmer's fields itself in Dakachya micro-watershield (22° 51' 28" N latitute 75° 57' 58" E longitude), respecively on the Malwa plateau. In all five tanks (four in 2005, one in 2006) were constructed. The details of these tanks are given in Table 1.

After the construction of tanks, the details regarding frequency of irrigation, area under different crops, crop diversification and the total quantity of water utilized during the entire season have been worked out.

Results and Discussion

Filling of tanks and recession pattern : The delayed monsoon during 2005-06 though delayed the planting of *kharif* crop by almost one month, but the heavy rainfall on 01.08.2005, which resulted in heavy runoff filled all the tanks to their capacity (Table 2). Part of this stored water was utilized during the dry spell period for life saving irrigation to soybean crop. Further, the tank was again filled to their full capacity on, 15th September 2005 due to heavy rains. The recession curve for availability of water for irrigation in these tanks also indicated that sufficient water was available for irrigating *rabi* crops in the month of November 2005.

It is very clear from the Table 2 that during

Table 2. Dates of filling to FSL, season's cumulative rainfall up to first filling to FSL (2005-08).

Tank	Type of the tank	Date of first filling to FSL	Season's rainfall (mm)	Seasonal cummulative rainfall upto filling to FSL (mm)	% of seasons' rainfall needed to fill the tank
Manohar	Excavated cum embankment	01.08.2005	733	430.8	58.7
Abhyankar	Excavated	01.08.2005	733	430.8	58.7
Prasanna	Excavated	01.08.2005	733	430.8	58.7
Sandeep	Excavated	01.08.2005	733	430.8	58.7
Dates of filling to FSL, season's cummulative rainfall during (2006-07) :					
Manohar	Excavated cum embankment	24.07.2006	1065	337	32
Abhyankar	Excavated	29.06.2006	1065	138	13
Prasanna	Excavated	21.07.2006	1065	261	24
Sandeep	Excavated	24.07.2006	1065	337	32
Dates of filling to FSL, season's cummulative rainfall during (2007-08) :					
Abhyankar	Excavated	08.07.2007	865.4	348.8	40
Prasanna	Excavated	08.07.2007	865.4	348.8	40
Sandeep	Excavated	08.07.2007	865.4	348.8	40
Chainsingh	Excavated	08.07.2007	865.4	348.8	40

Table 3. Details of irrigation applied during *kharif* (2005-06).

Tank	Manohar	Sandeep	Abhyankar	Prasanna
Time of Irrigation	28-30 August	25-30 August	25-30 August	-
Type of Irrigation	Flood irrigation	Sprinkler + flood	Sprinkler irrigation	-
Amount of water used (m^3)	2485	680	815	-
Area irrigated (ha)	2.75	1.0	3.25	-

No water was utilized during *kharif* 2006 for irrigation purpose.

Table 4. Overall increase in yield due to *kharif* irrigation (2005).

Tanks	With irrigation (q)	Without irrigation (q)	Increase in yield (q)
Manohar	55.0	44.0	11.0
Sandeep	20.4	14.4	6.0
Abhyankar	48.36	28.86	19.5
Prasanna	-	12.0	-

2006, Abhyankar tank got filled on 29th June itself as high rainfall occurred in its catchment. About 100 mm rainfall was recorded on that day. Despite unsaturated soil profile, the runoff was quite high and it filled the tank within 2-3 hours. Though Manohar tank, which is located only 1 km away from Abhyankar tank, started receiving runoff on the same date, it got filled to its capacity in the last week of July 2006 as not much rains occurred in its catchment area. However, all tanks were filled in the last week of July when sufficient rains occurred in the region.

However, during 2007 it was quite visible that the onset of monsoon was almost uniform and different tanks located in various locations and villages got filled simultaneously on 08.07.2007 itself as catchment area of all these tanks received heavy rainfall which in turn generated sufficient runoff to bring all the tanks to their capacity.

Effect of supplemental irrigation during *kharif* season (2005-06) : During the three years of study period, it was observed that only during 2005 the soybean crop needed supplemental irrigation due to long dry spell. It was observed that the provisions of supplemental irrigation from these tanks during *kharif* season increased the overall productivity.

Crop diversification in *kharif* : As already pointed out, the major crop of the region is soybean. The farmers grow only soybean in the *kharif* season as the rainfall fulfills its water requirement. Further, it has

Table 5. Change in *rabi* cropping pattern due to availability of water in the tanks.

Farmer/Crop/ Tanks	Area under cultivation (ha) (2005-06 and 2007)						Area under cultivation (ha) (2006-2007)			
	Gram		Wheat		Potato	Garlic	Maize + Barseem		Brinjal + Tomato	
	2005	2006	2005	2006	2006	2006	2006	2007	2006	2007
Manohar	5.0	1.0	2.5	5.25	1.25	0.625	0.5	0.75	0.25	0.375
Sandeep	1.0	1.25	-	-	-	-				
Abhyankar	2.5	2.25	-	1.75	0.38	0.25	Grown and planted fruit plants on pigeonpea bunds of the tank		0.5	-
Prasanna	1.25	1.5	-	-	-	0.25				
Chain Singh*	-	1.0	-	1.00	-	-	Grown pigenpea on bunds of the tank in first year i.e. 2006 itself			

Table 6. Total increase in yield of gram due to tank irrigation (2005-06).

Tanks	Area	With irrigation (q)	Without irrigation (q)	Increase in yield (q)
Manohar :				
- Wheat	2.5	60.0	0.0	60.0
- Gram	5.0	60.0	0.0	60.0
Sandeep	1.0	8.0	0.0	8.0
Abhyankar	2.5	24.5	0.0	24.5
Prasanna	1.25	10.0	0.0	10.0

been reported that due to continuous cultivation of the same crop many problems like pest infestation, non-fruiting are responsible for the reduction in yield levels. Therefore, farmers are being convinced to diversify their cultivation practices. However, due to non-availability of sufficient water, the farmers do not take risk of cultivating other crops, which require frequent irrigation even during rainy season. If source of water is available, the farmers may even opt for high value crops, e.g. the farmer (Manohar) developed such a confidence with water harvesting tank constructed in 2005 that he transplanted cauliflower, a high value crop which require assured irrigation during dry spells in 0.62 ha. Further, he transplanted brinjal in 0.25 ha.

Similarly, in the adjoining field of Abhyankar tank, about 0.5 ha was brought under cauliflower transplanting. Even at Barlai, due to construction of tank and availability of assured water throughout the year, fish rearing has been taken up continuously for second year. Thus even in *kharif*, there are other options with the farmers to grow high value crops if sufficient water is available in the tanks.

Crop diversification due to availability of water in the tanks during *kharif* season

Tank	Crop during 2005-06	Crop during 2006-07	Crop during 2007-08
Manohar	Soybean	Soybean Sorghum Vegetables	Soybean Sorghum
Abhyankar	Soybean	Soybean Vegetables	Soybean Maize

Table 7. Cropped area and number of irrigations provided from different sources during *rabi* 2006-07.

Tank	Crop	Area (ha)	Yield (q ha^{-1})	Irrigation by tubewell	Irrigation by tank	Total no. of irrigation by tubewell and tank
Manohar	Wheat	5.25	40	1	4	5
	Gram	1	21.5	1	1	2
	Garlic	0.625	64	2	3	5
	Potato	1.25	333.76	3	0	3
	Vegetable	0.25	250	0	5	5
	Maize + Barseem	0.5	115	0	3	3
Sandeep	Gram	1.25	20	0	2	2
Prasanna	Gram	1.5	20	1	1	2
	Garlic	0.25	60	2	3	5
Abhayankar	Wheat	1.75	48	4	0	4
	Gram	2.25	20	1	1	2
	Garlic	0.25	60	2	3	5
	Potato	0.38	325	1	2	3
	Moong	0.25	2	0	2	2
	Vegetable	0.5	230	0	5	5
Chain Singh	Gram	1.5	18	0	2	2

Effect of supplemental irrigation during *rabi* season : Most of tanks provided one pre sowing irrigation to the *rabi* crops. Since, the pre sowing irrigation requires maximum irrigation water due to cracking pattern and unsaturated soil profiles (10 to 11.5 cm ha^{-1}), the irrigation water from the tanks saved atleast two subsequent irrigations from other sources like tubewells. However, the requirement of water for pre sowing irrigation depends on the distribution, amount and stored soil moisture in the soil profiles. Therefore, it is very clear that the amount of water required per irrigation particularly for pre sowing depends on the soil moisture profile and cracking pattern in the vertisols. It is, therefore, really difficult to propose practical size of the dugout ponds particularly in black soil as water requirement or area commanded mainly depends on the water front advancement, which is governed mainly by physical properties of soil and ultimately soil moisture storage.

During *rabi* 2006-07, due to good and well-distributed rainfall condition the ground water availability also increased. Thus most of the farmers in the region provided pre-sowing irrigations through tube wells for wheat and gram. However the availability of stored water in the tanks constructed encouraged and provided confidence to the farmers to grow even other crops like potato, garlic, brinjal, fenugreek, fodder crops in addition to traditional crops like wheat and gram.

Crop diversification in *rabi* : This is to highlight that due to availability of surface water in Abhayankar and Manohar tanks, summer moong and vegetables after the harvest of *rabi* crops, was planted during 2006-07 utilizing the stored water for irrigation purpose.

Increase in yield due to *rabi* irrigation: It is very clear that only because of tank construction and availability of water in these tanks; all the farmers could grow gram in *rabi* in their fields (Table 6). The other adjoining farmers could not grow any crop due to non-availability of surface water.

Due to evenly distributed rainfall during

Table 8. Overall income earned by farmers by using tank water during 2006-07.

Tank	Crop	Area (ha)	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Irrigation cost (Rs. ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C
Manohar	Wheat	5.25	27	6880	3273	10153	24300	14147	2.393
	Gram	1	7.5	6600	1656	8256	26250	17994	3.180
	Garlic	0.625	42	73600	2275	75875	138600	62725	1.827
	Vegetable	0.25	250	20000	3792	23792	87500	63708	3.678
	Maize+ Barseem	0.5	115	6400	2276	8676	23000	14324	2.651
Sandeep	Gram	1.25	20	6600	2560	9160	50000	40840	5.459
Prasanna	Gram	1.5	15	6600	759	7359	37500	30141	5.096
	Garlic	0.25	40	73600	2276	75876	132000	56124	1.740
Abhayankar	Gram	2.25	7	6600	759	7359	17500	10141	2.378
	Garlic	0.25	40	73600	2276	75876	124800	48924	1.645
	Potato	0.38	188	59200	1518	60718	83472	22754	1.375
	Moong	0.25	2	4000	1516	5516	7000	1484	1.269
	Vegetable	0.5	230	20000	3792	23792	80500	56708	3.3S3
Chain Singh	Gram	1.5	18	6600	2133	8733	45000	36267	5.153

2006 monsoon, the ground water availability increased in the area. The farmers utilized the stored water in their tanks in conjunction with tubewell water for irrigating the *rabi* crops. The details of area irrigated and number of irrigation provided from tubewell and tank and the overall yield of different crops recorded is presented in Table 7.

As already pointed out during 2006-07 tank water was utilized in conjunction with tube well water for irrigating *rabi* crops and the overall yield obtained is given in Table 8. It is very clear that for all the *rabi* crops, higher B:C ratio could be obtained due to irrigation from the stored water. Narayan *et al*. (1988) and Mishra *et al*. (1998) reported similar results for small farm ponds.

It can thus, be concluded that the provision of tanks provides sufficient water not only during *kharif* season but also during or before planting of *rabi* crop. Since, the pre sowing irrigation requires maximum irrigation water due to cracking pattern and unsaturated soil profiles, the irrigation water from the tanks saves atleast two subsequent irrigations from other sources *viz*., tubewells. The availability of stored water in the tanks encourages and provides confidence to the farmers to grow even other crops like potato, garlic, brinjal, fenugreek, fodder crops in addition to traditional crops like wheat and gram.

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References

Mishra, P. K., Rama, Rao, C. A. and Shiv Prasad, S. 1998. Economic evaluation of farm pond in a micro watershed in semi arid alfisol Deccan Plateau. Indian J. of Soil Conserv. 26(1): 59-60.

Narayan, H. C., Itnal, Gopalakrishnan, C. J., Hebber, B. and Patil, V. S. 1988. An evaluation of, supplemental irrigation through farm pond on drylands. Indian J. of Soil Conserv. (1): 1-6.

Ranade, D. H., Gupta, Ram, K., Jain L. K. and McCool D. K. 1993. Comparative performance of different sealant materials for seepage control. Indian J. Soil Conser. 21(2): 1-5.

Ranade, D. H., Tomar, A. S., Jain, L. K. and Vishwakarma, S. K. 2001. Reduction in seepage rate and storage capacity of a dugout pond - A case study, J. of Soil and Water Conserv. 45(1 and 2): 50-52.

Singh, R. P. 1983. Farm ponds. Project Bulletin No. 6, All India Coordinated Research Project for Dryland Agriculture, Hyderabad, Andhra Pradesh.

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Effect of Formaldehyde Treated Groundnut Cake on Growth Performance of Heifers

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Abstract

Effect of feeding of formaldehyde treated GNC treatment on average daily body weight gain was significant (P<0.05). The body weight gain in treatment T_0, T_1 and T_2 was 449.00, 564.01, 602.20 g day^{-1}, respectively. Feeding formaldehyde treated GNC significantly increased the growth rate in crossbred heifers.

Key words : Crossbred heifers, formaldehyde, lucerne, jowar green.

Use of GNC in animal ration is well known but feeding of formaldehyde treated oil cakes generally increase the growth rate of animals up to 25-30 per cent over the control group. A significant increase in growth rate was observed on feeding formaldehyde treated groundnut cake and mustard cake in goat kids (Mudgal nad Sengar, 1980 , Gupta and Walli, 1987), crossbred calves (Kumar and Walli 1994) and in buffalo calves (Chatterjee and Walli, 2003). Groundnut cake (GNC) is rich in some of the essential amino acids such as lysine and sulphur containing amino acids in comparison to other commonly used cakes. Formaldehyde has been found to be an efficient and comparatively cheaper method to protect highly degradable protein sources in rumen hence present investigation was undertaken.

Materials and Methods

Twenty one crossbred heifers were randomly divided into three groups of seven each on the basis of body weight and age. All the heifers were offered Lucerne + Green Jowar + Dry Jowar fodder. The heifers in treatment T_0 were fed with concentrate mixture having untreated GNC, while those in treatment T_1 and T_2 GNC was treated with formaldehyde @ 0.5 g per 100 g CP and 1.0 g per 100 g CP, respectively.

Table 1. Treatmentwise ingredient in concentrate mixture.

Ingredients	T_0	T_1 (0.5% FA treated GNC)	T_2 (1% FA treated GNC)
GNC	30	30	30
Maize	25	25	25
Wheat bran	22	22	22
Tur chuni	20	20	20
Mineral mixture	2	2	2
Common salt	1	1	1

Table 2. Chemical composition of experimental feeds.

Item	Proximate components (DM basis) %					
	DM	CP	EE	CF	NFE	TA
Green jowar	25.56	6.25	2.37	28.28	56.44	6.66
Lucerne	21.96	20.2	2.43	24.48	42.49	10.40
Dry jowar kadbi	88.03	5.83	2.11	32.20	52.53	7.33
Conc. mix	90.89	20.93	4.68	8.52	58.21	7.66

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All the heifers were fed individually as per Thumb Rule, during the experimental period of 90 days. Clean and fresh water was offered to all the animals daily. All other management practices were similar in all the treatment groups.

Required amount of formalin solution (Formaldehyde 40%) was spread uniformly on the groundnut cake and stored in air tight bags for one week before its use in the conc. mixture i.e. T_1 @ 0.5 g FA/100 g CP i.e. 420 ml. formalin per 100 kg groundnut cake is required. In T_2 @ 1.0 g FA/100 g CP i.e. 840 ml formalin per 100 kg groundnut cake is required.

Results and Discussion

The CP content in green jowar, lucerne and dry jowar kadbi was 6.25, 20.20 and 5.83 per cent, respectively. The CF content in green jowar, lucerne and dry jowar kadbi was 28.28, 24.48 and 32.20 per cent, respectively. The CP content of concentrate mixture was 20.93 per cent. The EE, CF, NFE and TA content of concentrate mixture were 4.68, 8.52, 58.21 and 7.66 per cent, respectively.

The results presented in Table 3 indicated that the formaldehyde treatment had significant ($P<0.05$) effect on the final body weight and body weight gain in all three trials. These results are in agreement with Chatterjee and Walli (2003) and Yadav *et al*. (2000) who reported improved ($P<0.01$) body weight gain in crossbred calves and buffalo calves following their feeding on protected protein based concentrate mixture. This might be due to the protection of highly degradable GNC protein by formaldehyde treatment caused efficient utilization of proteins in growing heifers. The final body weight and body weight gain was significantly highest in treatment T_2.

From the Table 4 it was revealed that the interaction effect of trial and treatment was non-significant indicating that treatment had significant effect on final body weight and body weight gain of crossbred heifers.

Table 3. Effect of feeding of formaldehyde treated GNC on body weight of heifers.

Treatment	Initial body weight (kg)	Final body weight (kg)	Body weight gain (g)
Trial 1 :			
T_0	120.214	156.143^b	400.857^b
T_1	120.171	168.286^a	534.429^a
T_2	120.000	171.000^a	566.714^a
Mean	120.129	165.143	500.667
Trial 2 :			
T_0	78.00	131.429^b	593.714^b
T_1	91.714	150.714^a	703.143^a
T_2	82.714	156.286_a	769.714^a
Mean	84.143	146.143	688.857
Trial 3 :			
T_0	94.857	145.000^b	556.143^b
T_1	96.143	150.000^b	603.286^b
T_2	105.714	172.571^a	752.286^a
Mean	98.905	155.857	637.238

Table 4. Pooled analysis.

Particulars	Initial body weight (kg)	Final body weight (kg)	Body weight gain (g)
Calculated X^2 Value	20.554	7.679	9.850
EMSS	Heterog-eneous	Heterog-eneous	Heterog-eneous
X^2 Value for interaction	2.244^{NS}	1.875^{NS}	3.102^{NS}

Table 5. Weighted means.

Treatment	Initial body weight (kg)	Final body weight (kg)	Body weight gain (g)
T_0	116.768	150.570^c	449.009^c
T_1	117.389	162.969^b	564.013^b
T_2	117.493	167.542^a	602.204^a
CD at 5 %	2.934	4.103	22.587

The results presented in Table 5 indicated that the weighted means of final body weight and body weight gain in treatment T_0, T_1 and T_2 were significantly different from each other.

It is concluded that feeding of formaldehyde treated GNC @ 1.0 g FA/100 g CP significantly increases the body weight of growing crossbred heifers.

References

Chatterjee, A. and Walli, T. K. 2003. Economics of feeding formaldehyde treated mustard cake as bypass protein to growing buffalo calves. Indian J. Dairy Sci. 56: 241-244.

Gupta, H. K. and Walli, T. K. 1987. Influence of feeding formaldehyde treated GN cake and its partial replacement with area on growth and feed utilization in crossbred kids. Indial J. Anim. Nutri. 4: 94-99.

Kumar, V. and Walli, T. K. 1994. Effect of feeding urea treated wheat straw supplemented with HCHO treated groundnut cake on growth performance of crossbred calves. Indian J. Anim. Nutri. 11: 29-33.

Mudgal, V. D. and Sengar, S. S. 1980. Effect of feeding protected and unprotected protein on growth and body composition of goats J. Nucl. Agric. Biol. 9: 19.

Yadav, K. R., Paliwal, V. K., Manadal, A. B. and Krishna, G. 2000. Effect of feeding formaldehyde treated cluster bean meat on nutrient utilization and growth in buffalo calves. Indian J. Anim. Nutri. 17: 206-210.

RESEARCH NOTES

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Forms of Sulphur in Swell-Shrink Soils of Western Maharashtra

The deficiency of sulphur in soils and crop plants has become common due to use of high analysis sulphur free fertilizers coupled with intensive cropping, high yielding genotypes and higher sulphur removal by crops. Sulphur deficiency has been also reported in swell-shrink soils of western Maharashtra (Malewar and Sayed Ismail, 1997). However, very little work has been done on the status and forms of sulphur in these soils. A knowledge of different forms of sulphur is essential for understanding sulphur behaviour in soil and its application. A present investigation was planned to study the status and forms of sulphur in intensively cultivated swell-shrink soils of Rahuri tahsil in Ahmednagar district of Western Maharashtra.

Considering the total area under cultivation the map of Rahuri tahsil was marked on 4 km grid basis to identify the locations of soil sample collection. Thus two hundred soil samples (0-15 cm depth) were collected from 110 villages in Rahuri tahsil of Ahmednagar district. After processing, the soil samples were analysed for texture, pH, EC, organic C, $CaCO_3$, available N and P by standard methods (Jackson, 1973). Available S extracted with 0.15 per cent $CaCl_2$ solution (Williams and Steinbergs, 1959), total S (Hesse, 1972), inorganic S (Tabatabai, 1982) and organic S by difference between total S and inorganic S. Sulphur in the soil extract was determined by the procedure of Chesnin and Yein (1951). Simple correlation coefficients (r values) were calculated between the soil properties and forms of S and among the forms of S. From the relative proportions of different soil separates *viz*., coarse sand, fine sand, silt and clay in all the soil samples textural classes were known using the triangular graph. All the soil samples were grouped into four classes *viz*., silty clay (4 soil samples), clay loam (10 soil samples), clay (186 soil samples) on the basis of texture. Soil properties, forms of S and their correlations were studied as per these four groups of soils.

