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RESEARCH NOTES

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Effect of Integrated Phosphorus Management on Productivity, Nutrient Uptake, Soil Fertility and Economics of Soybean-Wheat System

V. N. Nale[1] and S. R. Patil[2]
Department of Soil Science and Agricultural Chemistry, MPKV, Rahuri - 413 722 (India)
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Abstract

A field experiment was conducted to study the effect of integrated phosphorus management on productivity, nutrient uptake, soil fertility and economics of soybean-wheat cropping system. The productivity of soybean and wheat crops was higher (31.79 and 48.46 q ha^{-1}) with application of manures and fertilizers as per STCRC equation with FYM of soybean and AST RD NK + residual P of soybean to wheat treatment. Similar trend was noticed in soybean equivalent yield (26.92 q ha^{-1}), the yield of same treatment increased by 31.26 and 72.21 per cent grain yield of soybean and wheat, respectively over recommended chemical fertilizers. Among the different organic phosphorus sources 25 per cent P_2O_5 substitute through different organic manures AST RD NK + 25% P_2O_5 through PMC + 75% P_2O_5 through SSP to soybean and AST RD NK + residual P of PMC to wheat treatment recorded highest soybean equivalent yield (26.92 q ha^{-1}). The highest nutrients uptake in soybean and wheat (238.26, 19.76, 104.31 and 94.19, 24.92, 84.64 NPK kg ha^{-1}, respectively) were recorded under integrated phosphorus management through application of manures and fertilizers as per STCRC equation with FYM of soybean and AST RD NK + residual P of soybean to wheat. The application of FYM as per STCRC equation of soybean and AST RD NK + residual P to wheat resulted in significantly higher OC (0.68 and 0.70%) and available NPK after soybean (236.85, 20.10 and 372.60 kg ha^{-1}) and wheat harvest (174.00, 14.31 and 358.58 kg ha^{-1}), respectively than recommended fertilizers. Economic returns were highest (Rs. 92,446/-) in application of manures and fertilizers as per STCRC equation with FYM to soybean and AST RD NK + residual P of soybean to wheat treatment. However, B:C ratio was highest (2.05) in the treatment AST RD NK + 25% P_2O_5 through PMC + 75% P_2O_5 through SSP to soybean and AST RD NK + residual P of PMC to wheat. The result of experiment revealed that for IPM application of manures and fertilizers as per STCRC equation with FYM to soybean and AST RD NK + residual phosphorus to wheat found higher productivity, uptake of nutrients and higher monetary returns with improving soil fertility in soybean-wheat cropping system.

Key words : Integrated phosphorus management, organic, inorganic, productivity, soybean equivalent yield, nutrient uptake, soil fertility, economics.

Soybean (*Glycine max* (L.) Merrill) with its 40-42 per cent protein and 20-22 per cent oil has already emerged as one of the major oilseed crop in India. The modern agricultural practices have emphasized the widespread use of fertilizer and this approach has certainly increased grain yields in many countries in the last three decades. Soybean-wheat cropping system is an important cropping sequence. Phosphorus is a major nutrient element in legume nutrition. It is involved in several energy transformation and biochemical reactions including biological nitrogen fixation. The low mobility of applied P and its marked fixation results in low crop recoveries of the order of 20 to 25 per cent (Singh, 1993). Hasan (1999) reported that higher P rates and its repeated application every year results in higher P build up in soil. Phosphorus is not lost from soil and is known to leave residual effect. The calcareous soils restrict the availability of phosphorus to the plants as phosphorus is fixed with the Ca ions. This adversely influences the growth and yield of the crops. Micro organisms

1. Ph.D. student and 2. Assistant Professor

play key role in phosphorus availability to plants through mineralizing organic P in soil and by solubilising precipitated phosphates (Richardson, 2001). Generally, addition of organic manures with inorganic fertilizers had the beneficial effect in increasing the P availability.

The conjoint use of P based organic manures, biofertilizers and inorganic sources of plant nutrients, not only push the production and economic profitability of soybean-wheat sequence but also help in maintaining the soil fertility. Thus, it is necessary to search out ways and means to develop integrated phosphorus management (IPM) for soybean-wheat cropping system, which can make best use of residual phosphorus in soils thereby increased P use efficiency. Keeping this in view, the present field investigation was under taken to study the effect of integrated phosphorus management on productivity, nutrient uptake, soil fertility and economics of soybean-wheat cropping system.

Materials and Methods

A field experiment was conducted during *kharif* and *rabi* season of 2011-12 at the Post Graduate Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, (19°47' N to 19°57' N latitude and between 74°18' E to 74°19' E, 435 m above mean sea level) in Inceptisols Vertic Haplustepts. The soil was clayey (20.24% sand, 26.50% silt and 52.72% clay), medium in organic carbon (0.59%), low available N (166.20 kg ha^{-1}) and available P (13.78 kg ha^{-1}) and very high available K (365.90 kg ha^{-1}) with alkaline pH 8.27 and EC 0.23 dS m^{-1}. Experiment was laid out with nine treatment combinations in randomized block design with plot size 5.10 x 4.50 m^2 in three replications to soybean (T_1- Absolute control, T_2- As per soil test crop response correlation (STCRC) equation without Farm Yard Manure (FYM), T_3- As per STCRC equation with FYM, T_4- As per soil test (AST) RD NK+P (SSP), T_5- AST RD NK+P (25% P_2O_5 - FYM+75% P_2O_5 -SSP), T_6- AST RD NK+P (25% P_2O_5 - Poultry manure (PM)+75% P_2O_5 - SSP), T_7- AST RD NK+P (25% P_2O_5 - Vermicompost (VC)+75% P_2O_5 - SSP), T_8- AST RD NK+P (25% P_2O_5 - Pressmud Compost (PMC) +75% P_2O_5 - SSP) and T_6- AST RD NK+P (25% P_2O_5 - Neem cake (NC) +75% P_2O_5 - SSP). For wheat treatment combinations were T_1- Absolute control, T_2- As per STCRC equation without FYM and treatment T_3 - T_9 were AST RD NK+ residual effect of phosphorus. The PSB @ 5 kg ha^{-1} were applied in soil to all the treatments except absolute control (T_1) of soybean and wheat crops. Yield target 25 q ha^{-1} for treatment T_2 and T_3 and 45 q ha^{-1} for treatment T_2 was for soybean and wheat, respectively. While applying NPK through chemical fertilizer to soybean NPK content of inorganic manures were considered.

Before conduct of experiment maize crop grown as an exhaust crop with NK and without P application for fertility gradient level. Soybean was sown at 30 x10 cm row spacing in month of June and harvested in October and *rabi* wheat was sown at 22.5 cm row spacing in month of November and harvested in the month of March 2012 and one cycle of the crop sequence were completed without disturbing the plots. The different organic manures and fertilizers were applied as per soil test to supply required quantity of nutrients. The quantity of manures applied before soybean sowing as per treatment on basis of proximate analysis of manures. The content of N, P and K in organics *viz*., FYM, PM, VC, PMC and NC is given in Table 1.

Soil samples from 0-15 cm depth were collected in triplicate, from individual plots after harvest of both the crops. The treatment wise soil samples were air-dried, processed to passed through 2 mm sieve and analysed for pH, EC, organic carbon (Nelson and Sommer (1982), available N (0.32% alkaline $KMnO_4$ oxidizable) (Subbiah and Asija 1956), available P (0.5 M $NaHCO_3$ extractable) (Watanabe and Olsen (1965), K (1N neutral ammonium acetate extractable) (Knudsen *et al*. (1982).

Grain and straw yields of both crops were recorded at maturity. The grain and straw samples were collected before harvesting. The grain and straw samples were first air dried and then dried in oven at 65°C. Total N and K in grain and straw samples were estimated after digestion in di-acid mixture (H_2SO_4 + H_2O_2) in digestion system. Total P was estimated after digestion in tri-acid mixture (HNO_3:H_2SO_4: $HClO_4$) using standard methods. Uptake of N, P and K was computed by multiplying with nutrient concentration in grain and straw sepratly with corresponding yields of the crops and total was made.

All the experimental data of soil and plant were statistically analyzed to draw conclusion of significance by using the methods prescribed by Panse and Sukhatme (1985).

Results and Discussion

Productivity : The soybean and wheat yield differences due to different treatments showed significant variation under integrated phosphorus management (Table 2).

The significant variations in grain and straw yield of soybean were observed due to various IPM treatments to soybean. The IPM treatment application of manures and fertilizers as per STCRC equation (yield target 25 q ha^{-1}) with FYM to soybean (T_3) recorded significantly the highest grain yield of soybean (31.79 q ha^{-1}) over the rest of the treatments, but at par with T_8 (29.53 q ha^{-1}), T_5 (28.11q ha^{-1}), T_6 (27.32 q ha^{-1}) and T_7 (26.82 q ha^{-1}) treatments, respectively. The per cent increase in grain yield of soybean over AST RD NK + P (SSP) (T_4) treatment was 31.76, 22.39, 16.51, 13.24, 11.18, 8.21 and 5.40 per cent under the treatments T_3, T_8, T_5, T_6, T_7, T_9 and T_2, respectively. The straw yield of soybean was found significantly the highest (33.68 q ha^{-1}) with the IPM treatment application of manures and fertilizers as per STCRC equation with FYM (T_3) treatment to soybean and which is on par with T_8 followed by T_5 , T_6 , T_2, T_7, T_9 and T_4 treatments, respectively.

The data on grain and straw yields of *rabi* wheat as influenced by residual effect of IPM treatments to preceding soybean crop are presented in Table 2. The residual phosphorus effect due to IPM treatments to soybean had showed the significant effect on grain and straw yield of wheat. The application of fertilizers to wheat AST RD NK + residual P treatment (T_3) recorded significantly the highest wheat grain yield (48.46 q ha^{-1}) which was on par with freshly applied P as per STCRC equation (yield target 45 q ha^{-1}) without FYM to wheat (T_2) treatment (46.55 q ha^{-1}) followed by T_8 (42.58 q ha^{-1}) and T_5 (41.67 q ha^{-1}) treatments. Among the residual IPM treatments (T_5 to T_9), the treatment T_8 found maximum wheat grain yield. The per cent increase in wheat grain yield of residual IPM treatment over T_4 treatment was 72.21, 65.40, 51.31, 48.06, 41.50, 36.31 and 28.57 per cent under T_3, T_2, T_8, T_5, T_6, T_7 and T_9 treatments, respectively. As

Table 1. Content of nitrogen, phosphorus and potassium in organics

Nutrients	Organic manures				
	FYM	PM	VC	PMC	NC
Total N (%)	0.62	1.20	1.58	1.24	2.61
Total P (%)	0.28	1.37	0.58	1.68	0.55
Total K (%)	0.58	1.25	1.37	1.13	0.75

FYM: farmyard manure, PM: Poultry manure, VC: Vermicompost, PMC: Pressmud compost and NC: Neem cake regards to straw yield, the application of freshly fertilizers as per STCRC equation without FYM (T_2) treatment to wheat crop recorded significantly the highest wheat straw yield (57.56 q ha^{-1}) and was on par with T_3 treatment followed by T_8, T_5, T_7, T_6 and T_9 treatments, respectively.

Soybean equivalent yield : Among the nine treatments applied to soybean for P management to soybean-wheat, the treatments (T_3, T_5 to T_9), application of manures and fertilizers as per STCRC equation (yield target 25 q ha^{-1}) with FYM to soybean and AST RD NK + residual P to wheat (T_3) treatment registered significantly the highest (26.92 q ha^{-1}) soybean equivalent yield than rest of the treatments. However, T_3 treatment was at par with T_2 followed by T_8 and T_5 treatments, respectively.

The increase in productivity of this treatment might be due to the higher uptake of nutrient and easy availability of nutrient from inorganic sources. Organic phosphorus applied through FYM slowly available over a long period than chemical fertilizers. This often limits plant growth due to mismatch between crop nutrient demand and nutrient supply from organic sources (Nasholm and Pearson, 2001). The organic manure FYM and PSB increased the available nutrients and specially phosphorus to plants through solubilisation effect. These growth factors in combination with nutritional condition due to increased availability of P in soil might have played an important role in increasing the grain yield (Pramanik and Singh, 2003).

Nutrient uptake : The N, P and K uptake of soybean and wheat was significantly influenced by different treatments (Table 2). It

Table 2. Effect of integrated phosphorus management on soybean and wheat system productivity and uptake of N, P, K

Treatment	Soybean yield (q ha^{-1})		Wheat yield (q ha^{-1})		Soybean equvivalent yield (q ha^{-1})	Soybean uptake (kg ha^{-1})			Wheat uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw		N	P	K	N	P	K
T_1	15.42	19.45	16.57	22.91	9.20	113.17	5.15	53.02	32.41	5.58	31.94
T_2	25.43	30.26	46.55	57.56	25.86	201.03	14.64	94.96	105.70	28.26	96.79
T_3	31.79	33.68	48.46	56.90	26.92	259.93	22.75	115.07	110.64	30.29	99.33
T_4	24.13	26.74	28.14	39.68	15.64	183.55	12.43	80.83	58.75	12.48	59.30
T_5	28.11	31.01	41.67	50.82	23.15	228.00	18.99	101.30	91.54	23.41	83.27
T_6	27.32	30.81	39.82	48.64	22.12	216.75	17.48	96.21	86.33	21.00	79.87
T_7	26.82	29.70	38.36	49.73	21.31	206.74	16.30	92.68	82.13	19.67	80.03
T_8	29.53	31.13	42.58	50.92	23.66	238.26	19.76	104.31	94.19	24.92	84.64
T_9	26.11	29.58	36.18	47.32	20.10	213.00	15.69	90.50	81.41	17.81	75.03
SE (m)±	1.74	2.38	2.37	3.59	1.32	12.47	1.18	6.64	4.52	1.04	5.07
CD at 5(%)	5.22	7.15	7.10	10.75	3.95	37.38	3.54	19.91	13.54	3.10	15.19

T_1 - Absolute control, T_2 - Soybean: As per STCRC equation without FYM Wheat: As per STCRC equation without FYM, T_3 -Soybean: As per STCRC equation with FYM Wheat: AST RD NK + residual effect of P, T_4 -Soybean: AST RD NK+ P (SSP) Wheat: AST RD NK + residual effect of P, T_5 - Soybean: AST RD NK + P (25% P_2O_5 - FYM+ 75% $P_2O_5$5 -SSP) Wheat: AST RD NK + residual effect of P, T_6 - Soybean: AST RD NK + P (25% P_2O_5 - PM+75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P, T_7 - Soybean: AST RD NK + P (25% P_2O_5 - VC +75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P, T_8 - Soybean: AST RD NK + P (25% P_2O_5 - PMC +75% P_2O_5 -SSP) Wheat: AST RD NK + residual effect of P, T_9 - Soybean: AST RD NK + P (25% P_2O_5 - NC +75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P revealed that the total uptake of nitrogen at soybean harvest was significantly the maximum (259.93 kg ha^{-1}) in T_3 treatment and which was at par with T_8 (238.26 kg ha^{-1}) and T_5 (228.00 kg ha^{-1}) treatment. The total phosphorus uptake in soybean straw was significantly higher (22.75 kg ha^{-1}) with application of manures and fertilizers as per STCRC equation with FYM of soybean (T_3) treatment over rest of the treatments. However, it was at par with AST RD NK + P-25% P_2O_5 through PMC + 75% P_2O_5 through SSP (T_8) (19.76 kg ha^{-1}) treatment. The per cent increase in total phosphorus uptake in soybean over T_4 treatment was 83.05, 58.95, 52.78, 40.60, 31.10, 26.23 and 17.80 per cent under the T_3, T_8, T_5, T_6, T_7, T_9 and T_2 treatments, respectively. As regards to total uptake of potassium by soybean at harvest, T_3 treatment recorded significantly the highest (115.07 kg ha^{-1}) potassium uptake and is at par with T_8 (104.31 kg ha^{-1}), T_5 (101.30 kg ha^{-1}) and T_6 (96.21 kg ha^{-1}) IPM treatments, respectively.

From the scrutiny of the data presented in Table 2 revealed that total nitrogen uptake at wheat harvest was recorded significantly highest (110.64 kg ha^{-1}) in application of fertilizers to wheat AST RD NK + residual P to wheat (T_3) treatment and which is at par with freshly applied P by STCRC equation without FYM (T_2) treatment. In respect of total uptake of phosphorus in grain and straw of wheat, the fertilizers application AST RD NK + residual P to wheat (T_3) treatment significantly recorded the highest (30.29 kg ha^{-1}) total phosphorus uptake in wheat and is on par with freshly

Table 3. Effect of integrated phosphorus management on soil properties after harvest of soybean and wheat

Treatment	pH		EC (dSm^{-1})		O.C. (%)	Available nutrients (kg ha^{-1})					
						N		P		K	
	Soybean	Wheat	Soybean	Wheat		Soybean	Wheat	Soybean	Wheat	Soybean	Wheat
T_1	8.27	8.27	0.23	0.23	0.60	118.22	93.95	9.21	4.64	319.59	284.35
T_2	8.26	8.26	0.23	0.24	0.61	205.58	156.61	13.16	10.23	341.28	311.64
T_3	8.21	8.19	0.21	0.22	0.68	236.85	174.00	20.10	14.31	372.60	338.58
T_4	8.26	8.26	0.23	0.24	0.61	202.18	151.21	14.89	9.24	321.29	284.69
T_5	8.24	8.23	0.22	0.22	0.64	200.14	132.33	16.05	11.34	318.46	271.19
T_6	8.24	8.23	0.23	0.23	0.63	211.97	148.72	16.90	11.89	310.87	266.88
T_7	8.25	8.24	0.22	0.22	0.63	214.06	153.95	17.20	12.41	331.65	286.84
T_8	8.23	8.22	0.24	0.25	0.65	206.67	136.88	16.45	10.11	323.85	274.56
T_9	8.26	8.25	0.22	0.23	0.62	222.49	161.34	17.48	13.14	332.51	292.10
SE (m)±	0.01	0.01	0.01	0.01	0.01	6.83	5.39	0.60	0.38	9.08	13.93
CD at 5(%)	NS	0.02	NS	NS	0.04	20.47	16.17	1.80	1.13	27.22	41.77

T_1 - Absolute control, T_2 - Soybean: As per STCRC equation without FYM Wheat: As per STCRC equation without FYM, T_3 -Soybean: As per STCRC equation with FYM Wheat: AST RD NK + residual effect of P, T_4 -Soybean: AST RD NK+ P (SSP) Wheat: AST RD NK + residual effect of P, T_5 - Soybean: AST RD NK + P (25% P_2O_5 - FYM+ 75% $P_2O_5$5 -SSP) Wheat: AST RD NK + residual effect of P, T_6 - Soybean: AST RD NK + P (25% P_2O_5 - PM+75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P, T_7 - Soybean: AST RD NK + P (25% P_2O_5 - VC +75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P, T_8 - Soybean: AST RD NK + P (25% P_2O_5 - PMC +75% P_2O_5 -SSP) Wheat: AST RD NK + residual effect of P, T_9 - Soybean: AST RD NK + P (25% P_2O_5 - NC +75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P applied P fertilizer as per STCRC equation (yield target 45 q ha^{-1}) without FYM to wheat (T_2) (28.26 kg ha^{-1}) treatment. Amongst the IPM treatments T_5 to T_9, the significantly highest (24.92 kg ha^{-1}) total P uptake was observed by application of fertilizers AST RD NK + residual P - PMC (T_8) treatment in wheat. At wheat harvest, the phosphorus uptake was higher in T_3 and T_5 to T_9 residual IPM treatments might be due to maximum residual phosphorus availability. The treatment T_2 also showed more uptake which might be due to freshly application of P fertilizer as per STCRC equation without FYM. The significant highest (99.33 kg ha^{-1}) total uptake of K by wheat was recorded in T_3 treatment and it was at par with T_2 (96.79 kg ha^{-1}) and T_8 (84.64 kg ha^{-1}) treatments. This may be due to favourable effect of physical and chemical environment of soil with FYM application which causes continuous supply of nutrients (Mandal and Sinha, 2002).

Soil fertility : The influences of IPM practices to soybean on chemical properties are presented in Table 3. The treatment T_3 recorded significantly the highest (0.68%) organic carbon and which is at par with T_8 (0.65%) and T_5 (0.64%) treatments. An increase in organic carbon, this could be due to application of organic matter as per STCRC equation with FYM to soybean resulted in increase in organic carbon content in soil. As regards available nitrogen, the significantly maximum (236.85 kg ha^{-1}) available nitrogen was recorded through the application of manures and fertilizers as per STCRC equation of soybean with FYM (T_3) treatment and which

Table 4. Economics of integrated phosphorus management to soybean-wheat cropping sequence

Treatment	Gross monetary returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C ratio
T_1 - Absolute control	80162	60573	17549	1.32
T_2 - Soybean: As per STCRC equation without FYM Wheat: As per STCRC equation without FYM	166338	83771	82567	1.99
T_3 - Soybean: As per STCRC equation with FYM Wheat: AST RD NK + residual effect of P	187377	94931	92446	1.96
T_4 - Soybean: AST RD NK+ P (SSP) Wheat: AST RD NK + residual effect of P	128613	76184	52429	1.69
T_5 - Soybean: AST RD NK + P (25% P_2O_5 - FYM+ 75% P_2O_5 -SSP) Wheat: AST RD NK + residual effect of P	164498	84999	79499	1.94
T_6 - Soybean: AST RD NK + P (25% P_2O_5 - PM+ 75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P	158872	82801	76071	1.92
T_7 - Soybean: AST RD NK + P (25% P_2O_5 - VC +7 75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P	155279	88546	66733	1.75
T_8 - Soybean: AST RD NK + P (25% P_2O_5 - PMC + 75% P_2O_5 -SSP) Wheat: AST RD NK + residual effect of P	169769	82702	87067	2.05
T_9 - Soybean: AST RD NK + P (25% P_2O_5 - NC + 75% P_2O_5 - SSP) Wheat: AST RD NK + residual effect of P	149298	98545	50753	1.52
SE (m)±	5931			
CD at 5(%)	17782			

is at par with AST RD NK + P - 25% P_2O_5 through neem cake +75% P_2O_5 through SSP (222.49 kg ha^{-1}) treatment.

The available phosphorus in soil at soybean harvest due to IPM treatments ranged between 9.21 to 20.10 kg ha^{-1}. However, significantly the highest available P (20.10 kg ha^{-1}) was noticed in T_3 treatment. Among the IPM treatments (T_5 to T_9), highest available P (17.48 kg ha^{-1}) was noticed in T_9 which was at par with all other IPM treatments (T_7, T_6, T_5 and T_8). The per cent increase of available phosphorus over T_4 treatment was 35.01, 17.42, 15.51, 13.78, 10.48 and 7.79 per cent under the treatments T_3, T_9, T_7, T_6, T_8 and T_5, respectively. The available potassium was significantly highest (372.60 kg ha^{-1}) in T_3 treatment.

The influences of residual IPM practices on chemical properties at wheat harvest are presented in Table 3. The effect of residual IPM practices to wheat by application of fertilizers AST RD NK + residual P to wheat (T_3) treatment observed slightly decline in pH (8.19). The treatment T_3 recorded significantly higher (0.70%) organic carbon and it was at par with T_8 (0.67%) and T_5 (0.66%) residual IPM treatments of wheat. As regards to available nitrogen, significantly the highest (174.00 kg ha^{-1}) available nitrogen was recorded by AST RD NK + residual P to wheat (T_3) treatment. However, it is at par with application of fertilizers to wheat AST RD NK + residual P - neem cake (T_9) treatment. The available phosphorus in soil at wheat harvest due to residual IPM treatments ranged in between 4.64 to 14.31 kg ha^{-1}. However, significantly highest (14.31 kg ha^{-1}) available P was noticed in T_3 treatment. Due to residual IPM to wheat, available potassium recorded significantly highest (338.58 kg ha^{-1}) in T_3 treatment followed by T_2, T_9, T_7, T_4, T_8, T_5 and T_6 treatments, respectively. Similar results were also reported by Badanur *et al*. (1990) and Tiwari *et al*. (2002). The improvement in nutrients and especially available P could be attributed due to addition of FYM and PSB to both crops. The residual available P might also be due to the release of organic acids during microbial decomposition of organic matter and increased solubility of native phosphorus. Balaguravaiah *et al*. (2005) also reported that the solubility of native phosphorus due to the release of organic acids during decomposition of organic matter.

Economics : Economics of the cropping sequence, significantly higher (Rs. 92,446/-) total monetary returns were recorded through application of manures and fertilizers as per STCRC equation with FYM of soybean and AST RD NK + residual P of soybean to wheat treatment (Table 4). However, benefit cost ratio was significantly highest (2.05) under application of manures and fertilizers AST RD NK + 25% P_2O_5 through PMC and 75% P_2O_5 through SSP to soybean and AST RD NK + residual P of PMC to wheat which was significantly superior over all the treatments. Higher returns were obtained in application of manures and fertilizers as per STCRC equation with FYM to soybean and AST RD NK + residual P of soybean to wheat treatment may be due to the higher yield with maximum available and uptake of nutrients.

It could be concluded that integrated phosphorus management through application of manures and fertilizers as per STCRC equation with FYM to soybean and AST RD NK + residual P of soybean to wheat found higher productivity, uptake of nutrients and higher monetary returns with improving soil fertility under soybean-wheat cropping system.

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Effect of Different Irrigation Levels on Growth, Yield and Yield Attributes of Wheat Varieties

A. G. Mundhe[1], U. N. Alse[2] and R. L. Aundhekar[3]
Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402 (India.)
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Abstract

A study was undertaken on the effect of different irrigation levels on growth, yield and yield attributes of wheat varieties during *rabi* 2009-10 at an experimental farm, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The results clearly indicated that, the application of irrigation at 1.0 IW/CPE ratio significantly improved the grain yield of wheat compared to 0.8 and 0.6 IW/CPE ratio. The variety PBN-51 produced significantly higher grain yield than rest of the wheat varieties.

Key words : Growth and yield attributes, irrigation levels, water use efficiency, wheat varieties.

Wheat is highly sensitive to water stress specially at critical growth stages. However, the water use efficiency is decreased with more or less frequencies of irrigation. Hence efficient resource utilization with maximum yield and minimum disturbance to soil health will be possible by efficient scheduling. Under field conditions timely irrigation could adjust the amount of irrigation water (IW) equal to some suitable fraction/multiple of cumulative pan evaporation (CPE). The major advantage of this approach is that it considers farmers need to change the amount of water from one irrigation to another. Where evaporation does not vary appreciably from year to year, the IW/CPE approach permits the formulation of irrigation time table for irrigating crop sown on different dates. Hence, it was considered worthwhile to find out appropriate IW/CPE ratio and irrigation depth for dwarf wheat at Parbhani will be useful to farmers as well as canal authorities. With this view the present investigation was carried out to assess the water requirement of wheat crop.

1. and 3. M. Sc. (Agri.) student, 2. Sorghum Agronomist

Materials and Methods

Field experiment was conducted during *rabi* season of 2009-10 on experimental farm, Department of Agronomy, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The soil reaction was slightly neutral, medium in total nitrogen, low in available phosphorus and high in available potassium. Depth of soil was 140 cm with 60.69 per cent maximum water holding capacity. The mean combined values of field capacity, permanent wilting point and bulk density (mg m^{-1}) of soil were 35.10, 17.39 and 1.29, respectively. An experiment was laid out in split plot design with three replications. Each replication consisted of 12 treatment combinations with three irrigation schedules *viz*., I_1- 0.6 IW/CPE, I_2- 0.8 IW/CPE and I_3- 1.0 IW/CPE were taken in main plots and four wheat varieties *viz*., V_1-PBN-51, V_2-NIAW-917, V_3-RAJ-4037 and V_4-NIAW-301 in sub-plots. Sowing was done on 24th November 2009. Fertilizers were applied as per the recommendation. No incidence of insect, pest and diseases were noticed and growth of crop was normal. Immediately after sowing, irrigation was given to experimental plot. Irrigation was applied to different plots by surface irrigation method. Two common irrigations were applied to all the plots. After pre-sowing irrigation, as per main plot treatments, irrigations were applied scheduled according to the specified cumulative pan evaporation was given in each irrigation treatment plot.

Results and Discussion

Data on effect of different irrigation levels on growth, yield attributes and yield of wheat is given in Table 1, 2 and 3.

Effect of different irrigation levels on growth of wheat varieties : The growth of wheat crop in general could be understood if series of physiological processes are observed critically during various growth stages. The rate of increase in height of plant was faster at early stage, normally vegetative growth becomes slow when reproductive phase of crop starts. The plant height was significantly influenced by different treatments except 30 DAS because irrigation treatments were applied after 30 days onwards for crop establishment. The irrigation at 1.0 IW/CPE ratio recorded significantly more plant height than 0.8 IW/CPE and 0.6 IW/CPE ratios. This might be due to adequate availability of soil moisture under former irrigation level which helps to more nutrient availability to the plant growth, which was in line with the previous findings of Panda *et al*. (1988). Similarly 0.8 IW/CPE ratio produced more plant height than 0.6 IW/CPE ratio on same principle.

The mean number of functional leaves per plant increased continuously upto 50 days and decreased thereafter due to senescence stage. The application of irrigation at 1.0 IW/CPE ratio recorded maximum number of functional leaves as well as highest leaf area plant^{-1} (dm^2) than 0.8 IW/CPE and 0.6 IW/CPE ratio (Table 1). The mean leaf area plant^{-1} increased continuously upto 50 days and decreased thereafter due to leaf senescence. Bandopadhyay and Mallic (2003) reported that the most important consequences of the

Table 1. Growth parameters and yield as influenced by different treatments

Treatments	Mean height plant (cm) (At harvest)	Mean leaf area plant^{-1} (dm^{-1}) (50 DAS)	Mean no. of functional leaves plant^{-1} (60 DAS)	No. of effective tillers plant^{-1}	No. of panicle plant^{-1}	Wt. of grain panicle^{-1}	Grain yield plant^{-1} (g)	Grain yield (q ha^{-1})	Bio-logical yield (q ha^{-1})
Irrigation levels (I)									
0.6 IW/CPE (I_1)	77.41	5.12	11.94	3.36	2.36	1.12	1.85	28.20	64.58
0.8 IW/CPE (I_2)	82.58	5.48	14.28	4.10	3.15	1.29	2.00	35.23	74.87
1.0 IW/CPE (I_3)	84.40	5.83	15.80	4.50	3.61	1.40	2.18	37.73	80.06
S.E.±	0.64	0.02	0.29	0.09	0.21	0.04	0.03	0.68	1.03
C.D. at 5%	1.89	0.06	0.88	0.26	0.64	0.12	0.11	1.99	3.07
Varieties (V)									
PBN-51 (V_1)	77.47	6.13	15.02	5.16	3.82	1.73	2.17	36.84	79.55
NIAW-917(V_2)	82.61	5.08	13.01	3.49	2.61	1.08	2.01	32.42	70.87
RAJ 4037 (V_3)	80.63	4.92	13.54	2.95	2.49	0.98	1.78	30.65	67.26
NIAW-301(V_4)	85.95	5.82	14.58	4.35	3.25	1.29	2.08	34.97	74.10
S.E.±	0.98	0.03	0.36	0.17	0.23	0.05	0.03	0.92	1.33
C.D. at 5%	2.80	0.11	1.09	0.51	0.68	0.13	0.11	2.73	3.96

sensitivity of all enlargements to water deficit is due to the marked reduction in leaf area.

All the wheat varieties recorded more or less similar plant height in early stage which might be due to slow growth during seedling stage. During later stages variety NIAW-301 produced taller plants as compared to PBNS-51, NIAW-917 and Raj 4037 indicating differential plant type.

In respect of number of functional leaves plant^{-1} and leaf area plant^{-1} variety PBN-51 recorded more values than NIAW-913, Raj 4037 and NIAW-301 throughout the growth period which may be attributed due to long duration and genetic potential.

Effect of different treatments on yield and yield attributes on wheat varieties : All the yield-contributing characters differed significantly due to irrigation levels. Among these, effective tillers plant^{-1}, length of panicles, number of spikelets panicle^{-1}, number of grains panicle^{-1}, number of panicle plant^{-1}, weight of grains panicle^{-1}, 1000 grain weight and grain yield plant^{-1} were significantly superior with 1.0 IW/CPE ratio as compared to 0.8 and 0.6 IW/CPE ratio. It might be due to no stress occurred during growth period of crop and also improvement in dry matter helped the plants to produce greater yield attributes. Similar findings were reported by Singh and Sharma (1997).

Maximum grain, straw and biological yields were recorded by scheduling irrigation at 1.0 IW/CPE ratio, due to its better development of yield attributes. Irrigation at 0.6 IW/CPE ratio recorded lowest yield attributes and yield. It can be attributed to the fact that water stress reduced the photosynthetic area which consequently reduced the yield attributing characters and finally the grain yield (Table 1). Similar results were also reported by Mishra *et al*. (1994).

The variety PBN-51 was superior in yield attribute and grain yield (36.84 q ha^{-1}) and biological yield (79.55 q ha^{-1}) as compared NIAW-301, NIAW-917 and Raj 4037, which might be due to synthesis of more photosynthates due to increased source capacity and efficient translocation of photosynthates from the sink to source (seed). This was similar to the results of Patel *et al*. (1991) and Pandey (1999), Yadav and Raghuvanshi (2007) and Choudhary and Singh (2007) at different locations.

Effect of different treatments on Water use efficiency : Water use efficiency decreased with increasing irrigation levels. The application of 0.6 IW/CPE ratio recorded the highest water use efficiency (14.00 kg ha^{-1} mm^{-1}), however, the application of 1.0 IW/CPE observed the lowest water use efficiency (10.93 kg ha^{-1} mm^{-1}). Different varieties had different water use efficiency. The maximum water use efficiency was recorded by variety Raj 4037 (13.48 kg ha^{-1} mm) and lowest water use efficiency was recorded by variety NIAW-917 (11.26 kg ha^{-1} mm) (Table 2).

Table 2. Irrigation water applied, consumptive use, total water requirement and water use efficiency as influenced by different treatments

Treatments	Irrigation water applied (mm)	Consumptive use (mm)	Total water requirement (mm)	Water use efficiency (kg ha^{-1} mm)
Irrigation levels (I)				
0.6 IW/CPE (I_1)	320.00	202.92	337.50	14.00
0.8 IW/CPE (I_2)	335.30	296.60	352.30	11.77
1.0 IW/CPE (I_3)	450.00	345.00	467.50	10.93
Varieties (V)				
PBN-51 (V_1)	385.60	304.90	402.93	12.20
NIAW-917 (V_2)	361.70	292.87	379.03	11.26
RAJ 4037 (V_3)	354.70	230.90	372.03	13.48
NIAW-301 (V_4)	371.70	297.40	389.03	11.97
G. Mean	368.43	281.51	385.76	12.23

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Effect of Fertilizer Levels and Split Application of Nitrogen on Growth and Yield of Wheat

H. A. Jadhav[1], U. N. Alse[2], A. G. Mundhe[3] and R. L. Aundhekar[4]
Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402 (India)
(Received : 10-05-2014)

Abstract

An experiment was conducted during *rabi* season of 2009-10 at Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani with twelve treatment combinations of fertilizer levels (3) and nitrogen splitting (4) replicated thrice under split plot design. Results indicated that the application of 150 per cent recommended dose of fertilizer increased grain (26.43 q ha^{-1}), straw (40.27 q ha^{-1}) and biological yield (66.70 q ha^{-1}) of wheat significantly over 125 per cent (21.18 q ha^{-1}) and 100 per cent (16.89 q ha^{-1}) recommended dose of fertilizer. However, the application of nitrogen in three split doses (25:50:25 % N) increased in the grain (22.73 q ha^{-1}), straw (37.05 q ha^{-1}) and biological yield (59.78 q ha^{-1}) as compared to 125 and 100 per cent recommended dose of fertilizer (RDF). Similar trend was observed with growth and yield attributes.

Key words : Fertilizer levels, split application of nitrogen, wheat.

Wheat (Triticum spp.) is the world's most widely cultivated food crop and in India it is second important staple food, rice being the first. Adoption of suitable practices like seed rate and split nitrogen application play a key role on the quality of wheat. Nitrogen is the most important constituent of plant proteins and is required throughout the crop growth period from vegetative stage to subsequent harvesting. In advanced agriculture, the nitrogen use efficiency was reduced to 50 per cent only whereas, remaining was loss due to

1., 3. and 4. M.Sc.(Agri.) Student, 2. Sorghum Agronomist.

leaching or denitrification. An increase demand for nitrogen in modern agriculture could therefore be solved by the exploitation of biologically fixed nitrogen. With this view an experiment on "Effect of fertilizer levels and split application of nitrogen on growth and yield of wheat" was conducted to evaluate the effect on growth and yield of wheat.

Material and Methods

An experiment was conducted during *rabi* 2009-10 on experimental farm, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The soil of the experimental field was black and clayey in texture and slightly alkaline in reaction. It was medium in available nitrogen, phosphorus and high in available potassium. An experiment was laid out in split plot design replicated thrice. Each replication consisted of 12 treatment combinations with three fertilizer levels *viz*., F_1-100% RDF (100 : 50 : 50 NPK kg ha^{-1}), F_2-125% RDF, F3-150 % RDF were taken in main plots and four nitrogen splitting *viz*., N_1-50: 50%, N_2-75: 25%, N_3-50: 25: 25%, N_4-25: 50: 25% in sub-plots (according to treatments, nitrogen was applied at the time of sowing, 30 and 60 DAS). FYM @ 5 t ha^{-1} was applied at the time of ploughing. Basal dose of fertilizer was applied through 18: 18: 10 mixed fertilizer, muriate of potash and top dressing was done with the help of urea. A variety NIAW-917 treated with thirum @ 4 g kg^{-1} seed was used with recommended seed rate 100 kg ha^{-1}.

Results and Discussion

Data on effect of fertilizer levels and split application of nitrogen on growth, yield and attributing traits of wheat is given in Table 1, 2, 3 and 4.

Effect of fertilizer levels on growth of wheat : The growth of wheat crop in general could be assessed if series of physiological processes are observed critically during various growth stages *viz*., seedling, tillering, jointing, boot leaf, flowering, dough and grain filling.

Table 1. Mean plant height, total dry matter, leaf area plant^{-1}, functional leaves plant^{-1} and leaf area index of wheat as influenced by different treatments

Treatments	Mean height of plant (cm) at harvest	Mean total dry matter (g plant^{-1})		Mean leaf area plant^{-1} (dm2) 50 DAS	Mean no. of functional leaves plant^{-1} 60 DAS	Mean leaf area index 31-60 DAS
		60 DAS	90 DAS			
Fertilizer levels (F)						
F_1 - 100 % RDF	91.82	2.84	5.32	1.36	12.50	4.51
F_2 - 125 % RDF	93.07	3.10	5.37	1.66	12.58	4.63
F_3 - 150 % RDF	96.94	3.90	6.54	1.76	13.32	4.71
S.E. ±	0.43	0.04	0.03	0.01	0.07	
C.D. at 5 %	1.28	0.13	0.11	0.03	0.22	
Split application of nitrogen (N)						
N_1 - 50 : 50 % N	92.84	3.23	5.52	1.54	12.76	4.23
N_2 - 75 : 25 % N	93.44	3.24	5.71	1.55	12.79	4.32
N_3 - 50 : 25 : 25 % N	94.29	3.19	5.83	1.60	12.68	4.56
N_4 - 25 : 50 : 25 % N	95.21	3.40	5.90	1.67	12.97	4.65
S.E. ±	0.59	0.04	0.04	0.01	0.12	
C.D. at 5%	1.75	0.11	N.S.	0.02	N.S	
G. Mean	93.95			1.60	12.81	4.52

The plant height recorded an increasing trend and at harvest it was 93.95 cm.

Application of 150 per cent RDF recorded significantly more plant height than 125 per cent and 100 per cent RDF. The rate of increase in height of plant was faster at early stage normally vegetative growth becomes slow when reproductive phase of crop starts. These finding are in conformity with Singh *et al.* (2007). The similar findings were reported by Sharma *et al.* (1999).