Clay contents (Table 1) of the soils in all the four groups ranged from 34.3 to 58.7 per cent with mean values of 36.4 per cent in clay loam to 52.4 per cent in clay soils. The silt contents varied from 31.0 to 43.6 per cent with mean values of 34.9 per cent in clay soils to 41.4 per cent in silty clay soils. The sand contents ranged from 8.0 to 26.0 per cent with mean values of 12.2 per cent in clay soils to 23.1 per cent in clay loam soils. The pH of soils in all the four groups ranged from 7.7 to 9.2 with mean values of 8.05 in silty clay to 8.46 in clay loam soils. The EC of soils ranged from 0.12 to 1.06 dSm^{-1} with mean values of 0.33 dSm^{-1} in silty clay to 0.48 dSm^{-1} in clay. Organic C contents ranged from 0.20 to 0.99 per cent with mean values of 0.48 per cent in clay loam to 0.63 per cent in clay soils. The $CaCO_3$ contents ranged from 1.1 to 15.3 per cent with mean values from 3.9 per cent in silty clay to 6.0 per cent in clay soils. Available N in soils ranged from 132 to 254 kg ha^{-1} with mean values from 158 kg ha^{-1} in clay loam to 168 kg ha^{-1} in silty clay and clay. While available P content of soils ranged from 3.9 to 36.7 kg ha^{-1} with mean values of 7.1 kg ha^{-1} in clay loam to 12.8 kg ha^{-1} in clay soils. Available S contents varied from 6.6 to 42.1 mg kg^{-1} with mean values of 12.8 mg kg^{-1} in silty clay to 18.8 mg kg^{-1} in clay soils (Table 1). Organic S in soil ranged from 111 to

277 mg kg^{-1} with mean values of 191 mg kg^{-1} in clay loam to 277 mg kg^{-1} in clay. Higher organic S in the soils associated with higher organic C content has also been reported by Venkatesh and Satyanarayana (1999) in Vertisols. Inorganic S contents ranged from 58 to 188 mg kg^{-1} with mean values of 114 mg kg^{-1} in silty clay to 126 mg kg^{-1} in clay loam and clay. High content of inorganic S in the soils of Rahuri tahsil might be due to high content of clay and $CaCO_3$ and basaltic alluvial parent material (Malewar and Sayed Ismail, 1997). Total S contents which indicates the reserve pool of this element in soil, varied from 183 to 396 mg kg^{-1} with mean values of 308 mg kg^{-1} in silty clay to 334 mg kg^{-1} in clay soils. The organic S content on an average accounted for 64 per cent of the total S in these soils. Thus, in general, the soils of Rahuri tahsil were calcareous, clay with alkaline reaction, medium in organic C, available P and available S and low in available N. Clay is the dominant fraction with soil texture varying from silty clay to clay. The results indicated that 16 per cent soils of Rahuri tahsil were deficient in available S considering 10 mg kg^{-1} as the critical limit, 35 per cent medium (10-20 mg kg^{-1}) and 49 per cent soils sufficient (>20 mg kg^{-1}) in available S content. However, sulphur deficient area is likely to be increased in near future.

Available S fraction of sulphur is the most important for plant nutrition point of view. Available S content was significantly positive related with pH in clay soils ($r = 0.214^{**}$) and in all 200 soils ($r = 0.218^{**}$). It was significantly related with EC in clay soils ($r = 0.146^{*}$) and with organic C in clay ($r = O.261^{**}$) and in all 200 soils ($r = 0.244^{**}$) (Table 2). Organic S compounds present in the soils are very important with respect to S availability. However, very little is known about the nature of organic S. In the case of organic S, it was correlated with EC in clay soils ($r = 0.166^{*}$). In the present study, organic S content did not observe close association with organic C. There are instances where the organic S content of soils bears no relationship with its organic C content as has been reported by Pandey *et al*. (1989). Such results indicated that not only the content but the nature and chemical composition of organic matter may be an important determinant of the fraction of organic S. Inorganic S was significantly and positively related with pH in silty clay ($r = 0.954^{*}$) and with organic C in clay ($r = 0.321^{**}$)

Table 1. Range and mean values of properties and forms of sulphur in soils of Rahuri tahsil.

Particular	Silty clay	Clay loam	Clay	All 200 soils
Clay (per cent)	40.3-41.7 (40.8)	34.3-38.2 (36.4)	40.3-58.7 (52.4)	34.3-58.7 (51.4)
Silt (per cent)	40.9-42.1 (41.4)	31.0-43.6 (38.1)	31.4-38.1 (34.9)	31.0-43.6 (35.0)
Sand (per cent)	18.1-18.3 (18.2)	20.9-26.0 (23.1)	8.0-25.8 (12.2)	8.0-26.0 (12.8)
pH	8.0-8.1 (8.05)	8.0-9.0 (8.46)	7.7-9.2 (8.24)	7.7-9.2 (8.25)
EC (dSm^{-1})	0.12-0.79 (0.33)	0.17-0.87 (0.37)	0.14-1.06 (0.48)	0.12-1.06 (0.48)
Org. C, %	0.23-0.75 (0.54)	0.28-0.68 (0.48)	0.31-0.99 (0.63)	0.20-0.96 (0.62)
$CaC0_3$, %	2.7-6.8 (3.9)	2.0-13.0 (5.5)	1.1-15.3 (6.0)	1.1-15.3 (5.7)
Avail. N (kg ha^{-1})	153-178 (168)	146-175 (158)	132-254 (168)	132-254 (168)
Avail. P (kg ha^{-1})	5.1-19.1 (9.0)	5.0-9.4 (7.1)	3.9-36.7 (12.8)	3.9-36.7 (12.5)
Avail. S (mg kg^{-1})	7.6-20.0 (12.8)	7.7-24.1 (16.1)	6.6-42.1 (18.8)	6.6-42.1 (17.7)
Org. S (mg kg^{-1})	131-262 (194)	120-249 (191)	111-277 (210)	111-277 (209)
Inorg. S (mg kg^{-1})	67-139 (114)	63-168 (126)	58-188 (126)	58-188 (126)
Total S (mg kg^{-1})	198-379 (308)	183-372 (318)	187-396 (334)	187-396 (311)

Figures in bracket indicate mean values.

and in all 200 soils (r = 0.292**). Similarly, inorganic S was significantly related with available N in clay (r = 0.215**) and in all 200 soils (r = 0.219**). Total S was positively related with EC in clay soil (r = 0.154*) and with organic C in clay (r = 0.158*) and in all 200 soils (r = 0.200**). Accumulation of total S was accompanied by deposition of sulphate rich salts in soil. This was reflected in establishing significant relationship between total S and EC of soil (Dwarkanath, *et al*. 1995 and Pareek , 2007). Total S was correlated with available N in all 200 soils (r = 0.168*). A significant relationship of total S with all other forms was observed in the present investigation. These results are in conformity with the results reported by Malewar and Sayed Ismail (1997), Gowrisankar and Shukla (1999) and Basumatari *et al*. (2008) for different soils. In general, correlation studies indicated significant relationship of organic C and available N with forms of sulphur. These results are in conformity with the findings reported by Gundalia *et al*. (1996).

Among the forms of S, available S was correlated with inorganic S in silty clay (r = 0.706*), clay loam (r = 0.909*), clay (r = 0.194**) and in all 200 soils (r = 0.337**). It was also correlated with inorganic S in clay (r = 0.304**) and all 200 soils (r = 0.337*). Available S in soil was significantly and positively related with total S in clay loam (r = 0.706**), clay (r = 0.194**) and in all 200 soils (r = 0.214**). Organic S was correlated with inorganic S in clay (r = 0.156*) and in all 200 soils (r = 0.153*). Similarly, organic S was significantly and positively related with total S in silty clay (r = 0.987*), clay loam (r = 0.805**), clay (r = 0.838**) and in all 200 soils (r = 0.840**). The higher organic S associated with higher organic C content has also been reported by Venkatesh and Satyanarayana (1999) in Vertisols. While inorganic S was correlated with total S in clay loam (r = 0.723*), clay (r = 0.669*) and in all 200 soils (r = 0.665**) (Table 3). These results are in conformity with the results reported by Malewar and Sayed Ismail (1997) and Gowrisankar and Shukla (1999). A significant and positive correlation of total S with all the forms of sulphur have been observed in the present investigation (Table 3). Thus, it indicated that all the forms of sulphur existed in a state of dynamic equilibrium in the soil. Similar observations were also made by Borkotoki and Das (2008).

From this study it can be concluded that the

Table 2. Correlation coefficients between soil properties and forms of sulphur in soils of Rahuri tahsil.

Soil property	Forms of sulphur			
	Avail. S	Org. C	Inorg. C	Total S
Silty clay :				
pH	0.931	-0.842	0.954*	-0.748
EC	0.241	-0.701	0.310	-0.733
Org. C	0.110	0.372	0.025	0.431
$CaCO_3$	-0.529	0.249	-0.611	0.147
Avail. N	0.638	-0.547	0.558	-0.500
Avail. P	0.345	-0.814	0.401	-0.842
Clay loam :				
pH	0.334	-0.101	0.090	-0.017
EC	-0.531	-0.535	0.331	-0.575
Org. C	-0.243	0.524	-0.076	0.332
$CaCO_3$	-0.189	0.043	-0.252	-0.122
Avail. N	-0.128	0.373	0.145	0.349
Avail. P	0.048	0.003	0.239	0.146
Clay :				
pH	0.214**	-0.047	-0.029	-0.051
EC	0.146*	0.166*	0.053	0.154*
Org. C	0.261**	-0.025	0.321**	0.158*
$CaCO_3$	-0.140	-0.035	0.083	-0.073
Avail. N	0.062	0.045	0.215**	0.152
Avail. P	-0.068	-0.065	0.083	-0.004
All 200 soils :				
pH	0.218**	-0.065	-0.030	-0.066
EC	0.134	0.124	0.039	0.115
Org. C	0.244**	0.052	0.292**	0.200**
$CaCO_3$	-0.133	-0.019	0.092	-0.065
Avail. N	0.068	0.063	0.219**	0.168*
Avail. P	-0.036	-0.048	0.097	0.017

*,** significant at 5 and 1 per cent level of significance respectively.

Table 3. Correlation coefficients among the forms of sulphur in soils of Rahuri tahsil.

Form of S	Forms of sulphur			
	Avail. S	**Org. C**	**Inorg. C**	**Total S**
Silty clay :				
Avail. S	-	-0.629	0.995*	-0.574
Organic S		-	-0.701	0.987*
Inorganic S			-	-0.575
Total S				-
Clay loam :				
Avail. S	-	0.226	0.909**	0.706*
Organic S		-	0.172	0.805**
Inorganic S			-	0.723*
Total S				-
Clay :				
Avail. S	-	0.035	0.304**	0.194**
Organic S		-	0.156	0.838**
Inorganic S			-	0.669**
Total S				-
All 200 soils :				
Avail. S	-	0.038	0.337**	0.214**
Organic S		-	0.153*	0.840**
Inorganic S			-	0.665**
Total S				-

*,** significant at 5 and 1 per cent level of significance respectively.

soils of Rahuri tahsil of Ahmednagar district are calcareous, clay, alkaline in reaction, medium in organic C, available P and available S and low in available N. The forms of S except organic S are significantly and positively related with organic C and available N. All the forms of sulphur are significantly and positively related to each other. Although 16 per cent soils are deficient in sulphur at present, it is likely to increase the sulphur deficient area in future. Hence there is a need for sulphur fertilization for sustainable higher crop production.

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References

Basumatari, A., Talukdar, H. C. and Ramchiary, S. 2008. Interrelationships of sulphur with soil properties and its availability index in some rapeseed-growing Inceptisols of Assam. J. Indian Soc. Soil Sci. 58(4): 394-402.

Borkotoki, B. and Das, K. N. 2008. Forms of sulphur and their relationship with soil properties in Entisols, Inceptisol and Alfisols of Assam. J. Indian Soc. Soil Sci. 56: 186-191.

Chesnin, L. and Yien, C. H. 1951 . Turbidimetric determination of available sulphur. Soil Sci. Soc. Am. Proc. 16: 149-151.

Dwarkanath, K., Mohite, A. V. and Patil, M. D. 1995. Sulphur status of some important series of Vertisols of Maharashtra state. J. Indian Soc, Soil Sci. 43(3): 364-367.

Gowrisankar, D. and Shukla, L. M. 1999. Sulphur forms and their relationship with soil properties in Inceptisols of Delhi. J. Indian Soc. Soil Sci. 47(3): 437-442.

Gundalia, J. D., Golakiya, B. A., Hadvani, G. J., Hadiyal, T. M. and Qureshi, A. U. 1996. Nitrogen research in Gujrat. In: Soil Research in Gujarat Agriculture. GAU Anand, pp. 23-32.

Hesse, P. R. 1972. A text book of Soil Chemical Analysis. Jhon. Marray Publ. Ltd. London.

Jackson, M. L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Malewar, G. U. and Sayed Ismail. 1997. Sulphur in balanced fertilization in Western India. In: Symp. on Sulphur in Balanced Fertilization. TSI/ FAI/ IFA Symp, New Delhi, Feb. 13-14, pp. SI, 4/1-4/20.

Pandey, D. K., Tiwari, K. N. and Tiwari, R. C. 1989. Different forms of sulphur in alluvial soils. J. Indian Soc. Soil Sci. 37: 161-163.

Pareek, N. 2007. Soil mineralizable sulphur: a sulphur availability index. J. Indian Soc. Soil Sci. 55(3): 289-293.

Tabatabai, M. A. 1982. Sulphur. In: Methods of Soil Analysis. A. L. Page et al. (Eds.), ASA, Madison, Wi. pp. 501-538.

Venkatesh, M. S. and Satyanarayana, T. 1999. Sulphur fractions and C : N : S relationships in oilseed growing Vertisols of North Karaataka. J. Indian Soc. Soil Sci. 47(2): 241-248.

Williams, C. H. and Steinbergs, A. 1959. Soil sulphur fractions as chemical indices of available sulphur in some Australian soils. Aust. J. Agric. Res. 10: 340-352.

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Heterosis Studies in Brinjal (*Solanum melongena* L.)

Brinjal is an important vegetable crop in India. It is a crop to which a considerable amount of hybrid vigour can be attributed. The information on the mode of inheritance of quantitative traits associated with yield, which include borer free produce, is necessary in the development of new hybrids, along with the phenotypic performance, selection based on heterosis will be highly useful to a great extent to screen the hybrids. The heterosis provide required information about the choice of parents and hybrids and also to determine the nature of gene action involved in the expression of desirable traits. Hence, the present investigation was undertaken to find out suitable cross combinations on the basis of heterosis percentage for different characters in brinjal.

The experimental material comprised of ten parents *viz*, (1) RHRB-35, (2) RHRB-36, (3) RHRB-28, (4) RHRB-14, (5) RHRB-6, (6) RHRB-11, (7) RHRB-34, (8) RHRB-12, (9) RHRB-53 and (10) RHRB-54 were subjected to the diallel system of mating excluding reciprocals and total 45 F_1's were derived. The F_1 hybrids along with their parents and standard check (Krishna hybrid) were raised in randomized block design with two replications at All India Coordinated Research Project on Vegetable Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri during *kharif* 2008.

The hybrids and parents were raised by adopting 75x75 cm inter and intra row spacing. Five competitive plants (except border plants) from each replications were selected at random and observations on days to 50 per cent flowering, plant height, number of primary branches plant^{-1}, fruit length, fruit diameter, average weight of fruit, number of fruits plant^{-1}, yield q ha^{-1} and per cent fruit borer infestation (number and weight basis) were recorded and means were used for statistical analysis as per method suggested by Panse and Sukhatme (1985). The heterosis percentage was estimated according to SPAR1 programme developed by IASRI, New Delhi.

The analysis of variance showed significant differences among the hybrids for all the characters at five and one per cent level. The variations in per cent heterotic effects over mid parent showed by various cross combinations was observed for days to 50 per cent, flowering (-25.31 to 6.41), plant height (-15.34 to 72.73), number of primary branches (-30.92 to 44.25), fruit length (-25.70 to 25.22), fruit diameter (-21.47 to 42.25), average fruit weight (-49.19 to 44.76), number of fruits plant^{-1} (-13.59 to 137.02), yield hectare^{-1} (19.42 to 133.62) and percent fruit borer infestation (number basis -30.73 to 44.34 and weight basis -37.93 to 20.45). A wide variation in per cent heterotic effects over better parent displayed by cross combinations was observed for days to 50 per cent flowering (-27.26 to 0.23), plant height (-27.35 to 64.15), number of primary branches (-34.35 to 32.20), fruit length (-31.20 to 23.08), fruit diameter (-31.83 to 20.11), average fruit weight (-57.16 to 32.56), number of fruits plant^{-1} (-22.78 to 124.55), yield hectare^{-1} (0.69 to 125.09) and per cent fruit borer infestation (number basis -30.79 to 20.50 and weight basis -40.87 to 19.09).

There were small amount of variation in heterotic effects shown by-standard check i.e. Krishna hybrid in positive and significant direction for some characters.

For days to 50 per cent flowering, the negative heterosis is considered as desirable. The cross 4 x 5 (-25.31%) showed maximum heterosis over mid parent, cross 2 x 4 (-27.26%) over better parent. The maximum standard heterosis was showed by 3 x 8 (-28.44%) and 3 x 6 (-28.33%). These findings were in conformity with those reported by Babu and Thirumurugan (2000).

For plant height, the highest heterosis over mid parent was recorded in cross 6x10 (72.73%). The cross 6 x 10 (64.15%) recorded highest heterosis over better parent and the highest standard heterosis was recorded by cross 2 x 3 (38.38%) followed by 6 x 10 (36.54%). These results were in conformity with Prasath *et al*. (2000).

The best cross combinations exhibiting high heterotic effects over mid parent for the character number of primary branches plant-1 were 5 x 6 (44.44%) and over better parent were also 5 x 6 (32.20%) while the crosses with high standard heterosis were 6 x 10 (18.44%) and 5 x 6 (16.94%). These findings are in close agreement with those reported by Prasath *et al*. (2000) and Das and Barna (2001).

For the character average fruit length the heterosis over mid parent was maximum for the cross 1 x 2 (25.22%) and over better parent the cross 1 x 2 (23.08%) and 1 x 9 (14.36%), also the standard heterosis was maximum in the same crosses. The findings of Prasath *et al*. (2000) and Bubu and Thirumurugan (2000) supported the above results.

The best cross showing highest heterostic effect on mid parent for the character average fruit diameter was 5 x 10 (42.25%) and over better parent also the same cross 5 x 10 (20.11%) followed by 8 x 10 (19.52%). The crosses proved better for this character over standard heterosis were 7 x 9 (2.07%) and 4 x 6 (1.66%). The remaining most of the crosses showed negative standard heterosis for this character. Similar results were also reported by Singh *et al*. (1978) and Prasath *et al*. (2000).

For the character average fruit weight, the crosses that proved superior were 1 x 7 (44.76%), 1 x 9 (37.53%) over mid parent, the crosses 1 x 7 (32.56%) and 1 x 5 (25.42%), 7 x 9 (23.24%), 1 x 2 (22.15%) and 1 x 9 (19.52%) over better parent and 7 x 9 (11.55%), 1 x 9 (8.19%) and 1 x 7 (6.51%) over standard check showing high and significant magnitude of heterotic effects. Findings of Prasath *et al*. (2000) and Bisht *et al.* (2009) supported the results of the present findings.

The crosses 2 x 3 (137.02%), 1 x 3 (84.23%), 1 x 2 (82.93%) over mid parent, the crosses 2 x 3 (124.55%), 1 x 3 (79.66%), 1 x 2 (68.90%) over better parent and the crosses 6 x 10 (49.14%), 2 x 3 (42.98%), 2 x 6 (34.93%) over standard check were found to be superior for the character number of fruits 45 per plant showing high heterotic effects. These findings are in close agreement with Prasath *et al.* (2000) and Bisht *et al.* (2009)

For the total yield quintal hectare^{-1}, the crosses *viz*., 2 x 3 (133.62%), 7 x 8 (130.61%), 6 x 7 (129.83%) showed highest heterosis over mid parent, the cross *viz*., 6 x 7 (125.09%), 7 x 8 (118.92%), 1 x 5 (109.00%) showed highest heterosis over better parent while the crosses 2 x 3 (48.26%), 1 x 5 (44.61%), 3 x 9 (40.57%) showed maximum heterosis over standard check i.e. F_1 hybrid Krishna. These findings are in accordance with that of Dahiya *et al*. (1984), Babu and Thirumurugan (2000) and Bisht *et al*. (2009).

The shoot and fruit borer is important pest in brinjal which causes maximum losses. The 45 F_1 hybrids were also screened for fruit borer infestation (number and weight basis). The

heterosis over mid parent, better parent and standard check were reported. The negative heterosis is desirable for this character. The maximum negative heterosis over mid parent was registered in crosses 5 x 10 (-30.44%) and 2 x 5 (-13.65%), the crosses 5 x 10 (-30.79%) and 2 x 5 (-11.28%) over better parent and over standard check, the same crosses i.e. 5 x 10 (-18.58%) and 2 x 5 (-11.28%) recorded negative but non-significant heterotic effects. The hetorosis values were negative, which revealed the possibility of getting fruit borer tolerant hybrids through heterosis breeding.

Thus the crosses *viz*., 2 x 4 and 4 x 5 for days to 50 per cent flowering, 6 x 10 and 2 x 3 for plant height, 5 x 6 and 6 x 10 for number of primary branches, 1 x 2 and 1 x 9 for fruit length, 5 x 10 and 8 x 10 for fruit diameter, 1 x 7, 1 x 5, 7 x 9, 1 x 2 and 1 x 9 for average fruit weight, 2 x 3, 1 x 3, 1 x 2, for number of fruits plant^{-1}, 2 x 3, 7 x 8, 6 x 7, 1 x 5, 3 x 9 for yield quintal hectare^{-1} which showed high heterosis for above characters and these hybrids should be selected for further exploitation. The less incidence of fruit borer should also be considered while selecting the hybrids for further exploitation in future.

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References

Babu, S. and Thirumurugan, T. 2000. Effect of heterosis in brinjal (*Solanum melongena* L.) J. Ecotoxicol. and Enviro. Monitoring, 10(1): 63-66.

Bisht, G. S., Major Singh, S. K. Singh, M. C. Singh and Rai, M. 2009. Heterosis studies in brinjal (*Solanum melongena* L.). Veg. Sci., 36 (2): 217-19.

Dahiya, M. S., Dhankar, B. S. and Kalloo, G. 1984. Hybrid performance in eggplant (*Solanum melongena* L.). Haryana J. Hort. Sci. 13 (3-4): 147-149.

Das, G. and Barna, N. S. 2001. Heterosis and combining ability for yield and its components in brinjal, Ann. Agric. New Series. 22(3): 399-403.

Panse, V. G. and Sukhatne, P. V. 1985. Statistical Methods for Agricultural Workers. Publ. and Inform. Div. ICAR, New Delhi, pp. 58.

Prasath, D., Natrajan, S. and Thamburaj, S. 2000. Line x tester analysis for hetorosis in brinjal (*Solanum melongena* L.) Orissa J. Hort. 28 (1): 59-64.

Singh, B., Joshi, S. and Kumar, N. 1978. Hybrid vigour in brinjal (*Solanum melongena* L.). Haryana J. Hort. Sci. 7(1-2): 95-99.

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Exploitation of Heterosis in CMS Based Hybrids in Pigeonpea (*Cajanus cajan* L. Millsp.)

Pigeonpea (*Cajanus cajan* (L.) Millsp) is one of the important legumes of the dry land agricultural production system. A number of Pigeonpea varieties have been released for cultivation. The area has increased to a certain extent (4.04 million ha) with the production of 2.65 million tonnes (2011-12) but to date the yield (655 kg ha^{-1}) has remained unacceptably low. There are two pre requisites for commercial exploitation of hybrid vigour in pigeonpea, a efficient natural out crossing ranged from 25 to 70 per cent (Saxena *et al*. 2005) and availability of stable male sterile source. Total five CMS system developed so far

in pigeonpea, *Cajanus cajanifolius* cytoplasm has been found to be stable across environment and being used in the hybrid breeding programme (Saxena *et al.* 2006).

The present investigation was undertaken to study the extent of heterosis in newly developed CMS based hybrids and to exploit the possibility of utilizing the hybrid vigour at commercial level.

Four newly developed *Cajanus cajanifolius* based cytoplasmic genetic male sterile lines *viz*., ICPA 2043, ICPA 2047, ICPA 2048 and ICPA 2092 were crossed with 12 identified restorers in line x tester manner. The resulting 48 hybrids along with their parents and three checks including two varieties *viz*. BSMR 736, ICP 8863 and one CMS based hybrid *viz*., GTH 1 were evaluated in a randomized block design with two replications at Agricultural Research Station, Badnapur during *kharif* 2007-08. Each entry was sown in two rows of 3 m length spaced 75 cm apart. Five plants were randomly selected for recording the observations on days to 50 per cent flowering, days to maturity, plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pods plant^{-1}, 100 seed weight and seed yield plant^{-1}.

The per cent heterosis over better parent (heterobeltosis) and standard check *viz*., BSMR 736 having highest mean on the basis of per se performance for seed yield and its attributing characters among the three checks were estimated as per Fonesca and Patterson (1968).

The results indicated that the phenomenon of heterosis was of a general occurrence and its magnitude varied with characters. The standard and better parent heterosis for days to 50 per cent flowering ranged from -6.03 to 9.48 and -7.94 to 24.00 per cent, respectively. Whereas standard and better parent heterosis for days to maturity ranged from -4.12 to 12.94 and -2.84 to 18.99 per cent, respectively. The crosses combination ICPA 2043 x ICPR 2671 and ICPA 2043 x ICPR 3473 were early in maturity having significant negative standard heterosis. Whereas the cross ICPA 2047 x ICPR 3514 showed high negative heterobeltosis for days to 50 per cent flowering and days to maturity. Wankhede et al. (2005) and Kandalkar (2007) reported significant negative heterosis for days to flowering and days to maturity in pigeonpea.

Standard heterosis and better parent heterosis for plant height ranged from 27.07 to -20.40 and 32.74 to -23.90 per cent, respectively. The range of standard heterosis and better parent heterosis among the cross combination for number of primary branches plant^{-1} varied from 18.89 to -40.00 per cent and 28.41 to -37.50 per cent, respectively. The standard heterosis and heterobeltosis for number of primary branches plant^{-1} was found in positive direction in 12 and 13 out of 48 crosses, respectively. The range of standard heterosis and better parent heterosis among the cross combination for number of secondary branches plant^{-1} varied from 35.48 to -47.31 per cent and 37.00 to -45.50 per cent, respectively. The standard heterosis and heterobeltosis for number of secondary branches plant^{-1} was found in positive direction in 14 and 17 out of 48 crosses, respectively.

The maximum standard heterosis for number of pods plant^{-1} were recorded by ICPA 2043 x ICPR 2671 (44.59%) followed by ICPA 2092 x ICPR 2671 (36.76%), ICPA 2048 x ICPR3473 (36.35%) and maximum better parent heterosis were reported by ICPA 2047 x ICP10934 (46.87%) followed by ICPA 2043 x ICPR 2671 (35.44%) and ICPA 2043 x ICPR 3473 (29.74%). For 100 seed weight standard heterosis ranged from 16.07 to -21.43 per cent and it was found highest in the cross ICPA 2092 x ICPR 2766. Maximum heterobeltosis

for 100 seed weight was recorded by the cross ICPA 2043 x ICP 87119 (22.00%).

For seed yield plant^{-1}, the standard heterosis (77.90 to -43.14%) and heterobeltosis (59.28 to -53.32%) range was wide. The crosses *viz*., ICPA 2043 x ICPR 2671 (77.94%), ICPA 2043 x ICPR 3473 (72.55%), ICPA 2043 x ICPR 3477 (64.55%), ICPA 2043 x ICPR 3514 (61.03), ICPA 2048 x ICPR 2671 (60.29%) recorded the maxinium heterosis over standard checks *viz*., BSMR 736. These first five hybrids were also recorded highest heterosis over better parent to the extent of 53.81, 59.28, 52.26, 48.64 and 31.59 per cent, respectively. These five hybrids have maximum standard heterosis and heterobeltosis for plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pods plant^{-1} and 100 seed weight. Pande and Singh (2002) reported significant positive heterosis for number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pods plant^{-1} and Seed yield plant^{-1}. Similar results were also reported by Kandalkar (2007) for number of pods plant^{-1}, 100 seed weight and seed yield plant^{-1}. Sekhar *et al*. (2004) reported best hybrids exceeding 40 per cent standard heterosis as promising for seed yield plant in pigeonpea. These results revealed the promising crosses like (ICPA 2043 x ICPR 2671), (ICPA 2043 x ICPR 3473), (ICPA 2043 x ICPR 3477), (ICPA 2043 x ICPR 3514), (ICPA 2048 x ICPR 2671) may be further tested on larger plots over different locations and season before recommending them for commercial utilization in pigeonpea.

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References

Fonesca, S. and Patterson, F. L. 1968. Hybrid vigour in a seven parent diallel cross in common winter wheat (*Triticum aestivum* L.). Crop Sci., 8: 85-88.

Kandalkar, V. S. 2007. Evaluation of standard heterosis in advanced CMS based hybrids for grain yield, harvest index and their attributes in pigeonpea. Pap. presented at 7th Internat. conf. on sustainable agriculture for food, bio-energy and livelihood security. February 14-16, pp. 195.

Pande, N. and Singh, N. B. 2002. Hybrid vigour and combining ability in long duration pigeonpea (*Cajanus cajan* (L.) Mill sp.) hybrids involving male sterile lines. Indian J. Genet. 62(3): 221-225.

Saxena, K. B., Kumar, R. V., Srivastava, N., and Shiying, B. 2005. A cytoplasmic nuclear male sterility derived from a cross between *Cajanus cajanifolius* and *Cajanus cajan* . Euphytica. 145(3): 289-294.

Saxena, K. B., Madhavi Latha, Kumar, R. V. and Dalvi, V. A. 2006. Commercial pigeonpea hybrids are just a few step away. Indian J., Pulses Res. 19(1): 7-16.

Sekhar, M. R., Singh, S. P., Mehra, R. B. and Govil, J. N. 2004. Combining ability and heterosis in early maturing pigeonpea (*Cajanus cajan* (L.) Mill sp.) hybrids. Indian J. Genet. 64(3): 212-216.

Wankhede, R. R., Wanjari, K. B., Kadam, G. M. and Jadhav, B. P. 2005. Heterosis for yield and yield components in pigeonpea involving male sterile lines. Indian J. Pulses Res. 18(2): 141-143.

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A Study of Operational Holding in Western Maharashtra

Operational holding means per family area of land. The families are dividing continuously, hence the operational holding per family also decreasing. Now the decrease of land holding has come to such an extent, where further decrease may not be possible. Because of the small land holding, the Government has framed a rule to group the families to make the land cultivation together.

The operational holding and the number of families are inversely related due to the consequences of these processes, the big land holders also have become small land holders. Keeping all this in view, a study was undertaken to access the changes in operational holding group wise of the families in the different districts of Western Maharashtra with the objectives to study the distribution of number of families in different groups, the group wise changes of operational holdings and the growth study of land holding per family in different groups.

The data of operational land holding in different districts has been taken from Epitome (Anonymous, 1971-2001) along with number of families, which has been further divided into different groups, marginal (up to 1 ha), small (1 to 2 ha), semi-medium (2 to 4 ha), medium (4 to 10 ha) and large (more than 10 ha).

The correlations have been worked out between the different groups of operational holding to know the shifting of area i.e. from one group to another. The linear growth rates of land holding per family from year to year which gave the situation for prediction of operational land holding for future i.e. useful for planning purpose.

The number of families is increasing from large to marginal group and the operational holding is decreasing from large to marginal group. The number of families is shifting to small and marginal group due to continuous family division. Similar findings were reported by Deshpande (2002), Mishra (2006) and Swain *et al*. (2009). The maximum per cent increase in number of families was found in Ahmednagar district for marginal (883%) and small (571%) while it was minimum in Jalgaon (202%) and Kolhapur (89%) for marginal and small groups, respectively. The overall picture of number of families in the Maharashtra as a whole are increasing from large to marginal group, indicating that 4 times increase in marginal and small group and twice in semi-medium group of Western Maharashtra (Table 1). The similar trend has been observed in all the groups pertaining to operational holding (Table 1). These findings are in conformity with findings of Khan (2004).

The operational holding per family per year for each group has been shown in Table 2, which is minimum in marginal group and highest in large group. Out of that the range of operational holding per family ranged from 0.349 ha in Kolhapur to 0.604 ha in Dhule in marginal group, from 1.429 ha in Kolhapur to 1.525 ha in Ahmednagar in small group, 2.811 ha in Dhule to 3.263 ha in Jalgaon in semi-medium, 5.769 ha in Kolhapur to 6.936 ha in Solapur for medium group and 14.353 ha in Jalgaon to 18.632 ha in Satara for large group. On an average, the operational holding has been found 2.584 ha per family in Western Maharashtra and 2.774 ha per family in Maharashtra.

Table 1. Per cent change over the base year 1971-72 to 2000-01 of number of families and operational holding.

District	Year and per cent change	Number of families						Operational holding (area in ha)					
		Marginal (0-1 ha)	Small (1-2 ha)	Semi-medium (2-4 ha)	Medium (4-10 ha)	Large (>10 ha)	Total	Marginal (0-1 ha)	Small (1-2 ha)	Semi-medium (2-4 ha)	Medium (4-10 ha)	Large (>10 ha)	Total
Dhule	1971	18361	24005	37859	53247	15593	149065	10370	35347	111021	335308	230694	722740
	2001	112428	137310	84340	35196	3161	369132	70640	190838	228711	200827	88878	690709
	% change	512.32	472.01	122.77	-33.90	-79.73	147.63	581.20	439.90	106.01	-40.11	-61.47	-4.43
Jalgaon	1971	41935	54447	60796	54718	15470	227366	23606	79973	174136	334483	237734	849932
	2001	126536	159627	48594	37922	2997	414496	78226	231894	241990	215687	41365	775248
	% change	201.74	193.18	-20.07	-30.70	-80.63	82.30	231.38	189.97	38.97	-35.52	-82.60	-8.79
Nashik	1971	39708	36582	54318	67162	24535	222305	19648	54170	157980	422965	384620	1039383
	2001	246051	187375	108220	46543	6090	590310	130005	270347	295434	268688	102643	977220
	% change	519.651	412.205	99.234	-30.7	-75.178	165.541	561.669	399.07	87.007	-36.475	-73.313	-5.981
Ahmednagar	1971	43998	42159	60840	77128	35333	259458	23158	61961	176335	486063	590013	1337530
	2001	432602	282833	152326	47791	4730	914062	229605	402405	415072	270772	84187	1315311
	% change	883.23	570.87	150.37	-38.04	-86.61	252.30	891.47	549.45	135.39	-44.29	-85.73	-1.66
Pune	1971	79596	50911	62009	66757	27081	286354	36831	74293	178736	418134	449143	1157137
	2001	346013	160175	106831	49363	8179	665920	170509	235722	298930	293935	141249	1032559
	% change	334.71	214.62	72.28	-26.06	-69.80	132.55	362.95	217.29	67.25	-29.70	-68.55	-10.77
Solapur	1971	29339	30550	49478	70311	38626	218304	14402	45156	143723	449204	644504	1296989
	2001	181312	175528	130936	64316	10416	564270	104036	261628	360236	676370	163796	1178538
	% change	517.99	474.56	164.64	-8.53	-73.03	158.48	622.37	479.39	150.65	50.57	-74.59	-9.13
Kolhapur	1971	134789	52671	44625	29954	6256	268295	54863	75860	125827	178415	103718	538683
	2001	459824	99294	40762	11929	2328	607418	165779	138347	110544	66585	28577	468505
	% change	241.14	88.52	-8.66	-60.18	-62.79	126.40	202.17	82.37	-12.15	-62.68	-72.45	-13.03
Sangli	1971	72694	42206	43807	39250	14735	212692	33330	61602	125509	242243	249739	712423
	2001	325168	125752	67816	27911	4108	555345	140428	172514	185685	161335	64362	701731
	% change	347.31	197.95	54.81	-28.89	-72.12	161.10	321.33	180.05	47.95	-33.40	-74.23	-1.50
Satara	1971	109556	55042	54813	43358	11889	274658	47180	79816	156018	263658	193433	740105
	2001	527928	153023	71909	22435	2370	777322	224313	205104	197532	127431	50115	759393
	% change	381.88	178.01	31.19	-48.26	-80.07	183.02	375.44	156.97	26.61	-51.67	-74.09	2.61
Western Mah.	1971	569976	388573	468545	501885	189518	2118497	263388	568178	1349285	3130473	3083598	8394922
	2001	2757862	1480917	811734	343406	44379	5458275	1313542	2108800	2334134	2281630	765172	7899213
	% change	383.86	281.12	73.25	-31.58	-76.58	157.65	398.71	271.15	72.99	-27.12	-75.19	-5.91
Maharashtra	1971	1241925	878267	1087149	1229161	514116	4950618	577581	1284164	3130647	7717351	8469682	21179425
	2001	5306000	3606000	2274000	865000	87000	12138000	2649000	5127000	6109000	4880000	1338000	20103000
	% change	327.24	310.58	109.17	-29.63	-83.08	145.18	358.64	299.25	95.14	-36.77	-84.20	-5.08

The linear growth rates of operational holding per family per five year with time has explained that how much operational holding is exchanged per family from every five years. It is ranging from - 0.033 ha in Kolhapur to 0.016 ha in Solapur per family per 5 years in marginal group, from - 0.014 ha in Sangli to 0.022 in Pune per family per five year in small group, from - 0.045 ha in Dhule to 0.295 ha per family per five year in Jalgaon in semi-medium, from - 0.129 ha in Ahmednagar to 0.561 ha per family per five year in Solapur for medium and from -0.422 ha in Kolhapur to 1.117 ha per family per five year in Satara in large group. The overall operational holding is decreasing by - 0.426 ha per family per five year in Western Maharashtra and - 0.441 ha per family per five year in Maharashtra (Table 2) as a whole. The parallel results were observed by Thimmaiah (2001).

The correlation analysis represents the relation between the groups correspondingly for operational holdings and number of families between the groups (Table 3). It revealed that the large and medium groups are negatively correlated with marginal, small and semi medium groups. Marginal and small groups are positively correlated among themselves for operational holding as well as number of families which indicated that one is decreasing and other increasing. So is the case with all the

Table 2. Per family average operational holding (ha) and linear growth rates over the period 1970-2001 in Western Maharashtra.

District		Marginal (0-1 ha)	Small (1-2 ha)	Semi-medium (2-4 ha)	Medium (4-10 ha)	Large (>10 ha)	Average area
Dhule	OH	0.604	1.456	2.811	6.023	16.881	3.163
	LGR (b)	0.011	-0.011	-0.045*	-0.128	1.841	-0.516**
Jalgaon	OH	0.587	1.478	3.263	5.893	14.353	2.756
	LGR (b)	0.009*	-0.008	0.295	-0.084**	-0.129	-0.313**
Nashik	OH	0.510	1.475	2.962	6.053	15.507	3.090
	LGR (b)	0.007	-0.009	-0.040	-0.101*	0.236	-0.513**
Ahmednagar	OH	0.544	1.525	2.944	5.95	16.571	2.913
	LGR (b)	0.002	-0.011	-0.033	-0.129**	0.204	-0.616**
Pune	OH	0.473	1.461	2.991	6.059	16.426	2.733
	LGR (b)	0.004	0.022	-0.020*	-0.067*	0.116	-0.413**
Solapur	OH	0.539	1.49	2.995	6.936	15.772	4.016
	LGR (b)	0.016*	0	-0.033*	0.561	-0.248	-0.620**
Kolhapur	OH	0.349	1.429	2.851	5.769	17.357	1.314
	LGR (b)	-0.033	-0.009	-0.020*	-0.067*	-0.422	-0.228**
Sangli	OH	0.446	1.436	2.937	5.99	15.744	2.197
	LGR (b)	-0.006	-0.014*	-0.025**	-0.080**	-0.308	-0.362**
Satara	OH	0.425	1.448	2.896	5.873	18.632	1.737
	LGR (b)	-0.001	-0.013	-0.023	-0.077**	1.117**	-0.296**
Western Maharashtra	OH	0.463	1.465	2.849	6.149	16.110	2.584
	LGR (b)	-0.002	-0.005	-0.010	0.031	0.156	-0.426**
Maharashtra	OH	0.488	1.467	2.801	5.964	15.556	2.774
	LGR (b)	0.005	-0.007	-0.034**	-0.105**	-0.057	-0.441**

*, ** Significant at 5 and 1 per cent level of significance, # OH : operational holding and LGR : Linear growth rate.

Table 3. Correlations between number of families and operational holdings according to size groups.

Size Groups	Marginal (0-1 ha)	Small (1-2 ha)	Semi-medium (2-4 ha)	Medium (4-10 ha)	Large (>10 ha)
Western Maharashtra					
Marginal	1	0.971**	0.640*	-0.995**	-0.937**
Small	0.973**	1	0.794*	-0.953**	-0.979**
Semi-medium	0.575*	0.738*	1	-0.594*	-0.857*
Medium	-0.999**	-0.966**	-0.546*	1	0.918**
Large	-0.955**	-0.985**	-0.775*	0.942**	1
Maharashtra					
Marginal	1	0.984**	0.890*	-0.903**	-0.928**
Small	0.978**	1	0.951*	-0.843**	-0.974**
Semi-medium	0.863*	0.939**	1	-0.639*	-0.994**
Medium	-0.936**	-0.885**	-0.672*	1	0.708*
Large	-0.913**	-0.968**	-0.990**	0.744*	1

*- Significant at 5 % and **- Significant at 1%. Above diagonal: Number of families, Below diagonal: Operational holdings.

groups in all the districts, which is evident from Table 3. Same thing is prevailing for Maharashtra as a whole. The same quantity of increase or decrease of the operational holding and number of families are shown in Table 1.