The increase in dry matter plant^{-1} was continuous from initial stage to maturity. Dry matter accumulation was slow during initial

Table 2. Mean Absolute Growth Rate (AGR) and Relative Growth Rate (RGR) as influenced by various treatments at various stages of growth

Treatment	Mean Absolute Growth Rate (AGR) (g day^{-1})				Mean Relative Growth Rate (RGR) (g g day^{-1})			
	0-30	31-60	61-90	91-at harvest	0-30	31-60	61-90	91-at harvest
Fertilizer levels (F)								
F_1 (100 % RDF)	0.015	0.079	0.080	0.046	0.015	0.006	0.018	0.009
F_2 (125 % RDF)	0.018	0.086	0.082	0.060	0.021	0.017	0.019	0.009
F_3 (150 % RDF)	0.021	0.107	0.090	0.069	0.027	0.030	0.019	0.011
Split application of nitrogen (N)								
N_1 (50 : 50 % N)	0.017	0.089	0.078	0.056	0.018	0.015	0.016	0.009
N_2 (75 : 25 % N)	0.018	0.091	0.079	0.064	0.020	0.017	0.024	0.009
N_3 (50 : 25 : 25 % N)	0.019	0.086	0.086	0.062	0.019	0.018	0.021	0.009
N_4 (25 : 50 : 25 % N)	0.019	0.097	0.092	0.065	0.022	0.023	0.024	0.010
G. Mean	0.018	0.091	0.084	0.061	0.018	0.018	0.019	0.009

Table 3. Yield attributes as influenced by various treatments

Treatments	Length of panicle (cm)	No. of spikelet panicle^{-1}	No. of grain panicle^{-1}	1000 grain weight (g)
Fertilizer levels (F)				
F_1 - 100 % RDF	6.84	13.86	43.96	34.21
F_2 - 125 % RDF	7.68	15.42	46.56	36.17
F_3 - 150 % RDF	8.60	17.59	49.87	37.64
S.E. ±	0.05	0.17	0.31	0.36
C.D. at 5 %	0.15	0.48	0.93	1.07
Split application of nitrogen (N)				
N_1 - 50 : 50 % N	7.54	15.40	46.73	36.09
N_2 - 75 : 25 % N	7.53	15.57	47.05	35.93
N_3 - 50 : 25 : 25 % N	7.65	15.53	46.08	35.56
N_4 - 25 : 50 : 25 % N	8.11	16.00	47.32	36.46
S.E. ±	0.11	0.18	0.37	0.36
C.D. at 5%	0.32	NS	N.S.	N.S.
G. Mean	7.71	15.63	46.80	36.01

stage upto 30 days, rapid during 30 to 60 days and moderate at 60 and 90 days after sowing and slow towards maturity. The application of 150 per cent RDF recorded maximum dry matter accumulation which was significantly superior to 100 per cent and 125 per cent RDF (Mahato *et al*., 2007).

The leaf area and number of functional leaves did not show any significant effect of fertilizer levels at 30 days after sowing (DAS). Thereafter, it was higher under 150 per cent RDF than 125 and 100 per cent RDF in 50 and 60 DAS, respectively (Table 1).

Leaf area index was maximum at 31-60 DAS thereafter it declined up to maturity, due to shedding of leaves towards maturity. The 150 per cent RDF recorded higher LAI than 125 and 100 per cent RDF. Similar results were reported by Ramniwas et al. (2006)

Mean AGR (Absolute growth rate) for plant dry matter was very slow initially but it was at peak between 30 to 60 DAS. It might be due to maximum tillering and height during this stage. Thereafter the AGR declined due to leaf senescence. The application of 150 per cent RDF recorded higher value of AGR than 125 per cent and 100 per cent RDF (Table 2). Similar results were reported by Essa (1996) and Zahran and Mosalem (1993).

Highest value of AGR and RGR was recorded in early phase of crop growth and decline gradually up to harvest. The treatment 150 per cent RDF recorded higher value of AGR and RGR than 125 per cent and 100 per cent RDF. These results are in line with Yadav and Verma (1991).

Effect of split application of nitrogen on growth of wheat : The application of nitrogen in three split (25: 50: 25) at basal, 30, 60 DAS recorded significantly maximum plant height and dry matter accumulation compared to rest of the treatments. Similar results were reported by Yadav and Verma (1991) and Kumar (1998).

The split application of N did not show any significant effect on number of functional leaves plant^{-1}. Whereas, three split application of N i.e. 25:50:25 per cent gave significantly higher leaf area per plant at 60 DAS and leaf area index (LAI) than rest of the treatments. The similar results are quoted by Yadav and Verma (1991).

The higher value of AGR and RGR was recorded in three splits application of nitrogen i.e. 25 : 50 : 25 per cent N as compared to 50 : 50 per cent N, 75 : 25 per cent N and 50 : 25 : 25 per cent N. These findings are in conformity with the Mahato *et al.* (2007).

Effect of fertilizer levels on yield and yield attributes of wheat : All the yield attributing characters were affected significantly due to increasing fertilizer levels. Among these length of panicle, number of spikelet panicle^{-1}, number of grains panicle^{-1} and 1000 grain

Table 4. Grain, straw and biological yield as influenced by various treatments

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})
Fertilizer levels (F)			
F_1 - 100 % RDF	16.89	28.03	44.92
F_2 - 125 % RDF	21.18	31.90	53.08
F_3 - 150 % RDF	26.43	40.27	66.70
S.E. ±	0.52	0.77	1.35
C.D. at 5 %	1.69	2.30	4.02
Split application of nitrogen (N)			
N_1 - 50 : 50 % N	20.32	30.08	50.40
N_2 - 75 : 25 % N	21.85	30.61	52.46
N_3 - 50 : 25 : 25 % N	21.11	31.78	52.89
N_4 - 25 : 50 : 25 % N	22.73	37.05	59.78
S.E. ±	0.41	2.04	2.16
C.D. at 5%	1.23	6.12	6.48
G. Mean	21.50	32.81	54.31

weight were significantly superior resulted into maximum grain, straw and biological yield with 150 per cent RDF as compared to 125 per cent RDF and 100 per cent RDF (Table 3). Availability of nutrient during grand growth of crop contribute to increase the photosynthetic area and also improvement in dry matter helped the plant to produce more yield attributes and finally grain yield. Similar results were also reported by Paliwal *et al*. (2003), Pandey *et al*., (2003) and Deor and Pathik (1997).

Effect of split application of nitrogen on yield and yield attributes of wheat : All the yield attributing characters were not significantly influenced due to split application of nitrogen except length of panicle, it was significantly higher with 3 split application of nitrogen 25:50:25 per cent N over rest of the split applications. Similar findings were reported by Sharma *et al*. (2002).

The grain, straw and biological yields were significantly influenced by split application of nitrogen. Maximum grain, straw and biological yield was recorded by nitrogen application in three split i.e. 25:50:25 per cent. However, it was at par with 50:25:25 per cent split application of nitrogen (Table 4). It might be due to better development of yield attributes. It can be attributed to the fact that increasing in number of nitrogen splits increases the supply of nitrogen during the growth of the crop and improved the plant growth and development, contributed to increase the photosynthetic area which has resulted into increase the yield attributing characters and finally the grain yield. Similar results were also reported by Gupta *et al*. (2007).

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Genetic Diversity Studies in *rabi* Sorghum (*Sorghum bicolor* L. Moench)

S. S. Swami[1], S. B. Chaudhary[2] and N. S. Kute[3]
Department of Agriculture Botnay, Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 (India)
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Abstract

Mahalanobis D^2 statistics was applied to assess the diversity among the 60 local genotypes and 1 check of *rabi* Sorghum. The analysis of variance revealed the significant differences among genotypes for all the 13 traits studied., The 61 genotypes were grouped into 14 clusters, where cluster-I was largest containing 28 genotypes followed by cluster IV with 13 genotypes cluster V with 9 genotypes. The inter-cluster distance was maximum between cluster IX and cluster XIII followed by cluster VIII and cluster XII and cluster XI and cluster XIII. Based on the inter cluster distance and per se performance, 12 genotypes from different clusters were selected which can be further utilized in breeding programme as a parent. Plant height contributed maximum to the divergence (28.52) followed by grain yield per plant (19.84) and 1000 seed weight (19.45).

Key words : Sorghum, genetic diversity, D^2

Sorghum is third most important cereal crop cultivated extensively in India after wheat and rice. The area under *rabi* sorghum is fairly consistent over many years but progress in productivity is much slower compared to *kharif*. Diverse parents is known to provide an opportunity for bringing together gene constellations resulting in desirable transgressive segregants in advanced generations. However, postulation of rational criteria for identification of such parents is still a big problem in plant breeding. However report on genetic diversity among *rabi* sorghum are very limited. In present study, D^2 analysis has been applied to access the diversity among 61 *rabi* sorghum genotypes to identify the divergent genotypes suitable for hybridization programme. Diversity analysis provides information on deciding choice of parents from distanstly related clusters to secure yield improvement in *rabi* sorghum.

1. M.Sc. (Agri.) student, 2. Asstt. Professor and 3. Asso. Professor

Materials and Methods

The materials for present study comprises of 60 local genotypes of sorghum and 1 check-Phule Vasudha. The present study carried out at Medicinal and Aromatic Plants Project, MPKV Rahuri (M.S.) during *rabi* 2012-13 in a randomized block design with three replications with spacing 45 cm between rows and 15 cm within row. Recommended package practices were followed for raising normal crop.

In each accession 5 plants were randomly selected and used for collecting data on days to 50 per cent flowering, day's to maturity, plant height (cm), inter node length, leaf length (cm), leaf width (cm), number of inter node, peduncle length (cm), number of leaves plants^{-1}, earhead length (cm) earhead width (cm), 1000 seed weight (g) and grain yield plant^{-1} (g). The data were subjected to statistical analysis using D^2 statistics given by Mahalanobis (1936) and Tochers method and described by Rao (1952) for determining group constellation.

Results and Discussion

The analysis of variance revealed significant differences among the genotypes studied. The 61 accessions were grouped into 14 clusters. However, with number of entries in each cluster revealing considerable amount of genetic diversity in material (Table-1). It was observed that cluster-I has maximum number of genotypes (28) followed by cluster-IV with 13 genotypes clusters V with 9 genotypes and remaining genotypes are solitary. Cluster I, IV, V together included 50 genotypes reflecting narrow genetic diversity among them.

The narrow genetic diversity may be attributed to similarity in base material from which they have been evolved. Further the cluster II, III, VI, VIII, IX, X, XI, XII, XIII and XIV are solitary clusters demonstrating the impact of selection pressure in increasing the genetic diversity. The check Phule Vasudha, included in cluster-II indicated its dissimilarly or distinctness from germplasm accessions, with respect to traits studied.

These results are in agreement with the earlier reports of Langhi (2009), Kusalkar *et al.* (2009), Mahajan *et al*. (2010) and Narkhede *et al.* (2009) in *rabi* sorghum.

Average intra and inter cluster D and D^2 values among 61 genotypes (Table-2) revealed that cluster V have maximum intra cluster value (11.99) and minimum intra cluster value observed for cluster-I (D=8.92) indicated that genotypes within the cluster are similar. Minimum inter cluster D value were observed between the cluster II and III (D=4.74) indicating close relationship among genotypes included in these clusters. Maximum inter cluster value (D=25.38) was observed between cluster IX and cluster XIII followed by cluster VII and cluster XII (D=25.07) and cluster XI and

Table 1. Cluster grouping of sixty one genotypes for 13 quantitative characters in *rabi* sorghum

Clusters	No. of genotype	Name of genotype included
Cluster - 1	28	IC-249070, IC-249112, IC-249040, IC-305920, IC-305912, IC-305919, IC-305890, IC-305916, IC-3151-1, IC-305932, IS 308619, IC -3605995, IS-308617, IS-308631, IS308620, IC-249036, IC-305918, IC-305882, IS-308640, IS-308608, IC-343570, IS-30308636, IC-347568, IC-345705, IC-343593, IC-345201, IC-308601, IC-343587
Cluster - 2	1	Phule Vasudha
Cluster - 3	1	IC-249114
Cluster - 4	13	IC-345721, IC-345206, IC-345711, IC-345204, IS-308638, IC-249093, IC-303896, IS-308652, IC-343573, IC-249043, IC-343595, IS-308670, IC-249036
Cluster - 5	9	IC-249031, IC-249099, IC-249167, IC-345244, IC-345736, IC-343563, IC-345190, IC-249049, IC-347580
Cluster - 6	1	IC-347569
Cluster - 7	1	IC-392141
Cluster - 8	1	IC-249052
Cluster - 9	1	IC-392129
Cluster - 10	1	IC-392156
Cluster - 11	1	IC-249041
Cluster - 12	1	IC-249107
Cluster - 13	1	IC-392157
Cluster - 14	1	IC-347589

Table 2. Intra and Inter cluster distance D^2 and D value of 14 clusters in rabi sorghum

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9	Cluster 10	Cluster 11	Cluster 12	Cluster 13	Cluster 14
Cluster 1	8.92 (79.56)	10.41 (108.36)	10.47 (109.62)	11.28 (127.33)	12.79 (163.58)	11.83 (139.94)	16.34 (266.99)	17.75 (315.06)	15.94 (254.08)	14.20 (201.64)	17.62 (310.46)	15.62 (243.98)	16.46 (270.93)	18.71 (352.31)
Cluster 2		0.00	4.74 (22.46)	15.37 (236.23)	13.74 (188.78)	13.99 (195.72)	20.20 (408.04)	22.65 (513.02)	17.34 (300.67)	16.21 (262.76)	22.06 (486.64)	17.17 (294.80)	18.29 (334.52)	24.06 (78.88)
Cluster 3			0.00	15.04 (226.20)	13.25 (175.56)	15.12 (228.61)	19.43 (377.52)	22.90 (524.41)	17.52 (306.95)	16.01 (256.32)	21.53 (463.54)	16.99 (288.66)	18.72 (350.43)	24.60 (605.16)
Cluster 4				10.11 (102.21)	15.74 (247.74)	13.15 (172.92)	14.81 (219.33)	13.65 (186.32)	14.82 (219.63)	12.93 (167.18)	13.70 (187.69)	14.90 (222.01)	17.61 (310.11)	15.49 (239.94)
Cluster 5					11.99 (143.76)	17.41 (303.10)	21.64 (468.28)	24.30 (590.94)	23.53 (553.66)	19.54 (381.81)	21.64 (468.28)	16.66 (277.55)	17.02 (289.68)	20.69 (428.07)
Cluster 6						0.00	12.31 (151.53)	14.47 (209.38)	15.46 (239.01)	16.45 (270.60)	18.30 (334.89)	20.59 (423.94)	18.17 (330.14)	17.09 (292.06)
Cluster 7							0.00	13.55 (183.60)	15.03 (225.90)	16.63 (276.55)	19.76 (390.51)	25.07 (628.50)	20.03 (401.20)	19.61 (384.55)
Cluster 8								0.00	12.24 (149.81)	14.87 (217.85)	13.51 (182.52)	21.27 (442.41)	23.12 (543.53)	16.41 (269.28)
Cluster 9									0.00	14.76 (217.85)	17.15 (294.12)	21.21 (449.86)	25.38 (644.14)	23.67 (560.26)
Cluster 10										0.00	16.33 (266.66)	17.51 (306.60)	14.19 (201.35)	19.71 (388.48)
Cluster 11											0.00	12.38 (153.26)	24.65 (607.62)	13.73 (188.51)
Cluster 12												0.00	22.42 (502.65)	17.95 (322.20)
Cluster 13													0.00	19.70 (388.09)
Cluster 14														0.00

Values in the parenthesis indicate D^2 value cluster XIII (24.65) which indicates that the genotypes included in these clusters are genetically diverse and may gave high heterotic response.

The cluster mean performance presented in Table-3. The data revealed considereable differences among the clusters for most of characters studied. The cluster VII has highest seed yield per plant and cluster VIII has recorded highest test weight. Highest earhead length recorded by cluster XIV. Highest plant height recorded by cluster VIII, early mature genotypes found in cluster XIV and highest leaf length found in cluster VIII.

On the basis of inter cluster distance, cluster mean and *per se* performance of genotypes, were genetically diverse and agronomically superior genotypes. The selected genotypes, exceptionally good with respect to one or more desirable characters. On the basis, the genotypes IC-392156, IC-392129, IC-247589, IC-249107, IC-308640, IC-347569, IC-249052 were distinct and diverse and selected as a promising line. Intercrossing of divergent group would lead to wide genetic base in the base population and greater opportunities for crossing over which may release hidden variability, providing greater scope for isolation of transegressive segregents in advanced generations. Hence, these genotypes may be used repeatedly in crossing programme to recover transegressive segregants, which can be either released as variety or can be utilized in genetic improvement of *rabi* sorghum crop.

Among the 13 characters studied, plant height contributed most (28.52%) to the genetic divergence of genotypes followed by grain yield per plant (19.84%), 1000 seed weight (19.45 %) earhead width (9.56%) However, earhead length (2.30%), days to 50% flowering (5.25%) and leaf length (0.44%) indicated a narrow range of diversity among the genotypes under study.

The result of this study indicated the maximum divergent cluster were cluster IX (IC 392129) and XIII (IC-392157) followed by cluster VII (IC-392141) and cluster XII (IC-249107) and cluster XI (IC-249041) and cluster

Table 3. Cluster mean performance for thirteen quantitative characters of *rabi* sorghum genotypes

Cluster no.	Days to 50% flowering	Days to maturity	Plant height	Inter-node length	Leaf length	Leaf width	No. of inter-node	Peduncle length	No. of leaves plant^{-1}	Ear-head length	Ear-head width	1000 seed weight	Seed yield plant^{-1}
1	79.98	126.96	159.88	18.33	64.49	6.90	7.20	19.55	9.32	13.68	6.61	38.52	56.61
2	91.67	134.00	125.33	17.00	60.33	6.40	8.33	17.00	7.77	16.00	5.33	35.00	62.00
3	87.33	134.00	124.00	18.67	56.00	5.73	6.00	15.00	7.67	17.00	7.17	40.00	67.33
4	76.90	123.00	179.00	21.28	66.54	6.91	8.59	28.82	10.17	18.15	8.14	36.74	43.23
5	71.48	121.00	142.33	16.37	61.15	6.53	6.62	21.96	8.83	12.97	6.27	29.67	55.33
6	90.33	132.67	188.00	25.00	68.00	5.40	9.00	26.00	7.80	8.67	4.43	21.00	64.00
7	89.33	134.00	208.00	24.00	69.00	8.10	10.33	29.00	11.87	22.00	9.13	34.00	75.67
8	84.00	127.00	225.00	25.83	82.00	6.70	10.90	33.00	10.33	18.00	8.90	41.67	55.00
9	89.00	134.67	185.00	20.83	64.67	8.40	10.17	22.33	11.20	18.37	9.33	40.00	64.00
10	98.00	138.00	172.67	17.33	71.33	8.00	5.67	24.67	10.33	21.67	8.17	25.00	17.67
11	65.00	129.00	195.00	25.00	60.00	5.50	7.67	59.00	10.73	21.00	9.07	31.00	32.00
12	70.33	118.00	151.33	15.67	56.00	4.83	6.83	50.67	8.17	15.00	8.03	27.00	22.67
13	95.00	135.67	165.33	14.67	75.67	8.50	6.33	20.00	8.87	10.00	4.50	17.00	18.00
14	69.33	113.00	215.00	25.83	64.00	6.30	9.67	58.67	11.70	24.00	4.43	24.00	21.67

XIII (IC-392157). The crosses between accessions in these cluster would yield high heterotic hybrids and desirable segregants in the subsequent generations.

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Effect of Nutrient Management Practices on Juice Quality, Jaggery Quality and Productivity of Sugarcane Plant Cane and it's Ratoon

K. B. Patil[1], G. S. Nevkar[2], B. S. Kadam[3], D. M. Veer[4], D. S. Patil[5], U. S. Kudtarkar[6] and B. G. Gaikwad[7]

Regional Sugarcane and Jaggery Research Station, Kolhapur - 416 005 (India)

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Abstract

The pooled results of three years revealed that application of fertilizers @ 25 % RD NPK through organic sources with 75% RD of NPK through chemicals fertilizers recorded significantly highest cane and CCS yield (102.43 and 15.23 t ha^{-1}) over rest of the treatments, while it was at par with application of fertilizers as per soil test and application of 50% of RD of fertilizers through organic + 50% RD NPK through chemical fertilizer (101.18, 15.06 t ha^{-1}) and (91.11, 13.64 t ha^{-1}).The application of fertilizer @ 25% organic sources with 75% RD of NPK through chemicals fertilizers recorded highest gross monetory returns, net returns and B: C ratio (Rs.1,12,673/- ha^{-1}, 53,576/- ha^{-1} and 2.0, respectively). Regarding jaggery quality the application of fertilizers @ 25% RD through organic with 75% RD dose of NPK through chemical fertilizers recorded significantly lowest reducing sugar and highest non reducing sugar (7.35% and 84.12%). The significantly highest jaggery recovery was recorded by application of fertilizer dose as per soil test with FYM and bio-fertilizers (10.96%) which was at par with the treatment 25% of RD through organics + 75% RD through chemical fertilizers (10.83 %). The colour of jaggery was found significantly superior in the treatment of Jivamarut (59.50 OD) which was on par with 100% application of RD dose through organic fertilizer (59.33 OD).

Key words : Nutrient management, juice quality, jaggery quality, productivity.

Fertilizer is a key input for sugarcane production as the crop is very responsive to higher fertilizer application. Due to this, there is increasing tendency among the farmers to use higher dose of chemical fertilizer (particularly

1. and 6. Jr. Res. Asstt., 2. Jr.Res.Officer, 3. Asstt. Proffesor 4. Plant Pathologist, 5. Asso. Professor and 7. Sr. Res. Officer

nitrogenous fertilizers) for getting higher yields without knowing it's ill effect on the physico-chemical and biological properties of soil which ultimately affect the yield and quality of sugarcane and its by products. Misra *et al.*, (1965) reported that the quality of jaggery as well as its keeping quality both are adversely affected due to increasing levels of nitrogen manuring. While combination of organic material like press mud with inorganic nitrogen fertilizers not only boost cane productivity but also give superior quality gur. Various studies on fertilization in the country showed that neither the mineral fertilizer alone nor the organic sources exclusively can achieve the production sustainability of soil and sugarcane under intensive cropping system. Bhoi *et al.*, (2004) supported this fact and reported that the combination of inorganic and organics were better over using only inorganic fertilizers or only organic manures so far as the yield and quality of sugarcane plant and ratoon is concerned. Banger and Sharma (1997) reported that integrated use of organic manures and chemical fertilizers can sustain sugarcane production.

Ratooning of Sugarcane is common practice followed by cane cultivators. In India and also in Maharashtra state about 40-50 per cent of total cane area is under ratoon which saves about 30-35 % expenditure on cultivation however, the productivity of ratoon cane remains much lower as compared to plant cane (Sundra, 1987). The main reason is the less attention paid by the farmers to ratoon crop. Stubble shaving, gap filling and judicious fertilizer management with an integrated approach are some of the ratoon specific management practices for more production (Ramdas *et al.*, 2004).Residual management through recycling of trash influences the physico-chemical and biological properties of soil favorably and sustains ratoon cane production (Shankriah *et al.*, 2002). Considering all the facts of sustainability of soil and sugarcane, the present investigation on integrated nutrient management practices of plant cane and ratoon, by using various sources of organic manures/fertilizers and their combinations, was undertaken to visualize it's effect on juice and jaggery quality and productivity of Sugarcane.

Material and Methods

Field experiments was conducted on plant cane of pre-seasonal sugarcane and its succeeding I and II ratoon at the Regional Sugarcane and Jaggery Research Station, Kolhapur (M.S.) during the years 2006-07 to 2008-09. The soil was medium deep with pH 6.38, E.C. 0.25 dSm^{-1} and nutrient status were organic carbon 0.94 per cent, available nitrogen 206.62 kg ha^{-1}, phosphorus 20.84 kg ha^{-1} and potassium 298.40 kg ha^{-1}. The released sugarcane variety Co 86032 was planted on ridges and furrows, spaced at 1 m interval, on 20-11-2006 under pre seasonal condition. Gross plot and net plot size were 7.5 x 10.0 m^2 and 6.5 x 8 m^2, respectively. Experiment was conducted in Randomized Block Design with three replications. Prevailing farmers practice of complete organic cultivation *viz.*, Rishi Krishi Tantra and Jivamrut were also incorporated in the study.

Sources and quantity of chemical and organic fertilizers applied to the sugarcane crop as per treatments for plant cane and ratoon crop are given in Table 1. All the recommended package of practices for cultivation of sugarcane plant cane was adopted. Crop was harvested at 12 months crop age and data on yield parameters *viz.*, cane yield (t ha^{-1}) and CCS yield (t ha^{-1}) were recorded. The juice samples were analyzed at harvest for quality parameters *viz.*, brix %, sucrose %, purity % and CCS % as per the analytical method described by Spencer and Meade (1964).The

Table 1. Sources of chemical and organic fertilizers applied for plant and ratoon cane

Treatment details	Sources for plant cane	Sources for ratoon cane
T_1 - 100 % NPK RD through organics	i) Sanhemp (GM) before sugarcane ii) Use of FYM @ 21 t ha^{-1} iii) Use of PMC @ 5 t ha^{-1} iv) Use of vermicompost @ 2.5 t ha^{-1} v) Composite culture of BF@ 5kg ha^{-1}	i) *In situ* trash@ 7.5 t ha^{-1} composting ii) Use of FYM @ 12 t ha^{-1} iii) Use of PMC @ 5 t ha^{-1} iv) Use of vermicompost @ 2 t ha^{-1} v) Composite culture of BF @ 5 kg ha^{-1}
T_2 - 100 % NPK RD through chemical fertilizers	i) Sanhemp (GM) before sugarcane ii) Use of FYM @ 21 t ha^{-1} iii) Use of PMC @ 5 t ha^{-1} iv) Use of vermicompost @ 2.5 t ha^{-1} v) Composite culture of BF@ 5kg ha^{-1}	i) *In situ* trash@ 7.5 t ha^{-1} composting ii) Use of FYM @ 12 t ha^{-1} iii) Use of PMC @ 5 t ha^{-1} iv) Use of vermicompost @ 2 t ha^{-1} v) Composite culture of BF @ 5 kg ha^{-1}
T_3 - Fertilizer dose As per soil test with FYM and Biofertilizers	i) NPK 400 :170 :170 kg ha^{-1} ii) Ferrous sulphate :25 kg ha^{-1} iii) Zinc sulphate : 20 kg ha^{-1} iv) Biofertilizers as seed treatment @ 5 kg ha^{-1} (Mixture of Azotobacter, Acetobacter, Azospirillum and PSB @1.25 kg each) v) FYM @ 25 t ha^{-1}	i) NPK (300 :140 : 140 : kg ha^{-1}) ii) Ferrous sulphate : 25 kg ha^{-1} iii) Zinc sulphate : 20 kg ha^{-1} iv) Trash mulching, fertilizer application by crow bar method in two splits without off barring & interculturing operation.
T_4 - 75 % RD Organics + 25 % RD chemical fertilizers	i) Sanhemp (GM) before sugarcane ii) Use of FYM @ 15 t ha^{-1} iii) Use of PMC @ 2 t ha^{-1} iv) Use of vermicompost @ 1 tha^{-1} v) Composite culture of BF@ kg ha^{-1} vi) NPK 100:43:43 kg ha^{-1}	i) *In situ* trash @ 7.5t ha^{-1} composting ii) Use of FYM @ 8 t ha^{-1} iii) Use of PMC @ 2.5 t ha^{-1} iv) Use of vermicompost @ 1.5 t ha^{-1} v) Composite culture of BF@5kg ha^{-1} vi) NPK 75:35:35 kg ha^{-1}
T_5 - 50 % of RD Organics + 50 % RD chemical fertilizers	i) Sanhemp (GM) before sugarcane ii) Use of FYM @ 4 t ha^{-1} iii) Use of PMC @ 1 t ha^{-1} iv) Use of vermicompost @ 0.5 t ha^{-1}1 v) Composite culture of BF @ 5 kg ha^{-1} vi) NPK 200:85:85 kg ha^{-1}	i) *In situ* trash@ 7.5 t ha^{-1} composting ii) Use of FYM @ 4 t ha^{-1} iii) Use of PMC @ 1 t ha^{-1}1 iv) Use of vermicompost @ 0.5 t ha^{-1} v) Composite culture of BF@ 5kg ha^{-1} vi) NPK(150:70:70 kg ha^{-1})
T_6 - 25 % of RD Organics + 75 % RD chemical fertilizers	i) Sanhemp (GM) before sugarcane ii) Composite culture of BF @ 5 kg ha^{-1} iii) NPK 300:128:128 kg ha^{-1}	i) *In situ* trash @7.5 t ha^{-1} composting ii) Composite culture of BF@5 kg ha^{-1} iii) NPK 225:105:105 kg ha^{-1}
T_7 - Rishi - Krishi Tantra	i) Angara - Soil beneath Baniyan tree:38 kg ha^{-1} ii) Amritpani - (Blending of following) a) Ghee of local cow : 625 g ha^{-1} b) Honey : 1.25 kg ha^{-1} c) Cow dung of local cow :25 kg ha^{-1} d) Water : 500 L ha^{-1} Application of above material three times i.e. one by seed treatment and two times as fertigation.	i) Angara - Soil beneath Baniyan tree:38 kg ha^{-1} ii) Amritpani - (Blending of following) a) Ghee of local cow : 625 g ha^{-1} b) Honey : 1.25 kg ha^{-1} c) Cow dung of local cow :25 kg ha^{-1} d) Water : 500 L ha^{-1} Application of above material three times i.e. one by seed treatment and two times as fertigation.

Table 1. Contd.

Treatment details	Sources for plant cane	Sources for ratoon cane
T_8 - Use of Jivamrut	i) Dung of indigenous cow/ bullock/ buffalo: 25 kg ha^{-1} ii) Urine of indigenous cow: 12.5 - 25L iii) Black/old jaggery 2.5 kg iv) Flour of any pulses : 5 kg v) Rhizosphere of same crop : 5kg vi) Water: 500 Lit. *Above material from Sr.1 to 5 dissolved in water and fermented for 2-7 days. *This material was applied per hectare at planting and monthly intervals up to 5 months.	i) Dung of indigenous cow/ bullock /buffalo : 25 kg ha^{-1} ii) Urine of indigenous cow: 12.5 - 25L iii) Black/old jaggery 2.5 kg iv) Flour of any pulses : 5 kg v) Rhizosphere of same crop : 5kg vi) Water: 500 Lit. *Above material from Sr.1 to 5 dissolved in water and fermented for 2-7 days. *This material was applied per hectare at planting and monthly intervals up to 5 months.

randomly five sugarcane clumps were selected for observation and mean values were worked out for investigation. The harvested sugarcane was crushed through horizontal, three roller crusher. The juice samples were taken to the laboratory and were analyzed for brix and sucrose content as per analytic methods described by Parthasarthi *et al*. (1979).

Based on brix and sucrose content data, the CCS and purity per cent were computed by using Winter's formula. The jaggery samples were prepared using small pan of 50 litre capacity. Improved jaggery production process was adopted for experimental jaggery production (Mungare *et al*., 2001). The jaggery samples were analyzed for jaggery quality parameters *viz*., reducing sugars, non-reducing sugars, pH and colour intensity. The reducing sugar was determined by Lane - Eynon volumetric method (A.O.A.C., 1960). The non reducing sugar was determined by using Polarimeter. The colour intensity was measured by using Klet Sumersion Colourimeter at 540 nm wavelength. All the data was analyzed statistically as per the procedure laid by Panse and Sukhatme (1967).

Results and Discussion

Yield parameters : The pooled mean data on cane and CCS yield of plant cane and its two succeeding ratoons are presented in Table 3. It is revealed from the data that, the treatment T_6 i.e. application of fertilizers @ 25 per cent through organic sources + 75 per cent of RD NPK through chemical fertilizers recorded significantly highest cane and CCS yield (102.43 and 15. 23 t ha^{-1}) however it was at par with treatment T_3 i.e. application of fertilizers as per soil test with FYM and biofertilizers (101.18,15.06 t ha^{-1}) and T_5 i.e. application of fertilizer @ 50 per cent through organic and 50 per cent through chemical fertilizers (91.11 and 13.64 t ha^{-1}). This might be due to beneficial effect of conjoint use of organic with chemical fertilizers. The similar results were reported by Pilane *et al.* (2003), Singh *et al*. (2003) and Ramdas *et al.* (2004). Farmers practice *viz*., use of Rishi-Krishi Tantra (T_7) and use of Jivamrut (T_8) recorded very low cane and CCS yield (57.85 and 8.57, 52.15 and 7.81 t ha^{-1}, respectively). Application of 100 per cent RD dose of NPK fertilizer either through organic or chemical fertilizer also showed lower cane and CCS yield of plant cane as well as it's succeeding two ratoon than integrated or conjoint use of RD of NPK fertilizers.

Quality Parameters :

Sugarcane juice quality : The pooled mean data of juice quality parameters *viz*., brix, sucrose, purity and CCS are presented in Table 2. From the data it is revealed that, significantly highest juice brix (21.88%) was recorded due to application of Jivamrut (T_8) however it was at par with rest of the treatments except T_2 i.e., 100 per cent NPK through chemical fertilizers. Significantly highest sucrose (62.60%) was observed due to application of Jivamrut (T_8) however it was at par with treatment T_5 (62.58%), T_3 (62.26%) and T_6 (62.26%). Application of 50 per cent RD through organics + 50 per cent RD through chemical fertilizers (T_5) recorded highest CCS (15.06%) which was found significantly superior over the treatment T_2 (14.54%), T_1 (14.38%) and was at par with rest of the treatments. Juice purity was found highest due to use of Rishi Krishi Tantra (95.96%) however all the treatments were at par with each other.

Jaggery quality : The pooled mean of jaggery quality parameters *viz*., reducing sugar, non reducing sugar, jaggery recovery, pH and colour intensity are presented in Table 2. Significantly lowest jaggery reducing sugar (7.35%) and highest non reducing sugar (84.12%) was recorded by treatment T_6 i.e. application of fertilizer @ 25 per cent RD through organic with 75 per cent RD dose through chemical fertilizers. There was almost no difference in pH values of jaggery prepared from all the treatments. The colour intensity of jaggery was found significantly superior in the

Table 2. Effect of different treatments on sugarcane juice and jaggery quality (pooled mean of one plant cane and two ratoons)

Treatment details	Sugarcane juice quality				Jaggery quality				
	Brix (%)	**Sucrose (%)**	**CCS (%)**	**Purity (%)**	**Reducing sugar**	**Non reducing sugar**	**Jaggery recovery**	**pH**	**Colour**
T_1 : 100% NPK RD through organics	21.41	20.12	14.38	94.16	8.04	81.58	9.81	6.31	59.33
T_2 : 100% NPK RD through chemical fertilizers	21.20	20.22	14.54	95.30	8.00	83.34	10.50	6.32	57.50
T_3 : Fertilizer dose as soil test with FYM and biofertilizers	21.74	20.75	14.93	95.43	7.90	83.10	10.96	6.32	57.70
T_4 : 75% RD through organics + 25% RD through chemical fertilizers	21.79	20.59	14.75	94.59	7.80	83.29	10.03	6.32	58.30
T_5 : 50% of RD through organics + 50% RD through chemical fertilizers	21.65	20.86	15.06	95.58	7.65	82.60	10.02	6.32	57.81
T_6 : 25% of RD through organics +7 5% RD through chemical fertilizers	21.84	20.75	14.90	95.12	7.35	84.12	10.83	6.29	55.78
T_7 : Use of Rishi Krishi Tantra	21.51	20.65	14.84	95.96	8.09	80.96	9.56	6.32	58.21
T_8 : Use Jivamrut	21.88	20.87	15.00	95.40	8.23	81.17	9.61	6.33	59.50
SE±	0.19	0.17	0.15	0.76	0.11	0.38	0.14	0.01	0.29
CD 0.05	0.59	0.51	0.45	2.31	0.32	1.016	0.42	NS	0.88

treatment T_8 i.e., use of Jivamarut (59.50) which was on par with 100 % dose thorough organic fertilizer (59.33). The significantly highest jaggery recovery (10.96%) was recorded by treatment T_3 i.e. application of fertilizer dose as per soil test with FYM and biofertilizers which was at par with the treatment T_6 i.e. 25 per cent of RD through organics + 75 per cent RD through chemical fertilizers (10.83%). Similar types of results were reported by Anonymous (1983).

Economics : The data pertaining to economics of different nutrient management practices are presented in Table 3. The highest gross monetary returns, net monetary returns and benefit cost ratio was achieved due to application of fertilizer @ 25 % through organic + 75 per cent RD NPK through chemical fertilizers (Rs.1,05,673 t ha^{-1}, Rs. 55,573 t ha^{-1} and 2.30, respectively) however it was at par with application of fertilizer dose as soil test with FYM and Biofertilizers (Rs.1,02,752 t ha^{-1}, Rs.47,681 t ha^{-1} and 1.94, respectively). Nutrient management treatments of purely organic nature *viz*., 100 per cent of RD NPK through organics (T_1), use of Rishi Krishi Tantra (T_7) and use Jivamrut (T_8) exhibited lower monetary returns with lower B: C ratio than treatments of combination of organic and

Table 3. Sugarcane yield and commercial cane sugar and economics of sugarcane influenced by different nutrient management treatments

Treatment details	**Cane yield (t ha^{-1})**	**CCS yield (t ha^{-1})**	**Gross monetory returns (Rs. ha^{-1})**	**Cost of culti-vation (Rs. ha^{-1})**	**Net returns (Rs. ha^{-1})**	**B:C ratio**
T1 : 100% NPK RD through organics	66.45	9.53	78,921	58,353	20,592	1.36
T2 : 100% NPK RD through chemical fertilizers	88.33	12.91	93,528	61,468	42,060	1.85
T3 : Fertilizer dose as soil test with FYM and biofertilizers	101.18	15.06	1,02,752	55,071	47,681	1.94
T4 : 75% RD through organics + 25% RD through chemical fertilizers	82.87	12.24	89,224	55,197	34,027	1.66
T5 : 50% of RD through organics + 50% RD through chemical fertilizers	91.11	13.64	91,042	52,006	39,036	1.87
T6 : 25% of RD through organics + 75% RD through chemical fertilizers	102.43	15.23	1,05,673	50,099	55,573	2.30
T7 : Use of Rishi Krishi Tantra	57.85	8.57	74,316	46,554	27,762	1.67
T8 : Use Jivamrut	52.15	7.81	72,079	46,687	25,392	1.57
SE±	4.34	0.65	5,323	3,957	4,450	0.13
CD 0.05	13.16	1.99	16,109	NS	13618	0.39

Average rates of organics and chemical fertilizer

A) Cost of fertilizers.

N : Rs.10.80/- kg^{-1}	$FeSO_4$: Rs.28/- kg^{-1}	Vermicompost : Rs.3400/- t^{-1}	Azospirillum : Rs.40/- kg^{-1}
P_2O5 : Rs.23.12 kg^{-1}	$FeSO_4$: Rs.28/- kg^{-1}	Composite Culture : Rs.40/- kg^{-1}	Azotobacter : Rs.36/- kg^{-1}
K_2O : Rs. 7.71 kg^{-1}	FYM : Rs.750/- kg-1 t^{-1}	Acetobacter : Rs. 40/- kg^{-1}	PSB : Rs.36/- kg^{-1}

B) Cost of cultivation of sugarcane : Rs.30,524/- ha^{-1} (Excluding cost of fertilizer and manures)

C) Cane price:Rs.1100/- t^{-1}

inorganic fertilizers. It is evident from the data that substitution of chemical fertilizers by organic manures found useful up to 25 per cent. Further substitution of inorganic by organic resulted in increase in cost and decrease in the yield and monetary returns. These economic results are in confirmatory with the results reported by Gawade *et al.* (2005).

Based on three years nutrient management study on sugarcane plant cane and it's two succeeding ratoon, application of fertilizer @ 25 per cent NPK RD through organic with 75 per cent NPK RD through chemical fertilizers found superior in increasing the cane yield, CCS yield and jaggery quality with highest monetary returns and benefit cost ratio.

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Heterosis for Pod Borer Resistance, its Associated Traits and Seed Yield in Chickpea (*Cicer arietinum* L.)

S. D. Jadhav[1] and V. L. Gawande[2]
Department of Agriculture Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola - 444 104 (India)
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Abstract

The sixteen crosses resulting from Line x Tester model involving two females and eight males were studied to know the magnitude of heterosis over the mid parent, better parent and over the standard checks *viz*., PKV *Kabuli*-2 and Digvijay for pod borer resistance, its associated traits and seed yield in chickpea. Significantly lower number of larvae plant^{-1} at vegetative, flowering and pod formation stage and significantly less per cent pod damage along with significantly higher levels of malic acid content was noticed in parents, ICC-506, JAKI-9218 and JG-62. The highest and significant heterosis to the magnitude of 71.61 per cent over mid parent and 48.15 per cent over the better parent for seed yield plant^{-1} (under unprotected condition) was recorded in the cross ICCV-2 x Chandrapur Chanoli, and 21.53 per cent over best check in cross JAKI 9218 x Gulak 1. The cross, ICCV 2 x Gulak 1 displayed highest significant average heterosis and heterobeltiosis in desirable direction for per cent pod damage and per cent malic acid content. Whereas, highest significant standard heterosis in desirable direction was recorded by the cross ICCV 2 x ICC 506 for per cent pod damage and JAKI 9218 x ICC 506 for per cent malic acid content. Highest desirable heterosis over mid and better parent for larval count at vegetative and flowering stage was noted by ICCV 2 x Gulak 1 and ICCV 2 x JG 62, respectively. The cross JAKI 9218 x ICC 506 was found the best cross for standard heterosis for larval count at vegetative, flowering and pod formation stage. Some cross combinations which gave increased heterosis (%) for one trait also gave high heterosis (%) for either one or more other characters in addition to good *per se* performance.The crosses,ICCV 2 x Gulak1, ICCV2 x ICC 506 and JAKI 9218 x ICC 506, found to be most promising and identified on the basis of heterosis response and mean performance of the parents and crosses. These diverse crosses have immense practical value and can be exploited in further breeding programme to isolate desirable segregants.

Key words: Chickpea, pod borer resistance, seed yield, heterosis, heterobeltiosis.

Amongst the pulses, chickpea (*Cicer arietinum* L.) is an important crop in India being grown on the largest area accounting 60-70 per cent of total global production. It plays an important role in human nutrition as a source of protein (12.4 to 31.5%), carbohydrate (48.2 to 67.6%), starch (41 to 50%), fat (6%), vitamins and minerals for large population sectors in the developing world and is considered a healthy food in many developed countries (Jodha and Subbarao, 1987 and Geervani and Umadevi, 1989).