There is continuous decrease in the operational holding in every group which indicates the division of families and reduction of joint family system. There is decrease in both, operational holding and number of families in large and medium group which are shifting to semi-medium, small and marginal groups. In Maharashtra State as a whole, there is increase in the number of families by 1.4 times and decrease in operational land holding by 5 per cent.

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References

Anonymous, 1971-2001. Districtwise Agricultural Database for Maharashtra and Epitome of Maharashtra. Commissionrate of Agriculture, Govt. of Maharashtra.

Deshpande, K. S. 2002. Impact of Infrastructure created under poverty Alleviation Programme (Maharashtara)-Report of Director, MAITREE, Aurangabad.

Khan, A. U. 2004. Growth and the poor farmer: why is it so important to reform agriculture? Report by India Develop. Foundation.

Mishra, Srijit. 2006. Suicide of Farmers in Maharashtra. Report submitted to the Govt. of Maharashtra by Indira Gandhi Insti. Of Devel. Res., Mumbai.

Swain, Mamata, Mrutyunjay, Swain and Das, O. K. 2009. Regional disparity in Agricultural development in Orissa in the pre and post- reform period. Social Change. 39(2): 195-215.

Thimmaiah, G. 2001. New Perspectives on Land Reforms in India. J. Social and Econ. Develop. III(2): 179-198.

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Characterization and Classification of the Soils and Ground Water of Farm at College of Agriculture, Osmanabad

The study area is located between 18° 17' 52" N latitude and 76° 05' 00" E longitudes at an altitude of 660 m above MSL and covering an area about 65 ha. at village Kini, tahsil district Osmanabad. In the area mean annual rainfall of 760 mm and mean minimum and maximum temperature is 18.6°C and 33.5°C respectively. The area has Ustic soil moisture regime and Hyperthermic temperature regime. The most of the soils are very shallow with underlined by saprolite layer as defined by Tambane *et al*. 1970. This layer developed from deccan basalt is found to be rich in smectite mineral as basalt readily weather to smectite as it is the first weathering product (Pal and Deshpande, 1987). Smectite is the important clay mineral in black soil, determine to large extent its physical and chemical properties and availability of nutrients in the soil. A documentation of soil properties in systematic manner is one of the vital components in formulating effective land use planning programme (Deshmukh and Bapat, 1993). Through the present investigation, the soil resources of a college farm are evaluated for their characterizations and classification.

Nine representative pedon were selected for different physiographic unit of study area. The morphology of the soil was described as per soil survey manual (Soil Survey Staff, 1995). The soil sample were collected horizone wise, air dried ground and sieved using 2 mm sieve. The particle size distribution was carried out by international pipette method (Jackson, 1979), pH, EC, cation exchange capacity (CEC) organic carbon, $CaCO_3$, exchangeable bases were determined by standard procedure

Table 1. Morphological characteristics of the representative pedons of College of Agriculture farm, Osmanabad.

Horizons	Depth (cm)	Boun dary	Matrix colour	Structure	Texture	Pores	Roots	Consis-tancy	Efferve sces
Pedon : 1 *Lithic Ustorthant* :									
Ah	0-11	cs	10YR4/4	Imgr	Scl	mf	mvf	1 vfr so po	e
Ac	11-30	gi	10YR5/6	Imgr	S	mf	mvf	1 vfr so po	e
M	>30		10YR5/6	-	S	-	-	-	-
Pedon : 4 *Lithic Ustorthant* :									
Ah	0-8	di	5YR5/4	Ofgr	Scl	mf	fvf	1 vfr so po	e
M	8-20		5YR5/6	-	-	-	-	-	-
Pedon : 5 *Lithic Ustorthant* :									
Ap	0-10	di	10YR3/4	2mgr	Scl	mvf	mvf	1 vfr so po	e
Ac	10-29	di	10YR5/6	Imgr	Scl	ff	mf	1 vfr so po	e
M	29-40		10YR5/6	-	S	-	-	-	-
Pedon : 7 *Typic Ustochrept* :									
Ap	0-10	cs	10YR4/3	3m sbk	cl	mvf	mvf	1 vfr ss ps	e
B1	10-30	cs	10YR4/4	2m sbk	cl	mvf	mvf	1 vfr ss ps	e
B2	30-75	cs	10YR5/4	2m sbk	cl	cvf	ff	1 vfr ss ps	e
M	>75		5YR5/6	-	S	-	-	-	-

(Richards, 1954). The available N were determined by Subbiah and Asija (1956), P and K were determined by standard procedure (Jackson, 1967). The soils were classified as per soil taxonomy (Soil Survey Staff, 1998). The ground water analysis and classification were made according to methods of Richards (1954).

The soils under study (Table 1) were developed on gently (1-3%) to moderate sloping (3-5%) over weather basalt underlined by saprolites layer and are very shallow (8 cm) to moderately shallow (75 cm) in depth. Soil associated with elevated topography is redish brown (5YR5/4) to yellowish red (5YR5/6) in colour were as the pedon situated on slightly depress topography and gentle sloping land is dark brown (10YR4/3) to yellowish brown (10YR 5/8) in colour. The structure of the pedons located on elevated topography (P_1 and P_9) are weak friable granular in structure were as the pedons located on slightly depressed topography and sloping land are weak moderate granular to moderate medium sub angular blocky structure.

Physical characteristics of soil (Table 2) indicated that the coarse fragments ranged from 7.33 to 93.6 per cent and sand is the dominate fraction in pedon located on elevated topography (P_4 and P_9) were as the clay dominant fraction in surface horizon in P_2 and P_7 which is situated in depress topography. The bulk density of these soils varied from 1.3 to 2.1 Mg m^{-3} and high bulk density was noticed in saprolite layer (1.98 to 2.1 Mg m^{-3}). The depth of soil including saprolite varied from 08 to 75 cm. The soil developed on elevated topography depth varied from 08 to 20 cm were as on depress area up to 75 cm. thus the soil depth is related in general to landform setting (Vadivelu *et al*. 1983) and in particular to slope and degree of erosion (Sehgal, 1986). Higher the degree of slope shallow is the soil depth. The available water capacity of these

Table 2. Physical characteristics of the representative pedons of College of Agriculture farm, Osmanabad.

Horizons	Depth (cm)	Coarse fragment (%)	BD (Mg m^{-3})	HC (cm hr^{-1})	Moisture retention (%)		AWC (%)	Partial size analysis		
								Sand (%)	Silt (%)	Clay (%)
Pedon 1 *Lithic Ustorthant*										
Ah	0-10	7.33	1.48	29.2	21.2	7.9	13.3	41.4	23.8	34.8
Ac	10-30	67.6	1.66	31.2	19.5	7.2	12.3	71.1	7.4	21.5
M	>30	89.1	2.11	-	-	-		71.0	9.2	20.8
Pedon 4 *Lithic Ustorthant*										
Ah	0-8	68.5	1.78	34.5	20.2	7.6	12.6	71.0	8.9	20.1
M	8-20	93.8	2.11	-	-	-	-	80.0	4.3	15.5
Pedon 5 *Lithic Ustorthant*										
Ap	0-10	16.0	1.53	28.4	19.8	7.6	12.2	46.9	22.7	30.4
Ac	10-29	64.5	1.98	29.2	19.1	7.4	11.7	54.0	17.8	28.2
M	29-40	89.0	1.98	-	-	-	-	71.4	10.1	18.3
Pedon 7 *Typic Ustochrept*										
Ap	0-10	8.0	1.38	7.25	31.2	17.7	13.5	40.2	14.1	45.7
B_1	10-30	7.5	1.39	8.46	30.5	16.9	13.6	28.1	20.0	51.9
B_2	30-75	7.1	1.48	8.12	30.5	17.5.	13.0	38.1	20.9	41.0
M	>75	80	1.98	-	-	-	-	53.0	20.4	26.6

soils ranged from 7.5 to 15.8 per cent this variation attributed to textural difference.

The soil was neutral to alkaline in reaction the pH range varied from 6.9 to 7.4. The pH value of P_4 and P_9 were lowered as compared to other pedons, Low pH value in these soil may be due to combine effect of sloping topography and high erosion. The soluble salt concentration of these soil were low (0.1 to 0.3 dSm^{-1}) The organic carbon content was low (0.3%) to high (1.1%). The surface soil high amount of organic carbon (05 to 1.1%), may be due to glyricidia plantation. The cation exchange capacity of these soils varied from 17.78-48.21 cmol (p^+) kg^{-1}. It was higher in P_7 which was directly related to clay content. The exchangeable complex were dominated by Ca^{++} followed by Mg^{++}, K^+ and Na^{++}. The base saturation percentage was more than 88 per cent. The available NPK ranged from 174.3-312.0, 7.1 to 14.3 and 156-278 kg ha^{-1} respectively and it was decreased with depth.

The pedon associated on elevated and sloping topography (P_1, P_3, P_4, P_5, P_6 and P_9) did not have any diagnostic horizon and thus soil were qualify the order Entisols and due to presence of Ustic soil moisture regime the soils were grouped into Ustorthents further in view of lithic contact with in 50 cm of surface those soil belonging to the subgroup Lithic Ustorthant. The pedon located in low lying tophography P_2 and P_7 having ocric epipedon undelined by cambic horizone had been classified as Ochrept within order Inceptisol. The study area belonging to Ustic moisture regime those soil qualify for the great group Ustochrepts. At subgroup level these soil classified as *Typic Ustochrept*.

Chemical composition and quality of ground water indicated that the depth of the tube well

Table 3. Chemical characteristics of the representative pedons of College of Agriculture farm, Osmanabad.

Horizons	Depth (cm)	pH	EC (dS m^{-1})	O.C. (%)	$CaCO_3$ (%)	CEC (cmol (p^+) kg^{-1})	Cations cmol (p^+) kg^{-1}				Base saturation (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
							Ca++	Mg+	Na+	K+				
Pedon 1														
Ah	0-10	7.2	0.1	1.0	3.7	26.0	18.4	6.1	0.2	0.3	96.1	302.6	10.7	278
Ac	10-30	7.4	0.2	0.5	4.2	26.8	18.7	7.4	0.2	0.1	98.4	174.3	8.9	156
M	>30	7.1	0.1	0.3	2.1	21.4	11.7	8.6	0.2	0.1	96.1	174.3	7.1	148
Pedon 4														
Ah	0-8	6.8	0.1	0.5	3.3	22.8	11.7	9.2	0.3	0.1	94.0	189.7	7.1	148
M	8-20	6.7	0.1	0.1	2.0	17.7	08.1	8.4	0.5	0.1	87.5	174.3	7.1	121
Pedon 5														
AP	0-10	6.9	0.1	1.1	2.1	25.9	17.4	6.1	0.2	0.3	92.7	302.6	12.5	254
Ac	10-29	7.1	0.1	0.5	3.3	31.7	21.9	8.6	0.2	0.2	97.4	233.6	10.7	171
M	29-40	7.1	0.1	0.2	2.8	19.7	09.9	8.6	0.2	0.1	95.6	202.2	7.1	121
Pedon 7														
Ap	0-10	7.0	0.3	1.0	3.3	48.2	21.9	8.4	0.3	0.5	98.0	271.2	12.6	452
B_1	10-30	7.0	0.3	1.0	3.3	48.0	28.5	7.7	0.4	0.4	97.8	239.9	10.7	350
B_2	30-75	7.1	0.3	0.9	3.3	46.9	28.4	7.3	0.3	0.3	98.8	239.2	09.7	278
M	>75	6.8	0.2	0.3	2.5	29.7	8.94	9.2	0.4	0.2	96.5	224.2	09.7	148

is 150 to 250 ft. the ground water were alkaline in reaction pH varied from 7.8 to 8.3 and electrical conductivity less than 0.6 dSm^{-1}. The proportion of monovalent to divalent cation governs the behavior of water. The Kelley's ratio were less than unity (0.4 to 0.7) indicating no sodiumisation of water. The carbonate and bicarbonate ranged from 1.1 to 1.7 $mmol^{-1}$ and 6.1 to 5.4 $mmol^{-1}$ respectively and residual sodium carbonates (RSC) less than 1.25 $mmol^{-1}$. This suggests that this water is suitable for irrigation purpose. The ground water were classified accordingly to US salinity laboratory (Richards, 1954) and it was grouped under C_2S_1 (Medium salinity and low sodicity)

Taxonomically, the soils were classified as Lithic Ustorthent and Typic Ustochrept. The most of the soils of study area was Lithic Ustorthent having low, production potential than *Typic Ustochrept*. This variation due to low rooting depth, clay content, available water capacity, cation exchange capacity and high amount coarse fragment in soils of *Lithic Ustorthent*. The tube well water of the college farm is medium saline with low sodicity (C_2S_1) and RSC is less than 1.25 meq lit^{-1}. This indicated that the tube well water of the study area is safe for irrigation purpose.

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References

Deshmukh, S. N. and Bapat, M. V. 1993. Land evaluation for different uses. J. Indian Soc. of Soil Sci. 41: 202-204.

Jackson, M. L. 1967. Soil Chemical Analysis, Prentice hall of India Pvt. Ltd, New Delhi, pp. 498.

Jackson, M. L. 1979. Soil Chemical Analysis - Advanced Course, 2nd Edn. Publ. Univ. of Wisconsin, Madison, USA.

Pal, D. K. and Deshpande, S. B. 1987. Characteristics and genesis of minerals in some benchmark vertisols of India. Pedologie. 37(3): 259-275.

Richards, L. A.(ed.) 1954. Diagnosis and improvement of saline and alkali soils. USDA Agric. Handbook. U.S. Govt. Print. Off. Washingtan, D.C. 160p.

Sehgal, J. I. 1986. Introductory pedology, Kalyani Publ. New Delhi.

Soil Survey Staff. 1995. Soil Survey Manual, New revised edition, USDA, Scientific Publ., Jodhpur, 437.

Soil Survey Staff. 1998. Key to Soil Taxonomy. Soil Conservation Service, US Department of Agriculture, Washington. DC.

Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for determination of available nitrogen in soil Current Sci. 25; 256-260.

Tamhane, R. V., Motiramani, D. P., Bali, Y. P. and Donahue, R. L. 1976. Soils: their chemistry and fertility in tropical Asia Prentice Hall Inter. Inc. New Delhi. 475.

Vadivelu, S., Lande, R. J. and Kalbande, A. R. 1983. Soil physiographic relationship and its impact on land use. J. Maharashtra agric. Univ. 8(1): 16-19.

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Effect of Different Legume Crop Residues on Soil Properties, Yield and Nutrient Uptake by Wheat on Inceptisol

The most effective means of improving natural supply of N and organic matter to the soil is the cultivation of suitable legumes and the in-situ incorporation at an appropriate stage of growth. Under present situation in country like India, the use of green manures in combination with fertilizers seems to be very essential for sustaining productivity and soil fertility (Singh and Singh, 2007). However, due to increase in prices, uncertainty in timely availability of fertilizers as well as scarcity of FYM under such situation, use of green manuring of crop residues along with chemical fertilizers is an alternative source in maintaining soil fertility and sustainable crop production. As a consequence, incorporation of crop residues in soil is becoming common practice in several parts of world to maintain high level of soil organic matter and productivity. The suitability of organic material as a source of N depends to a great extent on its mineralization of N in relation to crop demand. The mineralization of N from crop residues varies with N content and C:N ratio of residue (Pathak and Sarkar, 1994). In view of this, it becomes quite clear to develop economical and efficient N management strategies; evolution of N supplying capacity of wide variety of green manures is of practical importance. However, the synchronization of N release from legume plant residues *viz*., black-gram, clusterbean, cowpea, greengram, dhaincha, soybean and sunnhemp with crop demand for N is critical for successful use of such approaches and there is lack of information on the rate and chemical composition and magnitude of N mineralization of various legume crop residues added to the soil. Considering the importance of legume crop residues for sustaining productivity and soil fertility an attempt was made to study the different legume crop residues incorporation and their effects on yield and nutrient uptake by wheat on Inceptisol.

Bulk surface (0-30cm) soil sample collected from the experimental area of Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune and used in this study. The soil samples were air dried in shade and passed through 2 mm sieve. The soil of experimental field is clay in texture having field capacity of 38 per cent, pH 8.1, EC 0.22 dSm^{-1}, organic carbon 3.2 g kg^{-1}, $CaCO_3$ 72.5 g kg^{-1}, available N 50.4, P 6.88, K 186, DTPA extractable Zn 0.52, Fe 3.80, Mn 10.8, Cu 8.07 mg kg^{-1} respectively, microbial count for bacteria 14.67 x 10^5, fungi 9.67 x 10^3, actinomycetes 10 x 10^3, P solubalizer 1.33 x 10^3 and N fixer 4.33 x 10^3 cfu g^{-1} soil respectively.

Black gram (*Vigna mungo* L.), clusterbean (*Cyamopsis tetragonoloba* L. Taub.), cowpea (*Vigna unguiculata* L. Walp), soybean (*Glycine max* L. Merrill), green gram (*Vigna radiata* L. Wilczek), dhaincha (*Sesbania aculeata* Pres) and sunnhemp (*Crotolaria juncea* L.) legume crops were grown in field and fertilized with 25: 50 kg N: P_2O_5 ha^{-1}. They were harvested at 45 days old and air dried in shade subsequently. The processed legume crop residue was analyzed (Table 1) for total N, P and K content (Jackson 1973), organic carbon (Gorsuch, 1970) and cellulose (Sadasivam and Manickam 1996).

Ten kg of this well processed soil was filled in cement pots. The processed seven legume crops residue was applied @ 5 mg g^{-1} soil along with recommended fertilizer dose @ 120:60:60 kg N: P_2O_5 : K_2O ha^{-1} and control consisted of

recommended dose of fertilizer alone to wheat crop. The treatments were replicated thrice in completely randomized block design. As the requisite amount of legume crop residues and half fertilizers dose of N and full dose of P_2O_5, K_2O through urea, single super phosphate and muriate of potash were thoroughly mixing in the soil and remaining half N was applied one month after sowing.

A good quality of fifteen seeds of wheat (Cv. NIAW-301) were sown in each pot at equidistance and allowed to grown up to maturity. Pots were watered with tap water as and when required to field capacity. At maturity wheat crop was harvested by cutting at ground level. The grain and straw samples were separated after recording weight of grain and straw in each pot. The grain and straw samples were air dried, oven dried at 65°C, ground in multiplex grinder and digested in H_2SO_4:H_2O_2 (1:1) for analysis of N, P and K by adopting standard method (Jackson 1973). The total N, P and K uptake were computed after harvest of crop. Soil samples were collected air dried, processed and analyzed for organic carbon, available N, P, K, DTPA extractable micronutrients by adopting standard methods (Jackson 1973, Lindasy and Norvell, 1978). The biological properties of the soils in terms of population of bacteria, fungi, actinomycetes, P solublizers and N fixers in soil by adopting dilution plate technique (Dhingra and Sinclair, 1993).

Table 1. Chemical composition of green manuring crops.

Properties	Black gram	Clusrer-bean	Cowpea	Green gram	Dhaincha	Soybean	Sunnhemp
Nitrogen	2.26	1.98	2.02	2.40	2.06	1.98	1.84
Phosphorus	0.27	0.27	0.26	0.28	0.22	0.25	0.26
Potassium	2.14	2.08	2.10	2.16	2.07	2.04	2.03
Organic carbon (%)	41.8	44.5	42.6	41.2	43.8	44.70	42.00
Cellulose	6.33	5.80	5.72	6.08	6.52	6.82	6.90
C:N ratio	18.49	22.47	21.08	17.16	21.26	22.57	22.82
C:P ratio	154.8	164.8	163.8	147.1	199.0	178.8	161.5

Table 2. Effect of legume crop residues along with chemical fertilizers on yield, nutrient uptake and soil fertility at harvest of wheat.

Treatment	Yield (g pot^{-1})		Total nutrient uptake mg pot^{-1}			Organic carbon (%)	Available nutrients (mg kg^{-1})			DTPA-micronutrients (mg kg^{-1})			
	Grain	Straw	N	P	K		N	P	K	Zn	Mn	Fe	Cu
Black gram	15.91	25.99	461.80	122.97	617.93	0.410	76.8	11.92	258	0.67	14.76	4.05	10.25
Clusterbean	14.26	23.48	376.73	103.10	522.27	0.360	63.8	8.97	240	0.73	14.90	4.23	10.89
Cowpea	15.80	24.82	440.80	118.40	587.10	0.380	73.2	9.55	264	0.69	14.68	4.38	10.70
Green gram	17.60	27.95	514.07	140.33	678.00	0.400	78.6	13.20	292	0.66	15.31	4.30	10.48
Dhaincha	15.19	23.42	410.70	104.57	545.60	0.380	68.8	9.87	254	0.74	14.42	4.35	11.12
Soybean	16.93	26.28	469.43	125.47	605.33	0.370	70.1	10.85	285	0.69	14.69	4.03	10.42
Sunnhemp	14.64	23.26	404.07	107.23	537.70	0.360	65.6	9.69	256	0.81	15.50	4.28	11.06
Control	11.31	18.35	285.60	71.33	381.70	0.290	60.3	8.30	221	0.48	13.33	3.10	9.05
S.E.±	0.56	0.96	15.64	4.42	21.40	0.015	2.45	0.74	14.6	0.03	0.43	0.14	0.25
CD at 5%	1.68	2.90	47.35	13.38	64.76	0.045	7.42	2.23	44.37	0.10	1.32	0.43	0.76

The results in Table 2 revealed that grain (11.31 to 17.60 g pot^{-1}) and straw (18.35 to 27.95 g pot^{-1}) yield of wheat varied with different treatments. Application of green gram residue along with recommended dose of fertilizer produced significantly highest grain (17.60 g pot^{-1}) and straw (27.95 g pot^{-1}) yield in comparison to rest of the treatments. However, it was on par with soybean crop residue amended treatment. The lowest yield was recorded in control i.e. amended with recommended dose of fertilizer alone. The best performance of green gram crop residue might be attributed to less lignin content with more favorable narrow C:N ratio and higher content of N of green gram which caused faster N mineralization leading to higher nutrient availability. Rosegrant and Roumasset (1987) also reported beneficial effect of legume crop residues in rice base cropping system.

Total N, P and K uptake was significantly affected due to different nutritional treatments. Maximum uptake of N (514.17), P (140.33) and K (678) mg pot^{-1} were recorded due to application of green gram crop residue along with recommended dose of fertilizer which may be due to higher grain and straw yield of wheat recorded under this treatment. Minimum values for total uptake of all the nutrients (N, P and K) were obtained in control consisted of recommended dose of fertilizer alone. Similar results were also reported by Kumpawat and Rathore (2003) and Singh *et al*. (2008) in wheat.

The data given in Table 2 revealed that organic carbon, available N, P, K and DTPA Zn, Mn, Fe and Cu content of soil were significantly influenced due to different treatments at harvest of wheat. The maximum values of organic carbon (0.41%) was recorded in black gram, available N (78.60 mg kg^{-1}), P(13.20 mg kg^{-1}) and K (292 mg kg^{-1}) in green gram treatment, DTPA extractable Zn (0.81 mg kg^{-1}), Mn (15.5 mg kg^{-1}) in sunnhemp, Fe (4.38 mg kg^{-1}) and Cu (15.12 mg kg^{-1}) in dhaincha treatment respectively. Whereas minimum soil properties were observed in control treatment. Similar beneficial effects of legume crop residues as well as integration of nutrients on soil fertility were also reported by various workers (Tiwari *et al*. 2002, Tolanur and Badanur 2003 and Singh and Singh 2007).

The biological properties of soil in terms of population of bacteria, fungi, actinomycetes, nitrogen fixers and phosphate solubilizers were significantly improved due to incorporation of different legume crop residues along with recommended dose of fertilizers as compared

Table 3. Effect of legume crop residues along with chemical fertilizers on soil biological properties at harvest of wheat.

Treatment details	Bacteria (x 10^5 cfu g^{-1})	Fungi (x 10^3 cfu g^{-1})	Actinomycetes (x 10^3 cfu g^{-1})	P. solubilizers (x 10^3 cfu g^{-1})	N. fixers (x 10^4 cfu g^{-1})
Black gram	20.00	14.00	14.67	2.67	5.00
Clusterbean	21.67	12.67	15.67	3.67	6.67
Cowpea	23.00	17.00	21.33	4.00	7.00
Green gram	27.33	17.33	23.33	5.00	8.00
Dhaincha	25.00	19.33	28.33	5.67	11.00
Soybean	28.67	21.33	28.67	7.00	12.67
Sunnhemp	29.33	22.67	27.33	10.00	15.00
Control	15.00	11.33	12.67	2.00	4.00
S.E.±	1.23	0.82	1.22	0.57	0.82
CD 5%	3.76	2.50	3.70	1.73	2.49

to the control. The maximum population of the bacteria (29.33 x 10^5 cfu g^{-1} soil), fungi (22.67 x 10^3 cfu g^{-1} soil), P solubilizers (10 x 10^3 cfu g^{-1} soil) and N fixer (15.00 x 10^4 cfu g^{-1} soil) were recorded under sunnhemp legume crop residue along with recommended dose of fertilizer treatment. The maximum value of actinomycetes (28.67 x 10^3 cfu g^{-1} soil) was recorded under soybean treatment. Whereas minimum values of all soil biological properties were observed under control treatment. The incorporation of different legume crop residues in soil increased the organic carbon content of soil and subsequently resulted in increased microbial activity. Similar results were also reported by Tilak (2004) and Biederbeck *et al*. (2005).

Thus application of legume crop residues along with recommended dose of fertilizer to wheat can increase yield, post harvest soil and biological properties.

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References

Biederbeck, V. O., Zentner, R. P. and Campbell, C. A. 2005. Soil microbral populations and activities as influenced by legume green fallow in a semiarid climate. Soil Biol. and Biochem. 37(10): 1775-1784.

Dhingra, O. D. and Sinclair, J. B. 1993. Basic Plant Pathology Methods.CBS Pub. NewDelhi. pp. 128-135.

Gorsuch, T. T. 1970. The Destruction of Organic Matter. Pergamon Press. Ltd., New York, 143-144.

Jackson, M. L. 1973. Soil Chemical Analysis. Prentice Hall Pvt. Ltd., New Delhi. pp. 498.

Kumpawat, B. S. and Rathore,S.S.2003.Effect of proceeding grain legume on growth, yield nutrient content and uptake by wheat under different nitrogen levels. Crop Res. 25(2): 209-214.

Lindsay, W. L. and Norvell, W. A. 1978. Development of a DTPA (diethylenetriamine penta acetic acid) soil test of Zinc, Iron, Manganese and Copper. Soil Sci. Soc. Am. J. 42: 421-428.

Pathak, H. and Sarkar, M. C. 1994. Nitrogen supplying capacity of an ustorchrept amended with manures, urea and their combinations J. Indian Soc Soil Sci. 42(2): 261-267.

Rosegrant, M. W. and Roumasset, J. A. 1987. Economics feasibility of green manuring in rice based cropping system: concepts, methods and implications for research and policy. In Sustainable Agriculture; The Role of Green Manures Crops in Rice Farming Systems. IRRI, Manila, Philippines. pp. 168.

Sadasivam, S. and Manickam, A. 1996. Biochemical methods. New Age International (P) Ltd., Publ. pp. 123.

Singh, R. A. and Singh, M. 2007. Effects of organic manures and fertilizers on organic matter and nutrients status of the soil. Archives of Agron. and Soil Sci. 53(5): 519-528.

Singh, R., Singh, B. and Patidar, M. 2008. Effect of preceding crop and nutrient management on productivity of wheat (*Triticum aestivum*)- based cropping system in arid region. Indian J. Agron. 53(4): 267-272.

Tilak, K. V. 2004. Response of sesbania green manuring and mungbean residue incorporation on microbial Activities for sustainability of a rice-wheat cropping system. J. of Agric. and Rural Develop. in the Tropics and Subtropics. 105(2): 189-196.

Tiwari Alok, Dwivedi, A. K. and Dikshit, P. R. 2002. Long term influence of organics and inorganic fertilization on soil fertility and productivity of soybean-wheat system in Vertisol., J. Indian Soc. Soil Sci. 50: 472-475.

Tolanur, S. I. and Badanur, V. P. 2003. Effect of integrated use of organic manure; green manure and fertilizer nitrogen in sustaining productivity of *rabi* sorghum - chickpea system and fertility of a Vertisol. J. Indian Soc. Soil Sci. 51: 41-44.

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Variability Studies for Seed Yield and Yield Contributing Characters in Chickpea

The availability of genetic variability is the basic pre-requisite for genetic improvement in quantitative traits like yield. Hence an attempt was made to study the genetic variability in chickpea. Further estimates of variability and other parameters are beneficial to breeder to predict the performance of genotypes in the subsequent generation.

The experimental material comprised of sixty genotypes of chickpea collected from Pulses Improvement Project, M.P.K.V., Rahuri were used for the present investigation. The experiment was laid out in a randomized block design with three replications during *rabi*, 2011. The 60 genotypes were evaluated for 13 yield and yield contributing characters *viz*., days to 50 per cent flowering, days to maturity, plant height (cm), number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, 100-seed weight (g), protein content (%), rate of photosynthesis (µmol CO_2 m^{-2} s^{-1}), rate of transpiration (mmol m^{-2} s^{-1}), stomatal conductance (mol H_2O m^{-2} s^{-1}) and seed yield plant^{-1} (g).

Wide range of variability was observed for almost all the characters studied except number of primary branches plant^{-1} (2.53-4.73), number of seeds pod^{-1} (1.00-1.72) and stomatal conductance (0.02-0.08). The characters seed yield plant^{-1} (2.23-12.36) exhibited highest range of variability followed by days to maturity (92.67-124.33), number of pods plant^{-1} (19.13-86.47), days to 50 per cent flowering (46.67-85.00) rate of photosynthesis (27.08-48.53), plant height (29.27-42.73), protein content (15.98-24.23), 100-seed weight (11.88-17.38), number of secondary branches plant^{-1} (8.6-15.2), rate of transpiration (1.67-5.06) showed considerable amount of variability, while lowest variability was observed for number of primary branches plant^{-1} (2.13-4.73), number of seeds pod^{-1} (1.00-1.72) and stomatal conductance (0.02-0.08). Jeena *et al*. (2005) reported high amount of genetic variability for number of pods plant^{-1}, 100-seed weight and seed yield. Gupta and Krishna (1995) reported high variability for seed size followed by protein content and grain yield. Rao and Kumar (2000) reported high variability for trait seed yield plant^{-1} and reported low variability for days to maturity followed by days to 50 per cent flowering. Malik *et al*. (2010) reported high variability for pods plant^{-1} followed by secondary branches plant^{-1} and grain yield.

Among the 60 genotypes studied, Vijay (days to 50% flowering), Digvijay (days to maturity), Rajas (plant height), Virat (number of primary and secondary branches plant^{-1}, 100-seed weight, protein content), IC-268978 (number of pods plant^{-1}), IC-268946 (number of seeds pod^{-1}), Vijay (rate of photosynthesis), IC-268932 (rate of transpiration), IC-249481 and IC-268932 (stomatal conductance), Vijay (seed yield plant^{-1}) recorded the highest per se performance for the respective characters.

Genetic variability is the basis for any heritable improvement in the crop plants. The estimates of phenotypic coefficient of variation were magnitudinaly higher than the estimates of genotypic coefficient of variation, indicating that the variability existing in these characters was not only due to genetic factors but also due to environmental factors. The estimates of genotypic (GCV)-and phenotypic coefficients of

variation (PCV) in the present study were highest for seed yield plant^{-1} and number of pods plant^{-1} indicating good scope for their improvement through selection. Similar findings were also reported by Akhtar *et al*. (2011). Dwevedi and Gaibriyal (2009) reported high GCV and PCV for number of pods plant^{-1}. Ali *et al*. (2009) reported phenotypic coefficient of variability and genotypic coefficient of variability were highest for seed yield plant^{-1} than other traits.

The magnitudinal difference between genotypic coefficient of variation and phenotypic coefficient of variation were maximum for rate of photosynthesis, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, indicating that environment played significant role in expression of these characters. However, for the remaining characters the magnitudinal difference between GCV and PCV were minimum, indicating less role of environment in the phenotypic expression of these characters and one can relies on the phenotype alone while carrying out the selection.

In the present investigation, number of pods plant^{-1} and days to 50 per cent flowering exhibited high estimates of heritability (b.s.) accompanied with high genetic advance, indicating that these traits could be predominantly governed by additive gene action and selection of these traits could be more effective for desired genetic improvement. Similar, findings were reported by Dwevedi and Gaibriyal (2009) reported moderate to high degree of heritability and genetic advance for number of pods per plant. Ali *et al*. (2009) reported high heritability for days to 50 per cent flowering. Noor *et al*. (2003) reported high estimates of heritability (b.s) accompanied with high genetic advance for days to flowering.

In the present investigation, high heritability for stomatal conductance, yield plant^{-1}, rate of transpiration, protein per cent and number of seeds pod^{-1} was not associated with high genetic advance indicating that these characters were controlled by non-additive gene action i.e. dominance deviation or epistasis, and hence is limited scope for further improvement through selection for these characters. Thus considering

Table 1. Parameters of genetic variability in 60 genotypes of chickpea.

Character	Range	General mean	PCV	GCV	Heritability (h^2) (bs)	GA	GA as per cent of mean
Days to 50 per cent flowering	46.67-85	62.25	13.36	12.29	85	14.50	23.30
Days to matunty	92.67-124.33	105.38	8.14	5.87	52	9.20	8.73
Plant height (cm)	29.27-42.73	36.22	11.32	8.44	56	4.70	12.97
Pimary branches	2.53-4.73	3.26	17.05	13.71	65	0.74	22.68
Secondary branches plant^{-1}	8.6-15.2	10.77	15.46	12.43	65	2.22	20.57
Pods plant^{-1}	19.13-86.47	48.66	30.79	28.49	86	26.42	54.29
Seeds pod^{-1}	1-1.72	1.36	14.51	12.29	72	0.29	21.44
100-seed weight (g)	11.88-17.38	13.68	10.14	8.15	65	1.85	13.49
Protein content (%)	15.98-24.23	18.69	10.51	9.32	79	3.18	17.02
Rate of photosynthesis	27.08-48.53	35.14	16.72	12.16	53	6.40	18.22
Rate of transpiration	1.67-5.06	3.37	29.18	26.17	80	1.63	48.33
Stomatal conductance	0.0203-0.082	0.057	28.26	27.06	92	0.03	53.39
Seed yield plant^{-1} (g)	2.22-12.36	6.18	36.01	34.15	90	4.12	66.73

the estimates of genetic parameters like-genotypic coefficient of variation, heritability and genetic advance, number of pods plant^{-1}, days to 50 per cent flowering and seed yield plant^{-1} are the most important characters in chickpea.

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References

Ali, M. A., Nawab, N. N., Rasool, G. and Saleem, M. 2008. Estimates of variability and correlations for quantitative traits in *Cicer arietinum*. J. Agri. Soc. Sci., 4: 177-79.

Akhtar, L. H., Pervez, M. A. and Nasim, M. 2011. Genetic divergence and inter-relationship studies in chickpea (*Cicer arietinum* L.). Pak. J. Agri. Sci., 48(1), 35-39.

Dwevedi, K. K. and Gaibriyal M. Lal. 2009. Assessment of genetic diversity of cultivated chickpea. Asian J. of Agric. Sci. 1(1): 7-8.

Gupta, S. K. and Krishna, R. 1995. Genetic variability and heritability for quality traits in Bengali gram. Indian J. Agric. Biochem. 8(1 and 2): 66-67.

Jeena, A. S., Arora, P. P. and Upreti, M. C. 2005. Divergence analysis in chickpea. Legume Res. 28(2): 37-42.

Malik, S. R., Baksh, A., Ahsan Asif M., Iqbal, U. and Iqbal, S. M. 2010. Assessment of genetic variability and inter relationship among some agronomic traits in chickpea. Internat. J. Agril. Bio. 9(4): 219.

Noor, F., Ashraf, M. and Gafoor, A. 2003. Path analysis and relationship among quantitative traits in chickpea. Pakistan J. of Biol. Sci. 6(6): 551 -555.

Rao, S. K. and Kumar, K. S. 2000. Analysis of yield factors in short duration chickpeas. Agric. Sci. Digest, 20(1): 66-67.

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Performance of Lactating Crossbred (J x L) Cows under Different Housing Management During Summer in Konkan

High temperature caused increase in respiration rate and body temperatures and decrease in feed intake and milk production in cows. (Vazhapilly, *et al*. 1990). An ideal housing enables in moderating the range of microclimate to which the animals are exposed and the degree of comfort depends upon types of housing. It also improves the dairy cattle productivity by protecting them from extreme climate (Dhiman *et al*. 1990, Sharma and Singh, 2002). Therefore, the present investigation was carried out to study the performance of lactating crossbred (J x L) cows under different types of housing conditions and the suitable housing conditions for maintaining temperature inside the shed.

The trial was conducted on nine lactating crossbred (J x L) cows. A group of three cows was allotted randomly into three comparable shelters in switch over design for fixed period of 18 days. There was five days time interval kept between successive treatment periods, as an adjustment period. The experiment was conducted from 1st April, to 3rd June, 2008.

The fundamental construction of each shed was almost same having covered and open area. The changes were done in three sheds in respect to roofing. Shed-I was having asbestos sheet. Shed-II was thatched roof house; a modified barn with six inch layer of paddy straw bedding with bamboo structure over the

asbestos roof. Shed-III was having white painted asbestos sheets.

Micro-environmental data within these sheds was recorded during period of experiment. The maximum, minimum, wet bulb, dry bulb thermometers were fixed at 2 m height in the centre of shed and the temperatures were recorded at 7.30 a.m. and 2.30 p.m. in each shed daily.

According to requirement, the animals in each group were fed with dry grass, green maize and *jowar kadbi*. The concentrate mixture was fed at the time of milking. Daily morning and evening milk yields were recorded in respect of individual cow during the entire trial period. To evaluate the treatment effects on the milk composition, milk samples were collected once in fortnight and were analyzed for fat, solid not fat, proteins and total solid content.

The maximum temperature (Table 1) remained on higher side in macro environment as compared to other three shelters in all the periods. The average maximum temperature of macro environment and micro-environment like asbestos roofed shed, thatched roof shed and white painted roof shed were 37.20 ± 0.17, 34.27 ± 0.17, 31.90 ± 0.16 and 32.98 ± 0.18°C, respectively. The present investigations were in agreement with the findings of Singh *et al*. (1989). The minimum temperature was under asbestos roofed shed and was followed by the white painted roof shed and thatched roof shed over all the period. The average minimum temperature of asbestos roofed shed, thatched roof shed, white painted roof shed and macro-environment were 23.10 ± 0.33, 23.60 ± 0.32, 23.30 ± 0.32 and 22.07 ± 0.27°C respectively.

Relative humidity (morning) of thatched roof shed, white painted roof shed, asbestos roofed shed and macro environment were 83.94 ± 0.66, 85.70 ± 0.60, 86.90 ± 0.57 and 82.27 ± 0.49 per cent respectively. Similar trend was found in case of RH (evening). The average relative humidity (evening) of thatched roof shed, white painted roof shed, asbestos roofed shed and macro environment was 55.59 ± 0.75, 59.09 ± 0.74, 60.94 ± 0.79 and 50.87 ± 0.72 per cent respectively. The THI was commonly used method to know the degree of heat stress in animal (Fuquay, 1979). Over the whole period, temperature humidity index (morning) was higher in macro environment and it was followed by asbestos roofed shed, white painted roof shed and thatched roof shed.

The average milk yield of 8.17 ± 0.084 kg day^{-1} cow^{-1} was found significantly higher ($P < 0.05$) in thatched roof shed (T_2) in comparison with 7.91 ± 0.084 kg in the white painted roof shed (T_3) and 7.52 ± 0.084 kg in asbestos roofed shed (T_1) (Table 2). As compared to asbestos roofed shed (T_1), there was increase in

Table1. Mean climatic components in different micro and macro environment.

Treatment parameters	Asbestos roofed shed (T_1)	Thatched roof shed (T_2)	White painted shed (T_3)	Macro environment	Sem±	CD at 5%
Max (°C)	34.27 ± 0.17	31.9 ± 0.16	32.98 ± 0.18	37.20 ± 0.17	0.17	0.51
Min (°C)	23.10 ± 0.33	23.6 ± 0.32	23.30 ± 0.32	22.07 ± 0.27	0.31	0.93
Rh morn. (%)	86.90 ± 0.57	83.94 ± 0.66	85.70 ± 0.60	82.27 ± 0.49	0.58	1.71
Rh even. (%)	60.94 ± 0.79	55.59 ± 0.75	59.09 ± 0.74	50.87 ± 0.72	0.75	2.25
THI morn.	75.09 ± 0.51	74.56 ± 0.51	74.77 ± 0.51	76.58 ± 0.50	0.50	1.52
THI even.	82.42 ± 0.26	79.02 ± 0.24	80.63 ± 0.23	84.41 ± 0.27	0.25	0.75

Table 2. Milk yield of cow and its composition under different housing conditions during expeimental periods.

Constituents	T_1	T_2	T_3	Sem±	CD at 5%
Milk yield (kg)	7.52	8.17	7.91	0.08	0.25
Milk total solid (%)	13.04	13.71	13.31	0.070	0.21
Milk fat (%)	4.45	4.87	4.64	0.044	0.132
Milk protein (%)	3.28	3.48	3.40	0.018	0.054
Milk SNF (%)	8.41	8.89	8.62	0.036	0.108

milk production by 5.19 per cent in white painted roof shed (T_3) and 8.64 per cent in paddy straw thatched roof shed (T_2). High environmental temperature decreased milk production mainly due to lower feed intake (Singh and Mishra, 2007). The results were also in agreement with findings of the Singh *et al*. (2008) who noted that use of paddy straw bedding over the asbestos sheet significantly ($P < 0.05$) improved the milk yield of crossbred cows in comparison to the cows in the asbestos roofed shed. The average total solids in milk of crossbred cows was found significantly higher ($P < 0.05$) in thatched roof shed followed by white painted roof shed (T_3) and asbestos roofed shed (T_1). These results agree with Fumaiki Itoh *et al*. (1998), who found that, per cent total solid decreased in hot environment. In thatched roof shed (T_2) higher average fat, SNF and protein in milk was observed followed by white painted roof shed (T_3). There was increase in water intake which results in reduced milk fat percentage (Aggarwal and Singh, 2006). Comparable results were reported by Moody *et al*. (1967) who found that marked decrease in per cent of SNF, fat and protein in milk of lactating cows due to high temperature in the shed.