To meet the future requirements regarding chickpea, it is necessary to breed resistance varieties having most of the other desirable traits suitable to the chickpea growers for cultivation and its end users as well for which selection of the parents and superior crosses on the basis of distinguishing traits will play a vital role. In this regard, hybridization followed by selection to isolate desirable recombinants from the superior crosses is one of the important breeding methods for breaking yield barriers and to combine different traits in one genotype. It offers for great possibilities in crop improvement than any other breeding method and is the only effective means of combining together the desirable character of two or more

1. Post Graduate student and 2 Associate Professor.

varieties/genotypes. It helps to predict gene action i.e. additive and non-additive type of gene interaction. It also used for selection of the parents to be used in hybridization programme which is the most critical job. In the field of plant breeding, the most important breakthrough has been considered as heterosis. However, the possibility of exploitation of heterosis in chickpea is remote due to strict self pollination and non-availability of male sterility system coupled with high seed rate. Nevertheless, the study of heterosis in chickpea is important for the plant breeder to place hands on superior crosses by rejecting large number of crosses in first generation itself. In addition to this the magnitude of heterosis provides a basis for determining genetic diversity and also serve as guide to the choice of desirable parents (Swindell and Poehlman, 1976). The cross will have immense practical value if it shows superiority over standard or the best variety of the area. An attempt was therefore made to select diverse crosses for further breeding programme and to know the magnitude of heterosis over best check apart from that over better and mid parent for seed yield and other traits related with pod borer resistance in chickpea.

Material and Methods

Plant Material : Genetically diverse parents were deliberately selected on the basis of their distinguishing characters with high intensity *viz*., HC 5 (suitable for mechanical harvesting and high density planting), ICC 5O6 (pod borer resistant), PKV Harita (high yielding green seed coat type), Chandrapur Chanoli (very small seeded, *kabuli* type), JG 62 (twin poded), Gulak 1 (pink seed coat type suitable for parching), AKG10-1 (suitable for mechanical harvesting) and Bushy Mutant (spreading, *kabuli* type) as males and ICCV 2 (early, *kabuli* type) and JAKI 9218 (high yielding and wilt resistant) as females to test the performance of males. The crosses were effected in line x tester fashion for obtaining F_1 seeds of 16 crosses at Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *rabi* 2010-11.

Field Trial : A field trial was conducted comprising of ten parents, 16 F_1s and two checks *viz*., PKV *kabuli*-2 and Digvijay, replicated twice in a randomized block design during *rabi* 2011-12. Each genotype was represented by a single row of 4 m length keeping the 30 cm spacing between rows and 15 cm between plants. All the package of practices were applied to get sound and healthy crop except control measure for pod borer to exert pressure of pod borer population for selection of resistant/tolerant genotypes on the basis of various traits. The five compatative plants were randomly selected to record the observations on the various traits *viz*., larval count at vegetative, flowering and pod formation stages, per cent malic acid content, per cent pod borer damage and seed yield per plant (under unprotected condition) in parents, F_1s and checks.

i. Larval count at vegetative, flowering and pod formation stages : Number of larvae present on each randomly selected five plants from each genotype and replication at vegetative, flowering and pod formation stage were recorded.

ii. Per cent malic acid content : Malic acid content in leaves was estimated by determining the titratable acidity of extract of 1g of 3rd, 4th and 5th leaves from the top of the shoot collected at 9.00 hrs. The leaf sample was macerated in distilled water and filtered using Whatman No.1 filter paper. The filtrate was collected and volume was made up to 20 ml and then 5 ml of this aliquot was taken and titrated against 0.05 N NaOH using phenophthalein as an indicator. Average of three titre values was used to calculate the per cent malic acid content using the formula as given by Girija *et al*., (2008).

Per cent malic acid content = (TV x E x N x 100)/(1000 x W)

Where,

TV = average of three titre values

E = equivalent weight of malic acid

N = normality of NaOH

W = weight equivalent of the sample

iii. Per cent pod damage : At maturity, total pods were harvested from each of five selected plants of each genotype and replication and damaged pods counted using the following formula:

$$\text{Per cent pod damage} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

Statistical Analysis : Data were subjected to analysis of variance for mean performance (Panse and Sukhatme, 1967) and heterosis over mid parent (MP), better parent (BP) and standard check (SC) was calculated as per the standard procedure of Hays *et al*., (1955) and Turner (1953).

Results and Discussion

The analysis of variance raveled that genotypes differed significantly for all the traits studied except for larval count at vegetative stage indicating presence of substantial genetic diversity. Further, the *per se* performance for seed yield plant^{-1} (under unprotected condition) revealed that, out of ten parents i.e. amongst the males, AKG 10-1 and females, JAKI 9218 and amongst the crosses JAKI9 218 x Gulak 1 recorded significantly better yield than others (Table 1). However, the higher levels of malic acid content and lower per cent of pod damage were recorded in genotype ICC 506 and crosses involving ICC 506 as one of the parents. Further, these genotypes had significantly lower number of larvae per plant at vegetative, flowering and pod formation stage as compared to other genotypes. In addition to ICC 506, significantly lower number of larvae per plant at vegetative, flowering and pod formation stage and significantly less per cent pod damage was also noticed in other parents i.e. JAKI 9218 and JG 62 along with significantly higher levels of malic acid content which is in desirable direction. In general, the resistant genotypes had higher levels of malic acid content as compared to other genotypes which is in conformity of earlier reports (Yoshida *et al*., 1995 and Girija *et al*., 2008). The malic acid has been reported to have an antibiotic effect on larvae. Negate differences due to ovipositional antixenosis determine the size of the larval population and therefore pod damage on a particular genotype (Narayanamma, 2005).

There was no significant difference for larval count at vegetative stage among all the genotypes; however, there was significantly higher difference for larval count in some of the genotypes than other genotypes at flowering and pod formation stage. It might be due to the activation/induction of hypersensitive response of genes controlling resistance present and ultimately activation of antibiosis and non-preference mechanism in some of the genotypes carrying these genes. Similar results in chickpea were also reported by Narayanamma *et al*. (2007). Significantly higher per cent of pod damage was noticed in the parents *viz*., ICCV 2 and Gulak 1, however, the cross between these two parents i.e. ICCV 2 x Gulak 1 recorded significantly minimum per cent damage. This might be due to the heterotic effects (i.e. hybrid vigour) in the cross combination in desirable direction.

The range for heterosis over mid parent (MP), better parent (BP) and standard check

Table 1. Mean performance of parents, crosses and checks for seed yield and other traits related with pod borer resistance in chickpea

Genotypes	Seed yield plant^{-1} (g)	Larval count at vegetative stage	Larval count at flowering stage	Larval count at pod formation stage	Malic acid content (%)	Pod damage (%)
Crosses						
JAKI 9218 X HC 5	13.39	1.00 (1.220)	3.50 (1.996)	5.50 (2.447)	0.65** (1.072)	10.02** (3.243)
JAKI 9218 X ICC 506	17.38*	0.50* (0.970)	1.50** (1.403)	3.50** (1.996)	0.81** (1.146)	4.01** (2.122)
JAKI 9218 X PKV Harita	18.89**	1.00 (1.220)	3.50 (1.996)	5.50 (2.447)	0.61** (1.053)	11.08** (3.402)
JAKI 9218 x Chandrapur Chanoli	10.71	2.00** (1.58)	5.50** (2.447)	7.50** (2.827)	0.54** (1.018)	21.93** (4.736)
JAKI 9218 x JG 62	15.06	0.50* (0.970)	3.50 (1.996)	5.50 (2.447)	0.64** (1.067)	11.70** (3.493)
JAKI 9218 x Gulak 1	19.64**	1.00 (1.220)	3.50 (1.996)	4.50** (2.233)	0.65** (1.071)	11.16** (3.415)
JAKI 9218 x AKG 10-1	17.05	0.50* (0.970)	1.50** (1.403)	4.50** (2.233)	0.76** (1.122)	9.04** (3.088)
JAKI 9218 x Bushy Mutant	16.51	1.00 (1.220)	4.50** (2.233)	5.50 (2.447)	0.65** (1.073)	13.26** (3.709)
ICCV 2 X HC 5	17.87**	1.00 (1.220)	3.50 (1.996)	6.00** (2.542)	0.66** (1.077)	11.14** (3.412)
ICCV 2 X ICC 506	14.63	0.50* (0.970)	2.50** (1.726)	3.50** (1.996)	0.95** (1.203)	5.60** (2.467)
ICCV 2 X PKV Harita	14.22	1.00 (1.220)	2.50** (1.726)	4.00** (2.108)	0.68 (1.086)	9.55** (3.170)
ICCV 2 x Chandrapur Chanoli	18.80**	1.00 (1.220)	3.50 (1.996)	4.50** (2.233)	0.72* (1.105)	10.03** (3.244)
ICCV 2 x JG 62	10.48	1.00 (1.220)	1.50** (1.403)	4.50** (2.233)	0.76** (1.122)	9.34** (3.137)
ICCV 2 x Gulak 1	18.16**	0.50* (0.900)	2.50** (1.726)	5.00 (2.345)	0.76** (1.123)	9.19** (3.113)
ICCV 2 x AKG 10-1	11.82	1.50* (1.400)	4.50** (2.233)	5.5 (2.447)	0.69** (1.091)	12.98** (3.671)
ICCV 2 x Bushy Mutant	10.59	1.50* (1.400)	3.50 (1.996)	6.50** (2.644)	0.75** (1.118)	16.00** (4.061)
Males						
JAKI 9218	23.58**	1.00 (1.22)	2.50** (1.726)	5.00 (2.345)	0.72* (1.102)	11.41** (3.451)
ICCV 2	12.69	1.50* (1.40)	6.00** (2.550)	8.50** (2.999)	0.46** (0.980)	23.56** (4.905)
Females						
HC 5	10.65	0.50* (0.907)	2.50** (1.726)	5.00 (2.335)	0.73** (1.108)	9.00** (3.082)
ICC 506	14.01	0.00** (0.710)	1.00** (1.225)	3.50** (1.996)	1.04** (1.241)	3.12** (1.902)
PKV Harita	13.05	1.00 (1.220)	2.00** (1.581)	4.50** (2.233)	0.69 (1.090)	10.40** (3.301)
Chandrapur Chanoli	9.22	1.00 (1.220)	3.50 (1.996)	6.00** (2.542)	0.76** (1.122)	14.82** (3.913)
JG 62	16.33	1.00 (1.220)	2.50** (1.726)	4.50** (2.233)	0.78** (1.130)	8.72** (3.035)
Gulak 1	13.21	1.00 (1.220)	4.00** (2.121)	6.50** (2.644)	0.56 (1.031)	17.64** (4.259)
AKG 10-1	17.72*	1.00 (1.220)	3.50 (1.996)	6.00** (2.550)	0.63** (1.064)	13.71** (3.769)
Bushy Mutant	11.31	1.00 (1.220)	2.50** (1.726)	5.50 (2.447)	0.74** (1.112)	10.30** (3.283)
Checks						
PKV *Kabuli* 2	12.91	2.00** (1.580)	5.50** (2.447)	7.00** (2.739)	0.54 (1.021)	23.86** (4.935)
Digvijay	16.16	1.50* (1.400)	3.50 (1.996)	6.50** (2.644)	0.63** (1.062)	16.75** (4.153)
General mean	14.859	1.000	3.21	5.360	0.698	12.120
SE (m) ±	1.086	0.136	0.121	0.119	0.006	0.055
Heritability (Broad Sense) %	90.53	97.34	34.85	75.70	62.06	96.72

(*, ** significant at 5% and 1% level, respectively). Values shown in parenthesis are transformed values.

(SC) for various characters have been presented in Table 2. Highest heterosis in desirable direction over mid parent and better parent was recorded for the trait seed yield per plant (under unprotected condition) and over standard check for per cent pod damage.Considerable amount of useful heterosis in desirable direction was observed for seed yield per plant, larval count at vegetative, flowering and pod formation stage and per cent pod damage indicating the availability of substantial genetic variability in parents for these traits. On the contrary less genetic variability is available in the present material for the traits per cent malic acid content.

The highest magnitude of significant and beneficial average heterosis and heterobeltiosis for seed yield per plant (under unprotected condition) was exhibited by cross ICCV 2 x Chandrapur Chanoli to the extent of 71.61 per cent and 48.15 per cent, respectively, followed by cross ICCV 2 x HC 5 (53.13% and 40.82%, respectively) and ICCV 2 x Gulak 1 (40.23% and 37.47%, respectively) (Table 3). A total of three crosses showed significant and positive heterosis over mid parent and better parent, respectively. Whereas, only one cross exhibited significantand positive heterosis over the best check. The highest magnitude of standard heterosis was shown by cross JAKI 9218 x Gulak 1 (21.53%). The relative heterosis, heterobeltiosis and standard heterosis for this character in chickpea was also reported earlier by several researchers (Bharadwaj *et al*., 2010 and Bhatnagar *et al*., 2006).

In case of larval count at vegetative stage, none of the crosses showed significant heterosis over mid and better parent, whereas, five crosses *viz*., JAKI 9218 x ICC 506, JAKI 9218 x JG 62, JAKI 9218 x AKG 10-1, ICCV 2 x ICC 506 and ICCV 2 x Gulak 1 exhibited positive and significant heterosis over the best check. Amongst the four crosses showing significant and negative heterosis for larval stage at flowering stage, ICCV 2 x JG 62 noted highly significant and negative average heterosis to the extent of -34.50 per cent followed by ICCV 2 x Gulak 1, JAKI 9218 x AKG 10-1 and ICCV 2 x Chandrapur Chanoli. Two crosses *viz*., ICCV 2 x JG 62 (-18.84%) and ICCV2 x Gulak 1 (-18.63%) showed significant and negative heterobeltiosis. Whereas, three crosses *viz*., JAKI 9218 x ICC 506, JAKI 9218 x AKG 10-1 and ICCV 2 x JG 62 were found to have negatively significant magnitude of heterosis over the best check. For larval count at pod formation stage, six crosses showed significant and negative heterosis over the mid parent, out of which the cross ICCV 2 x ICC 506 (-20.12%) showed highest negative average heterosis followed by ICCV 2 x PKV Harita (-19.39%), ICCV2 x Chandrapur

Table 2. Range of heterosis for yield and traits associated with pod borer resistance in chickpea

Character	Rage of heterosis (%) over		
	Mid parent	Better parent	Standard check*
Seed yield plant^{-1} (unprotected condition)	-34.70 to 71.61	-54.58 to 48.15	-35.15 to 21.53
Larval count at vegetative stage	-26.34 to 29.51	-20.90 to 35.92	-31.07 to 12.86
Larval count at flowering stage	-34.50 to 31.72	-18.84 to 42.03	-29.82 to 22.81
Larval count at pod formation stage	-20.12 to 15.63	-12.18 to 20.43	-24.57 to 6.99
Per cent malic acid content	-8.11 to 11.44	-8.93 to 8.74	-3.77 to 13.21
Per cent pod damage	-32.10 to 28.67	-26.91 to 35.25	-48.80 to 14.10

* Best check amongst two checks i.e. Digvijay

Chanoli (-19.39%), ICCV2 x Gulak 1 (-16.74%) etc. However, none of the crosses showed significant and negative heterosis over better parent. Among the five negatively significant crosses over the best check, the highest magnitude of significant and negative standard heterosis was exhibited by crosses JAKI 9218 x ICC 506 and ICCV 2 x ICC 506 i.e. 24.43 per cent.

The trait per cent malic acid content is one of the most important traits imparting resistance to pod borer and hence, should be considered for its improvement. Out of all the crosses studied, ten, three and nine crosses noted significant and positive heterosis over mid parent, better parent and best check, respectively. The cross ICCV 2 x Gulak 1 showed highest significant and positive heterosis over mid parent and better parent (11.14% and 8.74%, respectively). Whereas, the cross ICCV 2 x ICC 506 recorded highest and positively significant useful heterosis (13.21%) followed by JAKI 9218 x ICC 506 (8.49%).

For the trait per cent pod damage, ten and three crosses were found to be significant in desirable direction for average heterosis and heterobeltiosis. The highest magnitude of heterosis over the mid and better parent was exhibited by the cross ICCV 2 x Gulak 1 i.e. -32.10 and -26.91 per cent, respectively. However, fourteen crosses recorded significant heterosis in desirable direction over the best check. The maximum standard heterosis in desirable direction was reflected by the cross JAKI-9218 x ICC 506 to the extent of -48.80 per cent, followed by ICCV 2 x ICC 506 (-40.60%); JAKI 9218 x AKG 10-1 (-25.54%); ICCV 2 x Gulak 1 (-25.06%), etc. which indicates the use of parents involved in these

Table 3. Estimates of heterosis (H_1), heterobeltiosis (H_2) and standard heterosis^ (H_3)

Croses	Seed yield plant^{-1} (unprotected condition)			Larval count at vegetative stage			Larval count at flowering stage		
	H_1	H_2	H_3	H_1	H_2	H_3	H_1	H_2	H_3
JAKI 9218 x HC 5	-21.76**	-43.21**	-17.14*	11.67	26.42	-12.86	15.65	15.65	0.00
JAKI 9218 x ICC 506	-7.53	-26.29**	7.55	0.00	35.92	-31.07*	-4.92	14.75	-29.82**
JAKI 9218 x PKV Harita	3.14	-19.89**	16.89	0.00	0.00	-12.86	20.73*	26.27*	0.00
JAKI 9218 x Chandrapur Chanoli	-34.70**	-54.58**	-33.73**	29.51	29.51	12.86	31.72**	42.03**	22.81*
JAKI 9218 x JG 62	-24.53**	-36.13**	-6.81	-20.9	-20.9	-31.07*	15.65	15.65	0.00
JAKI 9218 x Gulak 1	6.77	-16.71	21.53**	0.00	0.00	-12.86	3.77	15.65	0.00
JAKI 9218 x AKG 10-1	-17.43*	-27.69**	5.51	-20.9	-20.9	-31.07*	-24.73**	-18.84	-29.82**
JAKI 9218 x Bushy Mutant	-5.36	-29.98**	2.17	0.00	0.00	-12.86	29.57**	29.57**	12.03
ICCV 2 x HC 5	53.13**	40.82**	10.58	3.17	26.42	-12.86	-6.67	15.65	0.00
ICCV 2 x ICC 506	18.65	4.43	-9.47	-8.53	35.92	-31.07*	-8.49	41.39**	-13.53
ICCV 2 x PKV Harita	10.49	8.97	-12.00	-6.87	0.00	-12.86	-16.46*	9.18	-13.53
ICCV 2 x Chandrapur Chanoli	71.61**	48.15**	16.34	-6.87	0.00	-12.86	-12.21	0.00	0.00
ICCV 2 x JG 62	-27.77**	-35.82**	-35.15**	-6.87	0.00	-12.86	-34.50**	-18.84*	-29.82**
ICCV 2 x Gulak 1	40.23**	37.47**	12.38	-26.34	-20.9	-31.07*	-26.12**	-18.63*	-13.53
ICCV 2 x AKG 10-1	-22.26**	-33.30**	-26.86**	6.87	14.75	0.00	-1.65	12.03	12.03
ICCV 2 x Bushy Mutant	-11.75	-16.55	-34.47**	6.87	14.75	0.00	-6.67	15.65	0.00
SE (d)	0.981	1.132	1.132	0.176	0.204	0.204	0.135	0.156	0.156

*, ** significant at 5% and 1% level, respectively; ^Standard heterosis over the best check amongst two i.e. Digvijay.

Table 3. Contd.

Croses	**Larval count at formation stage**			**Per cent malic acid content**			**Per cent pod damage**		
	H_1	H_2	H_3	H_1	H_2	H_3	H_1	H_2	H_3
JAKI 9218 x HC 5	4.59	4.93	-7.37	-3.17**	-3.60**	0.94	-0.69	5.19*	-21.81**
JAKI 9218 x ICC 506	-8.17	0.00	-24.57**	-1.71*	-7.26**	8.49**	-20.56**	11.84**	-48.80**
JAKI 9218 x PKV Harita	6.87	9.62	-7.37	-3.65**	-4.09**	-0.47	0.89	3.18	-17.95**
JAKI 9218 x Chandrapur Chanoli	15.63*	20.43*	6.99	-8.11**	-8.93**	-3.77**	28.67**	37.25**	14.10**
JAKI 9218 x JG 62	6.87	9.62	-7.37	-4.48**	-5.75**	0.47	7.79**	15.16**	-15.78**
JAKI 9218 x Gulak 1	-10.51	-4.89	-15.50*	0.47	-2.73**	0.94	-11.36**	-1.01	-17.71**
JAKI 9218 x AKG 10-1	-8.78	-4.89	-15.50*	3.93**	2.27*	6.13**	-14.40**	-10.43**	-25.54**
JAKI 9218 x Bushy Mutant	2.08	4.26	-7.37	-3.17**	-3.60**	0.94	10.02**	12.79**	-10.72**
ICCV 2 x HC 5	-4.59	8.99	-3.78	2.87**	-3.15**	1.42	-14.64**	10.53**	-17.83**
ICCV 2 x ICC 506	-20.12**	0.00	-24.57**	8.11**	-3.23**	13.21**	-27.55**	29.74**	-40.60**
ICCV 2 x PKV Harita	-19.39**	-5.59	-20.23**	4.83**	-0.46	2.36*	-22.73**	-3.94	-23.61**
ICCV 2 x Chandrapur Chanoli	-19.39**	-12.18	-15.50*	5.24**	-1.34	4.25**	-26.38**	-17.01**	-21.81**
ICCV 2 x JG 62	-14.61*	0.00	-15.50*	6.64**	-0.44	6.13**	-21.03**	3.29	-24.46**
ICCV 2 x Gulak 1	-16.74**	-11.15	-11.15	11.44**	8.74**	5.66**	-32.10**	-26.91**	-25.06**
ICCV 2 x AKG10-1	-11.71*	-3.92	-7.37	6.60**	2.35*	2.83**	-15.39**	-2.65	-11.57**
ICCV 2 x Bushy Mutant	-2.94	7.96	0.00	7.18**	0.9	5.66**	-0.73	23.74**	-2.05
SE (d)	0.150	0.174	0.174	0.008	0.009	0.009	0.060	0.070	0.070

*,** significant at 5% and 1% level, respectively; ^Standard heterosis over the best check amongst two i.e. Digvijay.

crosses for improvement of resistance to pod borer in chickpea. It is well known fact that the heterosis phenomenon is the result of non-additive gene action for the respective trait and in addition to additive gene effects, importance of non-additive gene effects was also been reported for pod borer resistance in chickpea by Narayanamma *et al.*, (2013) and Singh and Paroda (1989).

The cross ICCV 2 x Gulak 1 noted significant *per se* performance in desirable direction for seed yield plant^{-1}, larval count at vegetative and flowering stage, per cent malic acid content and per cent pod damage (Table 4 and 5) further, the beneficial and highest significant heterosis over mid parent, better parent and best check for larval count at vegetative stage, beneficial and significant heterosis over mid and better parent for per cent malic acid content and per cent pod damage. Further, the cross ICCV 2 x ICC 506 showed highest magnitude of beneficial and significant heterosis over best check for larval count at vegetative and pod formation stage and per cent malic acid contentand in addition to highest average heterosis for larval count at pod formation stage as well as recorded significantly good per se performance for larval count at vegetative, flowering and pod formation stage, per cent malic acid content and per cent pod damage. Another cross JAKI 9218 x ICC 506 recorded highest magnitude of heterosis in desirable direction over the best check for larval count at vegetative, flowering and pod formation stage and per cent pod damage along with significantly superior *per se* performance for these traits.

Considering the magnitude of heterosis

alone in the absence of *per se* performance of F_1 hybrid will be of little use in genetic improvement programme, since many time poor parents express higher degree of per cent heterosis than the high yielding parents. This could be seen from the heterosis for the trait seed yield plant^{-1} in crosses ICCV 2 x Chandrapur Chanoli and ICCV 2 x HC 5 which exhibited highly significant and positive heterosis over the mid and better parent it may be due to involment of only non-additive gene action, however, the parents involved in these crosses did not performed well for the said trait.The cross ICCV 2 x Chandrapur Chanoli and ICCV 2 x HC 5 had mean seed yield per plant i.e. 18.80 g and 17.87 g, respectively, and their parents *viz*., ICCV 2, Chandrapur Chanoli and HC 5 had below average (general mean) seed yield plant^{-1} i.e. 12.69 g, 9.22 g and 10.65 g, respectively. On the contrary, the cross JAKI 9218 x AKG-10-1 displayed significant negative heterosis over the mid parent and better parent and non-significant heterosis over the best check though the

Table 4. Crosses showing maximum beneficial heterosis for various characters in chickpea

Character	Maximum beneficial heterosis (%) over MP		Maximum beneficial heterosis (%) over BP		Maximum beneficial heterosis (%) over SC*	
	Cross	**Heterosis**	**Cross**	**Heterosis**	**Cross**	**Heterosis**
Seed yield plant^{-1} (unprotected condition)	ICCV 2 x Chandrapur Chanoli	71.61	ICCV 2 x Chandrapur Chanoli	48.15	JAKI 9218 x Gulak 1	21.53
Larval count at vegetative stage	ICCV 2 x Gulak 1	-26.34	ICCV 2 x Gulak 1; JAKI 9218 x AKG 10-1	-20.90	JAKI 9218 x ICC 506; JAKI 9218 x JG 62; JAKI 9218 x AKG 10-1; ICCV 2 x ICC 506; ICCV 2 x Gulak 1	-31.07
Larval count at flowering stage	ICCV 2 x JG 62	-34.50	ICCV 2 x JG 62	-18.84	JAKI 9218 x ICC 506; JAKI 9218 x AKG 10-1; ICCV 2 x JG 62	-29.82
Larval count at pod formation stage	ICCV 2 x ICC 506	-20.12	ICCV 2 x Chandrapur Chanoli	-12.18	JAKI 9218 x ICC 506; ICCV 2 x ICC 506	-24.57
Per cent malic acid content	ICCV 2 x Gulak 1	11.44	ICCV 2 x Gulak 1	8.74	ICCV 2 x ICC 506	13.21
Per cent pod damage	ICCV 2 x Gulak 1	-32.10	ICCV 2 x Gulak 1	-26.91	JAKI 9218 x ICC 506	-48.80

MP=Mid parent; BP=Better parent; SC= Standard check and * Best check amongst two i.e. Digvijay genotypes JAKI 9218 and AKG 10-1 were the higher yielding parents. Thus while selecting potential crosses for its further use in breeding programmes, per se performance of parents and hybrids for various attributes must be taken in to consideration in addition to percentage of heterosis. Further, selection of crosses should not rest only on the per se performance of parents and heterosis for seed yield but the performance of parents and their hybrids for various traits related with pod borer resistance should also be considered.

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Seed Setting and Quality Affected by Different Modes of Pollination in Sunflower (*Helianthus annus* L.) Hybrid-Raviraj

G. J. Talele[1] , V. R. Shelar[2] and D. R. Nagawade[3]
Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 (India)
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Abstract

The role of honeybee in supplementary pollination in sunflower seed production and synchronization study of sunflower hybrid (KSH-437) and its parental lines were studied. The seed setting percentage (%) and seed quality parameters was found to be significantly higher in honey bee + hand pollination treatment (T_1) under caged conditions followed by natural + hand pollination treatment (T_2). Significantly, lowest seed setting percentage (%) and seed quality parameters was observed in net controlled pollination under caged without any pollinating agent (T_6). Maximum honey bees activity on male (6.68) and female (6.48) parental line was observed at 10:00 hr and the lowest honey bees activity observed on male (3.69) and female (3.49) parental line at 14:00 hr. Number of days for initiation of flowering, days to 50 per cent flowering and completion of flowering of both male and female line were observed for synchronization studies. The male parental line (R-437) was 2-3 days earlier in initiation of flowering, 50 per cent flowering and completion of flowering than that of female parental line (17A).

Key words : Supplementary pollination, synchronous flowering, sunflower, seed setting.

As sunflower is highly cross-pollinated crop, pollination and synchronization of flowering is most important in hybrid seed production. Staggered sowing of male and female parent is necessary to maintain synchronized flowering period. The knowledge regarding stigma receptivity of male sterile line (A) and pollen viability of B and R line is essential in hybrid seed production. This information is more useful when artificial hand pollination is need for highest seed setting percentage in hybrid seed production of sunflower. The present investigation was undertaken to study the role of honeybee in supplementary pollination in hybrid seed production of sunflower and synchronization flowering.

Materials and Methods

The research work was carried out at Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri during *rabi*, 2010. Seeds of hybrid Raviraj (KSH-437) and its parental lines *viz*., male sterile (17A) and restorer line (R-437) were obtained from Agricultural Research Station, Savalivihir, Tal. Rahata, Dist. Ahmednagar (MS). The experiment was conducted with four replications in a Randomized Block Design (RBD) with six treatments each for stigma receptivity, pollen viability and supplementary pollination as detailed below:

Treatment details

A) Role of honeybee in supplementary pollination : The parental lines of hybrid Raviraj (KSH-437) *viz*., male sterile line (A line: 17A) and restorer line (R line: R437) were raised by adopting the planting ratio of 2:1 (female: male) during *rabi* season 2010 in plot size of 4 x 5 m^2. There were six treatments *viz*., T_1: Honeybee + hand pollination (Under cage), T_2: Natural + hand pollination (without

1. M.Sc. (Agri.) student, 2. Seed Research Officer and 3. Ph.D. scholar.

cage), T_3: Natural control (Without cage, open to all insect vectors), T_4: Honey bee pollination (Under cage), T_5: Only hand pollination (Under cage) and T_6: Net control pollination (Under cage without any pollinating agent). [Honey bee species *Apis indica* (4-frame colony)]

Sowing : The seeds of male sterile line (17A) and restorer line (R-437) were dibbled at 30 cm plant to plant and 60 cm row-to-row distance. Two to three seeds per hill were dibbled. For stigma receptivity and pollen viability studies, the male sterile line and restorer line were sown in separate plot.

Fertilizer and irrigation : Fertilizer dose at the rate of 60 kg N, 30 kg P and 30 kg K per hectare was applied half, of the dose of nitrogen and full dose of P and K applied at the time of sowing. The remaining half dose of nitrogen was given at thirty days after sowing. One irrigation was given immediately after sowing and subsequent irrigations were given as and when required.

After care : The thinning was done at fifteen days after sowing to maintain desired plant population per plot. The weeding and inter culturing was done and experimental plot was kept clean throughout the experimental period to maintain good stand of crop.

The cage of fine white nylon mosquito net was used in treatments T_1, T_4, T_5 and T_6 just before initiation of flowering. For T_1 and T_4 treatments, colonies of Apis indica with four brood frames were kept inside the net until the end of flowering. In T_2 and T_3 treatments, natural pollinating insects had free access to the flowers of sunflower. In T_5 treatment, only hand pollination was carried out under cage avoiding insect pollination. In T_6, treatment was kept under caged condition without any pollinating agent.

Observations recorded

A) Role of honeybee in supplementary pollination studies

Honeybee's activity : Foraging activity of honeybees recorded by selecting five plants in male and female line. The flower heads were observed for 5 minutes each at subsequent hours. Seed yield plant^{-1} (g), seed yield plot^{-1} (kg), seed yield (kg ha^{-1}), 100 seed weight (g), germination (%) (Anonymous, 1985) and vigour index (Abdul Baki and Anderson, 1972) were recorded. Seed setting (%) was calculated by formula as below,

$$\text{Seed setting (\%)} = \frac{\text{Number of filled seed}}{\text{Total number of seed}} \times 100$$

Unfilled area: It was recorded at maturity. The diameter of whole head and unfilled area of flower of all five selected heads were measured and the average was worked out.

B) Synchronization studies : Number of days to initiation of flowering, number of days to 50 per cent flowering and number of days to completion of flowering for both male and female parents were recorded. The field data obtained from all parameters was analyzed by Randomized Block Design (RBD) and laboratory data was analyzed by Completely Randomized Design (CRD) method as described by Panse and Sukhatme (1989).

Results and Discussion

Role of honeybee in supplementary pollination studies

Honeybee activity : There was significant difference in frequency of honeybee visits at different hrs. of day (Table 1 and 2) on male parent (R-437) and female parent (17 A) of sunflower hybrid Raviraj (KSH-437). Maximum honey bee visits were observed at 10.00 hr on male and female parent (6.68 and 6.48, respectively) and lowest honey bee visits were observed at 14.00 hr on male and female parent (3.69 and 3.49, respectively). Honeybee visits were observed to be more on male parent (R-437) than female parent (17 A) during all hours of the day. This might be due to pollen parent (male) was visited by both pollen and nectar collecting bees while the seed parent (female) which is devoid of pollen is visited only by nectar collecting bees. Honeybee visits were more in the morning, might be due to more pollens and nectar production in morning. These results are in

Table 1. Frequency of honeybee visits at different hrs. of day on male parent (R-437) and female parent (17-A) of sunflower hybrid Raviraj (KSH-437)

Pollination treatments	Frequency at different hrs of the day (Male parent)				Frequency at different hrs of the day (Female parent)			
	8.00 hrs.	10.00 hrs.	12.00 hrs.	14.00 hrs.	8.00 hrs.	10.00 hrs.	12.00 hrs.	14.00 hrs.
Honeybee + Hand (T_1)	4.32	7.00	5.00	4.00	4.00	6.80	4.80	3.80
Natural + Hand (T_2)	4.12	6.72	4.68	3.72	3.72	6.52	4.48	3.52
Natural control (T_3)	3.80	6.48	4.48	3.48	3.52	6.28	4.28	3.28
Honey bee (T_4)	3.88	6.52	4.56	3.56	3.52	6.32	4.28	3.36
Mean	4.03	6.68	4.68	3.69	3.69	6.48	4.46	3.49
S.E. ±	0.130	0.138	0.150	0.143	0.141	0.188	0.140	0.154
CD at 5 %	0.284	0.301	0.327	0.313	0.311	0.301	0.307	0.309

Table 2. Role of honeybee pollination and hand pollination on seed yield and quality parameter of sunflower hybrid - Raviraj

Pollination treatments	Seed setting (%)	100 seed weight (g)	Seed yield plant^{-1} (g)	Seed yield plot^{-1} (kg)	Seed yield ha^{-1} (kg ha^{-1})	Whole dia-meter (cm)	Empty dia-meter (cm)	Germi-nation per-centage (%)	Vigour index
Honey bee + hand (T_1)	84.60 (66.86)	6.27	49.15	2.93	1462.87	18.430	1.705	91.00 (72.57)	2692.65
Natural + hand (T_2)	83.82 (66.28)	5.98	42.23	2.54	1271.37	16.270	1.945	90.50 (72.11)	2334.88
Natural control (T_3)	77.85 (61.94)	5.76	39.53	2.36	1180.50	15.690	2.030	87.50 (69.36)	2224.63
Honey bee (T_4)	71.27 (57.59)	4.90	37.03	2.22	1101.50	13.975	2.475	84.00 (66.44)	2093.95
Only Hand (T_5)	59.26 (50.34)	4.12	31.20	1.71	858.00	12.990	2.823	76.50 (61.02)	1739.50
Net control (T_6)	36.44 (37.13)	3.24	14.82	0.87	437.00	10.465	2.88	64.00 (53.14)	1216.85
S.E. ±	0.435	0.029	0.385	0.036	14.153	0.316	0.104	1.086	41.412
CD at 5 %	1.312	0.088	1.159	0.109	42.64	0.952	0.313	3.226	122.98

Figures in parentheses are arcsine values.

conformity with results reported by Satyanarayana and Seetharam (1982), Choulwar *et al*. (1988), Singh *et al*. (2000), and Yadav *et al*. (2007).

Seed yield plant^{-1} (g), yield plot^{-1} (kg) and yield ha^{-1} (kg ha^{-1}) : Honey bee + hand pollination treatment (T_1) under caged condition was observed to be statistically superior over rest of the treatments for seed yield plant^{-1} (g), seed yield plot^{-1} (kg) and seed yield ha^{-1} (kg ha^{-1}) (Table 3). Significantly higher seed yield plant^{-1} (49.15 g), yield plot^{-1} (2.93 kg) and yield ha^{-1} (1462.87 kg ha^{-1}) was recorded in the honeybee + hand pollination treatment (T_1) under caged condition followed by natural + hand pollination treatment (T_2) without caged condition. The lowest seed yield plant^{-1} (14.82 g), yield plot^{-1} (0.87 kg) and yield ha^{-1} (437.00 kg ha^{-1}) was obtained from the controlled pollination (T_6) under caged condition without honeybees. Maximum seed yield plant^{-1}, plot^{-1} and ha^{-1} was obtained due to hand pollination supplemented with insect pollination treatments than that of other pollination treatment. These results are in conformity with results reported by Seetaram and Satyanarayan (1983), Choulwar *et al*. (1988), Panda *et al*. (1993), Patil *et al*. (1999), Kumar *et al.* (2001) and Kumar and Singh (2003) in sunflower.

Seed setting percentage : Significantly, higher seed setting percentage (84.60%) was recorded in the honeybee + hand pollination treatment (T_1) under caged condition, which was at par with that of T_2 i.e. natural + hand pollination treatment (83.82%). The lowest seed setting percentage (36.44%) were obtained from T_6 treatment i.e. controlled plot without insect pollination under caged condition. Maximum seed setting percentage obtained due to hand pollination supplemented with insect pollination treatment than that of other pollination treatments. Seetaram and Satyanarayana (1983), Kumar *et al*. (2001) and Kumar and Singh (2003) reported similar results in sunflower.

100 seed weight, germination percentage and vigour index : Honeybee + hand pollination treatment (T_1) under caged condition was observed to be statistically superior over all the treatments for 100 seed weight, germination percentage and vigour index. Significantly higher 100 seed weight (6.27 g), higher germination percentage (91.00%) and vigour index (2692.65) was

Table 3. Mean number of days to initiation of flowering, 50 per cent flowering and completion of flowering for male parental line (R-437) and female parental line (17 A)

Treatments	Mean number of days of R-437 for (Male)			Mean number of days of 17A for (Female)		
	Flower initiation	50% flowering	Completion of flower	Flower initiation	50% flowering	Completion of flower
Honey bee + hand (T_1)	62.75	66.75	72.50	66.75	69.75	75.00
Natural + hand (T_2)	61.75	66.75	72.75	65.95	68.75	75.00
Natural control (T_3)	64.50	67.75	73.50	66.50	70.00	75.00
Honey bee (T_4)	62.75	66.25	71.50	66.25	69.00	74.75
Only hand (T_5)	63.25	66.50	72.25	66.50	70.25	75.50
Net control (T_6)	64.75	68.00	73.00	68.00	71.25	75.25
Mean	63.29	67.00	72.58	66.62	69.83	75.08
S.E. ±	0.297	0.357	0.415	0.320	0.247	0.307
CD at 5 %	0.895	1.077	N. S.	0.963	0.745	N. S.

obtained in the honeybee + hand pollination treatment (T_1) under caged condition followed by treatment T_2. The lowest 100 seed weight plant^{-1} (3.24 g), germination percentage (64.00 per cent) and vigour index (1216.85) was obtained from controlled pollination without insect pollination under caged condition. It is revealed that, maximum 100 seed weight due to hand pollination supplemented with insect pollination treatment than that other pollination modes. Similar results were reported by Kumar *et al*. (2001) and Kumar and Singh (2003) in case of 1000 seed weight (g) in sunflower.

Head diameter : The data on head diameter (cm) are presented in Table 3, indicates that whole diameter (cm) and empty diameter differed significantly in all treatments. Significantly, higher whole diameter of mature flower (18.43 cm) was recorded in the honeybee + hand pollination (T_1) under caged condition. The lowest whole diameter of mature flower was observed from T_6 treatment (10.47 cm) whereas empty diameter of mature flower (2.88 cm) was significantly higher in T_6 treatment i.e. controlled pollination without any pollinating agent under caged condition. Less empty diameter of mature flower was observed from T_1 i.e. honey bee + hand pollination treatment (1.71 cm) under caged condition. Hence maximum head diameter with less empty diameter was obtained when hand pollination supplemented with insect pollination mode than that of other pollination mode. It is cleared that there is positive correlation between seed yield, seed setting percentage, number of filled seed capitulum^{-1}, 100 seed weight and head diameter. Similar results are reported by Burns (1970) and Bhattacharya *et al*. (1975) observed head diameter, test weight of 100 seeds, and number of filled seeds capitulum^{-1} were positively correlated.

Synchronization studies : Mean number of days required for initiation of flowering in male (R-437) and female (17 A) parental line were 63.29 and 66.62, respectively. For 50 per cent flowering in male (R-437) and female (17 A) parental line number of days required were 67.00 and 69.83 respectively. Smilarly number of days required for completion of flowering in male (R-437) and female (17 A) parental line were 72.58 and 75.08, respectively.

From above results it is revealed that, male parental line (R-437) was 2-3 day earlier in flowering initiation, 50 per cent flowering and completion of flowering than that of female parental line (17 A). Hence, to overcome this problem, staggered sowing is one of the cheapest methods of synchronization of flowering. The staggered sowing of female parent 2-3 days early led the synchronization of flowering between these two parents. These results are in conformity with results of Kempegowda and Kalappa (1992) in KBSH-1 sunflower hybrid, Patil *et al*. (1999) in LSH-3 sunflower hybrid. Kunjamin and Meenakshi (1979), Krishnaswamy and Ramaswamy (1987) and Shelar and Patil (1993) reported similar results in sorghum hybrid.

Based on the present studies, it is concluded that maximum seed setting percentage, seed yield and good seed quality was obtained when hand pollination supplemented with insect pollination treatment than other pollination treatment. The frequency of honeybee visits at different hours of the day differs significantly and male parental line (R-437) was 2-3 days earlier in initiation of flowering, 50 percent flowering and completion of flowering than that of female parental line (17A). Hence, to overcome this problem male parental line (R-437) to be planted late by 2-3 days than female parental line (17A) in case of hybrid sunflower-Raviraj.

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Genetic Divergence Studies in Groundnut (*Arachis hypogaea* L.)

B. D. Waghmode[1], V. V. Sagvekar[2], S. G. Tambat[3], V. C. Navhale[4] and N. G. Sonone[5]
Dr. B. S. Konkan Krishi Vidyapeeth, Agricultural Research Station, Shirgaon - 415 629 (India)
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Abstract

Twenty nine groundnut genotypes were evaluated to assess the genetic diversity. The D^2 values ranged between 1.4 to 5.9 suggesting the presence of considerable amount of genetic diversity. All the twenty nine genotypes were grouped into 9 clusters in which cluster I had maximum genotypes (11) followed by cluster VII (4). The maximum intra cluster distance was exhibited by cluster IX (34.8) followed by cluster VII (26.4) and VIII (11.6) where as maximum inter cluster distance was recorded between cluster VII and IX (7.2), followed by cluster VI and VII (6.8), cluster IV and VI (6.0), indicating wide divergence between these clusters. Variance of cluster means revealed that dry pod yield plant^{-1}, number of kernels pod^{-1}, shelling percentage, 100 seed weight and number of pods plant^{-1} were the main characteristics contributing to divergence. On the basis of intra and inter cluster distance, cluster mean and *per se* performance of genotypes *viz*., RCM 555, DGR 48-115, DGR 59-470, RCM 705, RG 93, VALLENCIA EXISR, DGR 61-10, RCM 550, TKG 19A, RATE RAKHUDA, GUANG DONG 378, SPA 408 RED and RG 93 can be used for future breeding programme.

Key words : Divergence, D^2 statistics, groundnut.

The Konkan region of Maharashtra is one of the high potential areas for groundnut production. It was cultivated on 4850 ha area with 8600 tonnes production and 2150 kg ha^{-1} productivity during *rabi* 2011-12 (Anonymous, 2013b).

Success of plant breeding programme depends on the choice of appropriate parents. It is expected that the utilization of divergent parent in hybridization result in promising recombinants. Hence, the present investigation was undertaken to study the genetic divergence in groundnut germplasm to identify potential genotypes for yield contributing characters which could be utilized in further improvement programme.

1. Officer Incharge, 2. Jr. Agronomist, 3. Agril. Assistant, 4. Jr. Breeder and 5. Ex. Jr. Breeder.

Materials and Methods

The experimental material comparised of 29 genotypes of groundnut obtained from Directorate of Groundnut Research, Junagadh. The experimental materials were evaluated during four succeeding seasons from *rabi* 2009-10 to 2012-13 at Agricultural Research Station, Shirgaon Dist: Ratnagiri (MS). The genotypes were grown in two rows of 2 m length with 30 x 10 cm spacing during each season.

All the recommended cultural practices were adopted. The observations were recorded on five randomly selected plants in each genotype for 10 quantitative traits *viz*., days to 50% flowering, number of primary branches plant^{-1}, plant height (cm), number of pods plant^{-1}, number of kernels pod^{-1}, dry pod yield plant^{-1} (g), haulm yield plant^{-1} (g), 100 seed weight (g), shelling percentage and days to maturity. The analysis of genetic diversity was carried out by using Mahalanobis's (1936) D^2 statistics. The grouping of genotypes was done as per Tocher's method.

Results and Discussion

The analysis of variance exhibited significant differences among 29 genotypes of groundnut for all the ten characters. The 29 genotypes were grouped into 9 clusters (Table 1). The cluster I had maximum genotypes (11) followed by cluster VII (4). The maximum intra cluster distance was exhibited by cluster IX (34.8) followed by cluster VII (26.4) and VIII (11.6). The maximum inter cluster distance was recorded between cluster VII and IX (7.2), followed by cluster VI and VII (6.8), cluster IV and VII (6.0), indicating wide divergence between these clusters.

The cluster I was the largest, involving eleven genotypes followed by cluster-VII with four genotypes. The remaining clusters included only two genotypes each. Based on divergence existed among groundnut population Katule *et al*. (1992) grouped groundnut genotypes in 8 cluster. Golakiya and Makne (1991) grouped 24 groundnut genotypes in 6 clusters, Vankatramana *et al*.

Table 1. Composition of D^2 clusters on pooled basis

Cluster no.	No. of genotype included	Genotype
I	11	EC 24118, CPI 10507, VIRGINIA IMPROVED, AH 7434, AH 7575, AHMEDABAD LOCAL, G 302, AH 7725, ROXO, SMALL SPANISH, No.2
II	2	ACC#913, AH 24439
III	2	RCM 555, DGR 48-115 A
IV	2	DGR 59-470, RCM 705
V	2	DGR 61-10, RCM 550
VI	2	RCM 582, GG 7
VII	4	TKG 19A, RATE RAKHUDA, GUANG DONG 378, SPA 408 RED
VIII	2	SCHWARZ 21, DGR 57-103
IX	2	RG 93, VALLENCIA EXISR

Table 2. Intra and Inter cluster distance D^2 (above the diagonal) and D value (below the diagonal) on pooled basis

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	Intra cluster
I		6.7	10.6	11.2	8.6	28.3	28.2	14.2	28.8	6.8
II	2.6		8.3	6.4	4.6	26.0	23.8	8.4	22.8	2.0
III	3.3	2.9		18.7	6.3	22.0	25.9	10.9	26.3	3.2
IV	3.4	2.5	4.3		10.8	25.8	35.6	17.7	20.4	3.9
V	2.9	2.1	2.5	3.3		26.3	24.7	9.8	26.3	4.8
VI	5.3	5.1	4.7	5.1	5.1		45.6	28.2	15.5	5.4
VII	5.3	4.9	5.1	6.0	5.0	6.8		19.3	51.4	26.4
VIII	3.8	2.9	3.3	4.2	3.1	5.3	4.4		32.0	11.6
IX	5.4	4.8	5.1	4.5	5.1	3.9	7.2	5.7		34.8
Intra cluster	2.6	1.4	1.8	2.0	2.2	2.3	5.1	3.4	5.9	

Table 3. Intra cluster means for different characters and contribution of character towards genetic divergence of groundnut on pooled environment basis

Character	Cluster means									Contri-bution (%)
	I	II	III	IV	V	VI	VII	VIII	IX	
Days to 50% flowering	34.9	37.0	36.6	35.6	37.1	35.9	37.4	36.3	36.6	1.2
Primary branches plant^{-1}	3.4	3.7	3.7	3.2	3.6	3.8	4.5	4.2	3.8	0.7
Plant height (cm)	36.5	36.8	37.8	40.7	39.1	41.3	42.0	36.7	42.4	0.3
Number of pods plant^{-1}	7.7	8.7	9.0	7.0	7.6	8.7	8.2	8.1	9.7	1.2
Number of kernels pod^{-1}	2.0	2.2	1.8	2.3	2.0	2.1	2.0	2.1	2.3	5.9
Dry pod yield plant^{-1} (g)	9.3	10.7	13.5	8.8	12.8	10.7	11.3	12.8	10.2	3.9
Haulm yield plant^{-1} (g)	8.6	8.6	8.6	8.6	9.6	8.9	9.2	9.7	7.5	5.9
100- kernel weight (g)	48.0	47.3	46.5	46.0	47.3	45.3	55.3	50.1	43.8	16.5
Shelling %	71.0	71.5	67.8	69.3	72.2	50.6	67.9	67.7	57.9	22.7
Days to maturity	103	105	105	105	102	103	105	105	105	41.6

(2001) grouped 144 genotypes in 6 clusters, Awatade (2007) grouped 40 genotypes in 7 cluster and Nikam and Thaware (2010), grouped 39 genotypes in 9 clusters in their groundnut crop studies.

In the present investigation the D^2 values (Table 2) between all possible pairs of 29 genotypes ranged between 1.4 to 5.9 suggesting the presence of considerable amount of genetic diversity. Among the clusters maximum intra cluster distance was recorded within cluster IX (5.9) followed by cluster VII (5.1) and cluster VIII (3.4). The maximum inter cluster distance was observed between cluster VII and IX (7.2), followed by cluster VI and VII (6.8), cluster IV and VII (6.0), indicating wide divergence between these clusters. The criteria used for hybridization using D^2 analysis is the inter cluster distance. Those genotypes included in cluster with maximum inter cluster distance are obviously genetically more divergent. Hence, it would be logical to choose genotypes from these clusters in the future breeding programme. Mahalaxmi *et al*. (2005) observed maximum inter cluster divergence between cluster IV and VII. Mximum inter cluster D^2 valued observed between cluster II and IV in both the environment by Vankatramana *et al*. (2001). Nikam and Thaware (2010) reported maximum inter cluster distance between clusters VI and VII (23.70) in their 39 groundnut genotype studies.

The cluster means for different characters (Table 3) showed that cluster-III exhibiting highest mean value for the character dry pod yield plant^{-1} (13.5 g). The genotypes, RCM 555 and DGR-48-115 were the members of this cluster. The cluster I had less number of days to 50 per cent flowering (34.9), and plant height (36.5 cm). While, cluster V had maximum shelling per cent (72.2) and least days to maturity (102) and cluster VII exhibited

Table 4. Genotypes identified for specific characters

Genotypes identified	Specific character
RCM 555, DGR 48-115	Dry pod yield plant^{-1}
DGR 59-470, RCM 705, RG 93, VALLENCIA EXISR	Number of kernels pod^{-1}
DGR 61-10, RCM 550	Shelling percentage
TKG 19A, RATE RAKHUDA, GUANG DONG 378, SPA 408 RED	100 seed weight
RG 93, VALLENCIA EXISR	Number of pods plant^{-1}

maximum number of primary branches (4.5) and 100 kernel weight (55.3 g). The four genotypes *viz*., TKG 19A, RATE RAKHUDA, GUANG DONG 378 and SPA 408 RED are the member of this cluster. The cluster IX recorded maximum number of pods plant^{-1} (9.7) and number of kernels pod^{-1} (2.3). The cluster VIII exhibited maximum haulm yield plant^{-1} (9.7g).

Golakia and Makne (1992) observed highest mean for the character kernels yield plant^{-1}, biomass yield plant^{-1} and recovery percentage in cluster III. They reported that genotype for important characters like pod yield, 100-kernal weight and recovery percentage recording maximum mean performance were grouped into cluster II, III and IV. Nikam and Thaware (2010) recorded that cluster II exhibited highest mean value for the character oil percentage and cluster III had maximum number of pods plant^{-1}.

Maximum contribution towards the genetic divergence was by days to maturity (41.6) followed by shelling (%) (22.7), 100 kernel weight (g) (16.5) and haulm yield plant^{-1} (5.9). Nikam and Thaware (2010) observed maximum genetic divergence for days to maturity (113.49) followed by shelling per cent (80.07) and oil percentage (45.33)

Based on cluster mean and genetic diversity studies genotypes *viz*., RCM 555, DGR 48-115 for dry pod yield plant^{-1}, DGR 59-470, RCM 705, RG 93, VALLENCIA EXISR for number of kernels pod^{-1}, DGR 61-10, RCM 550 for shelling percentage, for 100 seed weight TKG 19A, RATE RAKHUDA, GUANG DONG 378 and SPA 408 RED and for number of pods plant^{-1}, RG 93, VALLENCIA EXISR were consider as potential parents for breeding programme (Table 4).

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Analysis of Genetic Variability in Finger millet Mutant Lines Using ISSR Markers*

H. G. Gilande[1], N. B. Gokhale[2], S. V. Sawardekar[3] and D. M. Patil[4]
Plant Biotechnology Centre, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli - 415 712 (India)
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Abstract

In the present study M_3 generation of radiation induced mutants of finger millet cv. Dapoli-1 were screened using 16 ISSR markers. The analysis revealed the characteristic band differences among the 31 mutant lines and the control parent. A total of 1808 bands amplified of which 1776 were polymorphic that means all of the ISSR markers showed 100% polymorphism except UBC-827 (58.97%) while the average bands per primer were 113. The average per cent polymorphism across the all ISSR primer was 97.43% and the average amplification range of the product was 0.337 - 1.390 kb. The data of 31 mutants and 1 control (DPL-1) of finger millet were used to generate pair-wise matrix based on the Jaccard's co-efficient. The similarity co-efficient ranged from 0.096 in between mutant line 18 and 31 to maximum 0.629 in between mutant line 1 and 2; mutant line 17 and 18.

Key words : Finger millet, mutants, ISSR, genetic diversity, polymorphism.

Finger millet (*Eluesine coracana*) is the most important of the small millets grown for food. It is a staple food in many African and South Asian countries. It is also considered a helpful famine crop as it is easily stored for lean years (FAO, 2012). The grain is readily digestible, highly nutritious and versatile. It can be cooked like rice, ground to make porridge or flour or used to make cakes. Sprouted grains are recommended for infants and elderly people. Finger millet is also used to make liquor and beer, which yields by-products used for livestock feeding (FAO, 2012). Like other cereal grains, finger millet is an energy feed valuable for its high carbohydrate content. The grain of finger millet has a fine aroma when cooked or roasted and is known to have many health-promoting qualities. The crop provides food grain as well as straw which are valued animal feed, especially in the rainfed areas.

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1. M. Sc. (Agri.) student, 2. and 3. Associate Professor, 4. JRF.

The genetic improvement of crop depends on the amount of genetic variability present in the population. Genetic diversity is normally assessed by common morphological traits. However, such traits are affected by effects of environment, development stage of the plant and the type of plant material and also it require several replications to establish the genotypic contributions (Prabhu and Ganesan, 2013). Hence, there is a need to go in for a highly reliable and precise method for assessment of genetic variability with no environmental effects. Assessment of genetic diversity with molecular markers overcomes this problem. Molecular markers have also provided a powerful tool for breeders to search for new sources of variation and to investigate genetic factors controlling quantitatively inherited characters. Among the different molecular markers, the ISSR technique is a powerful, rapid, simple, reproducible and inexpensive way to assess genetic diversity or to identify closely related cultivars in many species, including fruit trees (Moreno *et al.*, 1998).

Assessment of genetic diversity using DNA markers is one of the key tools of crop improvement and germplasm conservation. Several reports are available assessing the genetic diversity in finger millet using DNA based molecular markers namely RAPD (Fakrudin *et al.*, 2004, Salimath *et al.*, 1995) and ISSR (Dellaporta *et al.*, 1983). Till now very little efforts have been made to assess the genetic diversity among finger millet genotypes from Indian sub-continent at molecular level. There is little information on the extent of genetic diversity at molecular level among finger millet accessions adapted to various states of peninsular region of India. The present study was conducted with the objective to assess the extent of variation at molecular level among thirty one finger millet mutant lines with its control parent (Dapoli-1) by using ISSR markers.

Materials and Methods

Plant Material : Finger millet mutants obtained by gamma rays irradiation of seeds of cv. Dapoli-1 were used in this study. Seeds of Dapoli-1 of finger millet were exposed to 400 Gy, 500 Gy, 600 Gy and 700 Gy of physical mutagen; gamma rays. Dry seeds having storable moisture content i.e. 12 per cent were irradiated with gamma rays. The source used was ^{60}Co gamma cell installed at the Biology and Agricultural Division of the Bhabha Atomic Research Centre (BARC), Trombay, Mumbai. Desirable mutants from M_2 generation were selected on the basis of morphological features and harvested separately. Seeds harvested from individual M_2 plants were grown as M_3 generation at the Plant Biotechnology Centre, Dr. B. S. Konkan Krishi Vidyapeeth, Dapoli. The details of mutant lines used in the present study are given in Table 1.

DNA isolation : The genomic DNA used for analysis was isolated from green leaves of 31 field grown mutants and one control parent (Dapoli-1) by following the protocol of Doyle and Doyle (1990) i.e. rapid method with some modifications in buffer composition and chemical concentration. The extracted DNA was purified for RNA contamination by RNAase treatment. The extracted and purified DNA were then quantified and quality assessed by agarose gel-electrophoresis. Based on intensity of bands produced the DNA were diluted to appropriate concentration for use of molecular analysis (Data is not shown).

DNA amplification and gel electrophoresis : A set of 16 primers (Table-2) composed wholly of defined, short tandem repeat sequences with anchor and representing different microsatellites (di and tri-repeats) have been used as generic primers in PCR amplification of inter simple sequence repeat (ISSR) regions as according to the method of Adawy *et al.*, (2002). Amplification was achieved in eppendorf thermal cycler using 20 µl reaction mixture containing 3U of Taq DNA polymerase (Banglore Genei Ltd.), 2.5 µl of 10x Taq assay buffer Type I with 2.5 mM of MgCl2, 1µl of 10 mM mix of dNTPs, 0.5 µl of 25 mM MgCl2, 1µl of 5 pmoles concentration of oligonucleotide primer and approximately 50 ng of 1µl of template DNA. The PCR thermal cycler was programmed for initially 5-minute denaturation step at 94°C, followed by 30 cycles of denaturation at 94°C for 20-sec,

Table 1. Finger millet mutant lines used in the present study

Mutants line	Mutants line	Mutants line	Mutants line
DML-1	DML-9	DML-17	DML-25
DML-2	DML-10	DML-18	DML-26
DML-3	DML-11	DML-19	DML-27
DML-4	DML-12	DML-20	DML-28
DML-5	DML-13	DML-21	DML-29
DML-6	DML-14	DML-22	DML-30
DML-7	DML-15	DML-23	DML-31
DML-8	DML-16	DML-24	DPL-1 (Control)

annealing 58°C for 60-sec and extension at 72°C for 60 sec and finally 72°C for 7 min. The PCR product were mixed with 2µl of gel loading dye and electrophoresed alongside a molecular weight marker (1.3 kb) on 2 per cent agarose gel in 1 X TAE buffer at 100 volts. The gels were photographed under UV light using Pentax K 312 nm camera. The images of gels were also taken by the documentation systems (Uvi-Tech. Fire reader, Cambridge, England) and saved in computer for further analysis.

Data analysis : ISSR markers across the 31 mutant lines and one control parent (Dapoli-1) were scored for their presence (1) or absence (0) of bands for each primer. The binary data so generated was used to estimate the levels of polymorphism by dividing the number of polymorphic bands by the total number of scored bands. Jaccard's similarity co-efficients for each pairwise comparison between mutants were calculated and similarity co-efficient matrix was generated. This matrix was subjected to Unweighted Pair Group Method for Arithmetic Average analysis (UPGMA) to construct a dendrogram. The similarity co-efficient analysis and dendrogram construction were carried out by using MVSP-A Multivariate Statistical Package-5785 (Version 3.1).

Results and Discussion

ISSR analysis : Marker analysis helps to understand the genetic makeup of the accessions and also make it possible to analyze genetic diversity within species as well as between different species. The ISSR pattern of genomic DNA of 31 mutants and one control parent (Dapoli-1) were analyzed with respect to the fragments, informativeness of the markers and polymorphism for the assessment of genetic diversity present among the genotypes. For the present study 16 ISSR primers were used to asses genetic diversity and all of them were polymorphic. A total of 1808 scorable DNA fragments were produced of which1776

Table 2. ISSR primers and their sequences

Primer	Primer sequence (5' - 3')	Anne-aling temp. (°C)	GC cont-ent (%)
UBC-809	AGAGAGAGAGAGAGAGT	52.8	47.1
UBC-811	GAGAGAGAGAGAGAGAC	52.8	52.9
UBC-812	GAGAGAGAGAGAGAGAA	50.4	47.1
UBC-813	CTCTCTCTCTCTCTCTT	43.5	47.1
UBC-815	CTCTCTCTCTCTCTCTG	44.9	52.9
UBC-816	CACACACACACACACAT	51.1	47.1
UBC-820	GTGTGTGTGTGTGTGTC	50.3	52.9
UBC-825	ACACACACACACACACT	50.4	47.1
UBC-827	ACACACACACACACACG	54.9	52.9
UBC-828	TGTGTGTGTGTGTGTGA	53.2	47.1
UBC-834	AGAGAGAGAGAGAGAGT	45.4	47.1
UBC-836	AGAGAGAGAGAGAGAGC	52.6	52.9
UBC-841	GAGAGAGAGAGAGAGAC	54.8	52.9
UBC-844	CTCTCTCTCTCTCTCTC	46.5	52.9
UBC-847	CACACACACACACACAT	54.8	47.1
UBC-848	CACACACACACACACAT	54.8	47.1

Table 3. Molecular analysis of 32 mutant lines of finger millet using 16 primers

Primer	Total no. bands	No. of poly-morphic bands	% poly-morp-hism	Ampli-fication range (bp)	PIC value
UBC-809	108	108	100	243-1058	0.82
UBC-811	163	163	100	194-1240	0.83
UBC-812	103	103	100	240-1697	0.80
UBC-813	93	93	100	304-1288	0.74
UBC-815	57	57	100	500-1236	0.60
UBC-816	153	153	100	288-1136	0.86
UBC-820	36	36	100	529-1385	0.33
UBC-825	173	173	100	149-1290	0.86
UBC-827	78	46	58.97	597-1459	0.60
UBC-828	74	74	100	427-1723	0.80
UBC-834	124	124	100	510-1157	0.77
UBC-836	132	132	100	220-1228	0.81
UBC-841	133	133	100	298-1720	0.87
UBC-844	89	89	100	564-1200	0.75
UBC-847	182	182	100	208-1150	0.89
UBC-848	110	110	100	174-2278	0.88
Total	1808	1776	-	-	-
Average	113	111	97.43	337-1390	0.76

DNA fragments were found to be polymorphic among the finger millet mutants and its control parent. The size of amplified fragments ranged from 0.337-1.390 (Table 3). The minimum number of polymorphic fragments produced by the primer was 36 (UBC-820) while the maximum number of polymorphic fragments were found to be 182 (UBC- 847) and 111 average number of polymorphic bands observed per primer. The average percentage polymorphism across the 16 primers among the mutants and control found to be 97.43 per cent. It indicates that ISSR markers showed high polymorphism among the finger millet mutants. The Polymorphism Information Content (PIC) value was calculated for the 16 ISSR primers (Table 3). In the present study the maximum PIC value produced by the primer UBC-847 (0.89) while the minimum PIC value was given by the primer UBC-820 (0.33). The average PIC value obtained for each primer was 0.76. The similar result was obtained by the Prabhu and Ganeshan (2013). The higher PIC value indicated the informativeness of the primers. Hence, the primers UBC-847, UBC-848, and UBC-841 can be of use in future studies in the field of taxonomical and genetic resource management. Kumari and Pande (2010) reported that the per cent polymorphism with RAPD markers ranged from 6.6-100 per cent in eleven finger millet genotypes.

Genetic relationship among mutant lines : The pair-wise Jaccards co-efficients for the genetic similarities among the 30 mutant lines and one control are presented in table 3. The similarity co-efficient ranged from 0.096 (between mutant lines 18 and 31) to 0.629 (between mutant line 1 and 2; mutant line 17 and 18), indicated the distinctness of these mutants. In the present study it was observed that, the mutant line 31 occupied a unique position and was most diverse from rest of 30 mutants and one control (Dapoli-1). Similar observations were also recorded by Gupta *et al.* (2010) which carried out the study on assessment of genetic relatedness among three varieties of finger millet with variable seed coat colour using RAPD and ISSR markers. The ISSR primers have a high potential to reveal polymorphism and to determine intra and inter

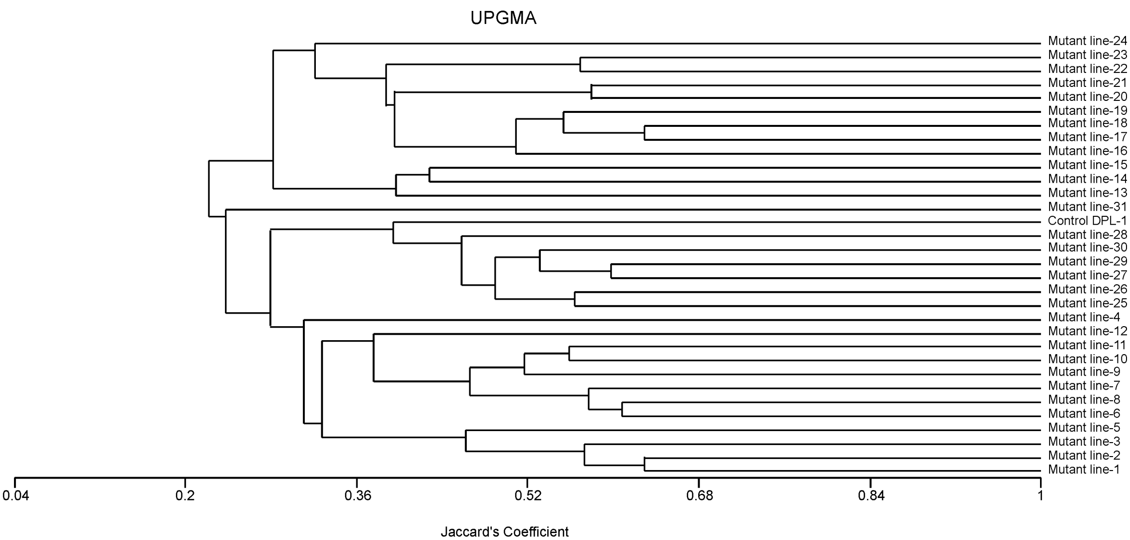

Fig. 1. UPGMA dendrogram showing clustering of 32 mutant lines of finger millet based on 16 ISSR primers.

Table 4. Genetic distances based on ISSR pooled over the 16 primers in 32 mutant lines of finger millet

	Mutant line-1	Mutant line-2	Mutant line-3	Mutant line-4	Mutant line-5	Mutant line-6	Mutant line-7	Mutant line-8	Mutant line-9	Mutant line-10	Mutant line-11	Mutant line-12	Mutant line-13	Mutant line-14	Mutant line-15	Mutant line-16
Mutant line-1	1.000															
Mutant line-2	0.629	1.000														
Mutant line-3	0.547	0.600	1.000													
Mutant line-4	0.281	0.308	0.315	1.000												
Mutant line-5	0.450	0.436	0.500	0.315	1.000											
Mutant line-6	0.337	0.322	0.424	0.347	0.532	1.000										
Mutant line-7	0.278	0.290	0.341	0.402	0.386	0.554	1.000									
Mutant line-8	0.386	0.372	0.446	0.380	0.429	0.608	0.600	1.000								
Mutant line-9	0.278	0.261	0.299	0.290	0.270	0.395	0.532	0.566	1.000							
Mutant line-10	0.283	0.281	0.303	0.255	0.289	0.414	0.512	0.452	0.533	1.000						
Mutant line-11	0.277	0.303	0.297	0.289	0.229	0.359	0.482	0.476	0.500	0.558	1.000					
Mutant line-12	0.325	0.325	0.284	0.233	0.333	0.306	0.366	0.410	0.373	0.395	0.403	1.000				
Mutant line-13	0.233	0.189	0.185	0.208	0.239	0.221	0.206	0.198	0.149	0.168	0.202	0.207	1.000			
Mutant line-14	0.183	0.165	0.149	0.223	0.227	0.223	0.196	0.239	0.163	0.170	0.179	0.140	0.392	1.000		
Mutant line-15	0.200	0.169	0.165	0.228	0.262	0.284	0.253	0.217	0.193	0.213	0.183	0.157	0.403	0.429	1.000	
Mutant line-16	0.181	0.176	0.185	0.247	0.267	0.318	0.345	0.264	0.241	0.291	0.228	0.165	0.268	0.338	0.485	1.000

Table 4. Contd.

	Mutant line-17	Mutant line-18	Mutant line-19	Mutant line-20	Mutant line-21	Mutant line-22	Mutant line-23	Mutant line-24	Mutant line-25	Mutant line-26	Mutant line-27	Mutant line-28	Mutant line-29	Mutant line-30	Mutant line-31	Control DPL-1
Mutant line-17	1.000															
Mutant line-18	0.629	1.000														
Mutant line-19	0.521	0.586	1.000													
Mutant line-20	0.442	0.461	0.521	1.000												
Mutant line-21	0.287	0.366	0.380	0.580	1.000											
Mutant line-22	0.386	0.438	0.400	0.400	0.361	1.000										
Mutant line-23	0.400	0.400	0.397	0.380	0.358	0.569	1.000									
Mutant line-24	0.291	0.276	0.286	0.385	0.380	0.302	0.416	1.000								
Mutant line-25	0.194	0.194	0.188	0.253	0.250	0.297	0.223	0.239	1.000							
Mutant line-26	0.202	0.240	0.208	0.261	0.300	0.290	0.245	0.234	0.564	1.000						
Mutant line-27	0.173	0.198	0.167	0.204	0.228	0.275	0.215	0.179	0.553	0.538	1.000					
Mutant line-28	0.172	0.172	0.165	0.165	0.176	0.183	0.189	0.191	0.436	0.390	0.549	1.000				
Mutant line-29	0.173	0.173	0.155	0.202	0.237	0.281	0.263	0.266	0.524	0.443	0.597	0.500	1.000			
Mutant line-30	0.163	0.175	0.168	0.216	0.202	0.232	0.240	0.255	0.459	0.416	0.470	0.415	0.593	1.000		
Mutant line-31	0.144	0.096	0.099	0.124	0.202	0.169	0.174	0.163	0.247	0.301	0.268	0.256	0.291	0.264	1.000	
Control DPL-1	0.133	0.159	0.151	0.179	0.205	0.120	0.136	0.179	0.419	0.372	0.373	0.426	0.392	0.380	0.300	1.000

genomic diversity reported by Ajitkhumar and Panneerselvam (2013).

Cluster analysis : In the present study, 31 mutants and one control parent (Dapoli-1) were subjected to cluster analysis for assessing the molecular diversity based on UPGMA analysis. The cluster analysis band on the similarity co-efficient clearly distinguished all the 31 mutants and one control to in two groups (Fig 1). The second cluster further subdivided into three sub-classes. The first sub-class of the second cluster consisted 3 mutants i.e. mutant line 13, 14 and 15 while the second sub-class consists of 19 mutant lines and finally third sub class had 7 mutant lines (Fig. 1). The mutant lines 6 and 8 were grouped together with maximum similarity co-efficient (0.629) followed by mutant line 1 and 2 with similarity co-efficient (0.629). These results are in line with Gupta *et al.* (2012) for finger millet accessions based on ISSR analysis. This study could be used to identify the diverse genotypes like DML-31 and their use in hybridization programme in finger millet. The genetic diversity observed in this study might be useful in future strategies for evolution of desired genotypes.

Conclusion : The study indicated that ISSR markers are suitable for the assessment of genetic variability among different mutant lines of finger millet. The ISSR analysis revealed substantial polymorphism in finger millet. The results of the present study indicated the efficiency of ISSR markers in investigating genetic variability at molecular level, which is important for detecting distinctness of mutants also for the identification of desirable mutants and its utilization for further breeding programme. Such information may be useful for selecting the diverse parents and monitoring the genetic diversity periodically for improvement of finger millet.

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Studies on Preparation of Functional Beverages from Karonda (*Carissa carandas* L)

V. S. Khandare[1], D. P. Waskar[2], B. M. Kalalbandi[3] and N. M. Navsare[4]
Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani- 431 402 (India)
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Abstract

The RTS beverage prepared with selected level of ingredients was preserved by various treatments at refrigerated (7±1 °C) and ambient temperatures. Based on sensory properties, a fresh RTS beverage containing juice 10 per cent, TSS 10° Brix and acidity 0.30 per cent was found to be the best giving highest score over other combinations studied. During the storage of RTS beverage, the total soluble solids, acidity, reducing sugars and total sugars increased while anthocyanin contents and antioxidant activity decreased. The beverage when stored at refrigerated temperature, exhibited better quality than that stored at room temperature.

Key words : Karonda, RTS beverage, storage, sensory properties.

Though there is a maximum availability of raw material of karonda fruits, it cannot be fully utilized, consumed or processed due to lack of processing techniques and technical knowhow. Therefore, attention has been focused on the preparation of different karonda beverages *viz*., RTS, Nectar etc. Considering the medicinal and nutritive importance of karonda fruit, karonda RTS can be prepared and preserved effectively by adopting appropriate juice extraction and storage methods using chemical preservatives (Khurdiya and Roy,1984). The problems encountered during processing are discoloration of juice and its products when they are stored for longer time at ambient temperature. Very little research work done and scanty information is available on processing of karonda. As the value and demand of karonda products and by-products is increasing, the research on preparation of consumer acceptable karonda products need to be explored. Hence, the present study was conducted with the objective to develop a technology for preparation of RTS beverage from karonda juice.

Material and Methods

The present research work on studies on preparation of functional beverages from karonda was undertaken at Department of Horticulture, Vasantrao Naik Marathawada Krishi Vidyapeeth, Parbhani, during the year 2011-12 so as to standardize the technology for making RTS beverage and to study the changes in beverage quality during storage. The juice was extracted and preliminary trials were conducted to standardize optimum level of ingredients for RTS beverage. The better levels of ingredient combinations were selected. The levels of TSS and acidity in the RTS beverage were standardized by conducting preliminary trials with 10 per cent juice, TSS (10%, 20% and 30%) and acidity (0.25%, 0.3% and 0.35%). The RTS obtained from better combination of juice: TSS: acidity levels were evaluated by organoleptic evaluation to select the best one. The standard RTS was prepared with 10 per cent juice, 20 per cent TSS and

1. Associate Professor, 2. Director of Research, 3. Assistant Professor and 4. M.Sc (Hort.) student.

0.3 per cent acidity. The karonda RTS beverage was prepared by diluting karonda juice with water in proportion of 1:2. The resultant RTS was heated at 90°C for 1 min. and packed in clean and sterilized bottles, upturned and sealed. The RTS beverage was preserved as per the treatment at room and refrigerated temperature (7°C). The treatment details are-T_1- Sodium benzoate (150 ppm) + Pasteurization, T_2 - Sodium benzoate (150 ppm) + Carbonation (150 ppm) at 80 psi, T_3- Sodium benzoate (150 ppm) + Carbonation at 100 psi, T_4- Sodium benzoate (150 ppm) + Carbonation at 120 psi, T_5 - Sodium benzoate (150 ppm) + Pasteurization + Carbonation at 80 psi, T_6- Sodium benzoate (150 ppm) + Pasteurization + Carbonation at 100 psi, T_7 - Sodium benzoate (150 ppm) + Pasteurization + Carbonation at 120 psi, T_8- Control with Sodium benzoate (150 ppm). The stored samples and Karonda RTS were analyzed for chemical and phytochemicals constituents and observations on the major physicochemical composition of Karonda RTS and stored samples were analysed for total soluble solids, pH, titrable acidity, iron and sugars and phytochemical composition *viz*., anthocyanin, total phenol, total flavonoid and antioxidant activity and evaluated for sensory qualities at180 days of storage. The data were analyzed statistically as suggested by Gomez and Gomez (1984).

Results and Discussion

Composition of functional beverage (RTS) : Based on preliminary trials revealed that the RTS beverage containing juice 10 per cent, TSS 20 per cent and titrable acidity 0.3 per cent was found best over all other combinations (Table 1). The karonda fresh RTS recorded total soluble solids 10 per cent in all treatments. The highest value of pH (4.35) was recorded in karonda RTS treated with Sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi followed by treatments T_5 (Sodium benzoate (150 ppm) + Pasteurization + Carbonation at 80 psi) and T_7 (Sodium benzoate (150 ppm) + Pasteurization + Carbonation at 120 psi). The highest titrable acidity (0.30%) was recorded in treatment T_6 followed by in treatments T_5, T_7 and T_3. The lowest titrable acidity was recorded in treatment T_8. The highest value of total sugars (12.27%) was recorded in karonda RTS treated with Sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi followed by

Table 1. Chemical and phytochemical composition of fresh karonda RTS

Treat-ments	TSS (%)	pH	Titrable acidity (%)	Reducing sugars (%)	Total sugars (%)	Iron (mg kg^{-1})	Antho-cyanin (mg L^{-1})	Phenol (mg GAE 100^{-1} ml)	Total flavonoid (mg CE 100^{-1} ml)	Antioxidant activity (µ mol Trolox g^{-1})	
										FRAP	CUPRAC
T_1	10.0	3.56	0.3	9.80	12.11	3.39	17.07	228.00	43.00	14.03	19.28
T_2	10.0	4.06	0.3	9.84	12.16	3.42	18.05	259.00	47.00	14.11	18.14
T_3	10.0	4.12	0.3	9.85	12.18	3.43	19.10	268.00	54.00	15.24	20.66
T_4	10.0	3.63	0.3	9.81	12.14	3.40	18.00	241.00	42.00	16.95	18.44
T_5	10.0	4.20	0.3	9.87	12.24	3.44	20.52	287.00	67.00	17.01	26.12
T_6	10.0	4.35	0.3	9.79	12.27	3.58	20.77	330.00	70.00	15.86	24.42
T_7	10.0	4.20	0.3	9.86	12.21	3.43	20.45	285.00	56.16	14.93	22.37
T_8	10.0	3.40	0.3	9.92	12.10	3.00	16.35	225.00	42.00	13.93	21.67
SE±	0.79	0.61	0.02	1.01	1.14	0.59	1.74	32.3	5.97	1.77	1.89
CD at 5%	2.40	1.85	0.07	3.08	3.45	1.80	5.29	97.83	18.08	5.37	5.64

treatments T_6 (12.24%), T5 (12.21%) and T_3 (12.18%). The lowest value of total sugars (12.10%) was recorded in control treatment T_8. The highest value (9.92%) of reducing sugars was recorded in control treatment followed by in treatments T_7 (9.86%) and T_3 (9.85). The lowest value (9.79 %) of reducing sugars was recorded in treatment T_6 (Sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi). The highest value (3.58%) of iron content was recorded in karonda RTS treated with Sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi fallowed by in treatments T_5 (3.44%), T_7 (3.43%), T_3 (3.43%), T_2 (3.42%) and T_4 (3.40%). The lowest value (3.00 mg kg^{-1}) of iron content was recorded in control treatment T_8. Similar results were reported for RTS beverage prepared from aonla : mango mixed pulp by Bhosale *et al.*, (2000).

The highest value (20.77 ml L^{-1}) of

Table 2. Effect of storage (180 days) on chemical and phytochemial composition of karonda RTS at room temperature

Treat-ments	TSS (%)	pH	Titrable acidity (%)	Total sugars (%)	Reducing sugars (%)	Iron (mg kg^{-1})	Antho-cyanin (mg L^{-1})	Phenol (mg GAE 100^{-1} ml)	Total flavonoid (mg CE 100^{-1} ml)	Antioxidant activity (µ mol Trolox g^{-1})	
										FRAP	CUPRAC
T_1	14.48	3.38	0.13	13.47	10.38	2.75	2.89	108.41	18.11	4.03	6.96
T_2	14.15	3.73	0.15	13.77	10.62	2.98	4.06	184.64	19.48	4.11	5.40
T_3	13.85	3.70	0.15	13.81	10.51	2.12	4.82	205.11	24.76	5.54	7.70
T_4	14.15	3.53	0.16	13.50	10.37	2.10	4.60	218.81	26.24	5.39	6.40
T_5	13.68	4.10	0.16	13.90	10.68	2.12	7.10	189.37	27.16	5.86	9.18
T_6	11.25	4.29	0.21	13.97	10.70	3.00	8.12	264.22	31.69	7.01	9.66
T_7	13.75	4.09	0.17	13.86	10.65	2.18	5.28	217.48	36.74	6.95	8.45
T_8	17.40	3.33	0.11	13.47	10.33	2.00	2.52	139.12	12.28	2.04	5.92
SE±	0.93	0.72	0.02	1.39	1.98	0.32	1.20	21.5	3.87	1.29	1.26
CD at 5%	2.83	2.21	0.06	4.17	3.89	0.99	3.66	62.87	11.61	3.87	3.87

Table 3. Effect of storage (180 days) on chemical and phytochemical composition of karonda RTS at refrigerated temperature (7°C)

Treat-ments	TSS (%)	pH	Titrable acidity (%)	Total sugars (%)	Reducing sugars (%)	Iron (mg kg^{-1})	Antho-cyanin (mg L^{-1})	Phenol (mg GAE 100^{-1} ml)	Total flavonoid (mg CE 100^{-1} ml)	Antioxidant activity (µ mol Trolox g^{-1})	
										FRAP	CUPRAC
T_1	14.38	3.40	0.17	13.48	10.36	2.77	4.54	110.41	19.11	4.18	6.97
T_2	14.00	3.75	0.21	13.78	10.62	3.00	7.06	187.64	20.48	4.89	5.42
T_3	13.83	3.81	0.20	13.82	10.63	2.14	7.64	210.11	25.76	7.59	7.72
T_4	14.15	3.55	0.23	13.51	10.37	2.12	6.48	218.81	29.24	5.41	6.42
T_5	13.67	4.12	0.21	13.91	10.68	2.14	9.16	190.37	29.16	5.89	9.19
T_6	11.20	4.30	0.24	13.65	10.70	3.02	9.84	266.22	36.69	7.03	9.68
T_7	13.74	4.10	0.23	13.87	10.65	2.20	8.30	219.48	34.74	6.97	8.46
T_8	17.38	3.34	0.16	13.48	10.34	2.02	3.54	140.12	12.38	3.94	5.96
SE±	0.89	0.68	0.03	1.32	1.91	0.32	1.18	22.02	3.13	0.97	0.97
CD at 5%	2.72	2.20	0.08	4.12	5.71	0.97	3.58	63.3	9.40	2.91	2.91

anthocyanin was recorded in Sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi in Karonda RTS fallowed by in treatments T_5 (20.52 mg L^{-1}) and T_7 (20.45 mg L^{-1}). The lowest value (16.35 mg L^{-1}) of anthocyanin was recorded in control treatment T_8. The highest value (330.00 mg GAE 100^{-1} ml) of total phenol was recorded in treatment with sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi in Karonda RTS followed by treatments T_5 (287.00 mg GAE 100^{-1} ml) and T_7 (285.00 mg GAE 100^{-1} ml). The lowest value (225.00 mg GAE 100^{-1} ml) of total phenol was recorded in control treatment T_8. The highest value (70.00 mg CE 100^{-1} ml) of Flavonoid was recorded in treatment with Sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi followed by in treatments T_5 (67.00 mg CE 100^{-1} ml). The lowest value (13.93 mol Trolox g^{-1}) of antioxidant activity by FRAP assay was recorded in control treatment T_8. The highest value (16.95 µmol Trolox g^{-1}) of flavonoid was recorded in treatment with Sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi followed by in treatments T_5 (16.95 µmol Trolox g^{-1}) and T_7 (15.86 µmol Trolox g^{-1}). The lowest value (42.00 mg CE 100^{-1} ml) of Flavonoid was recorded in control treatment T_8. The present results confirmed with the findings of Ponting *et al.*, (1952).