Results showed that thatched roof shed had significant ($P< 0.05$) incremental effect on the milk production and milk composition of cows than the cows in white painted roof shed and asbestos roofed shed during summer season.

It was clear from the above results that paddy straw thatching over the asbestos sheet effectively ameliorates heat stress during the summer season in the Konkan region.

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References

Aggarwal, A and Singh, M. 2006. Impact of macroclimatic modification on production of dairy animals during summer. Indian Dairyman. 58(3): 49-59.

Dhiman, P. C., Singh, N. and Yadav, B. L. 1990. A study of dairy cattle and buffalo managemnt practices in adopted and non adopted villages of Hissar district. Indian J. Anim. Prod, and Mgmt. 6(2): 84-89.

Fumiaki ITOH, Yoshiaki Drand, Michad T, Rose Hireshi fuse and Harro Harimato. 1998. Insulin and decagon sevation in lactating cows during heat exposure. J. Dairy Sci., 76: 2182-89.

Fuquay, J. W., Zook, A. B., Daniel, J. W., Brown, W. H. and Poe, W. E. 1979. Modifications in freestall housing for dairy cows during the summer. J. Dairy Sci. 62(4): 577-583.

Moody, E. G., Vansoest, P. O., Mcdowell, R. E. and Forel, G. L. 1967. Effect of high temperature and dietary fat on performance of lactating cows. J. Dairy sci. 50(12): 1909-1916.

Sharma , P. and Singh, K. 2002. Effect of shelters system on environmental variables. Indian J. Anim. Sci. 72(9): 806-809.

Singh, K., Kumar, P., Saini, A. L. and Bhattacharyya, N. K. 1989. Influence of commonly used roofing materials on microclimate in animal houses in hot semiarid zone. Indian J. Dairy Sci. 42(3): 505-510.

Singh, S. P. and Mishra, A. 2007. Impact of climatic variation on animal health and productivity. Indian Dairyman. 59(3): 47-54.

Singh, M., Sharma, D. K., Dutta, S. and Ghosh A. 2008. Effect of modified management on milk production composition and physiological responses in crossbred cows in eastern region. Indian J. Dairy Sci. 61(4): 295-297.

Vazhapilly, P., Frazzi, E., Lombardelli, R., Mainti, M. G. and Cappa V. 1990. Effect of microclimate on the physiological and metabolical responses of dairy cows and on milk quality. Fide Dairy Sci. Abstract. 55: 48.

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Evaluation of Pigeonpea Genotypes Against Pod Borer Complex

Pigeonpea (*Cajanus cajan* (L) Millep.) is one of the important pulse crops grown in India, however, due to the biotic stress, the yield of the pigeonpea is less. Pod borers comprising of lepidopteran borers i.e. pod borer. (*Helicoverpa armigera* (Hubner)), tur plume moth, (*Exelastis atomosa* Walshinghum)) and tur pod fly (*Melanagromyza obtusa* (Malloch)) are the major insect pests on tur which reduces the yield considerably. In India the total pod damage due to pod borer complex has been reported to be 33.8 to 49.9 per cent (Vishwa Dhar *et al.* 2005). Host plant resistance is a major component of IPM which is chief, non polluting and compatible with other methods of pest control (Sachan, 1990). Considering the severity of the borers, the study was undertaken to find out tolerant source in this crop.

Fifteen pigeonpea genotypes were screened for pests during *kharif* 2008-09 to 2010-11 at Pulses Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra). The genotypes which had initially exhibited tolerance/moderately tolerance against lepidopteron pod borers and pod fly were grown in a plot of two rows of 4 m length with two replications. The check Vipula was grown for confirmatory test against these pests under pesticide free field conditions for conducive infestation against pod borers. For assessment, the borer damage was recorded on five randomly sampled plants at the time of harvesting by counting the total number of healthy and damaged pods. From this per cent pod damage was calculated and these percentages were further converted into pest susceptibility rating (PSR). Similarly, pest susceptibility rating 1-9 scale (1 = 100%, 2 = 75 to 99%, 3 = 50 to 75%, 4 = 25 to 50%, 5 = 10 to 25%, 6 = 10 to 10%, 7 = -25 to -10%, 8 = -50 to -25% and 9 = -50% or less pest resistance percentage) for individual genotypes were worked out based on the formula suggested by Abott, (1925).

Pod damage : The data on lepidopteron pod borers damage (Table 1) revealed that the pod damage among the test genotypes ranged from 7.16 per cent in Phule T-00-12-1-1 to 15.26 per cent in BDN 2010 with the mean pod damage of 11.56 ± 2.17 per cent. From the pest susceptibility rating, the genotypes Phule T-00-16-4-2, Phule T-01-24-1-1 and Phule T-00-12-1-1 recorded PSR 4 and Phule T- 00-17-12-2, Phule T-04-24-2, Phule T-00-12-6-4, Phule T-00-1-25-1, PT-04-31 recorded PSR 5 and were most promising against lepidopteron pod borers, whereas, Phule-T-01-2010, Phule T-00-5-8-1, Phule T-00-5-7-4-J, Phule T-00-4-16-2 and Phule T-01-H-2 genotypes scored PSR 6 and found to he more susceptible than check Vipula. The highest PSR of 7 was observed for BDN-2010.

Table 1. Field reaction of pigeonpea genotypes against pod borer complex (2008-09 to 2010-11).

Genotype	Pod damage (%)		Pest susceptibility rating	
	Pod borer	Pod fly	Pod borer	Pod fly
Vipula (Ch)	13.21	11.53	-	-
Phule T-01-20 10	12.42	11.48	6	8
Phule T-00-5-8-1	14.09	11.00	6	6
Phule T-00-1-25- 1	10.59	11.03	5	6
Phule T-00-5-7-4-1	13.50	12.68	6	7
BDN-2010	15.26	11.94	7	6
Phule T-00-17-12-2	9.55	9.8	5	5
Phule T-00-4-16-2	12.13	8.25	6	5
Phule T-01-11-2	14.41	8.58	6	5
Phule T-00-16-4-2	9.38	7.74	4	4
Phule T-01-24-1-1	9.87	15.98	4	7
Phule T-00-12-1-1	7.16	8.95	4	5
Phule T-04-24-2	10.29	15.94	5	7
Phule T-00-12-6-4	11.26	12.93	5	7
Phule T-04-31	10.39	9.48	5	5
Mean	11.56	11.15		
SD±	2.17	2.43		

The pod fly damage ranged between 7.74 per cent in Phule T-00-16-42 to 15.98 per cent in Phule T-01-24-1-1 with the mean pod damage of 11.15±2.43 per cent. On the basis of pest susceptibility rating, the genotype Phule T- 00-16-4-2 scored PSR 4 and Phule T-00-17-12-2, Phule T-00-4-162, Phule T-01-11-2, Phule T-00-12-1-1 and Phule T-04-31 scored PSR 5 and were the most promising against pod fly. Rest of the genotypes had PSR above 6 and were more susceptible than check Vipula.

The results clearly indicated that the pigeonpea genotypes Phule T-00-17-12-2, PT-2000-16-4-2, Phule T-00-12-1-1 and Phule T-04-31 had dual resistance and high degree of resistance among the tested genotypes against lepidopteron pod borer and tur pod fly (*Melanagromyza obtusa* (Malloch)). Therefore, these genotypes could be used for further pigeonpea breeding programme.

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References

Abott, W. S. 1925. A method of computing effectiveness of an insecticide. J. of Econ. Ento., 18(1): 265-267.

Sachan, J. N. 1990. Progress in host plant resistance. Work in chickpea and pigeonpea against *Helicoverpa armigera* (Hubner) in India. In summary, Proceed. of the consultative group meeting, 5-7 March. ICRISAT. 19-22.

Vishwa Dhar, Raj, A. B. and Singh, S. K. 2005. Weather based forecasting system for management of pests and diseases in pigeonpea. pp. 60-77. Souvenir. In: Nat. Challenge held at Indian Institute of Pulses Research, Kanpur, Uttar Pradesh during 25-26th February.

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Effect of Green Manures on Physico-Chemical Properties of Soil

The physico-chemical properties of soil and its water retention are essential for life of plants. The addition of organic matter increases the soil pores and specific area of soil, thereby increasing soil moisture retention. About 80 per cent increase in water retention may be explained by soil texture and organic matter content of soil. The continuous use of inorganic fertilizers has not only result in impairment physico-chemical and biological properties but also increases the incidence of diseases, insect and pest attacks, thereby reducing the productivity and quality of crops. Under such circumstances, use of organic manures (FYM, compost, vermicompost or green manures) has assumed great importance in maintaining the soil quality indicators as well as for enhancing the better quality and productivity of crops. The beneficial effect of organic manaures *viz*., FYM, poultry manure and vermicompost in sodic soil has been reported by Pareek and Yadav (2011). The incorporation of green manures to the soil not only supply macro and micronutrients but also improves the physical and chemical properties of soil which will help in increasing the productivity and maintaining the fertility of soil. With this view, the present investigation was, therefore, undertaken to study the effect of green manuring on physico-chemical properties of soil in Inceptisol.

The laboratory incubation experiment was conducted at Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, Maharashtra during the year 2009-10. The seven sources of green manures *viz*., sunnhemp, *dhaincha*, cowpea, black gram, green gram, soybean were grown up to 45 days, harvested and dried under shed and in oven at 60°C and finely ground (2 mm). The green manaures were applied to the soil @ 20 t ha^{-1} with eight treatments and three replications and incubated for three months. The experiment was laid out in completely randomized design (CRD). After three months samples were used for estimation of physico-chemical properties and moisture retentions at various tensions with the help of pressure plate membrane apparatus.

The soil samples were collected from each bowl. It was air dried, ground, passed through 2 mm sieve and analyzed for soil texture. Bulk density, pH, EC, $CaCO_3$ and organic carbon and moisture content at various bars by adopting the standard methods of Page *et al*. (1982).

Physical properties of soil : The chemical composition of various green manures used for the experiment is given in Table 1. The bulk density of soil was found to be decreased by the addition of green manaures and FYM as compared to control. Significantly lowest bulk density (1.28 Mg m^{-3}) was observed due to the addition of cow pea which was at par with all the sources of green manures except black gram and green gram treatments. The highest bulk density (1.40 Mg m^{-3}) was noticed in control treatment. The cow pea treatment drastically reduced the bulk density as compared with other organics. It might be because of readily decomposable material. These findings corroborate the findings reported by Prakash *et al*. (2002) and Selvi *et al*. (2005). The per cent porosity was found to be increased with addition of green manuring crops. It was attributed to the decrease in bulk density. The highest percent porosity (51.70) was observed due to addition of cow pea @ 20

t ha^{-1} and it was significantly superior over green gram and control treatments. The significantly lowest per cent porosity (47.17) was noticed under control treatments as compared to all the organic sources. However, all the sources of organic manures were found to be on par with each other except green gram treatment. The incorporation of green gram and black gram treatment were found to be on par with each other in respect to percent porosity. Bellakki and Badanur (1997) reported the improvement in the porosity of soil due to application of sunnhemp.

The water retention of soil in all the treatments of green manures showed a little variation at higher tension (3, 5 and 15 bars). This is explained by the fact that water retention at lower tension depends primarily on pore size distribution. In general, data showed that in addition of all the sources of organic manures recorded higher water retention as compared to the control at all the tension. Among the sources, addition of sunnhemp recorded significantly the highest moisture retention (41.05%) as compared with all the treatments and control at 0.33 bar. The similar values of moisture retention were observed due to the incorporation of green gram, soybean and FYM at 0.33 bar. The lowest water (35.07%) retained in control treatment. From 0.33 to 1 bar there is clear cut difference in retention of water. After 3 to 15 bars there is little difference in retention of water. All the treatments revealed exactly similar values of moisture retention at 5 and 1 bar. The favorable effect of FYM on water retention has been reported by Bhattacharyya *et al*. (2004)

Table 1. Chemical composition of green manures and FYM used for experiment.

Properties	Sunnhemp	Dhaincha	Cow pea	Black gram	Green gram	Soybean	FYM
Nitrogen (%)	1.84	2.06	2.06	2.26	2.40	1.98	1.40
Phosphorus (%)	0.26	0.22	0.26	0.27	0.28	0.25	0.83
Potassium (%)	2.03	2.07	2.10	2.14	2.16	2.04	0.79
Organic carbon (%)	42.00	43.80	42.60	41.80	41.20	44.70	21.20
Cellulose (%)	6.90	6.52	5.72	6.33	6.08	6.82	8.22
C:N ratio	22.82	21.26	21.08	18.49	17.16	22.57	15.10
C:P ratio	161.5	199.0	163.8	154.8	147.1	178.8	25.54

Table 2. Physical and chemical properties of soil as influenced by addition of green manures.

Treatment	Bulk density (mg m^{-3})	Porosity (%)	pH (1:2.5)	EC (dSm^{-3})	Organic C (%)	CEC [cmol(p*) kg^{-1} soil]	$CaCO_3$ (%)
Control	1.40	47.17	7.75	0.47	0.43	55.00	8.87
Sunheamp	1.30	50.94	7.84	0.85	0.67	59.00	6.67
Dhaincha	1.30	50.94	7.89	0.92	0.77	59.00	6.81
Cowpea	1.28	51.70	7.83	1.00	0.73	60.00	6.73
Black gram	1.32	50.19	7.89	1.00	0.66	62.00	6.77
Green gram	1.35	49.06	7.96	0.92	0.59	61.50	6.94
Soybean	1.30	50.94	7.93	0.95	0.59	61.80	6.96
FYM	1.30	50.94	7.85	0.61	0.78	64.00	7.35
S.E.±	0.01	0.59	0.10	0.01	0.08	0.36	0.05
CD at 5%	0.03	1.72	N.S.	0.04	0.23	1.05	0.16

and Pareek and Yadav (2011). The lowest available water was observed in control treatment. The incorporation of sunnhemp, *dhaincha*, cow pea, black gram and FYM were beneficial for increasing the available water retension in Inceptisol.

Chemical properties of soil : Incorporation of green manaures did not influence the pH of soil. However, there was slight increase in pH of soil after addition of green manuring treatments and FYM. The incorporation of organic wastes [(*Lantana camera*, *Ipomoea cornea*, water hyacinth, *Karanj* leaves, *subabul*, Lentil straw and rice straw @ 0.5 per cent (w/w) significantly increased pH and nutrient status of the soil (Lal *et al*. (2000). The decrease in pH of sodic soil with the addition of organic manures (FYM, poultry manure and vermicompost) has been reported by Yadav and Chhipa (2007). All the green manuring crops significantly increased electrical conductivity of soil as compared with FYM and control treatments. It is due to addition of cations through green manuring crops. More or less exactly similar values of electrical conductivity were observed in all the sources of green manuring crops. The highest value of EC (1.0 dSm^{-1}) was recorded due to addition of cow pea and black gram and it was significantly superior over rest of the treatments. Selvikumari *et al*. (2000) also reported increase in EC of soil after addition of organic manures. The highest organic carbon content (0.78%) was noticed due to addition of FYM, followed by addition of *dhaincha* (0.77%). All the organic sources improved the organic carbon content of soil over control which were on par with each other. The increase in organic carbon content in the green manure treatment could be attributed to direct incorporation of the organic matter in the soil. The improvement in organic carbon content of soil was also observed due to the addition of different organic sources (paddy straw and *dhaincha*) by Surekha and Rao (2009). The cation exchange capacity (CEC) of soil was increased due to addition of FYM and it was significantly superior over rest of the treatments. Incorporation of black gram, soybean and green gram were at par with each other and these were significantly superior over cow pea, *dhaincha*, sunnhemp and control treatments. Babhulkar *et al*. (2000) also observed that cation exchange capacity of soil was significantly increased due to the application of higher rates of FYM. The beneficial effect of organic manaures in increasing CEC of soil has also been reported by Prakash *et al.* (2002) and Pareek and Yadav (2011). Calcium carbonate content of soil was found to be decreased by the addition of

Table 3. Moisture retention (%) of soil as influenced by addition of organic manure @20 t ha^{-1} at different bars.

Treatment	0.33	0.5	1	3	5	15	Ava. Water
Control	35.07	27.90	21.00	18.91	18.90	18.42	16.65
Sunnheamp	41.05	30.69	23.95	20.07	19.50	20.00	21.05
Dhaincha	38.39	30.20	22.34	19.39	19.20	19.09	19.30
Cow pea	38.05	30.00	22.58	19.31	19.21	19.10	18.95
Black gram	37.08	29.35	22.64	19.57	19.02	18.86	18.22
Green gram	36.00	28.96	21.63	19.52	19.32	19.19	16.81
Soybean	36.00	28.50	21.41	20.32	19.50	19.07	16.93
FYM	36.03	28.00	21.40	19.50	19.08	18.50	17.53
S.E. ±	0.13	0.31	0.44	0.38	0.14	0.01	0.32
CD at 5%	0.36	0.92	1.28	1.11	0.43	0.03	0.95

organic manures as compared with control. Significantly the lowest calcium carbonate (6.67%) was observed due to the addition of sunnhemp and it was at par with *dhaincha*, cow pea and black gram. The highest calcium carbonate was noticed in control treatment. The decline trend in calcium carbonate might be due to organic acid released during the decomposition of organics which might have reacted with $CaCO_3$ to release CO_2 thereby reducing $CaC0_3$ content of soil (Bellakki and Badanur, 1997).

From the present study it is evident that.the incorporation of green manures or FYM decreased bulk density and $CaCO_3$ while CEC, organic carbon and water retention at 0.33 and 15 bar were increased over control which will be helpful for sustaining soil quality and for elevating the moisture stress condition for better crop growth.

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References

Babhulkar, P. S., Wandile, R. M., Badole, W. P. and Balpande, S. S. 2000. Residual effect of long term application of FYM and fertilizer on soil properties (Vertisol) and yield of soybean. J. Indian Soc. Soil Sci. 48(1): 89-92.

Bellakki, M. A. and Badanur, V. P. 1997. Long term effect of integrated nutrient management on properties of Vertisol, under dry land agriculture, J. Indian Soc. Soil Sci. 45(3): 438-442.

Bhattacharyya, R., Prakash, V. Kundu, S., Srivastava, A. K. and Gupta, H. S. 2004. Effect of long term manuring on soil organic carbon, bulk density and water retention characteristics under soybean-wheat cropping sequence in North-Western Himalaya's. J. Indian Soc. Soil Sci. 52(3): 238-242.

Lal, J. K., Mishra, B. and Sarkar, A. K. 2000. Effect of plant residues incorporation on specific microbial groups and availability of some plant nutrients in soil. J. Indian Soc. Soil Sci. 48(1): 67-71.

Page, A. L, Millar, R. H. and Kenny, D. R. 1982. Methods of Soil Analysis. Amer. Soc. Agron., Madison, Wisconsin, USA 99. 1159.

Pareek, N. and Yadav, B. L. 2011. Effect of organic manaures on soil physical properties, soil microbial biomass and yield of mustard under irrigation of different residual sodium carbonate waters. J. Indian Soc. Soil Sci. 53: 302-307.

Prakash, Y. S., Bhadoria, P. B. S. and Rakshit, A. 2002. Comparative efficacy of organic manures on the changes in soil properties and nutrient availability in "Alfisols. J. Indian Soc. Soil Sci. 50: 219-221.

Selvi, D., Santhy, P. and Dakshinamoorthy. 2005. Effect of inorganic alone and in combination with farm yard manure on physical properties and productivity of Vertic Haplustepts under long term fertilization. J. Indian Soc. Soil Sci. 53: 302-307.

Selvikumari, G. M Baskar, M., Jayanathi, D. and Mathan, K. K. 2000. Effect of integration of flyash with fertilizer and organic manures on nutrient availability, yield and nutrient uptake of rice in Alfisols. J. Indian Soc. Soil Sci. 48(2): 268-278.

Surekha, K. and Rao, K. V. 2009. Direct and residual effect of organic sources on rice productivity and soil quality of Vertisols. J. Indian Soc. Soil Sci. 57(1): 53-57.

Yadav, K. K. and Chhipa, B. R. 2007. Effect of FYM, gypsum and iron pyrite on fertility status of soil and yield of wheat irrigated with high RSC water. J. Indian Soc. Soil Sci. 55(3): 324-329.

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Molecular Assessment of Sugarcane Plantlets Derived from NaCl and Sucrose Stressed Calli by RAPD Marker

The tissue culture technique provides a valuable method for enhancing tolerance through exploiting genetic variability (Staverek and Rains, 1984). In vitro selection is employed by incorporating inhibitory levels of NaCl in media for screening salt tolerance (Naik and Babu, 1988; Patade *et al*., 2006) and PEG for screening drought tolerance (Smith *et al.* 1985; Dragiiska *et al.*, 1996). Sucrose also serves the purpose of PEG. This technique was therefore used in present investigation to study the salinity and drought tolerance in sugarcane.