Storage of RTS beverage : Data presented in Table 2 and 3 revealed that total soluble solid increased from 10.12 per cent to 17.40 per cent. The highest TSS was recorded at refrigerated temperature as compared to room temperature. The total acidity decreased from 0.3-0.21 per cent. The highest titrable acidity was recorded at refrigerated temperature as compared to room temperature. The reducing sugars and total sugars in RTS increased from 9.78 to 9.89 per cent and 10.12 to 12.40 per cents, respectively. The higher reducing sugar was found at refrigerated temperature as compared to room temperature. The TSS and titrable acidity of RTS increased during storage. The

Table 4. Sensory quality of karonda RTS as influenced by storage conditions (180 days of storage)

Treatments	Sensory score														
	Colour			Flavour			Aroma			Texture			Overall acceptability		
	Initial	Storage (180 days)		Initial	Storage (180 days)		Initial	Storage (180 days)		Initial	Storage (180 days)		Initial	Storage (180 days)	
		Room temp.	7°C temp.		Room temp.	7°C temp.		Room temp.	7°C temp.		Room temp.	7°C temp.		Room temp.	7°C temp.
T_1	7.2	6.68	6.66	7.4	5.80	5.81	7.3	5.80	5.81	7.5	4.20	4.22	7.2	5.90	5.92
T_2	7.3	5.87	5.85	7.6	6.00	6.01	7.5	6.00	6.01	7.8	4.40	4.42	7.4	6.15	6.17
T_3	7.4	6.28	6.27	7.7	6.10	6.11	7.6	6.10	6.11	7.8	4.50	4.52	7.5	6.20	6.22
T_4	7.4	5.85	5.83	7.6	5.90	5.91	7.5	5.90	5.91	7.8	4.30	4.32	7.4	6.12	6.14
T_5	7.5	6.38	6.36	7.8	6.30	6.31	7.8	6.30	6.31	8.0	4.70	4.72	7.8	6.50	6.53
T_6	7.9	6.40	6.38	8.0	6.40	6.41	7.9	6.40	6.41	8.0	4.80	4.82	7.9	6.60	6.62
T_7	7.4	6.28	6.26	7.7	6.20	6.21	7.6	6.20	6.21	7.9	4.60	4.62	7.7	6.41	6.43
T_8	7.2	5.60	5.58	7.4	5.60	5.61	7.3	5.60	5.61	7.5	4.10	4.12	7.1	5.80	5.82
SE±	0.07	0.15	0.14	0.06	0.13	0.12	0.06	0.13	0.12	0.05	0.33	0.13	0.08	0.05	0.08
CD at 5 %	0.20	0.43	0.48	0.16	0.39	0.35	0.17	0.39	0.35	0.15	0.85	0.39	0.24	0.14	0.24

anthocyanin content decreased from 19.40 to 14.55 mg L^{-1}. The degradation of anthocyanin content was higher at room temperature than as compared to refrigerated storage. The RTS beverage preserved by sodium benzoate (150 ppm) + pasteurization + carbonation at 100 psi treatment remained in good condition upto sixth month storage at both the temperatures. Increase in TSS was due to partial hydrolysis of complex carbohydrates. A gradual increase in acidity of mixed fruit RTS beverage was observed during storage at different temperature by Kumar and Manimegalai, (2001). Ponting *et al.*, (1952) reported that anthocyanin pigments of fruit juices are destroyed at high storage temperature and the refrigerated temperature has stabilizing effect on anthocyanins. Similar results have been reported in phalsa beverages by Waskar and Khurdiya, (1987).

Sensory quality of fresh Karonda RTS and quality affected by storage conditions.

Data presented in Table 4 revealed that the sensory score of all parameters decreased continuously during storage. The overall acceptability score of karonda RTS decreased from 7.90 to 5.80. However, the maximum retention of colour, aroma and flavour was in treatment T_6. It is reported that flavour score decreased continuously in stored jamun juice by Garande (1992) due to fermentation. The refrigerated storage condition was more effective in maintaining colour and flavour of mixed juice beverages.

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Effect of Curing and Post Harvest Treatments on Shelf Life of Onion (*Allium cepa* L.) Cv. Agrifound Dark Red

V. S. Khandare[1], D. P. Waskar[2], B. M. Kalalbandi[3] and A. S. Khole[4]
Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402 (India)
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Abstract

An investigation was carried out on post-harvest studies in onion bulbs in which the bulbs were cured under 50 per cent shade (15 days) + tops removed 15 days after harvest resulted in minimum PLW (1.82%), sprouting (0.46%), rotting (2.72%) and maximum total sugars (7.76%) and dry matter (13.50%) contents and marketable bulbs (67.34). Among the different post-harvest treatments, dipping of bulbs in carbendazim (0.1%) for 2 min showed minimum PLW (11.44%), sprouting (0.64%), and maximum total sugars (6.10%) and dry matter content (10.17%) and marketable bulbs (76.69%) after 90 days of storage.

Key words: Onion, cured, post harvest treatment.

Significant losses in quality and quantity of onion occur during storage. The post-harvest losses, *viz*., sprouting, rotting and physiological loss in weight pose a great problem. Storage methods have their own impact on post-harvest life and keeping quality of onion. Normally, in Maharashtra, the bulbs are stored in thin gunny bags and kept in a room, which results quick spoilage. The storage losses of onion have been reported to reduce considerably by treatments with carbendazim, low temperature storage and controlled atmosphere storage (Proctor *et al*., 1981).These are not economically feasible methods for control of storage losses in the developing countries like India. Low cost farm level technology is, therefore, required to be developed to extend the shelf life of onion. Keeping in view the present investigation was undertaken.

Material and Methods

An investigation on effect of post harvest treatments and storage structures on shelf life of onion (*Allium cepa* L.) cv. Agrifound Dark Red was carried out during 2011-12 at Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidhyapeeth, Parbhani. Two sets of experiments were conducted in which the first experiment was laid out in Completely Randomized Block Design with seven treatments replicated thrice. Onion bulbs were divided into seven main lots each containing 10kg and subjected to various treatments. The treatment consisted of T_1-Curing under sun (3 days) + curing under 50% shade (12 days) + tops removed immediately after harvest, T_2-50% shade + tops removed 3 days after harvest, T_3-50% shade + tops removed 5 days after harvest, T_4-50% under shade + tops removed 10 days after harvest, T_5-50% shade + tops removed 15 days after harvest, T_6-100% shade + tops removed 7 days after harvest, T_7- At the end of curing period, a composite sample of five kilogram bulbs was packed in thin gunny bags and was used for second set of experiment on post harvest treatment storage studies under ambient conditions. The second experiment was laid out in completely randomized block design with six treatments and three replications. Treatments

1. Associate Professor 2.Director of Research 3. Assistant Professor 4. M.Sc. (Hort.) student.

consisted of T_1-Dipping bulbs in 0.1% carbendazim for 2 minutes, T_2-Dipping bulbs in 2% borax for 2 minutes, T_3-Dipping bulbs in 0.1% neem oil for 2 minute, T_4-Dipping bulbs in 10% trichoderma for 2 minutes, T_5-Dipping bulbs in 0.1% salicylic acid for 2 minutes, T_6-Control (untreated). Observations on physiological loss in weight (PLW %), sprouting percentage, rotting (%), moisture content (%), dry matter (%), TSS content, ascorbic acid, sugars, black mould (%), loss of scales (%), and marketable bulbs (%) were recorded at 15, 30, 45, 60 and 90 days after storage (DAS) for both experiment. The data generated were subjected statistical analysis as suggested by Panse and Sukhatme (1967).

Results and Discussion

Influence of curing methods on storability of onion : The influence of different curing methods, *viz.*, curing bulbs under sun (3 days) + curing under 50 per cent shade (12 days) + tops removed immediately after harvest, curing bulbs under 50 per cent shade (15 days) + tops removed three, five, seven, ten and fifteen days after harvest, curing bulbs under 100 per cent shade (15 days) + tops removed seven days after harvest and curing bulbs on tarpaulin under sun (3 days) + curing under 50 per cent shade (12 days) + tops removed seven days after harvest on storage quality and per cent marketable bulbs varied significantly for various parameters under study except TSS, total sugars and non reducing sugars which showed non significant difference.

Data presented in Table 1 reveled that among the different curing methods, curing bulbs under 50 per cent shade (15 days) + tops removed 15 days after harvest resulted in minimum PLW (1.82%), sprouting (0. 46%), rotting (2.72%), black mould (1.33.%), loss of scales (1.96%) and maximum TSS (13.34%), total sugars (7.76%) and dry matter (13.50%) contents. The least PLW may be attributed to the proper drainage of the outer scales and tight neck checking further escape of moisture and thus reduced the weight loss during

Table 1. Influence of curing methods on storability of onion bulbs during storage period of 90 days

Treat-ments	PLW (%)	Sprou-ting (%)	Rotting (%)	Black mould (%)	Market-able bulb (%)	Dry matter (%)	Moisture content (%)	TSS (%)	% loss of scales	Ascorbic acid (mg 100^{-1} g)	Reducing sugars (%)	Total sugars (%)
T_1	20.23	17.21	16.70	16.33	45.63	12.29	87.68	12.59	20.72	5.38	2.79	7.02
T_2	19.00	15.65	14.88	12.33	50.12	12.45	87.53	12.60	15.58	6.57	2.75	7.10
T_3	18.86	13.74	14.70	11.33	52.67	12.48	87.52	12.79	14.96	6.33	2.80	7.20
T_4	14.74	10.30	12.43	10.00	62.70	13.44	86.55	12.66	14.62	6.82	2.71	7.40
T_5	13.57	9.36	9.72	7.66	67.34	13.61	86.02	13.19	11.97	7.60	2.38	7.76
T_6	14.55	10.07	11.59	9.00	63.38	13.50	86.49	13.34	13.89	7.30	2.66	7.55
T_7	19.55	16.47	15.12	12.33	48.82	12.18	87.52	12.56	20.64	5.84	2.79	7.00
SE ±	0.43	0.17	0.01	1.35	0.01	0.11	0.01	0.34	0.01	0.14	0.01	0.43
CD at 5%	1.32	0.52	0.05	4.10	0.04	0.35	0.04	NS	0.03	0.42	0.03	NS

T_1 - Curing under sun (3 days) + curing under 50% shade (12 days) + tops removed immediately after harvest, T_2 -50% shade + tops removed 3 days after harvest, T_3 - 50% shade + tops removed 5 days after harvest, T_4 - 50% shade + tops removed 10 days after harvest, T_5 - 50% shade + tops removed 15 days after harvest, T_6 - 100% shade + tops removed 7 days after harvest and T_7 -Curing on tarpaulin under sun (3 days) + curing under 50% shade (12 days) + tops removed 7 days after harvest.

storage. Similar findings were reported by Sidhu and Chadha (1986) who observed that physiological loss in weight was lesser in cured bulbs during storage than the non-cured bulbs stored for 87 days. The maximum weight loss may be due to the absence of foliage resulting in full exposure of the bulbs to the radiant temperature leading to increased surface temperature of the bulbs helping to hasten the process of moisture reduction. The results are in conformity with the results obtained by Satish and Ranganna (2002). The least rotting and black mould percentage may be due to the fact that the neck of the bulb was completely dried and closed which helped in reducing the chances of entry of microorganism into the bulbs and lower order of pathological decay of microorganisms due to reduction in the moisture content of the onion bulbs. Similar findings were observed by Sidhu and Chadha (1986) in onion. The marketable bulbs (98.15) were also maximum in this treatment, which was closely followed by curing bulbs under 100 per cent shade (15 days) + tops removed seven days after harvest with respect to all the above parameters. The highest marketable bulbs may be attributed to minimum per cent PLW, per cent rotting and per cent sprouting. However, the lowest per cent marketable bulbs obtained in curing bulbs under sun (3 days) + curing under 50 per cent shade (12 days) + tops removed immediately after harvest, which is almost one and half times less than the best curing method. This could be reasoned due to highest weight loss, per cent rotting and per cent sprouting.

Effect of post-harvest treatments on keeping quality of onion : The influence of different post-harvest treatments, *viz*., carbendazim, borax, neem oil, trichoderma, and salicylic acid dipping on storage quality and percentage marketable bulbs were studied and the data is depicted in Table 2. All post harvest treatments applied differed significantly for various parameters except, dry matter content, moisture percent, TSS and total sugars which differed non significantly. Among the different post-harvest treatments, dipping bulbs in 0.1% carbendazim for two minutes resulted in

Table 2. Influence of post harvest treatment on storability of onion bulbs during storage period of 90 days

Treatments	PLW (%)	Sprouting (%)	Rotting (%)	Black mould (%)	Marketable bulb	Dry matter (%)	Moisture content (%)	TSS (%)	Ascorbic acid (mg 100^{-1} g)	Reducing sugars (%)	Total sugars (%)
T_1	11.63	4.41	7.46	7.66	76.69	12.34	86.74	13.19	7.54	2.50	8.32
T_2	12.83	5.52	12.04	12.66	69.52	13.10	86.89	12.80	7.06	2.63	7.84
T_3	12.80	5.15	9.41	9.33	72.61	13.05	86.93	12.49	7.07	2.60	7.72
T_4	12.77	4.97	11.37	11.06	70.85	13.16	86.82	12.66	7.37	2.55	8.00
T_5	13.73	6.04	12.11	13.66	68.09	12.00	87.33	12.50	5.58	2.55	7.60
T_6	14.32	7.08	14.42	14.33	64.14	12.66	86.66	12.50	5.35	2.54	7.50
SE ±	0.01	0.01	0.01	1.22	0.01	0.63	0.60	0.36	0.01	0.01	0.47
CD at 5%	0.04	0.04	0.05	3.76	0.03	NS	NS	NS	0.04	0.03	NS

T_1 - Curing under sun (3 days) + curing under 50% shade (12 days) + tops removed immediately after harvest, T_2 -50% shade + tops removed 3 days after harvest, T_3 - 50% shade + tops removed 5 days after harvest, T_4 - 50% shade + tops removed 10 days after harvest, T_5 - 50% shade + tops removed 15 days after harvest, T_6 - 100% shade + tops removed 7 days after harvest and T_7 -Curing on tarpaulin under sun (3 days) + curing under 50% shade (12 days) + tops removed 7 days after harvest.

minimum PLW (2.31%), sprouting (0.64%), and maximum ascorbic acid (11.45 mg 100^{-1} g bulb) , TSS (13.19%), total sugars (8.32%) and dry matter content (13.16%) of the bulbs at 90 days of storage, while the least rotting (14.42) and black mould (14.33%) were observed in carbendazim (0.1%). The highest percentage of marketable bulbs (76.69%) after 90 days of storage were obtained with dipping bulbs in carbendazim (0.1%) for two minutes. The findings of Noor *et al*. (1998) support the present results.

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Response of Egg Plant to Various N, P, K Levels and Plant Densities on Medium Black Soils of Western Maharashtra

K. G. Shinde[1], A. A. Bhuse[2], M. N. Bhalekar[3], B. T. Patil[4]

All India Coordinated Research Project on Vegetable Crops,

Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri – 413 722 (India)

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Abstract

The yield and growth parameters viz; plant height, spread, number of branches plant^{-1}, days to 50 per cent flowering, fruit length, fruit breadth, fruit girth, fruit weight, number of fruits plant^{-1}, per cent incidence of fruit borer, total yield and marketable yield were significantly affected with different spacing and NPK levels. The highest growth parameters were obtained with 90 x 120 cm followed by 90 x 90 cm with 250:125:125 NPK kg ha^{-1} along with 20 ton FYM hectare^{-1}. The yield contributing characters such as number of fruits plant^{-1}, weight of fruit and yield ha^{-1} were significantly highest with 90 x 120 cm followed by 90 x 90 cm along with 250:125:125 NPK kg ha^{-1} followed by 200:100:100 NPK kg ha^{-1} over rest of the treatments. The wider spacing had resulted in more vegetative growth and optimum dose of fertilizer resulted in good development of the fruit. The fertilizer dose of 250:125:125 NPK kg ha^{-1} with medium spacing of 90 x 90 cm was found satisfactory for obtaining highest yield in brinjal hybrid Phule Arjun in medium black soil having low nitrogen, medium phosphorus and high potassium in Western Maharashtra.

Key words : Spacing, NPK levels, Phule Arjun, brinjal, growth, yield.

Egg plant or Brinjal (*Solanum melongena* L.) is one of the most important, common and popular vegetable crop and it is cultivated in the tropical and subtropical regions. In India, it is

1. Vegetable Res. Officer, 2. M.Sc. (Agri.) student, 3. Sr. Veg. Breeder, 4. Jr. Veg. Breeder.

grown on 6.80 lakh hectare with production of 11.89 million tones with productivity of 17.5 tones per hectare. The major growing states in India are West Bengal, Bihar, Orissa, Andhra Pradesh, Maharashtra, Karnataka, Tamil Nadu, Madhya Pradesh, Chhattisgarh, Gujarat, Punjab, Haryana and Uttar Pradesh. It is hardy crop with a wider adaptability and was grown throughout the year. In Maharashtra, the area under brinjal cultivation is 35000 ha with the production of 4,90,000 metric tonnes with productivity of 14 tonnes per hectare (Anon, 2011b). In Maharashtra the brinjal growing districts are Kolhapur, Satara, Sangali, Pune, Ahmednagar, Nasik, Jalgaon, Nagpur, Chandrapur, Amravati and some regions of the remaining districts grows brinjal.

The average productivity of brinjal in Maharashtra is low as compared to production levels of other states as well as in India. Brinjal crop demands good nutrition and it responds well to fertilizers. Thus, there is wide scope to increase productivity by improving management practices such as fertilization and spacing. The optimum plant population hectare^{-1} is also an important for obtaining higher yields in brinjal. It can be achieved by adopting different spacing between the rows and plants. The balanced application of major nutrients such as nitrogen, phosphorus and potassium is also important for maximization of yields in brinjal. Brinjal produces fruits for longer time and needs balanced and sufficient supply of nutrients for higher yield and better quality. Therefore, it is necessary to investigate optimum dose of fertilizers and optimum spacing for higher yields. Recently the brinjal hybrid 'Phule Arjun' was released by M.P.K.V. Rahuri and is recommended for cultivation in Western Maharashtra (Anon. 2011 a). The agronomic practices such as spacing and fertilizer levels needs to be worked out for new hybrid Phule Arjun. In order to work out the optimum spacing and fertilizer levels of for new hybrid, the experiment was conducted by using three different spacing and four NPK levels during 2011-12.

Materials and Methods

The seed material of brinjal hybrid Phule Arjun was obtained from All India Coordinated Research Project on Vegetable Crops, Mahatma Phule Krishi Vidyapeeth, Rahuri. The experiment was laid out in Factorial Randomized Block Design with twelve treatment combinations having three different spacing's (90x75, 90x90 and 90x120 cm) and four levels of fertilizers i.e. NPK (100:50:50, 150:75:75, 200:100:100 and 250:125:125) along with 20 ton FYM hectare^{-1} common to all treatments and were replicated three times. Seedlings were transplanted as per treatment and five plants were randomly selected and labelled in each plot for recording the observations on plant height, spread, number of branches, days to 50 per cent flowering, fruit length, fruit breadth, fruit girth, fruit weight, number of fruits plant^{-1}, per cent fruit borer incidence, total yield and marketable yield (q ha^{-1}). The recommended package of practices were followed to grow healthy crop during experimentation.

A basal dose of FYM @ 20 tonnes hectare^{-1}, phosphorus and potassium was applied to all the plots uniformly in the form of single super phosphate and muriate of potash. The complete dose of both phosphorus and potassium was applied as basal dose at the time of transplanting. Nitrogen was applied in the form of urea in split doses as, 50 per cent dose of N at the time of transplanting as a basal dose, 25 per cent dose of N at 30 days after transplanting, 25 per cent dose of N at 60 days other transplanting. The soil sample was collected before transplanting and after transplanting for recording soil properties such as pH, EC, organic carbon, $CaCO_3$ and available NPK kg ha^{-1}. These parameters was estimated by procedures as suggested in A.O.A.C. (1990). The statistical analysis of data was carried out by analysis of variance method as suggested by Panse and Sukhatme (1985).

Results and Discussion

The effect of the spacing and N, P, K levels were significant in respect of yield (Table 1). The mean fruit yield (q ha^{-1}) had the significant effect with that of spacing and fertilizer levels. The highest yield was obtained with that of wider spacing of 90 x 90 cm (397.26 q ha^{-1}) and 90 x 120 cm (390.55 q ha^{-1}). Similar results were obtained with that Pawar (1990) who reported that wider spacing lead to higher yield. The lowest yield was noticed in close spacing of 90 x 75 cm i.e. (361.86 q ha^{-1}). Similarly there was increasing trend of yields in N, P, K levels also. The highest yield was recorded in F_4 250:125:125 NPK kg ha^{-1} (425.29 q ha^{-1}) followed by F_3 (391.11 q ha^{-1}) and F_2 (369.12 q ha^{-1}). The lowest yield was recorded by F_1 i.e. (347.35 q ha^{-1}). Similar results were also reported by Chadha *et al*. (1997) and Meritia and Chauhan (1970).

The interaction between spacing and fertilizer levels had significant effect on the yield per hectare. Maximum yield was obtained with 90 x 90 cm with 250:125:125 NPK kg ha^{-1} i.e. S_2F_4 (469.52 q ha^{-1}) followed by S_3F_4 i.e. 90 x 120 with 250:125:125 NPK kg ha^{-1} i.e. 411.07 q ha^{-1}. Minimum yield was obtained with S_1F_1 i.e. 90 x 75 cm along with 100:50:50 NPK kg ha^{-1} (333.12 q ha^{-1}). All other treatment had recorded the yields in between these spacings and N, P, K levels. These results were in close agreement with those reported by Rastogi *et al*. (1979) and Chadha *et al*. (1997).

All the characters showed significant effect due to different spacing and N, P, K levels (Table 2). The height of the plant was maximum with S_3F_4 (84.20 cm) i.e. wider spacing of 90x120 cm and decreased gradually at the closer spacing with S_1F_1 (62.53 cm). The results obtained were in agreement with Abutiate (1988) who reported that maximum plant height could be obtained with wider spacing. The height of the plant increased significantly under the increasing levels of fertilizers. The present findings are in accordance with the findings obtained by Singh and Sandhu (1970).

The results pertaining to the spread of the plant showed that an increase in planting density resulted in corresponding increase in the spread of the plant (East West and South

Table 1. Mean fruit yield (q ha^{-1}) as influenced by different spacing and NPK levels and their interactions in brinjal hybrid Phule Arjun

Fertilizer levels (NPK kg ha^{-1})	**Spacing (cm)**			
	S_1 = 90x75	**S_2 = 90x90**	**S_3 = 90x120**	**Mean**
F_1 = 100:50:50	333.12	341.52	367.42	347.35
F_2 = 150:75:75	352.25	369.90	385.21	369.12
F_3 = 200:200:100	366.78	408.09	398.48	391.11
F_4 = 250:125:125	395.29	469.52	411.07	425.29
Mean	361.86	397.26	390.55	383.22
Source	S.E.±	C.D. at 5%		
Spacing	1.95	5.72		
Fertilizer	2.25	6.60		
Spacing x Fertilizer	3.90	11.43		

Table 2. Growth and yield contributing characters as influenced by different treatments in brinjal hybrid Phule Arjun

Treat-ments	Plant height (cm)	Plant spread (EW) (cm)	Plant spread (SN) (cm)	No. of bran-ches plant^{-1}	Days to 50% flowe-ring	Fruit length (cm)	Fruit breadth (cm)	Fruit girth (cm)	Fruit weight (g)	No. of fruits plant^{-1}	% fruit borer incidence (wt. basis)	Market-able yield (q ha^{-1})
S_1F_1	62.53	90.53	81.67	6.20	54.33	4.89	3.76	13.20	58.13	37.47	16.01	279.79
S_1F_2	69.73	91.20	82.47	7.07	55.00	5.76	4.11	13.53	60.47	38.53	17.36	291.10
S_1F_3	73.60	93.47	83.53	7.87	55.67	5.97	4.43	13.87	62.77	40.04	18.06	300.54
S_1F_4	80.90	94.93	84.80	10.07	57.33	6.29	5.00	14.27	66.40	42.16	18.99	320.23
S_2F_1	64.47	93.67	83.27	7.53	54.67	5.69	3.89	13.60	61.87	47.39	15.01	290.26
S_2F_2	71.80	95.00	86.60	8.33	57.00	5.82	4.68	14.10	63.97	50.56	16.40	308.95
S_2F_3	75.93	96.13	88.20	9.13	57.33	6.06	5.15	14.90	67.47	54.20	16.39	341.21
S_2F_4	82.73	97.13	89.40	11.40	58.67	6.53	5.45	15.17	69.27	58.15	17.33	388.16
S_3F_1	66.73	96.00	84.47	8.53	55.67	5.71	4.08	14.13	64.17	56.84	13.79	316.76
S_3F_2	73.60	98.33	88.20	9.40	57.33	6.00	5.07	14.80	67.60	58.72	14.53	329.24
S_3F_3	77.33	100.33	90.13	10.47	58.67	6.51	5.29	15.37	71.80	59.77	15.34	337.36
S_3F_4	84.20	103.13	93.53	12.43	60.33	7.20	5.57	15.90	79.77	60.83	16.46	343.41
Source	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. ± C.D. at 5%	S.E. C.D. at 5%
Spacing (S)	0.06 0.18	0.04 0.10	0.13 0.37	0.03 0.11	0.16 0.46	0.07 0.20	0.04 0.14	0.05 0.16	0.63 1.84	0.21 0.63	0.13 0.39	1.70 5.70
Fertilizer (F)	0.07 0.21	0.04 0.12	0.14 0.42	0.04 0.13	0.18 0.53	0.08 0.23	0.05 0.17	0.06 0.18	0.73 2.13	0.25 0.72	0.15 0.45	1.92 6.57
S x F	0.12 0.36	0.07 0.21	0.25 0.73	0.07 NS	0.31 NS	0.14 0.40	0.09 0.29	0.11 0.32	1.26 3.69	0.43 1.25	0.26 NS	2.89 11.43

North directions). The wider spacing of 90 x 120 cm recorded the maximum East-West (103.13 cm) spread of the plant. These results confirmed the findings of Abutiate (1988). The maximum spread (93.53 cm) of the plant towards South-North directions were recorded by F_4 level i.e. 200:125:125 NPK kg ha^{-1} and minimum spread (81.67 cm) was recorded with F_1 level i.e. 100:50:50 NPK kg ha^{-1} to brinjal plot of hybrid Phule Arjun.

The number of branches $plant^{-1}$ was significantly influenced by different plant spacing and N, P, K levels. However interactions were non-significant. The results showed that the number of branches were more (12.43) under wider spacing (90x120) and decresed gradually with the decrease in planting distance. The results obtained are similar to those reported by Harminder Singh *et al.* (1997). The results showed that the number of branches increased significantly with the increasing fertilizer levels. The level F_4 recorded maximum number of branches per plant in each spacing. The results obtained were similar to those reported by Patnaik and Farooqui (1964).

The days to 50 per cent flowering has significant influence of different spacing and fertilizer levels. However interactions were nonsignificant. The minimum days required in close spacing and F_1 level of fertilizers. There is increasing trend towards increase in spacing and fertilizer levels.

The spacing had the significant effect on both the length as well as breadth of the fruit. The significantly maximum (7.20 cm) length of fruit was recorded with 90 x 120 cm spacing. Minimum length (4.89 cm) of the fruit was obtained with 90 x 75 cm spacing. The maximum breadth (5.57 cm) of the fruit was obtained with wider spacing of 90 x 120 cm, which was significant over 90 x 75 and 90 x 90 cm spacing. Minimum breadth (3.76 cm) of the fruit was obtained with 90 x 75 cm These results were similar with that of Ruiter (1974). The various levels of fertilizers significantly affect the length as well breadth of the fruit. Maximum fruit length was obtained with higher levels i.e. F_4 level of fertilizer which was

Table 3. Soil chemical properties as influenced by different treatments of spacing and NPK levels in brinjal hybrid Phule Arjun

Sample form	pH	EC (dsm^{-1})	Organic carbon (%)	$CaCO_3$ (%)	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potash (kg ha^{-1})
Before transplanting	8.16	0.38	0.48	15.00	254.02	32.83	336.00
Treatment wise chemical properties of soil after harvest of crop							
S_1F_1	8.46	0.32	0.42	16.88	249.70	16.41	350.78
S_1F_2	8.56	0.31	0.42	17.50	247.15	18.26	284.38
S_1F_3	8.45	0.30	0.45	16.25	240.88	17.08	434.11
S_1F4	8.43	0.36	0.48	15.63	233.42	20.21	297.02
S_2F_1	8.13	0.51	0.42	16.25	252.15	18.29	488.67
S_2F_2	8.43	0.31	0.48	16.88	246.56	20.00	315.84
S_2F_3	8.70	0.25	0.48	15.00	240.29	18.98	313.15
S_2F_4	8.55	0.29	0.39	15.00	237.15	21.60	333.37
S_3F1	8.35	0.32	0.49	16.88	260.29	19.19	287.62
S3F_2	8.13	0.43	0.45	17.50	253.42	18.32	301.06
S_3F_3	8.59	0.25	0.46	17.50	247.15	20.00	417.58
S_3F_4	8.52	0.27	0.48	16.88	234.00	22.62	447.55
S.E. ±	1.44	0.05	0.08	2.84	45.06	4.93	56.94
C.D. at 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	166.9

followed by F_3 and F_2 levels. The F_1 levels recorded minimum fruit length as well as fruit breadth. Similar results were also reported by Verma *et al*. (1974).

The spacing and fertilizer levels significantly influenced yield characters such as fruit girth, fruit weight, number of fruits plant^{-1} and yield hectare^{-1}. Spacing had significant effect on fruit girth. The highest girth was observed in wider spacing of 90 x 120 cm i.e. 15.90 cm while it was lowest in closer spacing of 90 x 75 cm i.e. 13.20 cm. There were increasing trend of fruit girth towards increasing levels of spacing and fertilizers (NPK).

The significantly maximum fruit weight (79.77 g) was obtained with wider spacing of 90 x 120 cm along with maximum fertilizer level i.e. F_4. The minimum fruit weight (58.13 g) was obtained with closer spacing of 90 x 75 cm along with minimum fertilizer levels i.e. F_1. These results are similar with that of Seth and Dhaudar (1970) and Pawar (1990) who reported that wider spacing resulted in higher fruit weight.

Spacing had significant effect on the number of fruits produced plant^{-1}. The highest number of fruits plant^{-1} (60.83) were produced with wider spacing having 90x120 cm distance, while the lowest (37.47) was obtained with spacing of 90x75 cm. These results confirm the findings of Pawar (1990) and Singh and Syamal (1995), who reported that wider spacing lead to the highest number of fruits in brinjal. The various levels of N, P, K had significant effect on the number of fruits produced plant^{-1}. The significantly highest number of fruits plant^{-1} (60.83) were produced with higher dose of NPK i.e. 250:125:125 kg ha^{-1}. These results are in agreement with the findings obtained by Mertia and Chauhan (1970), Singh and Sandhu (1970) and Seth and Choudhary (1970).

The spacing had significant effect on the incidence of fruit borer. Maximum incidence were observed in the plots with minimum plant density. Satyanarayana (1984) who reported that closer spacing lead to more pest infestation reported similar results. Maximum marketable yield was obtained with higher dose of NPK i.e. 388.16 q ha^{-1} followed by 343.00 q ha^{-1} and 320.23 q ha^{-1} in different spacing's adopted. The incidence of fruit borer was observed inbetween 13.79 to 18.99 per cent for different treatments under study.

The interactions of spacing and NPK levels had significant effect on growth, flowering, fruiting and yield of brinjal (Table 2). The significant effects of the interactions of spacing and NPK levels were evident with regard to the yield (q ha^{-1}), plant height, spread, fruit length, fruit breadth, fruit girth, fruit weight, number of fruits plant^{-1} and marketable yield (q ha^{-1}). The three plant densities i.e. 90 x 75, 90 x 90 and 90 x 120 cm along with four levels of NPK i.e. 100:50:50, 150:75:75, 200:100:100 and 250:125:125 had significant interactions for above mentioned characters. There was increasing trend of growth and yield observations as spacing and fertilizer levels increased. However the maximum yield (469.52 q ha^{-1}) was observed with 90 x 90 cm spacing along with 250:125:125 kg NPK level per hectare. This spacing and fertilizer level should be further exploited for confirmation of results obtained in present investigation.

The soil chemical properties as influenced by different treatments of spacing and N, P, K levels presented in Table 3. Soil pH, EC, organic carbon and $CaCO_3$ were non significantly influenced by various treatments. However, soil pH ranged from 8.59 to 8.13. The maximum pH value recorded in treatment S_3F_3 and minimum pH in S_3F_2 and S_2F_1. Soil EC (dSm^{-1}) was maximum in treatment S_2F_1 (0.51) followed by S_3F_1. However, minimum

EC (0.25) was recorded in treatment S_3F_3. $CaCO_3$ percentage was recorded maximum in treatment S_1F_2, S_3F_2 and S_3F_3 (17.5%) and minimum in S_2F_3 and S_2F_4 (15%). Organic carbon percentage was recorded maximum (0.49%) in treatment S_3F_1 and minimum in S_2F_4 (0.39%). Maximum available N in soil after harvest of brinjal recorded in treatment S_3F_1 (260.29 kg ha^{-1}) and minimum in S_1F_4 (233.42 kg ha^{-1}). Minimum available P in soil after harvest of brinjal recorded in treatment S_1F_1 (16.41 kg ha^{-1}) and maximum available P in treatment S_3F_4 (22.62 kg ha^{-1}). Minimum available K in soil after harvest of brinjal recorded (284.38 kg ha^{-1}) in treatment S_1F_2 and maximum in treatment S_2F_1 (488.67 kg ha^{-1}). The available NPK kg ha^{-1} was maximum before transplanting of crop as compare to after harvest of crop. This indicates that the nutrients was utilized by the crop for better yield. Similar results were also reported by Mangual (1981) and Rastogi *et al*. (1979).

Considering the findings of present investigation, it is concluded that, the soil with low nitrogen, medium phosphorus and high potassium, a fertilizer dose of 250:125:125 kg NPK ha^{-1} with medium spacing 90 x 90 cm was found satisfactory for obtaining highest yield in brinjal hybrid Phule Arjun in medium black soil of Western Maharashtra.

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Phule RDN 6 - A High Yielding Disease Resistant Rice Variety for Western Maharashtra

C. D. Sarawate[1] and S. D. Kumbhar[2]
Agricultural Research Station, Radhanagari, Dist. Kolhapur - 416 212 (India)
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Abstract

Phule RDN 6 (RDN 97-2-69-5-5-6) rice variety is developed by hybridization through pedigree selection method from a cross between TN 1 x IR 64. The variety matures in 125-130 days and has dwarf plant stature. The genotype has good consumption qualities owing to translucent, long bold grains with intermediate amylose and good elongation ratio. The variety is resistant to bacterial leaf blight, brown plant hoppers and gall midge and moderately resistant blast and stem borer. The genotype RDN 97-2-69-5-5-6 gave average grain yield of 53.03 q ha^{-1} over 65 locations and is superior to check RP 4-14, Jaya and Phule Samruddhi in respect of grain yield. The variety is released under the name Phule RDN - 6 for western Maharashtra in March 2013.

Key words : Rice, Phule RDN 6, mid-late.

Rice (*Oryza sativa* L.) is the most important food crop feeds more than half of humanity on daily basis and provides their major and most stable source of income. India is the leading country of the world in area of rice cultivation and second to China in rice production. The total area under rice cultivation in India is about 44 million hectare with a rough rice production of 143 million tonnes. In Maharashtra, rice is the second most important food grain crop, which is grown on an area of 15.20 lakh hectare with an annual rough rice production of 43.37 lakh tonnes and the average productivity is 2.85 tonnes hectare^{-1}. Western Maharashtra region contributes for 21 per cent of area under rice crop and 17 per cent of rice production at state level through an area of 3.17 lakh ha with an annual rough rice production of 7.21 lakh tons. The average rough rice productivity accounts to 2.27 tons ha^{-1} (Anonymous 2013). Developing high yielding varieties by changing genetic architecture of the rice plant is considered as one of the options to break the yield ceiling observed in the present day high yielding varieties.

In western Maharashtra an expected area of about 1.32 lakh ha is under midlate duration varieties. The limited varieties of this category demands to develop a long bold, midlate duration, multiple pests and disease resistant and high yielding variety for cultivation in western Maharashtra. With these objectives, the efforts were made at Agricultural Research Station, Radhanagari resulted in evolving a culture with mid-late duration, long bold grains, higher grain yield with resistance to important pests and diseases of the region.

Materials and Methods

The genotype RDN 97-2-69-5-5-6 has been evolved from a cross of TN-1 x IR 64 made at Agricultural Research Station, Radhanagari during the year 1997 and evaluating the segregating population from *kharif* 1998 to *kharif* 2003 following pedigree method. Among the several selections made the promising progeny RDN 97-2-69-5-5-6 was

1. Officer-in-Charge and 2. Junior Research Assistant.

isolated and studied for its yield and ancillary characteristics in station trial during 2004 and 2005. The culture was further evaluated in multilocational trials from 2007 onwards in randomized block design with three replications. It was tested at 26 locations in All India Rice Coordinated trial during *kharif* 2010. The quality analysis was carried out at DRR, Hyderabad during *kharif* 2010, whereas, adaptive trials of the culture were conducted on cultivators' field at 25 locations in western Maharashtra during *kharif* 2011. The culture was released for commercial cultivation in western Maharashtra in the year 2013 under the name "Phule RDN 6". The statistical analysis was carried out according to Panse and Sukhatme (1985).

Results and Discussion

Performance in station trials : The genotype RDN 97-2-69-5-5-6 was evaluated along with the checks Phule Maval and Jaya at Agricultural Research Station, Radhanagari during the year 2004 and 2005 (Anonymous 2004, 2005). The yield differences due to the varieties were highly significant. The culture RDN 97-2-69-5-5-6 (50.85 q ha^{-1}) gave 26.74 and 22.53 per cent higher mean grain yield than the checks Jaya (40.12 q ha^{-1}) and Phule Maval (22.53 q ha^{-1}), respectively (Table 1).