Randomly Amplified Polymorphic DNA (RAPD) analysis (Wiliiam *et al*. 1990) is simple, quick, require small amount of DNA for analysis and doesn't need prior sequence information. The technique has proven valuable for assessment of genetic fidelity of tissue cultured raised plants (Devarumath *et al.* 2007), to check genetic diversity (Da Silva *et al*. 2008) and for detection of somaclonal variation (Zucchi *et al.* 2002). The present investigation reports the genetic variation in plantlets of sugarcane variety CoM-0265 derived from calli screened on various concentrations of NaCl and sucrose as assessed by RAPD marker.

The regenerated and hardened plantlets derived from callus adapted on various concentrations of NaCl (0, 0.5, 1.0, and 1.5%) and sucrose (0, 0.2, 0.4 M) along with field control were used for assessment. Five plants were selected randomly from each concentration and DNA extracted separately from them. DNA from these five plants of each concentration mixed to form bulk segregant and utilized for analysis.

DNA was isolated from fresh leaves of selected plantlets of sugarcane using CTAB (Cetyl trimethyl ammonium bromide) given by Murray and Thompson (1986) and modified by Aljanabi *et al*. (1999). DNA quality was checked by loading 2 µl DNA in 0.8 per cent (w/v) agarose gel. DNA samples were quantified by UV spectrophotometer. The DNA were diluted in TE buffer to a working concentration of 20 ng/µl.

PCR amplification and gel electrophoresis : A total of 10 mer oligonucleotide primers of OPB series from Operon Technology Inc., Almeda. USA were used for amplification of DNA. Amplification were done in 25 µl of reaction mixture containing 40 ng of template DNA, 2.5 µl 10X PCR buffer, 2.5 µl of 25 mM MgCl2, 2 µl of 10 mM dNTPs, 5 µl of 1 µM primer and 1 unit of taq DNA polymerase in thermal cycler. The reactions were subjected to 45 amplification cycles, after an initial cycle of denaturation at 95°C for 1 minute. Each cycle consisted of denaturation step at 94°C for 1 min., primer annealing at 39°C for 1 min. and primer extension at 72°C for 1 min. followed by final extension at 72°C for 4 min.

The amplified products were resolved by electrophoresis in 1 per cent (w/v) agarose gel in 1X TBE buffer, stained with Ethidium bromide and documented on Gel Doc system (Fluor Chem^{TM} Alfa Innotech, USA).

RAPD bands were scored as present (1) or absent (0) across all samples and assembled in binary data matrix table. Data on resolved bands generated by 20 primers were used to estimate the genetic similarity among samples based on Jaccards coefficient matrix analyzed using UPGMA method following SAHN cluster analysis module to derive dendrogram. All

computations were carried out using NTSYS-pc version 2.1 software (Rohlf, 2000).

Total 136 bands (Table 1) were obtained by screening 20 primers. Out of which 60 were polymorphic with 44.11 per cent polymorphism. On an average, each primer produced 6.8 bands. The size of amplification products ranged from 0.203 to 3.420 kb. Maximum number of bands (14) were produced by OPB-03 and least (1) by OPB-07. Primer OPB-08 showed the monomorphic profile across all the samples while remaining showed polymorphism with variable extent for set of samples under study.

Beside this, some primers showed unique bands with particular treatment, while some showed absence of band in a particular treatment. Two unique bands of size 0.203 kb and 0.300 kb and one band of 0.579 kb were amplified in regenerates derived from 1 per cent NaCl treated calli with primer OPB-03 and OPB-16 respectively. In the regenerates derived from 0.5 per cent NaCl adapted calli, total four unique bands were amplified with different primers. Primer OPB-01, 15, 16 and 17 each amplified one non-parental band in all regenerants. RAPD profile of OPB-02 had one band missing in 1 per cent NaCl. Similar results were reported by Dhawan *et al*. (2006) who observed RAPD bands which were absent in control plantlets amplifies in TDZ treatment and several bands amplified in control plantlets disappeared due to TDZ treatment. These observations do point out either to a possible genetic change being brought about by NaCl and also sucrose stress. Since, even a single base change at the primer annealing site is

Table 1. Bands generated their polymorphism and fragment size due to different primers.

Primer code	Total bands generated	Mono-morphic bands	Poly-morphic bands	% Poly-morphism	Fragment size range (kb)
OPB-01	4	3	1	25	0.523-1.080
OPB-02	4	2	2	50	0.560-0.850
OPB-03	14	3	11	78.57	0.203-2.256
OPB-04	5	3	2	40	0.630-2.705
OPB-05	11	4	7	63.63	0.616-1.841
OPB-06	8	7	1	12.5	0.410-1.638
OPB-07	1	0	1	100	0.764
OPB-08	4	4	0	0	0.315-1.255
OPB-09	9	6	3	33.33	0.492-2.085
OPB-10	7	4	3	42.85	0.298-1.545
OPB-11	12	7	5	41.66	0.211-1.903
OPB-12	5	4	1	20	0.577-2.114
OPB-13	4	2	2	50	0.763-1.691
OPB-14	7	2	5	71.42	0.518-1.415
OPB-15	8	5	3	37.5	0.325-1.865
OPB-16	6	3	3	50	0.579-1.527
OPB-17	6	3	1	50	0.486-2.017
OPB-18	5	4	1	20	0.514-1.492
OPB-19	7	6	1	14.28	0.564-3.420
OPB-20	9	4	5	55.55	0.268-2.192
Total	136	76	60	44.11	

manifested as appearance or disappearance of RAPD bands, it could be suggested that tissue culture induce varied amount of genetic chances in different regenerants.

The use of Jaccard's coefficient to estimate genetic variation among samples gave similarity coefficient values ranging from 0.697 to 0.892. Among all regenerants obtained, 0.5 per cent NaCl showed maximum genetic polymorphism with least similarity coefficient of 0.697 with field control suggesting maximum genetic changes accumulated. The maximum similarity (0.861) with field control was shown by sucrose control. The Jaccard's coefficient between field control and regenerants was on an average 0.848. This value indicates that there is a genetic variation at fine scale.

Cluster analysis grouped regenerants into two main clusters which are then divided into sub clusters. Cluster I is solitary and contained only regenerants from 0.5 per cent NaCl. was the most divergent among all. As placed away from mother plant it depicts maximum accumulation of genetic changes. In cluster IIb, regenerants on 1 per cent NaCl formed an independent cluster away from field control revealing variability. The regenerants derived from calli screened on 0.2 and 0.4 M sucrose were placed together away from field control in one cluster with similarity coefficient of 0.864 between them and on an average 0.753 with field control. It suggested that sucrose stressed calli clones may be useful for selection. The results obtained are in line with that of observed by Patade *et al*. 2006). They found genetic polymorphism between salt and drought tolerant lines selected from callus culture exposed to NaCl and PEG respectively. The genetic similarity between control and salt and drought tolerant lines ranged from 0.63 to 0.80. Dendrogram separated salt tolerant plantlets from other.

The results revealed that the RAPD technique is feasible in analyzing genetic variation among plantlets derived from calli adapted on various concentrations of NaCl and sucrose and variation can be detected at an early stage. *In vitro* selection shortens the time considerably for selection of desirable trait under selection pressure and has been used for selection of abiotic stress. The regenerated plants exhibited considerable variation that could be exploited for *in vitro* selection system and regenerants with much variation for desirable characters can be used as progenitor in breeding programme.

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References

Aljanabi, S. M., Forget, L. and Dookun, A. 1999. An improved and rapid protocol for the isolation of poiysaccharide and polyphenol free sugarcane DMA. Plant Mol. Biol. Reporter. 17: 1-8.

Da Silva, C. M., Mangolin, C. A., Mott, A. S. and Machado, M. F. P. S. 2008. Genetic diversity associated with *in vitro* and conventional bud propagation of saccharum varieties using RAPD analysis. Plant Breed. 127(2): 160-165.

Devarumath, R. M., Doule, R. B., Kawar, P. G., Naikebawane, S. B. and Nerkar, Y. S. 2007. Field performance and RAPD analysis to evaluate genetic fidelity of tissue culture raised plains vis-a-vis conventional setts derived plants of sugarcane. Sugar Tech. 9(1): 17-22.

Dhawan, A. K., Moudgil, R., Dendsay, J. S. and Mandhan, R. P. 2006. Alterations in RAPD profiles of proliferating shootlets of sugarcane in response to thidizuron. Indian J. Bioteehno., 5: 207-210.

Dragiiska, R., Dimitar, D. D., Plamen and Atlas, A. 1996. *In vitro* selection for somatic tolerance in Alfalfa (*Medicago sativa* F.). Bulg. J. Plant Physiol. 22(3-4): 30-39.

Nailk, G. R. and Babu, K. H. 1988. Redifferentiation of NaCl tolerant sugarcane plants from callus derived resistant lines. Curr. Sci. 57(8): 432-434.

Patade, V. Y., Suprassana, P., Bapat, V. A. and Kulkarni, U. G. 2006. Selection of abiotic (salinity and Drought) stress tolerance and molecular characterization of tolerant lines in sugarcane. BARC Newslett. Issue No. 244-273.

Rohlf, F. J. 2000. NTSYS Numerical Taxonomy and Multivariate Analysis System Exeter Software (New York).

Smith, R. H., Bhaskaran, S. S. and Miller, F. R. 11985. Screening for drought tolerance in sorghum using cell cultures. *In vitro* Cellular Developmental Biol. 21: 541-545.

Stavarek, S. J. and Rains, D. W. 1984. Cell culture technique : Selection and physiological studies of salt tolerance. In : R. C. Staples and G. H. Toenniessen (lids) salinity tolerance in plants. John Willey, New York. pp. 321-334.

William, J. C. K., Kubelic, A. R., Livak, K. J., Rafalski, J. A. and Tingey, S. V. 1990. Nucleic Acid Res. 18(22): 6531-6535.

Zucchi, M. L., Arizono, H., Morais, V. A., Fungaro, M. H. P. and Veira, M. L. C. 2002. Genetic instability of sugarcane plants derived from meristem cultures. Genet. Mol. Biol. 25(1): 91-96.

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Effect of Sources and Levels of Sulphur on Yield and Quality of Summer Groundnut

The probable reasons for declining yields of groundnut are; unscheduled sowing dates, inadequate and imbalanced nutrition and moisture stress at critical stages. Among these factors, mineral nutrition to groundnut plays an important role in production of groundnut. Dimree *et al*. (1993) indicated that application of sulphur increased the yield attributes and yield of groundnut. Agasimani *et al*. (1993) observed significant increase in the yield and oil content of groundnut due to application of sulphur on medium black soil. Singh (2000) reported that about 45 districts of the country showed more than 40 per cent sulphur deficiency. Therefore, sulphur is now considered as fourth major plant nutrient next to nitrogen, phosphorus and potassium. For production of one tone seed on average 10 kg sulphur is required for oil seed crop. Considering the above facts the present study was under taken to study the effect of levels and sources of sulphur on yield and quality.

The pot culture experiment on groundnut was conducted on Inceptisol at the Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune during summer 2010. The two sources of sulphur *viz*., elmental sulphur, Bensulph and five levels of sulphur i.e. 0 ,15, 30, 45 and 60 kg S ha^{-1} were used. The experiment was laid out in factorial completely randomized design. The soil samples were processed and analyzed by using standard methods for physico-chemical and biological properties as well as available sulphur for judging the sulphur deficiency in soil (Page *et al*., 1982). The soil was slightly alkaline in reaction with pH value 7.8 and EC 0.22 dS m^{-1}. It was clayey texture with deficient in available S (6.25 mg kg^{-1}). The available sulphur less than 10 ppm is set to be deficient in soil. The soil was low in available N (242 kg N ha^{-1}), moderately high P (26.98 kg P ha^{-1}) and high in available K (411 K ha^{-1}). The plastic pots having 10 kg soil pot^{-1} capacity were used. The black polythene sheet was placed inside the plastic pot. The seeds erect type groundnut

(cv. TAG-24) were used for experiment. The basal dose of N and P was applied through urea and diammoniurn phosphate, respectively. The potassium content in soil samples was very high. Hence, K fertilizer was not applied to all the pots. The quantity of FYM was calculated for 10 kg of soil @ 5 t ha^{-1} and was applied to all the treatments. Deionized water was used for irrigation. At 40 days, two plants were uprooted and dry matter yield $plant^{-1}$ was recorded as well as functional nodules $plant^{-1}$ were counted. The plants were harvested at 115 days after sowing. The yield of pods $plant^{-1}$ was obtained by separating pods from all plants. The weight of haulm was recorded. The protein content of kernel was worked out by N x 6.25. The oil percentage of grain was determined by Soxhlet extracter using petroleum ether (B.P. 40°C) as a solvent. The data recorded were statistically analyzed as per the method described by Gomez and Gomez (1987).

The maximum number of nodules $plant^{-1}$ (26.63) was recorded due to the application of 60 kg sulphur ha^{-1} and it was statistically significant as compared with all the levels of sulphur (Table 1). The number of nodules $plant^{-1}$ increased progressively with increasing levels of sulphur from 0 to 60 kg ha^{-1}. The results indicated that the sulphur is essential for increasing number of nodules $plant^{-1}$ which helped in biological fixation of nitrogen. Among the sources, the application of sulphur in the form of Bensulph recorded the maximum number of nodules $plant^{-1}$ (18.95) as compared with elemental sulphur (16.70). It is because of higher amount of water soluble sulphur formed due to oxidation by oxidizing bacteria and it releases sulphur slowly due to Bensulph in pellet form, which was readily utilized by plant, resulting in increased number of nodules $plant^{-1}$. The number of nodules $plant^{-1}$ and dry weight of nodules $plant^{-1}$ of groundnut was increased due to the application of sulphur through iron pyrite (Sinha *et al*., 1978). The maximum number of nodules $plant^{-1}$ (27.50) was recorded due to the application of 60 kg sulphur through Bensulph and it was

Table 1. Effect of levels and sources of sulphur on yield contributing parameters and yield of groundnut.

Treatment	Nodules $plant^{-1}$	Pods $plant^{-1}$	Dry pod yield $plant^{-1}$ (g)	Haulm yield $plant^{-1}$ (g)	Protein (%)	Oil (%)
Levels of sulphur (kg ha^{-1}) :						
0	8.13	6.38	7.29	9.22	25.13	44.14
15	14.13	8.13	13.85	10.23	25.53	44.20
30	17.38	10.50	22.04	11.26	25.99	44.65
45	22.88	11.00	25.29	12.56	26.51	45.24
60	26.63	12.25	26.35	13.61	26.90	45.69
S.E. ±	1.11	0.50	1.29	0.25	0.13	0.96
C.D. at 5 %	3.21	1.44	3.71	0.72	0.37	NS
Sources of sulphur :						
Elemental	16.70	8.30	17.29	11.17	25.91	44.72
Bensulph	18.95	11.00	20.64	11.58	26.11	44.85
S.E. ±	0.70	0.32	0.81	0.16	0.08	0.09
C.D. at 5 %	2.03	0.91	2.35	NS	NS	NS
Interactions :						
S.E. ±	1.57	0.70	1.82	0.35	0.18	0.92
C.D. at 5 %	4.54	2.04	5.26	1.01	0.52	NS

significantly superior over all the interactions except sulphur application @ 45 kg ha^{-1} through Bensulph.

The levels of sulphur increased the number of pods $plant^{-1}$ of groundnut as compared to control (Table 1). The 60 kg ha^{-1} sulphur was significantly superior over 0, 15 and 30 kg sulphur ha^{-1}. However, it was at par with 45 kg sulphur ha^{-1}. The results obtained in present investigation are in accordance with the results recorded by Baviskar *et al*. (2005). Among the two sources, it was observed that sulphur application through Bensulph is significantly superior over sulphur application through elemental sulphur. Similar observations were recorded by Jena *et al*. (2006). They observed that application of sulphur through gypsum was significant over elemental sulphur. The maximum number of pods $plant^{-1}$ (12.25) were recorded due to the application of 60 kg sulphur ha^{-1} through Bensulph and it was significantly superior over all the interactions except application of sulphur @ 45 and 30 kg ha^{-1} through Bensulph. It was also on par with 60 kg sulphur ha^{-1} through elemental sulphur.

All the levels of sulphur increased the dry pod yield of groundnut as compared to control. The 60 kg ha^{-1} sulphur was significantly superior over 15 kg ha^{-1} sulphur application and control treatments. However, it was at par with 45 kg sulphur ha^{-1}. Similar observation was found by Misra (2003).The results showed that Bensulph is statistically significant over elemental sulphur for increasing the dry pod yield $plant^{-1}$. It is because of increase in number of nodules $plant^{-1}$, number of pods $plant^{-1}$ and dry matter yield $plant^{-1}$ (Table 1) and readily available suphur. The maximum dry pod yield $plant^{-1}$ (28.55 g $plant^{-1}$) was recorded due to the application of 60 kg sulphur through Bensulph and it was significantly superior over all the interactions except application of sulphur @ 45 kg S ha^{-1} through Bensulph and 45 and 60 kg S ha^{-1} through elemental sulphur.

Application of S @ 60 kg S^{-1} recorded significantly the highest haulum yield (13.61 g $plant^{-1}$) as compared with rest of the treatments. Among the sources, application of sulphur through Bensulph recorded the maximum haulm yield (11.58 g $plant^{-1}$) as compared to elemental sulphur (11.17 g $plant^{-1}$). The results showed that Bensulph is statistically non significant over elemental sulphur for increasing the haulm yield $plant^{-1}$. Patel *et al*. (2009) observed similar observation that the effect of sources and levels of sulphur on yield and quality of mustard varieties in loamy sand soil. The maximum haulm yield $plant^{-1}$ (13.73 g) was recorded due to the application of 60 kg sulphur through Bensulph and it was significantly superior over all the interactions.

Quality : The highest protein content (26.90%) was recorded due to the application of 60 kg sulphur ha^{-1} and it was significantly superior over rest of treatments. The control treatment showed the lowest protein content (25.13%). The results showed that the increasing levels of sulphur increased protein percentage in groundnut and it is because of increasing nitrogen content in seed. Sharma *et al*. (1991) observed that the protein content of mustard seed increased with increasing doses of sulphur and it was the highest with application of 60 kg ha^{-1}. Among the sources, the application of sulphur in the form of Bensulph recorded highest protein content (26.11%) compared with elemental sulphur (25.91%). The interaction effect was statistically significant in respect of protein content. It was observed that the higher protein content (27.01%) was recorded due to application ot 60 kg sulphur through Bensulph and it was at par with 45 kg S ha^{-1} through Bensulph and 60 kg S ha^{-1} through elemental sulphur. The highest oil content (45.69%) was recorded due to the

application of 60 kg S ha^{-1} and it was not significant over rest of the treatments. However, the lowest oil content (44.14%) was observed by without application of sulphur to the groundnut crop. This is in conformity with the findings by Koti *et al*. (1989). The interaction effect was found to be non significant in respect of oil content.

From the present investigation it may be inferred that the application of S @ 45 kg ha^{-1} through Bensulph is beneficial for increasing yield and quality of groundnut cv. TAG 24 in Inceptisol having low available Sulphur.

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References

Agasimani, C. A., Babalad, H. B. and Patil, P. L. 1993. Response of groundnut to sulphur and boron. J. Maharashtra agric. Univ., 18(2): 318-319.

Baviskar, P. K., Varsha, V., Tapre, Jagadale, R. B., Sune, V. V. and Bhatia, N. H. 2005. Effect of levels of sulphur and its sources on sulphur uptake, growth and yield of safflower. J. Soil and Crops, 15(2): 466-469.

Chapman, H. D. and Pratt, P. P. 1961. Methods of Analysis of Soils, Plants and Waters. Univ. Calf., Div. Ag. Sci., U.S.A. : 309.

Dimree, S., Dwivedi, K. N. and Hariram, A. 1993. Effect of sulphur and phosphorus nutrition on yield and yield attributes of groundnut. Indian J. Agron., 38(2): 327-328.

Gomez, K. A. and Gomez, A. A. 1987. Statistical Procedure for Agricultural Research 2nd Ed. John Wiley and Sons. New York., 1-680.

Jena, D., Sahoo, R., Sarangi, D. R. and Singh, M. V. 2006. Effect of different sources and levels of sulphur on yield and nutrients uptake by groundnut-rice cropping system in an Inceptisol of Orissa. J. Indian Soil Sci., 54(1): 126-129.

Koti, R. V., Panchal, Y. C. and Manjunath, S. 1989.Effect of sulphur on pod yield and oil content of groundnut. J. Maharashtra agric. Univ., 14(2): 243-244.

Misra, S. K. 2003. Effect of sulphur and potassium on yield, nutrient uptake and quality characteristics of mustard (*Brassica juncea* L.) in Udic Haplustepts of Kanpur. J. Indian Soc. Soil Sci., 51(4): 544-548.

Page, A. L., Miller, R. H. and Keeney, D. R. 1982. Method of Soil Analysis. 2nd Ed. Ame and Soil Sci Soc. of America, Inc. Madison, Wisconsin, U.S.A.: 11- 59.

Patel, G. M., Patel, B. T., Dodia, J. N., Bhatl, V. K. and Bhatt, R. K. 2009. Effect of sources and levels of sulphur on yield, quality and uptake of nutrients by mustard (*Brassica juncea* L.) varieties in loamy sandy soil. J. Soil and Crops., 19(1): 30-35.