Performance in multilocation trials : The culture RDN 97-2-69-5-5-6 was evaluated at three locations *viz*., Radhanagari, Vadgaon and Igatpuri in multilocation trials during *kharif* 2007 to *kharif* 2010. The culture recorded pooled grain yield of 45.61 q ha^{-1} in Initial Varietal Trial (M) - Midlate, during *kharif* 2007, which was 35.14 per cent higher than the checks R.P 4-14 (33.75 q ha^{-1}) and 24.69 per cent higher than Jaya (36.58 q ha^{-1}). In Advance Varietal Trial (M) - Midlate, conducted during *kharif* 2008, the culture recorded 44.14 q ha^{-1} grain yield which was 19.91 and 20.44 per cent higher than the checks R.P 4-14 (36.81 q ha^{-1}) and Jaya (36.65 q ha^{-1}),

Table 1. Performance of rice genotype Phule RDN 6 in comparison with checks in various trials

Name of the trial	Year	No. of locations	Weighted mean yield (q ha^{-1})			% increase over check
			RDN 97-2-69-5-5-6	Check variety		
Station	2004, 2005	02	50.85	Jaya Phule Maval	40.12 41.50	26.74 22.53
IVT (M) - Midlate	2007	03	45.61	RP 4-14 Jaya	33.75 36.58	35.14 24.69
AVT (M) - Midlate	2008	03	44.14	RP 4-14 Jaya	36.81 36.65	19.91 20.44
AVT (M) - Midlate	2009	03	43.46	RP 4-14 Jaya	33.82 34.44	28.50 26.19
MLT - Western Maharashtra	2010	03	38.70	RP 4-14 Phule Samruddhi	33.04 33.40	17.13 15.87
IVT - IME (AICRIP)	2010	26	45.20	National check Regional check Local ceck	44.00 45.80 45.77	07.90 -- --
Adaptive (Western Maharashtra)	2011	25	66.16	RP 4-14 Phule Samruddhi	54.20 56.49	22.07 17.12
Pooled mean		65	53.03			

Table 2. Reaction of Phue RDN 6 and checks to major diseases and insect pests of paddy in MSCRIP trials

Genotype	Disease			Insect pest		
	BLB	Leaf blast	Leaf scald	Stem borer	BPH	Gall midge
Phule RDN - 6	1.9	3.4	4.0	3.5	1.2	0.5
R.P. 4-14	2.8	3.3	6.0	4.0	1.1	3.15
Jaya	2.4	4.1	3.0	4.0	1.0	3.15
Ajaya	2.0	2.4	5.0	3.5	0.8	3.0
EK - 70	4.6	5.9	8.0	4.25	1.2	3.15

BLB : Bacterial leaf blight; BPH : Brown plant hopper.

respectively. Whereas, in Advance Varietal Trial (M)- Midlate, conducted during *kharif* 2009 this culture recorded 43.46 q ha^{-1} grain yield which was 28.50 and 26.19 per cent higher than the checks R.P 4-14 (33.82 q ha^{-1}) and Jaya (34.44 q ha^{-1}), respectively (Anonymus 2009). In MLT western Maharashtra conducted during *kharif* 2010, this culture recorded grain yield 38.70 q ha-1, which was 17.13 per cent higher than the check R.P. 4-14 (33.04 q ha^{-1}) and 15.87 per cent than the check Phule Samruddhi (33.40 q ha^{-1}) (Anonymous 2010(a)).

Performance in all India coordinated trials : The culture RDN 97-2-69-5-5-6 (IET 22126) was tested at 26 locations in IVT-IME trial under AICRIP during *kharif* 2010. The culture recorded average grain yield of 45.20 q ha^{-1} which was 7.90 per cent higher than the national check IR 64 (44.00 q ha^{-1}) (Anonymous 2010(b)).

Table 3. Grain quality and ancillary characteristics of Phule RDN 6 and Checks

Particulars	RDN 97-2-69-5-56	R P 4-14	Jaya	Phule Samrudhhi
Hulling (%)	78.6	78.6	77.9	79.5
Milling (%)	69.4	70.0	68.0	71.0
Head rice recovery (%)	64.1	63.1	59.5	63.9
Kernel length (mm)	6.18	6.30	5.37	6.49
Kernel breadth (mm)	2.16	1.99	2.59	1.93
L : B ratio	2.86	3.16	2.07	3.36
Grain type	LB	LS	SB	LS
Grain chalkiness	Absent	Absent	VOC	VOC
Alkali spreading value	5.0	5.0	7.0	6.0
Amylose content (%)	24.50	25.49	25.56	17.40
Gel consistency (mm)	61	75	25	79
Volume expansion ratio	4.8	5.3	5.0	4.7
Water uptake (ml)	205	210	340	295
Kernel length after cooking (mm)	10.8	8.7	9.5	10.2
Elongation ratio	1.74	1.38	1.77	1.57
Aroma	NS	NS	NS	S
Tenderness	Soft	Soft	Hard	Very Soft
Plant height (cm)	83.70	78.80	78.30	83.40
Days to 50 per cent flowering	106	107	108	104
Panicles per m2	262	252	257	256
Spikelets per panicle	163	166	161	172
Test weight (g)	25.62	24.35	28.17	25.00

LB : Long bold, LS : Long slender, SB : Short bold, VOC : Very occasionally present, S : Scented, NS : Non-scented.

Performance in adaptive trials : The promising rice culture RDN 97-2-69-5-5-6 was tested on farmer's field at 25 locations in Kolhapur, Sangli, Satara, Pune, Nasik and Ahmednagar districts of western Maharashtra. This culture recorded average grain yield of 66.16 q ha^{-1}, which was 22.07 per cent higher than the check R.P. 4-14 (54.20 q ha^{-1}) and 17.12 per cent over Phule Samruddhi (56.49 q ha^{-1}).

Disease and pest reaction : The culture recorded resistant reaction to bacterial leaf blight and moderately resistant reaction to blast. It also showed resistant reaction to brown plant hopper and gall midge and moderately resistant reaction to stem borer (Table 2) (Anonymous 2009) indicating genotypes superiority to important pests and diseases over the cultivated checks.

Quality analysis : The culture RDN 97-2-69-5-5-6 was tested for grain quality parameters at Directorate of Rice Research, Hyderabad during *kharif* 2008. The culture showed high head rice recovery (64.1%), long bold grain type (L/B ratio 2.86), intermediate amylose content (24.50 %), medium gel consistency (61) with elongation ratio > 1.7 (1.74) indicating excellence in its quality traits (Table 3). The culture showed superiority over the R.P. 4-14, Jaya and Phule Samruddhi for the characters *viz*., Head rice recovery (HRR), amylose content and elongation ratio indicating its supremacy for consumption qualities.

The genotype RDN 97-2-69-5-5-6 is high yielding with midlate maturity (125 - 130 days). It is having dwarf plant stature, long bold grain type and resistant to important pest and diseases. The culture is released by Maharashtra State Variety Release Committee as "Phule RDN 6" for commercial cultivation in western Maharashtra in 2013.

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Management of Safflower Aphid (*Uroleucon compositae* T.) by using Plant Oils

V. B. Akashe[1], M. A. Gud[2], S. K. Shinde[3] and J. R. Kadam[4]
All India Co-ordinated Research Project on Safflower,
Zonal Agricultural Research Station, Solapur - 413 002 (India)
(Received : 10-04-2014)

Abstract

Bio-efficacy study of various plant oils against safflower aphids, *Uroleucon compositae* T. was conducted during three consecutive years (2010-11 to 2012-13) at All India Co-ordinated Research Project on Safflower, Zonal Agricultural Research Station, Solapur under dry land condition. The results revealed that the lowest aphid population was recorded in the treatment karanj oil @ 10 ml l^{-1} (13.00 and 9.56 aphids on 5 cm twig $plant^{-1}$ after first and second spray, respectively) than all other treatments. It was followed by neem oil @ 10 ml l^{-1} (16.56 and 12.33 aphids on 5 cm twig $plant^{-1}$) and castor oil @ 10 ml l^{-1} (19.67 and 15.78 aphids on 5 cm twig $plant^{-1}$). Maximum per cent decline in aphid population after first and second spray was registered in karanj oil @ 10 ml l^{-1} (75.00 and 85.85) followed by neem oil @ 10 ml l^{-1} (68.15 and 81.75) and castor oil @ 10 ml l^{-1} (62.17 and 76.64). The results of this investigation concluded that karanj @ oil 10 ml l^{-1} was found effective in checking safflower aphid to the desired level and also produced the highest average seed yield (778.22 kg ha^{-1}) followed by neem oil @ 10 ml l^{-1} (627.08 kg ha^{-1}) and castor oil @ 10 ml l^{-1} (509.18 kg ha^{-1}).

Key words : Management, safflower aphid, plant oils.

India is a major Safflower (*Carthamus tinctorius* L.) growing country in the world with an area of 2.42 lakh ha, production of 1.21 lakh tones and productivity of 498 kg ha^{-1} (2011-12). Maharashtra state contributing nearly 51 per cent (1.23 lakh ha) and 55 per cent (0.67 lakh tones) of total area and production of the country, respectively. However, the productivity of safflower in Maharashtra state is comparatively low (545 kg ha^{-1}). In Maharashtra state it is grown extensively in marginal and sub marginal land particularly in drought prone areas.

The safflower oil and petals have medicinal importance for the heart patients because of rich profile of the polyunsaturated fatty acids (linoleic acid 78%). Dajue and Griffee (2001) reported that in China and India, the safflower corolla have been used for medicinal purposes and the cultivar with a red flower, spinelessness and narrow branching angle are much better than the cultivars with the spiny and yellow flower.

Safflower crop is infested by a number of insect pests and diseases causing substantial losses in yield (Singh *et al.*, 1999). However, safflower aphid (*Uroleucon compositae* Theobald) is one of the most destructive pest infesting the crop particularly from elongation stage up to flowering period (Akashe *et al.*, 1999). Several chemical insecticide have been tested and recommended for its management (Dhange *et al.*, 1996; Charati and Pawar, 1998; Neharkar *et al.*, 2003; Akashe *et al.*, 2007a and Sharma *et al.*, 2009) and thus farmers still depends on chemical insecticides only. The major limitations of chemical insecticides are hazards to ecosystem and their high cost. Such problems are arising from sole dependents on chemical insecticides have

1. Jr. Entomologist, 2. Jr. Research Asstt., 3. Breeder and 4. Ex. Associate Director of Research.

necessitated the use of alternate eco-friendly and effective management strategies. In thiscontext, exploiting the potential of plant oils possessing insecticidal properties for the eco-friendly management of safflower aphid is essential. Such plant originated insecticides ensure conservation of naturally occurring bio-control agents. In this investigation, an attempt has been made to compare the bio-efficacy of different plant oils against safflower aphids, *U. compositae* Theobald.

Material and Methods

Field experiment on management of safflower aphid by using plant oils was conducted during 2010-11, 2011-12 and 2012-13 at All India Co-ordinated Research Project on Safflower, Zonal Agricultural Research Station, Solapur with SSF-658 variety in randomized block design with three replications and eight treatments. The spacing was 45 cm x 20 cm and plot size was 4.0 m x 4.5 m. Seven popular and commonly available plant oils from karanj (*Pongamia pinnata*), neem (*Azadiracta indica*), castor (*Recinus commonis*), linseed (*Linum usitatissimum*), ground nut (*Arachis hypogaea*), mustard (*Brassica juncea*) and sesame (*Sesamum indicum*) were evaluated for their bio-efficacy against *U. compositae* T. Each oil @ 10 ml l^{-1} water was thoroughly mixed with nirma detergent powder @ 0.1 per cent (w/v). Two applications of the treatments at about 40 and 55 days after sowing (DAS) were given. The observations on aphid count at fortnightly interval were recorded on 5 cm apical twig plant^{-1} on randomly selected five plants in each treatment plot. The seed yield (kg ha^{-1}) of each treatment plot was recorded and benefit : cost (B:C) ratio and incremental cost : benefit ratio (ICBR) were also worked out.

Results and Discussion

Three years pooled data presented in Table-1 revealed significant differences among the various treatments in respect of aphid population (Number on 5 cm twig plant^{-1}). All the treatments recorded significantly lower aphid population (9.56 to 26.78) than absolute control (52.00 and 67.56). Among the treatments, karanj oil @ 10 ml l^{-1} registered statistically lowest aphid population (13.00 and 9.56) than all other treatments. It was followed by neem oil @ 10 ml l^{-1} (16.56 and 12.33) and castor oil @ 10 ml l^{-1} (19.67 and 15.78). Maximum percent decline in aphid population over control after both first and second spray could be achieved through karanj oil @ 10 ml l^{-1} (75.00 and 85.85) followed by neem oil @ 10 ml l^{-1} (68.15 and 81.75) and castor oil @ 10 ml l^{-1} (62.17 and 76.64). Other treatments *viz*., linseed oil, ground nut oil, mustard oil and sesame oil each @10 ml l^{-1} have reduced aphid population to the tune of 69.08, 66.12, 63.32 and 63.65 per cent, respectively after second spray.

Seed yield in all the treatments was significantly more than absolute control (Table 1). Significantly highest seed yield was obtained by karanj oil @ 10 ml l^{-1} (778.22 kg ha^{-1}) and it was superior over rest of the treatments. Neem oil @ 10 ml l^{-1} (627.08 kg ha^{-1}) and castor oil @ 10 ml l^{-1} (509.18 kg ha^{-1}) stood 2nd and 3rd, respectively in respect of reducing aphid population. The similar trend was recorded in respect of per cent increase in yield over control. However, the treatment of linseed oil @ 10 ml l^{-1}, mustard oil @ 10 ml l^{-1}, sesame oil @ 10 ml l^{-1} and ground nut oil @ 10 ml l^{-1} were statistically at par with each other in respect of seed yield.

The cost economics of the treatments showed that the highest benefit cost (B:C) ratio of 1.59 was obtained from the karanj oil 10 ml l^{-1} followed by neem oil 10 ml l^{-1} (1.13) and castor oil 10 ml l^{-1} (1.01). The incremental cost benefit ratio (ICBR) obtained was 6.49, 3.86, 3.25, 3.24, 2.48, 2.13 and 1.43 respectively from karanj oil, mustard oil, castor oil, ground nut oil, neem oil, sesame oil and linseed oil each @10 ml l^{-1}. All these plant oils were safer to the natural enemies of safflower aphid and pollinators (honey bees).

The relative efficacy of some of the botanicals including neem oil against safflower aphid has been reported by earlier workers also (Pal *et al*., 1999; Akashe *et al*., 2007b and Bisen *et al*., 2012). Ingawale *et al*. (2005) noticed that plant products and nirma (detergent powder) were totally safe to predators. The neem formulations have been reported to be safer to parasite and predators and effective against pests (Saxena, 2011). The 5 per cent leaf extract of karanj (*P. pinnata*) was found highly effective in reducing the aphid population and thereby increased the seed and oil yield of safflower (Ravikumar *et al*., 1999 and Mallapure *et al*., 2001). Hasan and Ansari (2012) reported that *A. indica* CUDs was found effective in suppressing the rapeseed-mustard aphid, *Lipaphis erysimi* Kalt. Singh *et al*. (2012) also reported that neem oil 1 and 2

Table 1. Bio-efficacy of various treatments against safflower aphids (2010-11, 2011-12 and 2012-13)

Treatments	Average aphids on 5 cm twing plant^{-1}				Grain yield (kg ha^{-1}) yield Pooled mean	Per cent increase in over control	Benefit Cost ratio Pooled mean	Incremental Cost of natural ratio Pooled mean	Population of natural enemies safflower aphids (coccinelids)
	After Ist spray		After IInd spray						
	Pooled mean	Per cent decline over control	Pooled mean	Per cent decline over control					
Karanj oil @ 10 ml l^{-1}	13.00 (3.60)*	75.00	9.56 (3.08)*	85.85	778.22	75.16	1.59	6.49	3.0
Neem oil @ 10 ml l^{-1}	16.56 (4.06)*	68.15	12.33 (3.48)*	81.75	627.08	69.18	1.13	2.48	2.8
Castor oil @ 10 ml l^{-1}	19.67 (4.43)*	62.17	15.78 (3.95)*	76.64	509.18	62.04	1.01	3.25	2.7
Linseed oil @ 10 ml l^{-1}	24.67 (4.96)*	52.56	20.89 (4.57)*	69.08	407.26	52.54	0.81	1.43	2.4
Ground nut oil @ 10 ml l^{-1}	25.67 (5.06)*	50.64	22.89 (4.78)*	66.12	341.33	43.37	0.78	3.24	3.1
Mustard oil @ 10 ml l^{-1}	26.78 (5.17)*	48.50	24.78 (4.97)*	63.32	388.79	50.28	0.86	3.86	3.3
Sesame oil @ 10 ml l^{-1}	25.89 (5.08)*	50.21	24.56 (4.84)*	63.65	355.91	45.69	0.77	2.13	2.6
Control	52.00 (7.16)*	-	67.56 (8.12)*	-	193.29	-	0.46	-	3.2
S. E. (m)±	0.70 (0.06)*	-	0.94 (0.06)*	-	24.82	-	-	-	-
C. D. at 5 %	2.00 (0.17)*	-	2.68 (0.18)*	-	70.63	-	-	-	-

* Figures in parenthesis are square root (√) transformed values.

per cent, azadirachtin 1500 mg kg-1 (0.1%) and karanj oil 1 per cent significantly suppressed the rapeseed-mustard aphid, *L. erysimi* Kalt. population and recorded higher mustard yield in comparison to control.

An overall pooled results showed that the two sprayings of karanj and/or neem oil 10 ml l^{-1} first at the ETL (40-45 days after sowing) and second spray 15 days thereafter (55-60 days after sowing) are beneficial for the effective and eco-friendly management of safflower aphid as well as for producing the higher seed yield of safflower under dry land conditions. The lowest B : C ratio of 0.46 noticed in absolute control indicated the importance of aphid management through such botanical insecticides which are safe to parasite and predators.

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Efficacy of different phytoextracts and human antibiotics for management of Bacterial Blight Disease of Pomegranate caused by *Xanthomonas axonopodis* pv. *punicae*

G. B. Raut[1], C. V. Ambadkar[2] and A. S. Dhawan[3]
College of Agriculture, Osmanabad - 413 501 (India)
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Abstract

A study on efficacy of different plant extracts and human antibiotics for management of Bacterial Blight Disease of Pomegranate caused by *Xanthomonas axonopodis* pv. *punicae* was conducted during the year 2011-12 at College of Agriculture, Osmanabad. Plant leaf extract of seven botanicals and seven antibiotics were evaluated *in vitro* by applying inhibition zone technique (paper disc method) and using Nutrient Agar (N.A.) as basal culture medium. The result revealed that Sadaphuli leaf extract was found most effective for controlling *X. axonopodis* pv. *punicae* by forming 8.22 and 9.06 per cent inhibition followed by Ritha leaf extract (6.50 and 8.22%), Adulasa leaf extract (5.35and 6.99%) at 10 and 20 per cent, respectively. The antibiotics, Streptocycline was found most effective by forming 7.29 and 8.77 per cent inhibition zone followed by Azithromycin (5.82 and 7.29 %), Cefixime (5.07 and 6.56%) at 250 and 500 ppm concentration level, respectively.

Key words : *Xanthomonas axonopodis* pv. *punicae*, plant leaf extract, antibiotics, bacterial blight disease of pomegranate.

Pomegranate is gaining lot of attention of the world over because of its high economic and nutritional values. India is largest pomegranate producer in the world sharing about 36 per cent of the world's production and above 30 per cent of the international pomegranate trade. Maharashtra is the leading state in area and production of pomegranate. However, pomegranate cultivation in Maharashtra has been threatened due to incidence of bacterial blight disease caused by *Xanthomonas axonopodis* pv. *punicae* in recent past. It is one of the most destructive disease of Pomegranate inflicting considerable quantitative and qualitative losses (Chand and Kishun, 1991 and Raghavan, 2007). The disease has been resulted in enormous losses to pomegranate orchards, as it renders fruits unfit for consumption and market. The disease has spread like wildfire in the pomegranate plantation in the Maharashtra, particularly in the districts of Solapur, Sangali, Satara, Osmanabad, Latur and Beed. Considering the economic importance of the fruit crop as well as disease, it is the demand of the time to search for suitable and effective control measures against the disease. Therefore, the present investigations were undertaken to find out the efficacy of different plant extracts and human antibiotics against *X. axonopodis* pv. *punicae in vitro*.

Material and Methods

Plant leaf extract of seven botanicals *viz*., Shatavari (*Asparagus racemosa*), Sadaphuli (*Catharanthus roseus*), Adulasa (*Adhatoda vasica*), Karanj (*Pongamia pinnata*), Ashwagandha (*Withania somnifera*), Behada (*Terminalia belerica*), Ritha (*Sapindus mukorossi*) @ 10 and 20 per cent were evaluated against *X. axonopodis* pv. *punicae*. Before preparation of leaf extract leaves of

1. M.Sc. (Agri.) student, 2. Assistant Professor and 3. Associate Dean and Principal.

each plant species were dipped in the 0.1 per cent mercuric chloride ($HgCl_2$) and washed thoroughly to remove traces of $HgCl_2$. Leaf extracts were prepared by grinding 100gm washed leaves of each plant species in 100ml distilled water with mixture-cum grinder. These were then filtered through Whatman No.1 filter paper using funnel and volumetric flask (100 ml capacity). The final clear filtrate obtained was treated as 100 per cent concentration of standard leaf extract. The desired quantity required for preparation of 10 and 20 per cent concentration was taken from this 100 per cent standard leaf extract. In another experiment, total seven antibiotics *viz*., Streptocycline, Azithromycin, Lincomycin, Aciclovir, Cefixime, Cefpodoxime, Cefadroxil @ 250 and 500 ppm were used for testing.These leaf extracts and human antibiotics were then evaluated *in vitro* against *X. axonopodis* pv. *punicae* by applying inhibition zone technique (paper disc method) and using Nutrient Agar (N.A.) as basal culture medium.

The fresh nutrient agar medium was prepared and dispersed in 100 ml quantities in conical flask (250 ml capacity), plugged and autoclaved at 15 lbs cm^{-2} pressure for 15-20 minute. The desired concentration of leaf extract @ 10 and 20 per cent and human antibiotics @ 250 and 500 ppm were prepared by using appropriate quantities of leaf extract required for 10 and 20 per cent and human antibiotics required for 250 and 500 ppm concentration. In these desired concentration of leaf extract and human antibiotics 5 mm disc of Whatman No. 1 filter paper were dipped for few minutes. After sterilization of media, it was allowed to cool down to 35°C before pouring. Approximately 20 ml liquid media was poured in previously sterilized petri plate and allowed them to solidify. Pouring of plates always done by using laminar air flow cabinet under aseptic condition. After solidification of media in petri plate, the bacterial suspension was spread on medium with glass spreader. After uniform spreading of bacterial suspension 5 mm. diameter Whatman No. 1 filter paper previously dipped in desired concentration of leaf extracts and antibiotics was placed in the center of medium. Plates containing nutrient agar with bacterial suspension without any leaf extract and human antibiotics were maintained as control. The experiment was conducted in completely randomized design with three replications and eight treatments. All these

Table 1. Inhibitory effect of different plant extracts on growth of *X. axonopodis* pv. *punicae*

Treatment	**Mean bacterial growth* (mm) at conc.**		**% inhibition of bacterial growth**	
	10%	**20%**	**10%**	**20%**
T_1 - Shatavari leaf extract (*Asparagus racemosa*)	85.93	84.08	4.52 (7.27)	6.58 (8.24)
T_2 - Sadaphuli leaf extract (*Catharanthus roseus*)	82.60	81.85	8.22 (9.01)	9.06 (9.39)
T_3 - Adulasa leaf extract (*Adhatoda vasica*)	85.18	83.71	5.35 (7.66)	6.99 (8.43)
T_4 - Karanj leaf extract (*Pongamia pinnata*)	86.30	84.82	4.11 (7.08)	5.75 (7.85)
T_5 - Ashwagandha leaf extract (*Withania somnifera*)	86.30	85.18	4.11 (7.08)	5.36 (7.66)
T_6 - Behada leaf extract (*Terminalia belerica*)	87.04	85.18	3.28 (6.69)	5.36 (7.66)
T_7 - Ritha leaf extract (*Sapindus mukorossi*)	84.07	82.60	6.50 (8.23)	8.22 (9.01)
T_8 - Control	90	90	0.00	0.00
S.E. ±	0.89	0.51	0.51	0.29
C.D.(P=0.05)	2.68	1.53	1.55	0.89

* Mean of three replications, Figures in parenthesis are arcsin values.

petri plates were incubated at room temperature (28 ± 2°C) for 48 hrs. Observation on colony growth of test pathogen and per cent inhibition over control was calculated by the formula of Vincent (1947).

$$I = \frac{C - T}{C} \times 100$$

Where,

I = Per cent inhibition

C = Growth of test pathogen in control plate

T = Growth of test pathogen in treatment plate

Results and Discussion

The result presented in Table 1 revealed that Sadaphuli leaf extract at 10 per cent was found most effective for controlling *X. axonopodis* pv. *punicae* by forming 8.22 per cent inhibition. Ritha leaf extract was found second best effective plant extract which showed 6.50 per cent inhibition followed by Adulasa leaf extract (5.35%), Shatavari leaf extract (4.52%), Karanj leaf extract (4.11%), Ashwagandha leaf extract (4.11%) and Behada leaf extract (3.28%). Similarly, at 20 per cent concentration, Sadaphuli leaf extract was found most effective for controlling *X. axonopodis* pv. *punicae* by forming 9.06 per cent inhibition. Ritha leaf extract was found second best effective plant extract which showed 8.22 per cent inhibition followed by Adulasa leaf extract (6.99%), Shatavari leaf extract (6.58%), Karanj leaf extract (5.75%), Ashwagandha leaf extract (5.36%) and Behada leaf extract (5.36%).The results obtained in present investigation correlates with the results of earlier worker *viz*., Vudhivanchi (2003), Tiwari *et al*. (2004), Suryawanshi *et al*. (2009) and Atar (2011).

The result presented in Table 2 revealed that antibiotic Streptocycline at 250 ppm concentration was found most effective for controlling *X. axonopodis* pv. *punicae* by forming 7.29 per cent inhibition zone. Azithromycin was found second best effective antibiotics which showed 5.82 per cent inhibition followed by Cefixime (5.07%), Aciclovir (4.71%), Cefadroxil (4.35%), Lincomycin (4.35%) and Cefpodoxime (3.60%). Similarly, at 500 ppm concentration Streptocycline was found most effective for controlling *X. axonopodis* pv. *punicae* by forming 8.77 per cent inhibition zone.

Table 2. Inhibitory effect of different antibiotics on growth of *X. axonopodis* pv. *punicae*

Treatment	Mean bacterial growth (mm)* at conc.		% inhibition of bacterial growth	
	250 ppm	**500 ppm**	**250 ppm**	**500 ppm**
T_1 - Streptocycline	88.07	86.67	7.29 (6.50)	8.77 (7.27)
T_2 - Azithromycin	89.47	88.07	5.82 (5.73)	7.29 (6.50)
T_3 - Lincomycin	90.87	90.17	4.35 (4.97)	5.08 (5.35)
T_4 - Aciclovir	90.53	89.47	4.71 (5.16)	5.82 (5.73)
T_5 - Cefixime	90.18	88.77	5.07 (5.35)	6.56 (6.12)
T_6 - Cefpodoxime	91.58	90.18	3.60 (4.58)	5.07 (5.35)
T_7 - Cefadroxil	90.87	89.82	4.35 (4.97)	5.45 (5.54)
T_8 - Control	95	95	0.00	0.00
S.E. ±	0.51	0.40	0.29	0.23
C.D.(P=0.05)	1.53	1.22	0.88	0.70

* Mean of three replications, Figures in parenthesis are arcsin values.

Azithromycin was found second best effective antibiotics which showed 7.29 per cent inhibition followed by Cefixime (6.56%), Aciclovir (5.82%), Cefadroxil (5.45%), Lincomycin (5.08%) and Cefpodoxime (5.07%).

The results obtained in present investigation are in full agreement with those reported in the past. Desai *et al*. (1967) evaluated *in vitro* activity of streptocycline against 17 *Xanthomonas* species and two *Pseudomonas* species with different concentrations (25, 50, 100, 250 ppm). The results indicated that Streptocycline in all concentrations tried (25, 50, 100, 250 ppm) inhibits the growth of all the bacterial plant pathogens belonging to *Xanthomonas* and *Pseudomonas* genera comprising 19 species. Similar results have been reported by Gandhi and Parashar (1978), Nath *et al.* (1979), Sharma *et al.* (1979), Ravikumar *et al.* (2003), Manjula *et al.* (2003) and Atar (2011).

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Marketing of Ornamental plants in Dapoli Tahsil of Ratnagiri District

M. G. Lagare[1], A. C. Deorukhakar[2] and J. M. Talathi[3]
Department of Agriculture Economics, Dr. B.S.K.K.V., Dapoli - 415 712 (India)
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Abstract

In the present study, per nursery total investment was Rs.4l5878, out of which 60.83 per cent shared by irrigation structures, followed by land 19.38 per cent, handtools used for nursery and other agricultural operations 10.00 per cent, sheds 8.69 per cent and equipments used only for nursery 1.08 per cent. Among the species, maximum labour use was for Rose i.e. 18.37 male days and 23.26 female days. Total quantity of ornamental plants/seedlings sold was 35865. Amongst them, the highest share was of shrubs 46.53 per cent followed by climbers 21.38 per cent, shade loving plants 20.66 per cent and bulbous plants 12.18 per cent and subsequently the share in amount realization 53.85 per cent, 18.10 per cent, 17.9l per cent and 10.12 per cent was in the same order. Amongst twelve species, highest returns were from *Michelia champaka* 51.42 per cent. Overall total 35865 plants/seedlings 26029.8 were sold directly to customers and 9835.2 to institutions. In shrubs, shade loving, climbers and bulbous plants direct sale to customers was 51.34 per cent, 18.98 per cent, 18.70 per cent and 10.96 per cent, respectively and remaining quantity was sold to institutions i.e 33.80 per cent, 25.11 per cent, 28.46 per cent and 12.60 per cent in the same order. In shrubs, maximum sale was in *Michelia champaka*, in shade loving *Croton*, in climbers *Bougainvillea* and in bulbous plants *Canna*.

Key word : Capital investment, sale of ornamental plants, disposal pattern.

India is endowed with diverse agro-climatic conditions which permits the growing of a large number of horticultural crops. Horticulture, which includes fruits, vegetables, medicinal and aromatic plants, has proved it's potentiality of income generation and gainful diversification. It accounts for considerable shares in country's export. 'India Agro-Horti Science' has adapted an assembly line approach from production to marketing and finally home delivery. Each type of potted plants needs to be accompanied by the instruction on aftercare, nutrients requirement, watering etc.

Ornamental plants are capital and labour intensive. Therefore, production and marketing of ornamental plant business is involving economics aspects such as status of ornamental plants, total capital investment, per nursery sale and disposal pattern of ornamental plants in the business. Despite the multi-ferrous utility and importance of ornamental plant business, there is no any documentation and research efforts in the field of agriculture economics. The study will be also useful to other investigators and research workers to know the existing position of ornamental plant business in this part of the State.

Material and Methods

The study was purposively carried out in Dapoli tahsil of Ratnagiri district. A list of ornamental nurseries was collected from Tahsil Agriculture Officer, Dapoli. There were five ornamental nurseries in Dapoli tahsil and all were selected for the study. These nurseries were having large number of different types of plants and species. Among them important twelve plant types were selected for the study.

1. Ph.D. scholar, 2. Associate Professor and 3. Head.

Table 1. Total capital investment per nursery

Particulars	Amount (Rs.)	Per cent
Land	80600	19.38
Sheds	36141	8.69
Equipments used only for nursery	4510	1.08
Hand tools and machinery used for nursery and other agricultural operations	41627	10.00
Irrigation and farm structures	253000	60.83
Total	415878	100.00

Figures in parentheses indicate percentages to total.

The data were pertained to the year 2010-2011.

The selected nursery owners were interviewed personally with the help of comprehensive pretested schedule specially designed for the purpose. The collected data were analyzed by tabular method. Simple statistical tools such as arithmetic averages, percentages and ratios were used for presenting the data. For estimating cost at different level, standard cost concepts were used.

Results and Discussion

Total investment for nurseries : The investment for nursery includes investment in land, sheds, and equipments used only for

Table 2. Status of ornamental plants/seedlings business (2010-2011)

Particulars	Number of seedling				
	Prepared in own nursery	Purchased	Total	Ready for sale	
				Number	Percentage to total
A. Shrubs					
Hibiscus	2610 (72.29)	1000 (27.70)	3610 (100.00)	3249.2	90.00
Rose	3050 (60.39)	2000 (39.60)	5050 (100.00)	4690	92.87
Tagar	1746 (60.39)	1800 (50.76)	3546 (100.00)	3141.8	88.60
Michelia champaka	4700 (72.30)	1800 (27.69)	6500 (100.00)	5610	86.30
Sub total	12,106 (64.71)	6600 (35.28)	18706 (100.00)	16,691	89.22
B. Shade loving					
Croton	1578 (42.90)	2100 (57.09)	3678 (100.00)	3198	86.94
Dracaena	600 (26.54)	1660 (73.45)	2260 (100.00)	1824	80.70
Calathea	1138 (40.09)	1700 (59.90)	2838 (100.00)	2390	84.21
Sub total	3316 (15.66)	5460 (27.24)	8776 (21.29)	7412 (20.66)	84.45
C. Climbers					
Bougennvellia	2115 (59.16)	1460 (40.83)	3575 (100.00)	3186	89.11
Krishnakamal	1220 (43.88)	1560 (56.11)	2780 (100.00)	2393	86.07
Lasunvel	1178 (47.92)	1280 (52.07)	2458 (100.00)	2090	85.02
Sub total	4513 (51.20)	4300 (48.79)	8813 (100.00)	7669	87.01
D. Bulbous plants					
Lily	804 (35.57)	1460 (64.48)	2264 (100.00)	1832	80.91
Canna	424 (16.03)	2220 (83.96)	2644 (100.00)	2261	85.52
Sub total	1228 (25.02)	3680 (74.97)	4908 (100.00)	4093	83.39
Grand total (A+B+C+D)	21163 (100.00)	20040 (100.00)	41203 (100.00)	35865 (100.00)	87.04

Figures in parentheses indicate percentages to total. In each groups percentage were worked out to group total.

nursery, handtools and machinery and irrigation structure which was used for nursery and other agriculture purposes. The investment on these items is presented in Table 1.

It is observed from the table that at overall level the per nursery total investment was Rs.4,15,878, out of which 60.83 per cent shared by irrigation structures, followed by land 19.38 per cent, handtools used for nursery and other agricultural operations, sheds 8.69 per cent and equipments used only for nursery 1.08 per cent.

The results of the present study is in confirmatory with the results reported by Sable (1982), Shendge (1991), Patil (1997) and Sengar and Kothari (2008).

Table 3. Sources of purchasing ornamental seedlings

Particulars	Sources								
	Baroda			Bangalore			Pune		
	No. of seedling purch-ased	Rate of purchase (Rs. seed-ling^{-1})	Amount (Rs.)	No. of seedling purch-ased	Rate of purchase (Rs. seed-ling^{-1})	Amount (Rs.)	No. of seedling purch-ased	Rate of purchase (Rs. seed-ling^{-1})	Amount (Rs.)
A. Shrubs									
Hibiscus	250	17.5	4375	525	20	10500	225	25	5625
Rose	600	17.7	10620	550	21	11550	850	23	19550
Tagar	325	16	5200	450	19	8550	1025	22	22550
Michelia champaka	475	18	8500	641	22	14102	684	26	17784
Sub total	1650	17.39	28695	2166	20.63	44702	2784	23.53	65509
	(46.68)	17.39	28695	(43.13)	20.63	44702	(24.24)		
B. Shade loving									
Croton	350	17	5950	450	18	8100	1300	20	26000
Dracaena	250	16	4000	400	17.5	7000	1010	20	20200
Calathea	300	17	5100	335	18	6030	1065	21.6	23004
Sub total	900	16.72	15050	1185	17.83	21130	3375	20.50	69204
	(25.46)	16.72	15050	(23.60)	17.83	21130	(29.38)		
C. Climbers									
Bougennvellia	300	16	4800	425	15	6375	735	20	14700
Krishnakamal	280	16	4480	320	16.5	5280	960	21.5	20640
Lasunvel	70	16.5	1155	250	15.5	3875	960	20.5	19680
Sub total	650	16.05	10435	995	15.60	15530	2655		55020
	(18.39)	16.05	10435	(19.81)	15.60	15530	(23.11)		
D. Bulbous plants									
Lily	110	16	1760	325	16	5200	1025	20	20500
Canna	224	16	3584	350	15	5250	1646	21	34566
Sub total	334	16	5344	675	15.48	10450	2671	20.61	55066
	(9.45)	16	5344	(13.44)	15.48	10450	(23.25)		
Total	3534	16.84	59524	5021	18.28	91812	11485	21.31	244799
	(17.63)*	16.84	59524	(25.05)*	18.28	91812	(57.31)*		
Grand Total							20040	19.77	396135

Figures in parentheses indicate percentages to total. *Figures in parentheses indicate percentages to grant total

Status of business (2010-2011) : The information on number of seedlings prepared in own nursery, number of seedlings purchased, number of total seedlings and number of seedlings ready for sale were worked out. During the year, the proportion of seedlings ready for sales (i.e. survival percentage) was also estimated. The detail information is given in Table 2.

In case of shrubs the survival percentage ranged between 86.30 to 92.87 per cent among various species. Maximum number of seedlings purchased were of *Tagar* (50.76%), followed by *Rose* (39.60%), *Hibiscus* (27.70%) and *Michelia champaka* (27.69%). In shade loving plants, *Croton* (42.90%) were produced in maximum quantity followed by *Calatheca* (40.09%) and *Dracaena* (26.54%). Seedlings ready to be sold ranged between 1824 to 3198. In climbers survival percentage ranged between 85.02 to 89.11 per cent, among various species. Maximum seedlings purchased were of Krishnakamal (56.11%) followed by Lasunvel (52.07%) and Bougainvillea (40.83%). In bulbous plant, *Lily* (35.51%) and *Canna* (16.03%) were prepared in own nursery and number of seedlings ready for sale were 2261 and 1832, respectively.

Sources of purchasing : Information about sources of purchasing ornamental seedlings is presented in Table 3. Sources for meeting additional requirement of ornamental plants/seedlings were far away from the nurseries. It is observed from Table 3, that at overall level, nursery owners purchased maximum number of ornamental seedlings from Pune (57.31%) followed by Bangalore (25.05%) and Baroda (17.63%). Rate given for per seedling was Rs. 21.31 for Pune, Rs. 18.28 for Bangalore and Rs.16.84 for Baroda. At overall level, total 20,040 ornamental seedlings were purchased at amount of Rs.3,96,135.

Table 4. Sale of ornamental plants/seedling per nursery

Particulars	Number*	Gross amount (Rs.)	Percentage to total amount realised
A. Shrubs			
Hibiscus	3249.2	78134	14.71
Rose	4690	110030	20.71
Tagar	3141.8	69847.8	13.14
Michelia champaka	5610	273150	51.42
Sub total	16691 (46.53)	531162	53.85
B. Shade loving			
Croton	3198	73360	41.52
Dracaena	1824	42290	23.93
Calathea	2390	61020	34.53
Sub total	7412 (20.66)	176670	17.91
C. Climbers			
Bougennvellia	3186	74082	41.48
Krishnakamal	2393	54848	30.71
Lasunvel	2090	49640	27.79
Sub total	7669 (21.38)	178570	18.10
D. Bulbous plants			
Lily	1832	44194	44.25
Canna	2261	55675.8	55.74
Sub total	4093 (12.18)	99869.8	10.12
Grand Total	35865 (100.00)	986271.8	100.00

Figures in parentheses indicate percentages to total. In each groups, percentage were worked out to group total.
* Indicates ready to sale column no.6 in Table 2.

Per nursery sale : The details of ornamental plants/seedlings sold is given in Table 4. It is revealed that at overall level, total 35865 number of ornamental plants were sold and the amount realised was Rs. 9,86,271.80. Amongst them, the highest share was of shrubs (46.53%) followed by climbers (21.38%), shade loving plants (20.66%) and bulbous plants (12.1%) and subsequently the share in amount realization was 53.85, 18.10, 17.91 and 10.12 per cent, respectively. Amongst twelve

Table 5. Disposal pattern of ornamental plants/seedlings

Particulars	Overall (N=5)		
	Seedling (Nos.)		
	Direct sold to customers	Sold to institutions	Total
A. Shrubs			
Hibiscus	2574	675.2	3249
Rose	3490	1200	4690
Tagar	2542	600	3141.8
Michelia champaka	4760	850	5610
Sub total	13366	3325	16691
	(51.34)	(33.80)	(46.53)
B. Shade loving			
Croton	2408	790	3198
Dracaena	1144	680	1824
Calathea	1390	1000	2390
Sub total	4942	2470	7412
	(18.98)	(25.11)	(20.66)
C. Climbers			
Bougennvellia	1836	1350	3186
Krishnakamal	1443	950	2393
Lasunvel	1590	500	2090
Sub total	4869	2800	7669
	(18.70)	(28.46)	(21.38)
D. Bulbous plants			
Lily	1282	550	1832
Canna	1571	690	2261
Sub total	2853	1240	4093
	(10.96)	(12.60)	(12.18)
Grand Total	26030	9835	35865
	(100.00)	(100.00)	(100.00)

Figures in parentheses indicate percentages to total.

species, the highest returns were from *Michelia champaka* (51.42%).

Disposal pattern : Information regarding the disposal pattern of ornamental plants/seedlings is given in Table 5. At overall level, nursery owners sold ornamental plants/seedlings directly to customers and to institutions.

It is observed that at overall 35865 plants/seedlings were sold, out of which 26030 directly to customers and 9835 to institutions. In shrubs, shade loving, climbers and bulbous plants, direct sale to customers was 51.34, 18.98, 18.70 and 10.96 per cent, respectively and remaining quantity was sold to institutions i.e 33.80 per cent, 25.11 per cent, 28.46 per cent and 12.60 per cent in the same order. In shrubs, maximum sale was of *Michelia champaka*, in shade loving *Croton*, in climbers *Bougainvillea* and in bulbous plants, *Canna*.

The results of the study conducted by Subrahmanyanm (1988), Shendge (1991), Hodges (2008) and Hall *et al.* (2011) are similar to the findings of the present study.

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Perception and Participation of Villagers in Activities of Adarsh Gaon Yojana

A. M. Chavai[1], A. P. Ekal[2] and S.B. Shinde[3]
Department of Extension Education, Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 (India)
(Received : 15-12-2013)

Abstract

The study revealed that nearly three fifth (64.55 %) of the villagers were in the middle age group, more than half (55.45 %) of them had education upto secondary and higher secondary, 64.55 per cent of the villagers belonged to medium sized families having six to eight members, majority of them (81.81%) had farming + dairy as their main occupation, more than half of the villagers had medium level of participation (68.19%) in social organizations, most (74.54%) of them were having an annual income between Rs. 1,43,551 to Rs. 4,47,229. While, 64.54 per cent of the villagers had used medium information sources, the 61.82 per cent of them had medium level of cosmopolitness, about half (55.46%) of the villagers had favorable attitude, most (69.09%) of the villagers had medium level of perception towards *Adarsh Gaon Yojana*. The 97.20 per cent of them had clear perception about *Kurhadbandi* prevents unnecessary cutting of trees, 80.90 per cent had clear perception about *Kurhadbandi*, facilitates growth of natural vegetation and the 67.28 per cent of them had clear perception about the growth of trees, increases precipitation. The 50 per cent villagers had clear perception about *Charaibandi*, avoid destruction of crops by stray animals. The 97.37 per cent of them had clear perception about *Nashabandi* prohibits sale of alcoholic drinks and the 90.30 per cent of them had clear perception about *Nashabandi* saves expenditure on intoxicants. While 45.46 per cent villagers had clear perception about *Shramdan* involves public sanitation and other development activities. The 42 per cent of them had medium level of participation towards *Adarsh Gaon Yojana*. The villagers regularly participated in the activities of *Kurhadbandi* (95.50%) and also motivated others to follow it (68.10%). The cent per cent villagers participated and followed the principles of *Charaibandi*, while 63.60 per cent villagers never participated in the activity of *Nasbandi*. The villagers occasionally participated in the awareness activities of Nashabandi (65.50%). The villagers participated regularly in the village development work project through *Shramdan*, *viz*., construction of gymnasium (71.82%) and school building (68.72%).

Key words : Profile, perception, participation, activities of *Adarsh Gaon Yojana*.

Development of India lies in development of villages. Mahatma Gandhi's vision of ideal, self sufficient and self reliant villages has yet to come in reality. So, it was necessary to launch a village development programme which will help in managing the local resources by making proper utilization and also lays stress on peoples participation in preparing the plan of action to it's implementation and to make a whole village a unit of development. On the eve of Golden Jubilee Celebration of "Quit India Movement" in the year 1991 the 'Adarsh Gaon Yojana' of Government of Maharashtra was launched. The criteria laid for the selection of 'Adrash Gaon Yojana' was the village belonged to the drought prone area, water scarcity is the prime problem, less than 30 per cent area under irrigation and the population below 4000. The villagers should follow the principles of *'Adrash Gaon Yojana' viz*., *Kurhadbandi*, *Charibandi*, *Nashabandi*, *Nasbandi* and *Shramadan*. The activities *viz*., the watershed development (core activities) and other development activities (non core activities) are undertaken in '*Adarsh Gaon Yojana*'. The watershed development activities are to be

1. Asstt. Professor, 2. M.Sc. (Agri.) student and 3. Head.

undertaken by non-government organization and other activities are to be undertaken by the respective government departments in consultation with the non-government organization and the people of village. The '*Adarsh Gaon Yojana*' programme is being implemented in village Lodhavade from Man tehsil of Satara District since 1995-96. For any successful development of programme perception of people about that programme is most important. Keeping this in view the present study was planned and undertaken with objectives, to study the profile of the villagers of *Adarsh Gaon Yojana*. To analyse the extent of perception and participation of the villagers towards *Adarsh Gaon Yojana* and to find out the relationship between the profile of the villagers with their perception and participation towards *Adarsh Gaon Yojana*.

Materials and Methods

The present study was conducted in the year 2013 and purposively selected *Adarsh Gaon* village Lodhavade which is situated in Man tehsil of Satara District in Maharashtra State. The total geographical area of the village is 1233.06 ha. The total cultivable area of the village is 982 ha. A list of all the farming community of the village Lodhavade was obtained from Gramsevak and Talathi. Out of that list 110 farmers were selected by using random method of selection. Simple statistical tools like percentage, mean, standard deviation and Karl pearson's correlation co-efficient were used for the analysis of data.

Results and Discussion

Profile of the villagers under *Adarsh Gaon Yojana* : The results indicated from Table 1, that a large proportion (64.55%) of the villagers belonged to the middle age group having 36 to 50 years , had secondary and higher secondary education (55.45%). Half of them belonged to medium sized families

Table 1. Profile of the villagers under Adarsh Gaon Yojana (N=110)

Particulars	Frequency	Percentage
Age		
Upto 35 years	22	20.00
36 to 50 years	71	64.55
51 and above years	17	15.45
Total	110	100.00
Education		
Illiterate	05	04.50
Pre-primary (Upto IV std.)	05	04.50
Secondary and Higher Secondary	61	55.45
College education	20	18.18
Total	110	100.00
Size of family		
Small (Upto 5 members)	32	29.09
Medium (6 to 8 members)	71	64.55
Large (9 and above members)	07	06.36
Total	110	100.00
Occuption		
Farming + Dairy	90	81.81
Poultry	07	06.36
Labour	04	03.65
Service/Job	09	08.18
Total	110	100.00
Social participation		
Low (3 score)	21	19.09
Medium (4 to 5 score)	75	68.19
High (6 and above score)	14	12.72
Total	110	100.00
(Mean =4.38, S.D.=1.18)		
Annual income		
Low (Upto Rs.1,43,550)	12	10.92
Medium (Rs.1,43,551 to 4,47,229)	82	74.54
High (Rs.4,47,230 and above)	16	14.54
Total	110	100.00
(Mean =2,95,390 S.D.=1,51,840)		
Information sources		
Less (Score upto 27)	17	15.45
Medium (Score 28 to 41)	71	64.54
More (Score 42 and above)	22	20.01
Total	110	100.00
(Mean =34.14, S.D.= 6.90)		
Cosmopoliteness		
Low (Score upto 9)	18	16.36
Medium (Score 10 to 24)	68	61.82
High (Score 25 and above)	24	21.82
Total	110	100.00
(Mean =17.16, S.D.= 8.01)		
Attitude		
Less favourable (Score upto 11)	16	14.54
Favourable (Score 12 to 13)	61	55.46
More favourable(Score 14& above)	33	30.00
Total	110	100.00
(Mean =12.11, S.D.= 1.54)		

Table 2. Distribution of the villagers according to their level of perception towards *Adarsha Gaon Yojana* (N=110)

Level of perceptions	**Frequency**	**Percentage**
Low (Score upto 54)	24	21.82
Medium (Score 55 to 67)	76	69.09
High Score 68 and above)	10	09.09
Total (Mean=60.55, S.D.=06.69)	110	100.00

Particulars about statement	**Level of perception (N=110)**		
	Clear	**Partial**	**No**
A) Criteria for selection			
Location of the village in a drought prone area	57 (51.81)	41 (37.27)	12 (10.92)
Problem of water scarcity	65 (59.09)	35 (31.82)	10 (09.09)
Irrigated area less than 30 per cent	08 (07.28)	21 (19.09)	81 (73.63)
Population less than 4000	02 (01.81)	15 (13.64)	93 (84.55)
B) Principles of *Kurhadbandi*			
Kurhadbandi prevents unnecessary cutting of trees	107 (97.27)	03 (02.73)	-
Kurhadbandi facilitates growth of natural vegetation	89 (80.90)	20 (18.20)	01 (0.90)
Natural vegetation prevents soil erosion	10 (09.09)	96 (87.27)	04 (03.64)
Growth of trees increases the growth of water table level	10 (09.09)	45 (40.91)	55 (50.00)
The growth of trees increases precipitation	74 (67.28)	18 (16.36)	18 (16.36)
Growth of trees maintain ecological and natural balance	11 (10.00)	39 (35.46)	60 (54.54)
C) Principles of *Charaibandi*			
Charaibandi helps in growing a variety of fodder grass	10 (09.09)	32 (29.09)	68 (61.82)
Animals get variety of fodder to feed upon	17 (15.46)	86 (78.18)	07 (06.36)
Growth of grass prevents soil erosion	02 (01.81)	78 (70.91)	30 (27.28)
Charaibandi prevents damage to natural resources	06 (05.45)	41 (37.27)	63 (57.27)
Charaibandi avoid destruction of crops by stray animals	58 (52.72)	47 (42.73)	05 (04.55)
Charaibandi increases utility of grazing animals	10 (09.09)	54 (49.09)	46 (41.82)
D) Principles of *Nashabandi*			
Nashabandi prohibits sale of alcoholic drinks	107 (97.27)	03 (02.73)	-
Nashabandi saves expenditure on intoxicants	100 (90.90)	08 (07.28)	02 (01.82)
Nashabandi effectively utilizes the human efficiency	02 (01.82)	53 (48.18)	55 (50.00)
Nashabandi make one's aware of family responsibility	26 (23.64)	81 (73.64)	03 (02.72)
Nashabandi checks the ill effects of using intoxicants	81 (73.64)	26 (23.64)	03 (02.72)
Nashabandi minimizes altercation in the family and village	80 (72.72)	26 (23.64)	04 (03.64)
Nashabandi nurses the social environment	56 (50.91)	50 (45.45)	04 (03.64)
Nashabandi establishes a sense of belonging	51 (46.36)	55 (50.00)	04 (03.64)
E) Principles of *Nasbandi*			
Carrying out family planning is a voluntary effort	29 (26.36)	46 (41.82)	35 (31.82)
People are motivated for family planning	10 (09.09)	75 (68.18)	25 (22.73)
Family planning limits the size of family	57 (51.82)	46 (41.82)	07 (06.36)
Family planning helps in judicious use of financial resources	07 (06.36)	55 (50.00)	48 (43.64)
Family planning gives a boost to national programme of population control	06 (05.45)	44 (40.00)	60 (54.55)
Limited families develops each and every member of the family	22 (20.00)	81 (73.64)	07 (06.36)
Limited families avoids division of land and property	21 (19.09)	76 (69.09)	13 (11.82)
A feeling of love and affection is established in small families	33 (30.00)	63 (57.27)	14 (12.73)
F) Principles of *Shramdan*			
Shramdan involves public sanitation and other development activities	50 (45.46)	53 (48.18)	07 (06.36)
No remuneration is paid for Shramdan	31 (28.18)	42 (38.18)	37 (33.64)
Remuneratoin saved is utilized for other development activities	18 (16.36)	40 (36.36)	52 (47.28)
Shramdan helps to save expenditure on labour	03 (02.73)	48 (43.64)	59 (53.63)
Any contribution through Shramdan gets prestige	23 (20.90)	56 (50.91)	31 (28.19)
Shramdan fetches atmost pride to an individual	23 (20.90)	81 (73.64)	06 (05.46)
Shramdan instills a sprit of co-operation and unity among the villagers	31 (28.19)	57 (51.81)	22 (20.00)

(65.54%), had farming + dairy as their main occupation (81.81 %), medium level of social participation (68.19%), had annual income between Rs. 1,43,551 to 4,47,229/- (74.54%), medium level of information sources (64.54%), medium level of cosmopoliteness (61.82%) and had favourable attitude (55.46%) towards *Adarsh Gaon Yojana*. These findings is similar to that of Patil *et al*. (2009) and Singh (2013).

Perception of the villagers towards *Adarsh Gaon Yojana* : Perception refers to the degree of awareness or understanding of the villagers towards the concept of *Adarsh Gaon Yojana*. The results shows from the Table 2, that the 69.09 per cent villagers had medium degree of perception towards *Adarsh Gaon Yojana*. The 51.81 per cent and 59.09 per cent villagers had clear perception about the criteria for selection of the village under *Adarsh Gaon Yojana*, that location of the village in a drought prone area and having problem of water scarcity, respectively. The 97.27 per cent of them had clear perception that *Kurhadbandi* prevents unnecessary cutting of trees, facilitates growth of natural vegetations (80.90%) and the growth of trees increases precipitation (67.28%), respectively. The 57.27 per cent villagers had no clear perception about *Charaibandi* prevents damage to natural resourses. The 97.27 and 90.90 per cent of them had clear perception that *Nashabandi* prohibits sale of alcoholic drinks and saves expenditure on intoxicants, respectively. The villagers (68.18%) had partial perception of *Nasbandi* which motivated people for family planning, while the (51.82%) villagers had clear perception of *Nasbandi* which limits the size of family. While, 45.46 per cent villagers had clear perception that *Shramdan* involves public sanitation and other development activities. This finding is similar with the findings of Tanawade (2001).

Participation of the villagers in the activities of *Adarsh Gaon Yojana* : Participation refers to the act of involving oneself actively in any kind of activity of Adarsh Gaon Yojana. It was observed from Table 3, that the 42.00 per cent villagers had medium level of participation in the activities of *Adarsh Gaon Yojana*. The 95.50 per cent and 68.10 per cent of the villagers had regularly participated in the activities of *Kurhadbandi* and also motivated others to follow it, respectively (Table 3). The cent per cent villagers participated and followed the principles of *Charaibandi*, while the 61.80 per cent of them had created awareness among the villagers about *Charaibandi*. Surprisingly it was observed that the 63.60 per cent villagers never participated in the activity of *Nasbandi*. This might be because of the fact of the traditional culture of the nation that, only women had undergone the medical operation process of *Nasbandi* and not a men due to their nature of work. The 65.50 per cent of the villagers occasionally participated in the awareness activities of *Nashabandi*, while only 18.10 per cent of them participated regularly. The 71.82 per cent and 68.72 per cent villagers participated regularly in the village development work project through Shramdan *viz*., construction of gymnasium and school building respectively. While 63.63 per cent of them had occasionally created awareness among the people about the importance of *Shramdan* in the activities of *Adarsh Gaon Yojana*. These findings is similar with the findings of Setty, 1985 and Singh 2013.

Relationship between profile of the villagers with their perception and participation towards *Adarsh Gaon Yojana* : Independent variables *viz*., age, education, annual income, social participation, information sources, cosmopoliteness and attitude had positive and highly significant relationship with the extent of their perception and participation towards *Adarsh Gaon Yojana* while size of family and occupation has shown highly negative non significant relationship with it. This might be because of the fact that, higher the age, education, annual income, social

Table 3. Distribution of the villagers according to their level of participation in the activities of *Adarsh Gaon Yojana*

Particulars	**Numer (N=11)**	**Per cent**
Less participation (score upto 19)	43	39.00
Medium participation (Score 20 to 42)	46	42.00
More participation (Score 43 and above)	21	19.00
Total (Mean =30.98, S.D.=12.30)	110	100.00

Particulars about statement	**Level of participation (N=110)**		
	Regularly	**Occassi-onally**	**Never**
A) Principles of *Kurhadbandi*			
Followed the principles of Kurhadbandi	105 (95.50)	05 (04.50)	-
Motivated other to follow Kurhadbandi	75 (68.10)	25 (22.70)	10 (09.09)
Created awareness among the villagers about Kurhadbandi	70 (63.60)	32 (29.09)	08 (07.20)
Brought to notice of the village level committee any violations	04 (03.50)	25 (22.70)	81 (73.60)
B) Principles of *Charaibandi*			
Followed the principles of Charaibandi	110 (100.00)	-	-
Motivated other to follow Charaibandi	65 (59.00)	41 (37.20)	04 (03.60)
Created awareness among the villagers about Charaibandi	68 (61.80)	38 (34.50)	04 (03.60)
Brought to notice of the village level committee any violations	-	14 (12.70)	103 (93.63)
C) Principles of Nasbandi			
Motivated others for family planning	-	40 (36.30)	70 (63.60)
Created awareness among villagers regarding family planning	-	30 (27.20)	80 (72.70)
D) Principles of *Nashabandi*			
One oneself does not consume alcohol	105 (95.50)	04 (03.60)	01 (0.90)
Dissuaded others in getting addicted to alcoholism	73 (66.30)	18 (16.30)	19 (17.20)
Created awareness regarding Nashabandi	20 (18.10)	72 (65.50)	18 (16.30)
Brought to the notice of the village level committee any violation	03 (02.72)	16 (14.50)	91 (82.70)
Banned the sale of intoxicants in the village	55 (50.00)	30 (27.20)	25 (22.70)
E) Principles of *Shramdan*			
Construction of sewage works	10 (09.09)	64 (58.10)	36 (32.70)
Construction of drinking water supply network	57 (51.80)	30 (27.22)	23 (20.89)
Construction of school building	75 (68.72)	31 (28.18)	04 (03.60)
Construction of open air auditorium	29 (26.50)	36 (32.91)	45 (40.90)
Construction of ladies community toilets	12 (10.90)	57 (51.80)	41 (37.20)
Construction of gymnasium	79 (71.82)	22 (20.00)	09 (08.23)
Construction of community hall-cum-temple	47 (42.72)	19 (17.27)	44 (40.00)
Construction of Artificial Insemination Centre	01 (0.90)	13 (11.80)	96 (87.30)
Motivating others to participate in Shramdan	06 (05.50)	62 (56.30)	41 (37.70)
Creating awareness among the people about the importance of Shramdan	37 (33.60)	70 (63.63)	03 (02.70)

Table 4. Relationship between profile with perception and participation

Particulars of characteristics	r' value perception	r' value participation
Age	0.2906**	0.2318*
Education	0.2721**	0.2721**
Size of family	-0.01517 NS	-0.1723 NS
Occupation	-0.0063 NS	0.1305 NS
Social participation	0.2450**	0.2038*
Annual income	0.2989**	0.295**
Information sources	0.2726**	0.1914*
Cosmopoliteness	0.2347**	0.2827**
Attitude	0.2530**	0.2479**

D.F. = 110, NS = Non-Significant, ** = Significant at 1 % level.

participation, information sources, degree of cosmopoliteness and attitude, greater was their perception and participation in the activities of *Adarsh Gaon Yojana*. The size of family has shown negative non-significant relationship with the extent of their perception and participation this might be because of the perception and participation of the villagers in the programme was not influenced by their size of family. The principles of *Shramdan* might have compelled the villagers who belonged to both small or large sized families to participate equally in the activities of *Adarsh Gaon Yojana* by motivating them to take benefit of the programme by involving themselves in it. An occupation has also shown negative non-significant relationship with the extent of their perception and participation towards *Adarsh Gaon Yojana*, this might be because of the fact that *Adarsh Gaon Yojana* makes attempts for overall development of village instead of giving stress on farming or only dairying etc. This makes the villagers to create interest and understanding of the programme irrespective of their occupation indicating that perception and participation of villagers was not influenced by their occupation. These findings is similar with the findings of Tanawade (2001), Patil *et al.* (2009) and Deshmukh *et al.* (2009).

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Study of Acreage response of the Pigeon Pea in the Western Vidarbha region of Maharashtra State

B. N. Ganvir[1], A. A. Bhopale[2] and U. J. Dhakal[3]
Department of Agricultural Economics and Statistics, Dr. PDKV, Akola - 444 104 (India)
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Abstract

The study revealed that at overall period, the compound growth rate for almost all the districts in Amravati Division increased per annum in the area as well as in the production for pigeon pea and was found statistically significant. It was found that there was drastically declined in the growth rate of area, production and productivity in period II and period III as compared to period I. The highest increase trend in area and production was found in Akola district and productivity in Buldhana district. The lowest coefficient of variation for area and production (5.01 and 12.58 % respectively) and lowest Coppock's Instability Index for production and productivity (12.27 and 11.43 %, respectively) were found in Amravati district. At overall period, the area effect was stronger factor however, in period II and period III yield effect showed stronger effect for increasing production of pigeon pea in all the districts. The result of district wise acreage response function revealed that value of R^2 ranged from 0.67 to 0.95 indicating that the variables included in the model explained most of the variations in area. Coefficient of one year lagged farm harvest price were less in all the cases and negative in case of Akola. Akola district indicated that the prices doesn't show any impact to increase the area of pigeon pea in the region. The short run and long run price elasticity of hectareage of pigeon pea showed positive price responsiveness of farmers except in Akola district (-0.68 and -0.10, respectively) while long run greater than short run price elasticity indicates that farmers were relatively market oriented in their decisions in the long run than in the short run.

Key words : Acerage, pigeon pea, instability, decomposition, short run, long run.

Pulses are a wonderful gift of nature as they nourish mankind with highly nutritive food and keep the soil alive and productive. On account of these virtues, pulse crops remained an integral part of the sustainable agriculture production systems of the semi-arid tropics. Pulses occupy 67.8 million hectares of area and contribute 55.2 million tonnes to the world's food basket (Gowada 2013). India is the largest producer and consumer of pulses in the world, accounting for 33 per cent of the world area and 22 per cent of world in production of pulses. Pigenopea is traditionally a *kharif*-sown (June-July) crop with an average yield of 660 kg ha^{-1}. Among total pulses, the pigeon pea accounts for 14.5 per cent in area and 15.5 per cent in production. Maharashtra is the largest producer with approximately 13.85 lakh hectare area with average productivity of 803 kg ha^{-1} and in Maharashtra, Vidarbha region contributes 5.9 lakh ha area which is 42.59 per cent of the total area in the state. Out of all pulses, pigeon pea shares the second largest production after chickpea which is 20 per cent of the overall pulses production. Acreage response of agricultural crop is one of the important procedure tools predicting crop production, when tries to measure the volume of agricultural commodities changes the trend of such production phenomenon (supply response). Thus, the function of functional changes in per acre production of its agricultural crop with respect to the change of its market price is known as the crop acreage response. Thus, the present study was confined

1. Professor and Head., 2. SRA and 3. M.Sc. student.

to the study of acreage response of the Pigeon Pea in the Western Vidarbha region of M.S. The studies on acreage response are useful to realize the farmer's attitude about the price and other relevant factors. However, the magnitude of farmer's response to price and other non-price variables may vary from region to region due to difference in agro-climatic and technological factors.

Materials and Methods

Western Vidarbha zone consist of four districts *viz*., Akola, Buldhana, Amravati & Yavatmal which forms Amravati Division. For the present study pigeon pea was selected. The selected crop occupied more than 9 per cent of the gross cropped area. Based on the objective of the study, for the analysis of growth rates, decomposition and acreage response, the period was divided into breakup of 10 years (Period I 1980-81 to 1989-90, Period II 1990-91 to 1999-2000, Period III 2000-01 to 2009-10 and overall period 1980-81 to 2009-10). Time series secondary data on the area, production and productivity of pigeon pea, annual rainfall, farm harvest price and other data were collected from various government published sources.

Growth rate analysis : The compound growth rate of area, production and productivity of pigeon pea was estimated for three sub periods as Period I1980-81 to 1989-90, Period II 1990-01 to 1999-2000 and Period III was 2000-01 to 2009-10.The district-wise compound growth rates of area, production and productivity were estimated by using following exponential model.

$$Y = ab^t$$

$$\text{Log } Y = \log a + t \log b$$

$$CGR = \{\text{Antilog } (\log b)-1\} \times 100$$

Where, CGR = Compound Growth Rate, t = Time period in a year, y = area/production/ productivity, a and b = Regression parameters and t test applied for significance of b.

Instability Analysis : To measure the instability in area, production and productivity, an index of instability was used as a measure of variability.

$$CV (\%) = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

The simple coefficient of variation (CV) often contains the trend component and thus overestimates the level of instability in time series data characterized by long-term trends. To overcome these problems, Coppock's instability index of variation was used.

Coppock's instability index is a close approximation of the average year to year per cent variation adjusted for trend. The algebraic form of equation is -

$$CII = \Sigma[(\text{Antilog} \sqrt{V \log}) = 1 \times 10_0]$$

$$V \log = \Sigma\{[\log (X_t + 1)/X_t] - m\}^2 / N-1$$

Where, xt = area/production/productivity in year t, N = Number of years M = Arithmatic Mean and V log = Logarithmic variable of series

Decomposition of output growth : To measure the relative contribution of area, yield to the total output change for the major crops the decomposition analysis model was used and studied growth performance of crops in the state. A_0, P_0 and Y_0 are area, production and productivity in base year and An, Pn and Yn are values of the respective variable in n^{th} year item respectively.

$$P_0 = A_0 \times Y_0 \text{ and}$$

$$P_n = A_n \times Y_n \quad \ldots\ldots\ldots\ldots\ldots (1)$$

$$Yn - Yo = \Delta Y \ldots\ldots (2)$$

From equation (1) and (2) we can write

$$Po + \Delta P = (Ao + \Delta A)(Yo + \Delta Y)$$

Hence,

$$P = \frac{A0\ \Delta Y}{\Delta P} \times 100 + \frac{Y0\ \Delta A}{\Delta P} \times 100 + \frac{VY\ \Delta A}{\Delta P} \times 100$$

Production = Yield effect + area effect + interaction effect

Thus, the total change in production can be decomposed into three components *viz*., yield effect, area effect and the interaction effect due to change in yield and area

Acreage response analysis : The model adaptive expectations or (Distributed Lagged) which generally used in supply response analysis based on time series data called as Regression model of the Nerlovian Lagged Adjustment Model (1958) has been used in the present study. The acreage response means the change in acreage with the unit change in the variables affecting on during the period of study.

$$At = a + b_1 A_t\text{-}1 + b_2 FHP_{t-1} + b_3Y_{t-1} + b_4W_t + b_5PR + b_6Y_R$$

The two models *viz*., Linear Regression Model and Cobb-Douglas Model were tested and out of these two models finally Linear Regression Model was selected on the basis of number of significant variables, desired signs of estimated regression coefficient and highest R^2 values.

Short run and long run elasticity : The elasticity's of variables shows that the influence of unit change in variable on acreage decisions of crop. In the present study, variable elasticity's were estimated for short run as well as for long run period.

Short Run Elasticity (SRE) = Regression coefficient of price x Mean of price/Mean of area

Long run elasticity (LRE) = SRE / Coefficient of area adjustment (r)

Result and Discussion

Growth performance of pigeon pea : Table 1 revealed that during period I almost all

Table 1. District wise compound growth rate for pigeon pea

Particular		Buldhana	Yavatmal	Akola	Amravati	Amravati division
Period I	Area	4.74 **	7.45**	10.47**	8.28**	7.85**
	Production	11.40 *	6.60*	15.43**	14.40**	11.68**
	Productivity	6.35*	-0.81	4.47*	5.19*	3.55
Period II	Area	1.54	2.70 *	3.76	1.02	1.60*
	Production	2.85	7.38*	13.93**	6.18	7.51
	Productivity	1.32	4.56	12.93*	5.20	5.82
Period III	Area	1.46*	-2.40	2.30**	0.119	0.084
	Production	4.98	-7.83	2.81	0.93	-1.22
	Productivity	3.14	-4.96	0.49	0.80	-1.29
Overall period	Area	1.90**	3.02 **	3.34**	2.64**	2.80**
	Production	2.35 *	2.99 **	4.42**	3.26**	3.45**
	Productivity	0.46	0.12	1.03	0.45	0.63

* Significant at 5% level and ** Significant at 1% level

the districts of Amravati division registered positive growth of area, production and productivity of pigeon pea including the division as a whole except the productivity of Yavatmal district. The highest increasing trend in area and production of pigeon pea was registered in Akola district followed by Amravati district. However, the highest growth in the productivity was recorded in Buldhana district (6.35% annum^{-1}) followed by Amravati (5.19% annum^{-1}) and Akola (4.47% annum^{-1}). Statistically all the districts and as a whole Amravati division the growth of area showed significance at 1 per cent level and growth production in Buldhana and Yavatmal showed significance at 5 per cent level and other district including Amravati division showed significance at 1 per cent level. The growth rate of productivity in Akola and Amravati districts shows the significance statistically at 5 per cent level in the period I.The result revealed that the area, production and productivity in Akola district showed increasing trend during the period II. The result shows that, Akola district recorded highest growth in production and productivity of pigeon pea i.e. 13.93 per cent annum^{-1} and 12.93 per cent annum^{-1}, respectively. Similarly, Yavatmal district showed increasing trend in area and production. The area under pigeon pea in Yavatmal district increased by 2.70 per cent annum^{-1} and the production increased by 7.38 per cent annum^{-1}. In Yavatmal district it has been found significant in both area and production at 5 per cent level of significance and Akola district also showed significance at 5 per cent and 1 per cent in compound growth rate of production and productivity, respectively in this period whereas as Amravati Division as whole showed significance of compound growth rate only in area at 5 per cent level of significance. During period III, the picture drastically changed that there was negative growth rate in the area, production and productivity i.e. -2.40 per cent, -7.83 per cent and -4.96 per cent annum^{-1}, respectively in Yavatmal district while in

Table 2. District wise instability indices in pigeon pea

Name of district	Particular	Period I		Period II		Period III		Overall	
		CV	CII	CV	CII	CV	CII	CV	CII
Buldhana	Area	17.04	5.65	12.29	11.64	5.30	3.57	20.34	11.82
	Production	39.80	25.43	37.07	36.17	35.32	31.32	39.24	33.99
	Productivity	26.85	21.62	29.77	29.50	28.03	26.01	27.27	27.02
Amravati	Area	34.16	12.95	5.63	4.88	5.01	5.003	27.20	14.92
	Production	42.90	19.92	27.11	22.18	12.58	12.27	33.02	22.38
	Productivity	17.58	11.43	23.78	20.06	13.44	13.18	18.04	17.68
Yavatmal	Area	21.52	5.01	11.12	7.56	7.48	4.003	27.56	14.44
	Production	25.48	16.11	31.03	22.99	41.13	25.63	39.01	29.30
	Productivity	13.28	13.08	24.17	20.24	24.85	16.67	21.12	21.10
Akola	Area	29.49	12.20	4.39	3.76	8.06	4.83	28.17	12.47
	Production	45.50	15.28	41.03	23.73	34.17	33.28	48.35	31.25
	Productivity	20.36	14.93	39.25	24.53	29.89	29.86	30.90	29.64
Amravati division	Area	24.85	7.29	6.67	4.69	2.30	2.28	25.22	11.28
	Production	37.41	17.11	29.95	22.70	15.92	15.64	35.35	22.91
	Productivity	17.32	15.01	25.68	20.59	15.46	15.13	19.42	18.76

CV = Coefficient of variation, CII = Coppock's instability index

Buldhana and Akola districts the compound growth rate of area was positive and statistically significant with 5 per cent level of significance and 1 per cent level of significance in Akola district and in the rest of the district it was not significant. In Amravati district area, production and productivity increased at decreasing rate. In the Amravati division as a whole, in period III, the growth rate in production and productivity was registered negative and non-significant. The growth rate was also worked for the overall period (pooled period of 30 years) for pigenopea where almost all found to be positive. The compound growth rate of area in all districts showed significance at 1 per cent level, production except in Buldhana all other districts showed significance at 1 per cent level whereas Buldhana showed significance for 5 per cent and productivity was registered positive for all districts but statistically non-significant during 30 years period. At overall level, the table shows that the compound growth rate in area and production for all districts as well as division as a whole has increased over the period of (30) years and which is statistically significant. It was also noted that in whole Amravati Division, Akola district showed highest increase in area, production and productivity in pigeon pea. Similar results were recorded by Chaudhary and Pawar (2010).

Instability in pigeon pea : The table 2 revealed that during period I, coefficient of variation for the area was less as compared to production and productivity except in Buldhana. In Buldhana district coefficient of variation for the area was 17.04 per cent annum^{-1} whereas coefficient of variation for the productivity was 26.85 per cent annum^{-1}. The highest coefficient of variation for area was found in Amravati district i.e. 34.16 per cent annum^{-1}. For the production, Akola district showed the highest coefficient of variation i.e. per cent annum^{-1} and for productivity Buldhana district has recorded highest coefficient of variation i.e. 26.85 per cent annum^{-1}. Amravati division as a whole the coefficient of variation was 24.8 per cent, 37.41 per cent and 17.32 per cent annum^{-1}, respectively for the area, production and productivity during period I. Coppock's instability index was found highest for area in the Amravati district i.e. 12.95 per cent annum^{-1} and for production and productivity, Buldhana district recorded the highest 25.43 per cent and 21.62 per cent

Table 3. District wise per cent contribution of area, yield and their interaction for increasing production of pigeon pea

Particular	Particulars	Buldhana	Yavatmal	Akola	Amravati	Amravati division
Period I	Area effect	55.13	36.49	276.96	66.74	76.18
	Yield effect	24.39	32.18	-37.69	18.40	10.78
	Interaction effect	20.44	31.20	-139.10	14.75	13.04
Period II	Area effect	2.5	9.08	12.5	19.45	12.42
	Yield effect	94.68	82.49	78.76	61.66	75.64
	Interaction effect	2.53	8.34	8.90	18.86	11.54
Period III	Area effect	6.24	11.59	5.16	23.95	17.59
	Yield effect	82.44	75.49	92.28	85.96	80.04
	Interaction effect	11.15	12.85	2.31	-9.92	2.55
Overall period	Area effect	52.18	28.02	212.39	117.28	80.12
	Yield effect	20.21	27.40	-17.40	-7.69	6.85
	Interaction effect	27.54	44.49	-95.04	-9.64	13.02

annum^{-1}, respectively. On the other hand it showed Coppock's instability index in the range of 5 to 20 per cent annum^{-1} which indicate inconsistent in the area, production and productivity of pigeon pea in all the districts of Amravati division. On the other hand high production instability than area and yield instability was estimated for all the districts of western Vidharba zone as well as zone as a whole contributed towards production fluctuation in the period I.

The instability in the area was found to be decreased in period III except the area of Akola district which had increased coefficient of variation 4.39 per cent annum^{-1} to 8.06 per cent annum^{-1}. Similarly, instability in production and productivity has been decreased in all the districts and Amravati division as a whole except Yavatmal district witch increased from coefficient of variation 31.03 per cent to 41.1 per cent annum^{-1} in production and coefficient of variation from 24.17 per cent to 24.85 per cent annum-1 in the productivity. Similarly, Coppock's instability index decreased in almost all the districts. Coppock's instability of Yavatmal & Akola increased from 22.99 per cent to 25.63 per cent annum^{-1} and 23.73 per cent to 33.28 per cent annum^{-1}, respectively. Coppock's instability index for Akola the yield increased from 24.53 per cent to 29.86 per cent annum^{-1}. Overall Coefficient of Variation and Coppock's instability index for area were obtained in the whole western Vidharba i.e. 2.30 per cent and 2.28 per cent annum^{-1} respectively and in the districts it showed 5 per cent to 35 per cent annum^{-1} which showed least consistency. During the overall period i.e. 30 years as a whole, Buldhana district recorded lowest degree of instability in area i.e. CV 20.3 per cent and CII 11.8 per cent annum^{-1}. Similarly in production and yield Amravati district was recorded with lowest CV 33.02 per cent and CII 22.3 per cent annum^{-1} and CV 18.04 per cent and CII 17.68 per cent annum^{-1}, respectively whereas Akola recorded highest instability in area i.e. CV 28.17 per cent annum^{-1} but Yavatmal showed in CII i.e. 14.9 per cent annum^{-1}. Akola in the production as well i.e. 48.3 per cent and CII 31.2 per cent annum^{-1} and in the yield Akola again shows highest CV i.e. 30.9 per cent annum^{-1} but through CII Amravati district came highest by 17.68 per cent annum^{-1} during overall period. Thus, it indicates least consistency in terms of area, production and

Table 4. District wise Results of acreage response function of pigeon pea

Particulars	Variables	Coefficients				
		Buldhana	Yavatmal	Akola	Amravati	Amravati division
	Intercepts	124.36	64.35	176.77	21.96	406.68
One year lagged area	A_{t-1}	0.46**	0.84***	0.84***	0.60***	0.84***
One year lagged farm harvest price	FHP_{t-1}	0.06*	0.04	-0.05	0.09	0.05
One year lagged yield	Y_{t-1}	0.007	0.006	0.038	0.090	-0.12
Annual rainfall	w_t	0.06	0.033	-0.094	0.023	0.052
Yield risk	Y_r	0.83	0.032	2.16	0.43	4.15
Price risk	P_r	1.24	2.12	-1.11	3.60	-1.51
Coefficient of determination	R^2	0.79	0.94	0.67	0.85	0.95

* Significant at 10% level, ** at 5% level and *** 1 % level

productivity during overall period of 30 years. Similar, results were reported by Shukla (1998) and Tripathi and Gowada (1993.)

Decomposition analysis of pigeon pea : The decomposition of pigeon pea production in area, productivity and interaction effect is presented in Table 3 and results demonstrate per cent contribution of area, productivity and their interaction for increasing production of pigeon pea in Western Vidarbha (i.e. Amravati division) and overall also. During period I , the result clearly indicate that the area effect 76.18 per cent was most responsible for increasing the production of pigeon pea in Amravati Division with yield effect 10.78 per cent and interaction effect 13.04 per cent. Interaction effect was positive for all the districts except Amravati which shows interaction effect of -139.10 per cent with yield effect -37.69 per cent and the district has recorded highest area effect i.e. 276.96 per cent. Yield effect was also showed negative only in the Amravati district. Akola district showed all the effect nearer to be proportional and in other, area effect has played a driving force in the differential production of pigeon pea in Amravati Division during period I. On the contrary during period II, it was noticed that yield effect has dominated over the area effect. In Amravati Division as a whole, area effect was found only 12.42 per cent whereas yield effect was 75.64 per cent and interaction effect was 11.54 per cent. The lowest area effect was found in the Buldhana district i.e. 2.5 per cent and highest yield effect was also found in this district with 94.68 per cent. In all the districts yield effect was higher i.e. more than 60 per cent. It was also noted that in this period the interaction effect was positive in all the districts and over Amravati division as a whole. Period III was also recorded as like the period II but area effect has been shown increased somehow. In whole Amravati Division, area effect, yield effect and interaction effect was recorded 17.59 per cent, 80.04 per cent and 2.55 per cent, respectively. The highest area effect was shown in Yavatmal district i.e. 23.95 and negative interaction effect was also shown in this district i.e. -9.92 per cent. The highest yield effect and lowest area effect were observed in Amravati district i.e. 92.28 per cent and 5.16 per cent respectively. So it can be concluded that in this period also yield effect was responsible for increasing production of pigeon pea in the Western Vidarbha Region of Maharashtra which may be because of the introduction of the HYVs and improved technology of production. During overall period, area effect was found most responsible factors for increasing pigeon pea production in Amravati division i.e. 80.12 per cent with positive yield and interaction effect i.e. 6.85 per cent and 13.02 per cent, respectively. The highest area effect was observed in Amravati division i.e. 212.39 per cent with both negative yield and interaction effect i.e. -17.40 and -95.04 per cent, respectively. Yavatmal district also recorded negative yield and interaction effect in this overall 30 years period i.e. -7.69 per cent and -9.64 per cent, respectively where remaining districts had got all the positive effect. And it was also observed that the highest interaction effect and yield effect was found in Akola district i.e. 44.49 per cent and 27.40 per cent, respectively. Similar results were reported by Shadmehri (2010).

Acreage response of pigeon pea : Table 4 presented the disrictwise estimated hectareage response functions of pigeon pea

Table 5. District wise price elasticity of pigeon pea in western Vidarbha

Name of districts	SRE	LRE
Buldhana	0.17	0.32
Yavatmal	0.058	0.36
Akola	-0.10	-0.68
Amravati	0.155	0.39

grown in most of the part of the Western Vidharba Zone of Maharashtra. On the basis of number of significant variables, a desired sign of estimated regression coefficient and higher R2 values Linear Nerlovian Lagged Adjustment Model was selected with the price and non price variables. With a view of estimating the response of producers in terms of pigeon pea area towards price and non price factors the actual area in the current year was expressed as a linear function of one year lagged area, one year lagged farm harvest prices, one year lagged yield, average annual rainfall, yield risk and price risk. The regression coefficient of these explanatory variables are presented in Table 4 revealed that the lagged area was found to be positively influential factors in the farmer's decision regarding area allocation to pigeon pea and found significant at 1 per cent level of significance in Yavatmal, Akola, and Amravati districts and 5 per cent level of significance in Buldhana district of Amravati division which indicated lesser rigidity in the adjustment of area under pigeon pea.The coefficient of farm harvest price were very less i.e. 0.06, 0.04, -0.05 and 0.09 in Buldhana, Yavatmal, Akola and Amravati districts, respectively. It was significant at 10 per cent level of significance only in Buldhana district which implies less and negative relationship between the variations in the acreage of pigeon pea and farm harvest price. It implied that prices had not shown any impact in the increase on area of pigeon pea in the study period. One year lagged yield was also included in the function but the coefficient turned out to be very small and negligible and non-significant which implies that one year lagged yield had no impact or very less impact to area allocation of pigeon pea in all the districts of western Vidarbha zone of Maharashtra. The annual rainfall was employed as a proxy for combating the weather influence on the pigeon pea acreage allocation decisions. The coefficient of annual rainfall variable showed positive relationship for Buldhana, Yavatmal and Amravati districts and negative relations to Akola district and statistically insignificant in all the districts which showed annual rainfall favourably didn't influence the area allocation decision of the farmers and in Akola district it did produced the negative relationships. The yield risk variable was incorporated in the model to gauge the impact of risk over the variation in the acreage under pigeon pea. The coefficient of variable had a positive and statistically non-significant response in all the districts of Amravati division which shows farmers are relatively better risk bearers. It was also recorded that regression coefficient of price risk variables were positive in all the districts except Akola district. In all these three districts cases, it indicate that farmers were relatively better risk bearers but were statistically non significant whereas in Akola negative relationship testified to the farmers risk aversion behaviour in pigeon pea production.The value of the coefficient of determinations ranged from 0.67 to 0.94 for all the districts of Amravati division. 0.67 was found in Akola districts and it was 0.79, 0.94, and 0.85 found in Buldhana, Yavatmal and Amravati district, respectively which indicates that variables included in the model explained most of the variations in area under pigeon pea in the study period. Similar results were also recorded by Acharya and Bhatia (1974) and Bhowmick and Ahmed (1993.)