Sharma, D. N., Khaddar, V. K., Sharma, R. A. and Singh, D. 1991. Effect of different doses and sources of sulphur on the quality of mustard. J. Indian Soc. Soil Sci., 39: 197-200.

Singh, M. V. 2000. Micro and Secondary Nutrient and pollutant Elements Research in India, ISSS, Bhopal.

Sinha, N. P., Singh, S. N. and Thakur, N. M. 1978. Use of pyrites to improve soil fertility Proc. Sem. FAI-PPCL-DAUP, Lucknow, pp. 163-167.

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Performance of Post-Emergence Weedicides for Weed Control in Safflower

Safflower (*Carthamus tinctorius* L.) is an important oilseed crop in India occupying an important place in oilseed scenario of the country. Weed pose serious problem in the cultivation of safflower if unchecked. Among the various factor responsible for the reduction

in yield level, weed plays an important role causing to 30 to 35 per cent yield loss. Thus weeds seems to be a major constraint of productivity. Safflower is heavily infected with weeds resulting in poor yield (Blackshaw 1993). Safflower is poor competitor with weeds and so required intensive weed control for optimum yield. The present study was conducted to find out the efficacy of three post emergence weedicides and cultural practices for controlling weeds in safflower.

The field experiment was conducted at Weed Science Research Centre, Marathwada Krishi Vidyapeeth, Parbhani during *rabi* 2011 in a randomized block design replicated 4 times with six treatments namely T_1 - PoE propaquizafop @ 625 g.a.i. ha^{-1} at 30 DAS, T_2 - PoE quizalofop ethyl @ 600 g.a.i. ha^{-1} at 30 DAS, T_3 - PoE imazethpyr @ 0.075 kg a.i. ha^{-1} at 30 DAS, T_4 - 2HW and hoeing at 20 and 40 DAS, T_5 - weedfree (weeding at 20 days interval) and T6 - weedy check. The crop variety Sharada was sown at 45 x 15 cm distance. The gross and net plot size was 4.5 x 4.5 m and 3.6 x 3.6 m respectively. The crop was sown on 16th November 2010 and harvested on 15th March 2011. The crop was irrigated as per the requirement with recommended plant protection measures and fertilizer application.

The highest weed control efficiency (Table 1) was observed in weed free condition (T_5)

Table 1. Weed control efficiency (%) influenced by different treatments at 30 and 60 days after sowing.

Treatment	Weed control efficiency at 30 DAS		Weed control efficiency at 60 DAS		Weed index (%)
	Monocot	Dicot	Monocot	Dicot	
T_1 - Propaquizafop PoE @ 625 g.a.i. ha^{-1}	45.81	61.26	62.95	76.36	16.54
T_2 - Quizalofop Ethyl PoE @ 600 g.a.i. ha^{-1}	74.18	71.54	75.61	83.65	7.75
T_3 - Imazethapyr PoE @ 75 g.a.i. ha^{-1}	71.63	81.92	86.34	84.72	42.46
T_4 - Two hand weeding and hoeing at 20 and 40 DAS	76.17	79.75	91.36	85.84	4.70
T_5 - Weed free (weeding @ 20 days interval)	7971	90.33	92.54	92.34	-
T_6 - Weedy check	-	-	-	-	40.78

Table 2. Safflower yield, yield attributes, monetary returns and B:C ratio as influenced by various treatments.

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Seed capi tula^{-1}	Capi-tula plant^{-1}	1000 seed weight (g)	Net mone-tary returns	Cost of culti-vation (Rs. ha^{-1})	B:C ratio
T_1 - Propaquizafop PoE @ 625 g.a.i. ha^{-1}	1857	4361	18.5	34.2	56.6	34127	20060	2.70
T_2 - Quizalofop Ethyl PoE @ 600 g.a.i. ha^{-1}	2053	4319	20.6	38.0	58.6	39695	19880	2.98
T_3 - Imazethapyr PoE @ 75 g.a.i. ha^{-1}	1480	2243	16.2	29.2	56.4	17031	19950	1.85
T_4 - Two hand weeding and hoeing at 20 and 40 DAS	2121	4406	21.5	38.5	57.5	35712	25880	2.37
T_5 - Weed free (weeding @ 20 days interval)	2225	4468	22.4	40.5	58.6	35775	28780	2.24
T_6 - Weedy check	1318	2309	16.8	24.5	54.6	19780	18280	2.08
SE±	106	180	0.68	0.93	1.1	1585	-	-
CD @ 5%	319	545	2.07	2.88	N.S.	4770	-	-

followed T_4 i.e. 2HW + hoeing at 20 and 40 DAS for monocot and dicot weeds at 30 and 60 DAS respectively. Among herbicide for monocot and dicot weeds highest weed control efficiency was observed in PoE Imazethapyr @ 75 g.a.i. ha^{-1} and PoE Quizalofop ethyl @ 600 g.a.i. ha^{-1} at 30 and 60 DAS. Weedy check recorded lowest weed control efficiency. Imazethapyr PoE @ 75 g.a.i. ha^{-1} (T_3) was effective for weed controlling but has phyto toxic effect on safflower crop. The results are similar to those reported by Uslu *et al.* (1998).

Highest seed and straw yield was recorded in weed free condition and was at par with 2HW + hoeing at 20 and 40 DAS and post-emergence application of Quizalofop ethyl @ 600 g.a.i. ha^{-1} which were significantly superior than all other treatments.

The yield attributes *viz.*, number of seeds $capitula^{-1}$, number of capitula $plant^{-1}$ and 1000 seed weight showed similar trend as that of seed yield. Similar results were also reported by Bajpai *et al*. (1990), Birajdar (1990) and Jagdale (2002).

Highest net monetary returns and B:C ratio was obtained with post-emergence application of Quizalofop ethyl @ 600 g.a.i. ha^{-1} due to higher yield and comparatively lower cost of cultivation as compared to WF condition, which could be used for effective and economical weed control in safflower.

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References

Bajpai, R. P., Bisen, C. R. and Tomar, S. S. 1990. Chemical weed control in safflower. Indian J. of Weed Sci. 22: 3-4, 74-15.

Birajdar, U. B. 1990. Low weed cost management in safflower (*Carthamus tinctorius*). thesis submitted to M.K.V, Parbhani. P- 74-75.

Blackshaw, R. E., Darksen, D. A., and Muendel, H. H. 1993. Herbicides for weed control in safflower (*Carthamus tinctorius*). Canadian J. of Plant Sci. 70: 237-245.

Jagdale, S. D. 2002. Effect of weed control methods on growth and yield of safflower (*Carthamus tinctorius*). Dissertaion submitted to M.K.V. Parbhani. P. 67-68.

Uslu, N., Akin, A. and Halitligil. 1998. Effect of weed control treatments on the agronomic character of safflower crop. Turkish J. of Agric. and Forestry. 22(6): 533-536.

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Genetic Diversity Studies in Germplasm of Rice (*Oryza sativa* L.)

Hybridization programme involving genetically diverse parents belonging to different clusters would provide an opportunity for bringing together gene constellations of diverse nature resulting in promising hybrid derivatives probably due to complementary interaction of divergent genes in parents. Several workers have emphasized the importance of genetic divergence for the selection of desirable parents (Murthy and Arunachalam, 1996 and Rahman, 1997). The use of Mahalanobis D^2 statistics for estimating

genetic divergence has been emphasized by many workers (Roy and Panwar, 1993; Ramya and Senthilkumar, 2008). Hence in the present study 50 genotypes of rice were evaluated to assess the nature and magnitude of genetic diversity among them for use in further hybridization programmes.

The experimental material for the present study comprised of 50 genotypes of rice laid in randomized block design with three replications at the field experimentation centre of department of Genetics and Plant Breeding, Allahabad School of Agriculture, Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, U.P., during *kharif* 2012. Standard agronomic practices and plant protection measures were taken as per

Table 1. Variability parameters for 13 quantitative characters in rice germplasm.

Character	GCV (%)	PCV (%)	h^2 (bs) (%)	Genetic advance	Genetic advance as % of mean
Days to 50% flowering	8.32	9.73	73.58	14.41	14.68
Plant height	11.87	12.87	86.31	28.49	22.72
Flag leaf length	23.11	23.55	96.29	20.07	46.72
Flag leaf width	16.26	16.65	87.50	0.55	32.71
Number of tiller $hill^{-1}$	24.57	24.83	97.91	14.43	50.09
Number of panicles $hill^{-1}$	25.53	26.30	94.18	7.61	51.03
Panicle length	16.30	16.52	97.27	7.61	33.12
Days to maturity	35.73	36.27	97.06	127.48	72.17
Number of spikelets $panicle^{-1}$	5.15	7.40	48.52	9.42	7.39
Biological yield	14.13	14.98	89.98	32.36	27.47
Harvest index	20.45	20.63	98.31	9.61	41.77
Test weight	16.91	18.42	84.28	14.90	31.99
Seed yield $plant^{-1}$	28.42	28.93	96.44	32.07	57.49

GCV=Genotypic Coefficient of Variation, PCV=Phenotypic Coefficient of Variation, h^2(bs)= Heritability (broad sense).

Table 2. Grouping of 50 rice genotypes into different clusters.

Cluaster number	Number of genotypes	Genotypes included
I	5	KMP-105,CR-2042-2-2, WHGR-4009, ADO-5017, IR-40.
II	12	CR-2707, SARJU-52, CR-2705, IR-69726-1 16-1-3, CR-2703, IR-42, CR- 2699, UPR-3281, CR-2702, ZR-25976-1 2-2-2-2-1 1, ZR-61608-3B-20-2-2-1-1.GR-85.
III	6	SAMBLEHWARI, ZR-64683-87-2-2-3-3, CR-2075, MANHAR, R-1566-2577-2-1530-1, HIPA 3.
IV	4	ZR-70, IR51500-AC-11-1, WAS. 197-8-6-3-4, CT-1605-4-1-1S3-2-1-1-1N.
V	5	JGL 1 7204, CR-05-50 1 . BAMBLESHWARI, IR 65 1 85-38-8-3-2, CHANDRA HANSRAJ.
VI	9	CIBOG-D, CR 20698, ZRSS 195-3B -B-2-3, CCR-61 1-13-2-75-11, ZR 64, NDR 113, CUNDE, UPR-328 1-25-1-1, ZR 60.
VII	3	R2039-RF-23,KJT48,NDR118
VIII	6	NDR 8834-2, ADT(R)48, WC -1240, ZR-62141-114-3-2-2-2-2, ZR 52713-2B-1-2, NDR359

schedule. Observations were recorded on five randomly selected plants per replication for 13 characters. The data was subjected to Mahanlobis D^2 statistics to measure the genetic divergence as suggested by Rao (1952).

Both PCV and GCV estimates (Table 1) were highest for spikelet panicle^{-1} followed by grain yield and panicles plant^{-1}. The results are in consideration to the findings of Anjaneyulu *et al.* (1989). High estimates of heritability (above 60%) in broad sense were recorded for all the-characters under study except number of spikelets panicle^{-1} which ranged from 48.52 to 98.31 per cent. Johnson (1955) reported that high heritability should be accompanied by high genetic advance to arrive at more reliable conclusion. A perusal of genetic advance for all the quantitative characters under study ranged from 0.55 (flag leaf width) to 127.48 per cent. These findings were in agreement with Bihari *et al*. (2004). High heritability coupled with high genetic advance was registered for days to maturity, suggesting predominance of additive gene action in the expression of the traits. Similar findings were reported by Krishna *et al*. (2010).

The fifty genotypes under study were grouped into eight clusters (Table 2). Cluster II constituted 12 genotypes forming the largest cluster followed by cluster VI (9 genotypes) cluster III and VIII (6 genotypes each), cluster I and V (5 genotypes each), cluster IV (4 genotypes) and cluster VII (3 genotypes). The pattern of group constellation proved the existence of significant amount of variability. The clustering pattern of ttie genotypes revealed that the clustering did not follow any particular clustering pattern with respect to the origin observed by Ushakumari and Rangaswamy (1997) and Gupta *et al*. (1909).

The intra cluster distance (Table 3) ranged from 170 (cluster IV) to 454 (cluster II). The inter cluster distance was maximum between cluster II and VII (1014) and minimum inter cluster distance was observed between cluster III and cluster IV (430). To realize much variability and high heterotic effect, Mishra *et al*. (2003) and Chaturvedi and Mourya (2005) recommended that parents should be selected from two clusters having wider inter cluster distance. The cluster mean values showed wide range of variations for all the characters under study. Cluster II exhibited highest mean value for tillers plant^{-1}. Cluster VII recorded highest value for plant height and spikelets panicle^{-1} and lowest mean values for days to maturity. While highest mean values for flag leaf width, panicles plant^{-1} and test weight was recorded by cluster VIII. Cluster III had highest values for grain yield, harvest index and biological yield. While cluster I recorded lowest mean values for days 50 per cent flowering. Cluster VI had recorded highest mean values for flag leaf length and panicle length. From this, suitable parents can be selected as the selection and choice of parents mainly depends upon contribution of characters towards divergence (Nayak *et al*. 2004). The highest contribution in manifestation of genetic divergence was exhibited by test weight (27.51%) followed by tillers plant^{-1} (19.18%) and harvest index (13.31%).

It is well known that crosses between divergent parents usually produce greater

Table 3. Intra (Diagonal) and inter cluster (off diagonal) distance (D^2) in upland rice germplasm.

Cluster	I	II	III	IV	V	VI	VII	VIII
I	278	593	846	489	657	533	870	718
II		454	635	538	678	889	1014	712
III			273	430	527	652	543	643
IV				170	537	584	538	489
V					414	710	677	966
VI						381	514	624
VII							261	686
VII								289

heterotic effect than between closely related ones. Considering the importance of genetic distance and relative contribution of characters towards total divergence, the present study indicated that parental lines selected from cluster II (CR-2707, SARJU- 52, GR- 85,IR-69726-116-1-3) for plant height, harvest index and panicles plant^{-1} and cluster VII (R-2039-RF-23,KJT-48, NDR-118) for days to 50 per cent flowering, spikelets panicle^{-1} and harvest index could be used in crossing programmes to achieve desired segregants.

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References

Anjaneyulu, M., Reddy, D. R. and Reddy, K. H. 2010. Genetic variability, heritability and genetic advance in rice (*Oryza sativa* L.). Res. on Crops, 11: 2, 415-416.

Bihari, P. K., Richharia, A. K. and Sahu, R. S. 2004. Genetic advance for yield attributes in aromatic rice. J. of Applied Bio., 14:2, 1-5.

Chaturvedi, H. P. and Maurya, D. M. 2005. Genetic divergence analysis in rice (*Oryza sativa* L.) Advances P. Sci., 18(1): 349-353.

Johanson, H. W., Robinson, H. F. and Comstock, R. E. 1955. Estimates of genetic variability in soybean. Agron. J. 47: 314-318.

Tandekar, Krishna, Agrawal, Kavita and Tirk, Pushpalata. 2010. Genetic variability, heritability and genetic advance for quantitative traits in rice (*Oryza sativa* L.) accession. Agric. and Biol. Res., 26:1, 13-19.

Mahalanobis, P. C. 1936. On the generalized distance in statistics. Proc. Nat. Inst. Sci. India., 2:49-55.

Mishra, L. K., Sarawgi, K. and Mishra, R. K. 2003. Genetic diversity for morphological and quality traits in rice (*Oryza sativa* L.). Adv. in Plant Sci., 16(1): 287-293.

Nayak, A. R., Chaudhury, D. and Reddy, J. N. 2004. Genetic divergence in scented rice Oryza, 41:(3 and 4): 79-82.

Rao, C. R. 1952. Advance statistical methods in biometrical research. John Wiley and Sons, New York.

Roy, A. and Panwar, D. V. S. 1993. Genetic divergence in rice.30: 197-201.

Ushakumari, R. and Rangaswamy, P. 19971. Studies on genetic diversity in international early rice genotypes. Ann. Agri. Res. 18: 29-33.

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Correlation of Incidence of Aphid (*Melanaphis sacchari* Zehntner) on *Rabi* Sorghum with Abiotic Factors

Sorghum (*Sorghum bicolor* (L.) Moench) is the major source of food and fodder for millions of people in the tropics and semi-arid tropics. It is attacked by more than 150 insect pests from sowing stage to harvest (Sharma, 1985). Sorghum aphid (*Melanaphis sacchari* Zehntner) is becoming economically important in recent years in many sorghum growing areas leading to losses in grain and fodder yield. Sorghum aphid which was previously a minor pest, has now assumed major status in certain parts of states of Karnatka, Maharashtra, Andhra Pradesh and Tamil Nadu in India. Both nymphs and adults suck the sap from lower surface of leaves, which leads to stunted plant growth. The damage is more severe in crops

under drought stress, and during *rabi* season (Nov-Jan) which results in drying up of leaves and plants may lead to mortality. The aphid secrete honey dew which fall on the leaves and on the ground, on which sooty mold grow. Aphid infestation also spoil crop's fodder quality (Balikai and Lingappa, 2003). Considering economic importance of this pest on sorghum, this investigation was carried out to study the incidence of aphid in *rabi* season and it's correlation with abiotic factors.

The study was carried out during *rabi* season of 2011 at All India Coordinated Sorghum Improvement Project, M.P.K.V., Rahuri. The experiment was conducted in a randomized block design with three replications on Phule Vasudha variety of sorghum sown on 12/09/2011. Recommended agronomic practices were followed in raising the crop. No plant protection measures were taken throughout crop season.

Observations on aphid incidence were recorded at weekly interval starting from the initial appearance to final disappearance of the pest. The number of aphids per plant was counted and averages was worked out. Meterological data on temperature, relative humidity and rainfall were recorded during period of experimentation. Simple correlation coefficient were worked out between weather parameters and mean aphid population as per the procedure given by Panse and Sukhatme (1967).

It is evident from the Table 1 that the incidence of aphid started from 1st week of December, i.e. 90 days after sowing and further increased continuously upto last week of January and declined thereafter. The population was at its peak in the month of January i.e. 120 days after sowing. The correlation coefficient (r) of aphid incidence and weather parameters of same week, one, two and three week prior to the date of observation indicated that the weather parameters of one and two week prior to the date of observation had significant correlation with the incidence of aphid (Table-1) and there was negative correlation with maximum (-0.640, -0.863) and

Table 1. Incidence of sugarcane aphid (*Melanaphis sacchari*) on sorghum during *rabi* 2011-12 and correlation with weather parameters.

Dates of observations	**Aphids sq.$^{-1}$ cm.**	**Max. Tem x_1**	**Min. Tem x_2**	**RH morn. x_3**	**RH Eve x_4**	**Rain x_5**
10.12.11	5.1	32**	13.5**	65**	29**	0
17.12.11	12.6	30	11.7	69	30	0
24.12.11	32.4	29.9	11.1	75	30	0
31.12.11	48.2	29.1	9.4	62	30	0
7.1.12	60.8	29	10.5	55	29	0
14.1.12	56.4	33	14.9	71	35	0
21.1.12	43.9	35.2	16.5	62	23	0
28.1.12	26.6	34.6	13.5	54	21	0
4.2.12	8.4	35	13.3	33	18	0
Same week of observation	r	-0.2731	-0.1044	0.2595	0.4285	0
One week prior to observation	r	-0.6409*	-0.7039*	0.0161	-0.235	0
Two week prior to observation	r	-0.8637*	-0.6950*	0.0741	-0.1093	0
Three week prior to observation	r	-0.6065	-0.3454	0.1194	-0.1228	0

* Significant at 0.05 % level, * * Weather parameters of the date of observation.

minimum temperature (-0.703, -0.695).

On the basis of regression analysis the following equation with significant values was fitted. $Y = 284.7 - 7.666\ x_1 - 0.8305\ x_2$ ($R^2 = 0.7505$). The regression equation indicated that an increase or decrease in one unit of maximum temperature (x_1) and decrease in minimum temperature (x_2) resulted on increase in the aphid population by 7.6 and 0.83 leaf^{-1} sq.$^{-1}$cm., respectively. The favorable range of maximum temperature and minimum temperature during the peak infestation of aphid was from 29 to 30°C and 9 to 11°C respectively. The values of coefficient of determination (R^2) revealed that the weather parameters under study contributed 75.05 per cent variation in aphid population in *rabi* sorghum. The results of the present studies are in close agreement with studies of Kumar *et al*. (2006). Thus, the present findings suggested that maximum and minimum temperature play a significant role on aphid population built up during *rabi* season.

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References

Balikai, R. A., and Lingappa, S. 2003. Loss estimation due to sorghum aphid, *Melanaphis sacchari*, (Zehntner) with respect to fodder yield and it's quality. J. Ent. Res. 27(4): 329-334.

Kumar, V. L., Prabhuraj, A., Patil, B. V. and Chakravarthy, A. K. 2006. Influence of abiotic factors on population fluctuation of sorghum shoot bug. Internat. Sorghum and Millets Newsletter. 78-80.

Panse, V. G. and Sukhatme, P. V. 1967. Statistical Methods for Agricultural Workers. New Delhi, India; Indian Council of Agric. Res.

Sharma, H. C. 1985. Strategies for pest control in sorghum in India. Tropical Pest Manag. 31: 167-185.

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Whiteside, W.F. 1973. A study of light as influenced by time and planting date on growth of onion (*Allium cepa* L.) in the glasshouse and the field. Ph.D. thesis, Univ. of Illinois at Urbana-Champaign, pp.53.

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