Short run and long run elasticity : The variation in the magnitude of short run and long run price elasticity factors between different districts of Western Vidarbha zone were evident from the Table 5. The short run and long run price elasticities of pigeon pea showed positive price responsiveness of farmers in all the districts of Amravati division except Akola district which turned out to be surprisingly negative. It was negative , that it represents the prices were inelastic with acerage allocation. The pigeon pea is cultivated as intercrop with cotton. Hence the prices of pigeon pea was not much sensitive and responsive with area. The short run price elasticity for different districts were 0.17, 0.058, 0.155 and -0.10 for Buldhana, Yavatmal, Amravati and Akola districts, respectively. The highest short run price elasticity was found in the Buldhana district and negative price elasticity was found in the Akola district i.e. -0.10 which is fairly highest and is called for further investigation. The long run elasticity for Buldhana, Yavatmal, Amravati and Akola districts were 0.32, 0.36, 0.39 and -0.68 respectively. Akola districts again reveal negative price responsiveness for long run as well. It can be observed from the table 5 that long run price elasticities are comparatively higher than the short run price elasticity indicated that the farmers were relatively market oriented in their decisions in the long run than in the short run in respect to the pigeon pea in the Western Vidharba Region of the Maharashtra.

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Economics of production and Marketing of *Lathyrus* in Chandrapur district

B. N. Ganvir[1], A. A. Bhopale[2] and R. S. Shende[3]
Department of Agricultural Economics and Statistics, Dr. PDKV, Akola - 444 104 (India)
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Abstract

The present study data was collected from 96 lathyrus cultivators from four tehsils *viz*., Nagbhid, Sindewahi, Bramhapuri and Saoli of Chandrapur district for the year 2008-09. At overall level net sown area was 2.16 hectare and *Lathyrus* was in 1.13 hectare area of the gross cropped area with cropping intensity 188.43 per cent. Paddy was leading crop in the cropping pattern and accounted for more than 50 per cent area. Per hectare cost "A", "B" and "C" were Rs. 3652.33, Rs. 5406.25 and Rs. 5917.08 at overall level, respectively. There was no expenditure on components like fertilizer, irrigation and plant protections. The overall yield hectare^{-1} observed was 4.70 quintals. The quintal^{-1} cost of cultivation in Lathyrus was Rs. 1075.95, Rs. 1137.04 and Rs. 1058.53 in small, medium and large farmers, respectively. Overall quintal^{-1} cost of cultivation for *Lathyrus* was Rs. 1094.18. The net return quintal^{-1} obtained by small farmers was Rs. 595.41, by medium farmers was Rs. 491.50 and by large farmers was Rs. 537.90. Overall net return quintal^{-1} obtained was Rs. 552.44. Overall input-output ratio was found to be 1.44 at cost 'C'. Two marketing channels are identified in marketing of lathyrus *viz*., Channel-I : Producer→Consumer. Channel-II : Producer→Retailer→Consumer. Overall marketing cost incurred by producer was Rs. 31.55 and Rs. 43.86 quintal^{-1} in Channel-I and Channel-II, respectively. Overall quintal^{-1} total marketing cost incurred was Rs. 31.55 and 92.33 in channel-I and channel-II, respectively. In channel-I, the producer's share in consumer rupee was 99.22 per cent, 98.15 per cent and 98.15 per cent in case of small, medium and large farmers, respectively. Overall producer's share in consumer rupee was 98.19 per cent. Price paid by consumers was less in channel-I than channel-II in small, medium and large farmers. Channel-I was more beneficial from the producers and consumers point of view.

Key words : Lathyrus, cost of cultivation, marketing, producers share in consumers rupee.

India is a major pulse producing country which accounts for 33 per cent of the total area and 25 per cent of production in the world. *Kharif* pulses cover 45 and 30 per cent of total area and production, whereas *rabi* pulses cover 55 and 64 per cent, respectively.

It is common belief that the *lathyrus* is taken in India in *rabi* season in October-November as a winter crop before harvesting of rice known as Utera crop. *Lathyrus* is mostly grown as rainfed crop in marginal lands under minimum or zero input level. Few studies have been conducted to optimize seed rate, plant establishment and inter/mixed cropping ratios. Pulses are richest source of protein, however per capita availability of pulses in India has been continuously decreasing (32.5 g against the requirement of 80 g). Pulses production has been stagnated between 11 to 15 million tones in the last decade, while the requirement of pulses is estimated to increase to about 20 million tones by 2015. The seed of *Lathyrus* contain 25 to 28 per cent protein, 0.6 to 1 per cent fat, 45 to 61 per cent carbohydrate and 3 per cent mineral matter. Being a pulse crop, provides much protein to consumer and also helps to maintain the fertility level of soil by fixing the atmospheric nitrogen through bacteria present on root nodules of *Lathyrus*. Generally it adds 68 kg nitrogen hectare^{-1} in a

1. Professor and Head, 2. SRA and 3. M.Sc. student.

single season. It is, therefore, required to study the economic aspects of *Lathyrus* in terms of its profitability and producers share in consumers rupee.

In this study an attempt has been made to investigate the problem of both production and marketing of *Lathyrus*, the existing level of utilization of different inputs on the farm of *lathyrus* grown in the area of Chandrapur district.

Materials and Methods

Data was collected in the specially prepared questionnaire. The primary data collected from the selected farmers by the interview method. Simple tabular analysis was carried out to workout hectare^{-1} cost of production, gross returns, net returns, marketing cost and price-spread for the different channels. Total 96 farmers from the villages under consideration who have raised *Lathyrus* during the year of investigation were selected on random sampling basis and categorized into small, medium and large size groups.

Cost concept : Cost " A": It is actual cost paid by owner cultivator both in cash and kind. It include expenses on all variable items is analogous to cost of cultivation. Cost "B" : Cost B = Cost "A" + Rental value of land + Interest on fixed capitals. Cost "C" :Cost C = Cost "B" + Imputed value of family labour. Net returns hectare^{-1} : Net Return = Gross Return - Cost "C"

Cost of cultivation hectare^{-1} : The cost of cultivation is equivalent to the total variable cost. The Cost A is worked out in respect of each land holding group and for all land holding groups taken together, further Cost B and Cost C for the said group have been worked out.

Net returns hectare^{-1} : The net return hectare^{-1} is worked out under each land holding group by subtracting the Cost A, Cost B and Cost C, respectively from the gross monetary

Table 1. Average cropping pattern of selected farmers (Area in hectare)

Crop	Size of land holding			
	Small	Medium	Large	Overall
Kharif				
Paddy	1.35 (49.81)	3.04 (53.62)	6.14 (55.82)	2.14 (52.58)
Tur	0.01 (0.37)	0.00 (0.00)	0.10 (0.91)	0.01 (0.25)
Soybean	0.01 (0.37)	0.00 (0.00)	0.00 (0.00)	0.01 (0.25)
Total A	1.37 (50.55)	3.04 (53.62)	6.24 (56.73)	2.16 (53.08)
Rabi				
Lathyrus	0.97 (35.79)	1.45 (25.57)	1.61 (14.64)	1.13 (27.76)
Wheat	0.15 (5.54)	0.62 (10.93)	2.02 (18.36)	0.41 (10.07)
Gram	0.18 (6.64)	0.44 (7.76)	0.75 (6.82)	0.29 (7.12)
Pea	0.01 (0.37)	0.08 (1.41)	0.00 (0.00)	0.02 (0.49)
Udid	0.03 (1.11)	0.04 (0.71)	0.05 (0.45)	0.03 (0.74)
Total B	1.34 (49.45)	2.63 (46.38)	4.43 (40.27)	1.88 (46.18)
Summer				
Paddy	0.00 (0.00)	0.00 (0.00)	0.33 (3.00)	0.03 (0.74)
GCA	2.71 (100.00)	5.67 (100.00)	11.00 (100.00)	4.07 (100.00)

Figures in parenthesis indicates percentage to the gross cropped area return hectare^{-1}.

Cost of production quintal^{-1} : The cost of production quintal^{-1} is worked out by using the formula;

$$\text{Per quintal cost of production} = \frac{\text{Cost C}}{\text{Out put}}$$

Input-output ratio : The input-output ratio are worked out with reference to Cost A, Cost B and Cost C. The importance of working out of input-output ratio with reference to cost is to judge the efficiency of farm inputs.

a) Input-output ratio at Cost "A"
Input-output ratio = Gross return/Cost A

b) Input-output ratio at Cost "B"
Input-output ratio = Gross return/Cost B

c) Input-output ratio at Cost "C"
Input-output ratio = Gross return/Cost C

Marketing margin and price spread : Data were collected from farmers and retailers, about the price spread, labour charges, transportation costs, commission charges and other expenses if any and also the price received by them.

Table 2. Average per holding fixed capital investment of selected lathyrus growers (Amount in Rs. holding^{-1})

Particulars	Small	Medium	Large	Overall
Land	1378254 (96.35)	3756211 (96.27)	7048236 (97.08)	2450619.79 (96.58)
Farm Building	1818.23 (0.13)	3573.53 (0.10)	5710.31 (0.08)	2544.83 (0.11)
Well	2545.46 (0.18)	10227.27 (0.26)	10000 (0.14)	4927.08 (0.19)
Implements & Machinery	17901.91 (1.25)	86928.23 (2.23)	126149.3 (1.73)	42741.27 (1.68)
Livestock	29910.68 (2.09)	44610.39 (1.14)	70250 (0.97)	36590.41 (1.44)
Total (including land)	1430430.28 (100.00)	3901550.42 (100.00)	7260345.61 (100.00)	2537423.38 (100.00)
Total (excluding land)	52176.28 (3.65)	145339.42 (3.73)	212109.61 (2.92)	86803.59 (3.42)

Figures in parenthesis indicates percentage to the total

Table 3. Per hectare utilization of physical inputs for cultivation of lathyrus

Particulars	Unit	Size of land holding			
		Small	Medium	Large	Overall
Hired Labour					
(a) Male	Days	2.30	1.70	4.17	2.35
(b) Female	Days	22.62	25.14	22.48	23.32
Total(a+ b)	Days	24.92	26.84	26.65	25.67
Family Labour					
(a) Male	Days	3.79	3.13	5.04	3.75
(b) Female	Days	8.33	7.60	7.44	8.02
Total (a + b)	Days	12.12	10.73	12.48	11.77
Bullock Pairs	Days	0.03	0.10	0.08	0.06
Machinery Hours	Hrs.	1.43	1.37	1.32	1.42
Seeds	kg	75.57	73.04	70.85	74.29
Main produce	Qt.	4.62	4.74	5.06	4.70

a) Marketing channel : Marketing channels are the route through which produce move from producer to consumer. In the study area following two marketing channels were observed. Channel I: Producer → Consumer. Channel II: Producer → Retailer → Consumer.

b) Marketing cost : Marketing cost will

Table 4. Average hectare^{-1} cost of cultivation of lathyrus (Rs. ha.)

Particulars	Unit	Small		Medium		Large		Overall	
		Unit used	Total cost	Unit used	Total cost	Unit used	Total cost	Unit used	Total cost
Hired human labour									
a) Male	Days	2.30	140.77 (2.46)	1.70	100.42 (1.62)	4.11	271.32 (4.38)	2.35	144.88 (2.45)
b) Female	Days	22.62	769.91 (13.45)	25.14	880.50 (14.23)	22.48	917.05 (14.79)	23.32	818.66 (13.84)
Machinery hours	Hrs.	1.43	593.08 (10.36)	1.37	558.53 (9.02)	1.32	503.88 (8.13)	1.42	580.08 (9.80)
Seeds	kg	75.57	1223.45 (21.37)	73.04	1185.52 (19.16)	70.85	1182.48 (19.08)	74.29	118.72 (20.60)
Incidental charges	Rs.		20.33 (0.36)		30.81 (0.50)		23.26 (0.38)		37.93 (0.64)
Land revenue	Rs.		19.17 (0.33)		49.56 (0.80)		38.76 (0.62)		30.09 (0.51)
Depreciation	Rs.		375.79 (6.56)		410.05 (6.63)		405.61 (6.54)		365.09 (6.17)
Interest on working capital	Rs.		193.78 (3.39)		194.62 (3.14)		213.98 (3.45)		197.18 (3.33)
Cost A	Rs.		3336.28 (58.28)		3410.01 (55.10)		3556.34 (57.37)		3392.63 (57.34)
Rental value of land	Rs.		1393.33 (24.34)		1370.23 (22.14)		1446.28 (23.33)		1388.83 (23.47)
Interest on fixed capital	Rs.		480.80 (8.40)		957.08 (15.46)		559.52 (9.03)		624.79 (10.56)
Cost B	Rs.		5210.41 (91.02)		5737.32 (92.70)		5562.14 (89.73)		5406.25 (91.37)
Family labour charges									
a) Male	Days	3.79	226.55 (3.96)	3.13	184.87 (2.99)	5.04	342.64 (5.53)	3.75	228.57 (3.86)
b) Female	Days	8.33	287.23 (5.02)	7.60	266.87 (4.31)	7.44	293.80 (4.74)	8.02	282.26 (4.77)
Cost "C"			5724.19 (100.00)		6189.06 (100.00)		6198.58 (100.00)		5917.08 (100.00)
Value of main produce ha^{-1}		4.62	7721.70	4.74	7719.27	5.06	8067.83	4.70	7739.12
Value of By- produce ha^{-1}		5.58	753.30	6.15	799.50	6.48	842.40	5.90	774.42
Cost "C" for main produce ha^{-1}			4970.89		5389.56		5356.18		5142.66
Per quintal cost of main produce			1075.95		1137.04		1058.53		1094.18

Figures in parenthesis indicates percentage to the total includes the total cost incurred on marketing of *lathyrus* by producers and by various intermediaries involved in sale and purchase of *lathyrus* under study till it reaches to the consumer.

I. Marketing margins : Marketing margins are the actual amount received by the marketing agencies in the marketing process, profits of the various market functionaries involved in moving the produce from the initial point of production till it reaches the ultimate consumer.

II. Price spread : Price spread is the difference between the price paid by consumer and price received by the producer for an equivalent quantity of farm produce.

c) Producer's share in consumer's rupee : It is the price received by the producer, expressed as percentage of retail price (i.e. price paid by consumer).

Results and Discussion

Cropping pattern of selected holding : The cropping pattern of selected holding according to different crop is presented in the table 1.It revealed that gross cropped area was highest in case of large farmers (11.00 hectare) followed by medium farmers (5.67 hectare) and lowest in small farmers (2.71 hectare). Overall gross cropped area among the all grouped farmers was 4.07 hectare. Area under *kharif* crop was highest in case of large farmers i.e. 6.24 hectare followed by medium farmers i.e. 3.04 hectare and lowest in case of small farmers i.e. 1.37 hectare. Overall area under the *kharif* crop was 2.16 hectare. In *kharif* season paddy is main crop of selected farmers and highest area under paddy was in large farmers group followed by medium farmers i.e. 6.14 hectare (55.82%) and 3.04 hectare (53.62%) and lowest in small farmers i.e. 1.35 hectare (49.81%), respectively. Area under *rabi* crop was highest in large farmers i.e. 4.43 hectare followed by medium farmers i.e. 2.63

Table 5. Average hectare^{-1} cost of production, gross income and net income for lathyrus (Rs. ha.)

Particulars	Land holding groups			
	Small	Medium	Large	Overall
Value of main produce	7721.70	7719.27	8067.83	7739.12
Value of by produce	753.30	799.50	842.40	774.42
Gross Income	8475.00	8518.77	8910.23	8513.54
Cost of Production at				
Cost A	3336.28	3410.01	3556.34	3392.63
Cost B	5210.41	5737.32	5562.14	5406.25
Cost C	5724.19	6189.06	6198.58	5917.08
Net return over				
Cost A	5138.72	5108.76	5353.89	5120.91
Cost B	3264.59	2781.45	3348.09	3107.29
Cost C	2750.81	2329.71	2711.65	2596.46
Net return quintal^{-1}	595.41	491.50	535.90	552.44
Input-output ratio at				
Cost A	2.54	2.50	2.51	2.51
Cost B	1.63	1.48	1.60	1.57
Cost C	1.48	1.38	1.43	1.44

hectare and 1.34 hectare in small farmers. Overall area under *rabi* crop was 1.88 hectare. In summer crop, area under paddy was 0.33 hectare in large farmers and summer crop comprised only paddy crop. No other crop were grown by farmers in summer other than paddy. In *rabi* season *lathyrus* and wheat crop are grown by most of the farmers. Area under the *lathyrus* crop was highest in large farmers i.e. 1.61 hectare (14.64% of GCA) followed by medium farmers i.e. 1.45 hectare (25.57 % of GCA) and lowest in small farmers i.e. 0.97 hectare (35.79 % of GCA). Wheat crop was taken by all the grouped farmers i.e. small, medium and large farmers. Highest area under wheat crop was observed in large farmers followed by medium and lowest in small farmers *viz.*, 2.02 hectare, 0.62 hectare and 0.15 hectare, respectively. It can be seen that about 53.08 per cent of overall area was under *kharif* crops, 46.18 per cent area was under *rabi* crops and 0.74 per cent area was under summer crops. Area under *kharif* crop was highest in large farmers i.e. 56.73 per cent and area under *rabi* crop was highest in small farmers i.e. 49.45 per cent, respectively.

Fixed capital investment of selected *lathyrus* growers : Investment in different capital assets on selected holding is presented in table 2. It is observed that, on an average per holding fixed capital investment was highest in case of large farmers including land was Rs. 72,60,345.61 followed by medium farmers

Table 6. Marketing cost and market margin in *Lathyrus* for small size of holding (Rs. qt^{-1})

Particulars	Channel-I	% of consumer's price	Channel-II	% of consumer's price
Price received by the producer	1767.32	99.22	1671.36	88.59
Marketing cost incurred by producer				
Packaging cost	0.00	0.00	0.69	0.07
Loading-unloading charges	0.00	0.00	1.36	0.07
Weighing charges	1.73	0.10	1.73	0.09
Transportation cost	0.00	0.00	5.13	0.27
Cost of gunny bags	29.70	1.68	29.70	1.57
Hamali	0.00	0.00	2.49	0.13
Miscellaneous expenses	0.00	0.00	1.64	0.09
Total	31.53	1.78	42.74	2.27
Price paid by retailer to producer			1671.36	88.59
Marketing cost incurred by retailer				
Packaging cost			1.02	0.05
Loading-unloading charges			1.36	0.07
Weighing charges			1.73	0.09
Transportation cost			8.23	0.44
Cost of gunny bags			29.92	1.58
Hamali			2.56	0.13
Rent of shop			1.45	0.08
Miscellaneous expenses			2.06	0.11
Total			48.33	2.56
Retailers margin			167.00	8.85
Price paid by consumer	1767.32	100.00	1886.69	100.00

Rs. 39,01,550.42 and was lowest in case of small farmers Rs. 14,30,430.28. The overall investment on land by *lathyrus* growers was 96.58 per cent, farm building account 0.11 per cent, well 0.19 per cent, implements and machinery 1.68 per cent and livestock was contributed 1.44 per cent of the total. The investment of small, medium and large farmers excluding land was 3.65 per cent, 3.73 per cent and 2.92 per cent, respectively of the total capital investment. It can be inferred from table 2 that, farmer's maximum investment was made in land followed by implements and machinery and livestock in the overall and among all the grouped farmers.

Per hectare utilization of physical inputs for cultivation of *lathyrus* : Details of per hectare human and bullock labour as well as other inputs are given in table 3. It reveals that overall per hectare total male, female and bullock labour were used to extent of 6.10 days, 31.14 days and 0.06 days, respectively for *lathyrus*. Total male, female and bullock labour used for *lathyrus* was 9.21 days, 29.92 days and 0.08 days by large farmers and 4.83 days, 32.74 days, and 0.10 days by medium farmers and 6.09 days, 30.95 days and 0.03 days by small farmers respectively. Total seed for cultivation of *lathyrus* used were 75.57 kg and 73.04 kg and 70.85 kg by small, medium and large farmers, respectively. Hectare seed used by overall farmers for cultivation of *lathyrus* was 74.29 kg. Total machinery hours

Table 7. Marketing cost and market margin in Lathyrus for medium size of holding (Rs. qt^{-1})

Particulars	Channel-I	% of consumer's price	Channel-II	% of consumer's price
Price received by the producer	1726.99	99.16	1628.54	87.99
Marketing cost incurred by producer				
Packaging cost	0.00	0.00	0.88	0.05
Loading-unloading charges	0.00	0.00	1.49	0.08
Weighing charges	1.97	0.11	1.97	0.12
Transportation cost	0.00	0.00	7.30	0.39
Cost of gunny bags	29.90	1.73	29.90	1.61
Hamali	0.00	0.00	2.48	0.13
Miscellaneous expenses	0.00		1.59	0.08
Total	31.87	1.84	45.61	2.46
Price paid by retailer to producer			1628.54	87.99
Marketing cost incurred by retailer				
Packaging cost			1.00	0.05
Loading-unloading charges			1.49	0.08
Weighing charges			1.97	0.11
Transportation cost			9.22	0.50
Cost of gunny bags			30.45	1.64
Hamali			2.47	0.13
Rent of shop			0.95	0.05
Miscellaneous expenses			1.80	0.10
Total			49.35	2.67
Retailers margin			173	9.34
Price paid by consumer	1726.99	100.00	1850.89	100.00

used were 1.43 hours, 1.37 hours and 1.32 hours in small, medium and large farmers, respectively. Overall machinery hours used were 1.42 hours. The selected cultivators has not used the manures, chemical fertilizers and insecticides for *lathyrus* crop.

Average hectare^{-1} cost of cultivation of *lathyrus* : Overall per hectare cost of cultivation of *lathyrus* was calculated and presented in the table 4. It was observed that the cost "A" for *lathyrus* was worked out to Rs. 3336.28 in small farmers and Rs. 3410.01 in medium farmers and Rs. 3556.34 in large farmers, which is important expenditure in the cultivation of *lathyrus* crop which is called as actual pocket expenses. It has been observed that the more expenditure incurred in cost "A" was for the seeds. Total expenditure on seed material was worked out to 21.37 per cent and 19.16 per cent and 19.08 per cent of cost "C" for small, medium and large farmers, respectively. No fertilizers, insecticides and weedicides were applied on *lathyrus* crop by selected cultivators, so that the expenditure in fertilizer, plant protection measure and weedicide was nil. Overall cost "A" for *lathyrus* crop was worked out to Rs. 3392.63 which is 57.34 per cent of cost "C". It was observed from table 4 that per hectare cost "B" for *lathyrus* cultivation was incurred to Rs. 5210.41, Rs. 5737.32 and Rs. 5562.14 for small, medium and large farmers, respectively, among which share of rental value of land contributes 24.34 per cent, 22.14 per cent and 23.33 per cent of cost "C" in small, medium

Table 8. Marketing cost and market margin in *Lathyrus* for large size of holding (Rs. qt^{-1})

Particulars	Channel-I	% of consumer's price	Channel-II	% of consumer's price
Price received by the producer	1696.68	99.15	1594.43	87.37
Marketing cost incurred by producer				
Packaging cost	0.00	0.00	0.84	0.05
Loading-unloading charges	0.00	0.00	1.39	0.08
Weighing charges	2.04	0.12	2.04	0.00
Transportation cost	0.00	0.00	7.20	0.39
Cost of gunny bags	29.32	1.73	29.32	1.61
Hamali	0.00	0.00	2.54	0.14
Miscellaneous expenses	0.00	0.00	1.46	0.08
Total	31.36	1.85	44.79	2.45
Price paid by retailer to producer			1594.43	87.37
Marketing cost incurred by retailer				
Packaging cost			0.90	0.05
Loading-unloading charges			1.39	0.08
Weighing charges			2.04	0.11
Transportation cost			7.71	0.42
Cost of gunny bags			30.29	1.66
Hamali			2.54	0.14
Rent of shop			0.94	0.05
Miscellaneous expenses			1.65	0.09
Total			47.46	2.60
Retailers margin			183.00	10.03
Price paid by consumer	1696.68	100.00	1824.89	100.00

and large farmers, respectively. Overall cost B was worked out to Rs. 5406.25 which accounts 91.37 per cent of cost 'C'. Per hectare cost "C" incurred was worked out to be Rs. 5724.19, Rs. 6189.06 and Rs. 6198.58 for small, medium and large farmers, respectively. Overall cost C was worked out to Rs. 5917.08. The average yield per hectare was observed 4.62 quintals in case of small farmers, 4.74 quintals in case of medium farmers and 5.06 quintals in case of large farmers. The overall yield per hectare observed was 4.70 quintals. The average gross income per hectare obtained from *lathyrus* was worked out to be Rs. 8475.00, Rs. 8518.77 and Rs. 8910.23 by small, medium and large farmers, respectively. Overall gross income was worked out to Rs. 8513.54. The quintal^{-1} cost of cultivation in *lathyrus* was Rs. 1075.95, Rs. 1137.04 and Rs. 1058.53 in small, medium and large farmers, respectively. Overall quintal^{-1} cost of cultivation for *lathyrus* was Rs. 1094.18. Similar result were reported by Kad *et al.* (2008) and Gupta and Bhowmick (2005).

Economics of production of *lathyrus* : It was revealed from the table 5 that the average per hectare gross return obtained from cultivation of *lathyrus* worked out to Rs. 8475.00, Rs. 8518.77 and Rs. 8910.23 by small, medium and large farmers, respectively. The cost 'A', cost 'B' and cost 'C' per hectare worked out to be Rs. 3336.28, Rs. 5210.41 and Rs.5724.19, respectively for small farmers

Table 9. Overall marketing cost and market margin in *Lathyrus* (Rs. qt.$^{-1}$)

Particulars	Channel-I	% of consumer's price	Channel-II	% of consumer's price
Price received by the producer	1745.62	99.19	1646.62	88.05
Marketing cost incurred by producer				
Packaging cost	0.00	0.00	0.77	0.04
Loading-unloading charges	0.00	0.00	1.40	0.07
Weighing charges	1.84	0.11	1.84	0.10
Transportation cost	0.00	0.00	6.04	0.32
Cost of gunny bags	29.71	1.70	29.71	1.29
Hamali	0.00	0.00	2.50	0.13
Miscellaneous expenses	0.00	0.00	1.60	0.08
Total	31.55	1.81	43.86	2.34
Price paid by retailer to producer			1646.62	88.05
Marketing cost incurred by retailer				
Packaging cost			1.00	0.05
Loading-unloading charges			1.40	0.07
Weighing charges			1.84	0.10
Transportation cost			8.45	0.45
Cost of gunny bags			30.12	1.61
Hamali			2.53	0.13
Rent of shop			1.20	0.06
Miscellaneous expenses			1.93	0.10
Total			48.47	2.59
Retailers margin			175	9.36
Price paid by consumer	1745.62	100.00	1870.09	100.00

and Rs. 3410.01, Rs. 5737.32 and Rs. 6189.06, respectively for medium farmers and Rs. 3556.34, Rs. 5562.14 and Rs.6198.58, respectively for large farmers. Overall cost of production at cost 'C' was Rs. 5917.08. The overall net return per hectare at cost 'A', cost 'B', and cost 'C' from *lathyrus* crop for different groups were calculated. It was observed that the net return at cost 'A' was Rs. 5138.72, at cost 'B' it was Rs. 3264.59 and at cost 'C' it was Rs. 2750.81 obtained by small farmers. The net return at cost 'A' was Rs. 5108.76, at cost 'B' it was Rs. 2781.45 and at cost 'C' it was Rs. 2329.71, obtained by medium farmers. The net return at cost 'A' was Rs. 5353.89, at cost 'B' it was Rs. 3348.09 and at cost 'C' it was Rs. 2711.65, obtained by large farmers. Overall net return at cost 'C' was worked out to Rs.2596.46. The net return quintal^{-1} obtained by small farmers was Rs. 595.41, by medium farmers was Rs. 491.50 and by large farmers was Rs. 535.90. Overall net return quintal^{-1} obtained was Rs. 552.44. "*Lathyrus* is profitable crop and it gives satisfactory returns to the farmers", this hypothesis has been proved here. Table 5 revealed that amongst the different groups of *lathyrus* growers, input-output ratio at cost 'A', cost 'B' and cost 'C' in respect of small farmers was more than medium and large farmers. Input-output ratio was 2.54, 2.50 and 2.51 at cost 'A', at cost 'B' it was 1.63, 1.48 and 1.60 and in case of cost 'C' it was observed to 1.48 and 1.38 and 1.43 among the small, medium and large farmers, respectively. Overall input-output ratio at cost 'C' was 1.44. The findings of present study are noted with previous study conducted by Mondal *et al*. (2004).

I. Marketing of *lathyrus* : The cultivators or producers in the study area sells majority of their produce to the local area or at their field to the retailer and remaining produce used to sell at the local market. The information collected in marketing aspect for *lathyrus*, from the selected farmers was analyzed and results presented in this section.

II. Channels of distribution : Marketing channels are the route through which produce move from producer to consumer. In the study area following two marketing channels are

Table 10. Price-spread in lathyrus marketing (Rs. qt.)

Particulars	Small		Medium		Large		Overall	
	I	II	I	II	I	II	I	II
Net price received by producer	1735.79 (98.22)	1628.62 (86.32)	1695.12 (98.15)	1582.93 (85.52)	1665.32 (98.15)	1549.64 (84.92)	1714.07 (98.19)	1602.76 (85.70)
Cost incurred by producer	31.53 (1.78)	42.74 (2.27)	31.87 (1.85)	45.61 (2.46)	31.36 (1.85)	44.79 (2.45)	31.55 (1.81)	43.86 (2.35)
Price received by producer	1767.32 (99.22)	1671.36 (88.59)	1726.99 (99.16)	1628.54 (87.98)	1696.68 (99.15)	1594.43 (87.37)	1745.62 (99.19)	1646.62 (88.05)
Cost incurred by retailer	0.00	48.33 (2.56)	0.00	49.35 (2.67)	0.00	47.76 (2.62)	0.00	48.47 (2.59)
Net margin received by retailer	0.00	167.00 (8.85)	0.00	173.00 (9.35)	0.00	183.00 (10.01)	0.00	175.00 (9.36)
Price paid by consumer	1767.32 (100.00)	1886.69 (100.00)	1726.99 (100.00)	1850.89 (100.00)	1696.68 (100.00)	1824.89 (100.00)	1745.62 (100.00)	1870.09 (100.00)

Figures in parenthesis indicate the percentage to price paid by consumers.

observed. Channel - I : Producer→Consumer. Channel - II : Producer→Retailer→Consumer.

1. Producer - The most important channel of distribution was producer ' retailer ' consumer. Producer directly sell their produce either to retailer or consumers at the farm because, an ideal market for the *lathyrus* has not been developed in the area. The small producer did not find it convenient to take small quantity or marketable surplus to the distance market because of long distance and heavy transportation charges.

2. Retailer - Retailers purchases the *lathyrus* from the producers directly. The retailers generally purchase the quantity required for sale as per their need and demand in the local market. The retailers sale the purchased *lathyrus* in their own shop which are in daily and weekly market.

3. Consumer - Consumer purchases required quantity of *lathyrus* directly from the farmers at their local place for their own consumption. Throughout the year the consumer purchase the *lathyrus* as per the availability in the weekly and daily market from the retailer at the prevailing market price.

Marketing cost and market margin for *Lathyrus* : The marketing cost, market margin, price spread and producer's share in consumer rupee has been calculated and presented in the table 6, 7, 8 and 9. It was revealed from table 6 that, in case of small farmers, price paid by the consumers for one quintal of *lathyrus* was Rs. 1886.69 in channel-II and Rs. 1767.32 in channel-I. The total marketing cost incurred by the small farmers i.e. producer was Rs. 31.53 in channel-I and Rs. 42.74 in channel-II. The cost of gunny bag was the major cost incurred by both producers (Rs.29.71) and retailers (Rs.30.12) in the marketing of *lathyrus*. In channel-II, cost incurred by the producers for gunny bag was Rs. 29.70, followed by transportation cost i.e. Rs. 5.13. In channel-I, cost of gunny bag contributed about 94.20 per cent of the total marketing cost by small farmers however there was no transportation cost in channel-I as producer sold their produce directly to the consumer. The packaging cost, loading-unloading charges, weighing charges, *hamali* and miscellaneous charges are other cost components, which contributes about 8.69 per cent of the total marketing cost in channel-II. The retailer was the only the functionary observed in marketing channel-II. The total cost incurred by the retailer was Rs. 48.33 in channel-II. The major components of marketing cost at this level were the cost of gunny bags and transportation cost which together contributed to 41.89 per cent of the total marketing cost. The quintal^{-1} total marketing cost was observed to Rs. 91.07 in channel-II. It was revealed from table 7 that, in case of medium farmers, price paid by the consumers for one quintal of *lathyrus* was Rs. 1850.98 in channel-II and Rs. 1726.99 in channel-I. The total marketing cost incurred by the medium farmers i.e. producer was Rs. 31.87 in channel-I and Rs. 45.61 in channel-II. In channel-II, cost incurred by the producers for gunny bag was Rs. 29.90, followed by transportation cost i.e. Rs. 7.30. In channel-I, cost of gunny bag contributes1.61per cent of the total marketing cost by medium farmers, however there was no transportation cost in Channel - I as producer directly to the consumer. The packaging of cost, loading-unloading charges, weighing charges, *hamali* and miscellaneous charges are other cost components, which contributes about 8.85 per cent of the total marketing cost in channel-II. The retailer is only the functionary observed in marketing channel-II. The total cost incurred by the retailer was Rs. 49.35 in channel-II. The major components of marketing cost at this level were the cost of gunny bags and transportation cost which together contributes to 41.78 per cent of total marketing cost. The quintal^{-1} total marketing cost was observed to Rs. 94.96 in channel-II. It was revealed from table 8 that, in case of large farmers, price paid by the consumers for one quintal of *lathyrus* was Rs. 1824.89 in channel-II and Rs. 1696.68 in channel-I. The total marketing cost incurred by the large farmers i.e. producer was Rs. 31.36 in channel-I and Rs. 44.79 in channel-II. The cost of gunny bag was the major cost incurred by both producers and retailers in the marketing of *lathyrus* followed by transportation cost. In channel-II, cost incurred by the producers for gunny bag was Rs. 29.32, followed by transportation cost i.e. Rs. 7.20. In channel-I, cost of gunny bag contributed about 93.49 per cent of the total marketing cost by large farmers, however there was no transportation cost in channel-I as producer sold their produce directly to the consumer. The packaging cost, loading-unloading charges, weighing charges, *hamali* and miscellaneous charges are other cost components, which contributes about 8.77 per cent of the total marketing cost in channel-II. The retailer was only the functionary observed in marketing channel-II. The total cost incurred by the retailer was Rs. 47.46 in channel-II. The major components of marketing cost at this level were the cost of gunny bags and transportation cost which together contributes to 41.19 per cent of the total marketing cost. The quintal^{-1} total marketing cost was observed to Rs. 92.45 in channel-II. It was revealed from table 9 that, the overall price paid by the consumers for one quintal of *lathyrus* was Rs. 1870.09 in channel-II and Rs. 1745.62 in channel-I. The total marketing cost incurred by the overall farmers i.e. producer was Rs. 31.55 in channel-I and Rs. 44.79 in channel-II. The cost of gunny bag was the major cost incurred by both producers and retailers in the marketing of *lathyrus* followed by transportation cost. In channel-II, cost incurred by the producers for gunny bag was Rs. 29.71, followed by transportation cost i.e. Rs. 6.04. In channel-I, cost of gunny bag contributes about 94.17 per cent of the total marketing cost by large farmers, however there was no transportation cost in channel-I as producer sold their produce directly to the consumer. The packaging cost, loading-unloading charges, weighing charges, *hamali* and miscellaneous charges are other cost components, which contributes about 8.78 per cent of the total marketing cost in channel-II. The retailer was only the functionary observed in marketing channel-II. The total cost incurred by the

Table 11. The problems faced by the lathyrus cultivators (all in numbers)

Problems	Number of farmers faced the problems (N=96)	Percentage to the total
Production problem		
Non adoption of proper cultivation practices	13	13.54
Lack of knowledge about plant protection	12	12.50
Low production of lathyrus	11	11.46
Marketing problem		
Less demand by consumers	28	29.17
Low price problem	17	17.71
Lack of timely transport facility	09	9.37
Lack of market information	06	6.25
Total	96	100.00

retailer was Rs. 48.47 in channel-II. The major components of marketing cost at this level were the cost of gunny bags and transportation cost which together contributes to 41.77 per cent of total marketing cost. The quintal^{-1} total marketing cost was observed to Rs. 92.33 in channel-II.

Price- spread in *lathyrus* marketing : The price spread is calculated and presented in table 10. It was observed from table 10 that, in channel-II, the net price received by the producer was Rs. 1628.62, Rs. 1582.93 and Rs. 1549.64 quintal^{-1} which was 86.32 per cent, 85.52 per cent and 84.92 per cent in case of small, medium and large farmers, respectively in the consumer's rupee. The retailer's share was observed that 8.85 per cent, 9.35 per cent and 10.01 per cent in the consumer rupee in small, medium and large farmers, respectively. Overall retailer's share was 9.36 per cent of consumer's rupee. In Channel-II the marketing cost incurred by producer and retailer was observed as Rs. 42.74 and Rs. 48.33 quintal^{-1} which together contributes 4.83 per cent in the consumer rupee in case of small farmers, in case of medium farmers the marketing cost incurred by producer and retailer was observed as Rs. 45.61 and Rs. 49.35 quintal^{-1} which together contributes 5.12 per cent in consumer rupee and in case of large farmer it was Rs. 44.79 and Rs. 46.76 which together contributes 5.07 per cent in consumer rupee. In channel-I, the producer's share in consumer rupee was 98.22 per cent, 98.15 per cent and 98.15 per cent in case of small, medium and large farmers, respectively. Overall producer's share in consumer rupee was 98.19 per cent. Remaining 1.78 per cent, 1.85 per cent and 1.85 per cent was marketing cost incurred by the producer in small, medium and large farmers, respectively. Overall marketing cost incurred by producer was 1.81 per cent. In case of small farmers the net price received by producer was 1735.79 quintal^{-1} which was higher than Rs. 1628.62 quintal^{-1} in channel-II. The price paid by consumer was Rs. 1767.32 and Rs. 1886.69 in channel-I and channel-II, respectively. In case of medium farmers the net price received by producer was 1695.12 quintal^{-1} which was higher than Rs. 1582.93 quintal^{-1} in channel-II. The price paid by consumer was observed Rs. 1726.99 and Rs. 1850.89 in channel-I and channel-II, respectively. In case of large farmers the net price received by producer was 1665.12 quintal^{-1} which was higher than Rs. 1549.64 quintal^{-1} in channel-II. The price paid by consumer was observed Rs. 1696.68 and Rs. 1824.89 in channel-I and channel-II, respectively. Overall price paid by consumer was Rs. 1745.62 and Rs. 1870.09 in channel-I and channel-II respectively. Price paid by consumers was less in channel-I than channel-II among small, medium and large farmers. It is concluded that channel-I is more beneficial from the producers and consumers point of view. Similar results were reported by Ghosh (1988) and Chakraborthy (2005)

The problems faced by the *lathyrus* cultivators : The seven constraints faced by the farmers in production and marketing of *lathyrus* were arranged as per the scores of the farmers and is presented in table 11. The highest number of farmers i.e. 29.17 per cent, expressed the low demand by consumers, 17.71 per cent farmers expressed the low price problem while 13.54 per cent farmers express non adoption of proper cultivation practices followed by 12.50 per cent farmers express the lack of knowledge about plant protection. It is revealed from the above discussion that the majority of the farmers facing the problem of low demand by consumers.

Suggestions : 1) At overall level B:C Ratio at cost A,B,C is 2.51,1.57 & 1.44 which showed that *lathyrus* is profitable crop, therefore farmers should be motivated by the government agencies for cultivation of *lathyrus* so as to meet the public demand for pulses. 2) The less demand and low price for the *lathyrus* are the main problem reported by the cultivators therefore, the public should be motivated for the consumption of *lathyrus* so as to increase the demand for it.

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Economics of Existing Farming Systems in Banswara District of Southern Rajasthan

Hari Singh[1], S. S. Burark[2], D. C. Pant[3], H. K. Jain[4] and J. L. Choudhary[5]
Rajasthan College of Agriculture, MPUAT, Udaipur - 313 001 (India)
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Abstract

The present investigation was under taken to work out the economics of existing farming systems in Banswara district of Southern Rajasthan during 2012-13. A total sample of 60 household consisting of 30 under rainfed and 30 under irrigated situation was selected for the study. Four farming systems existed in both the rainfed and irrigated areas of Banswara district *viz*., FS-I: Crop + Vegetables, FS-II: Crop + Dairy, FS-III: Crop + Dairy + Goat and FS-IV: Crop + Poultry. In rainfed area of Banswara district the maximum number (43.33%) of households were adopted FS-II Crop + Dairy. The cropping intensity ranged from 88.23 per cent in FS-III to 94.44 per cent in FS-II. Similarly in irrigated area of Banswara district four farming systems were prevailing i.e. FS-I: Crop + Vegetable, FS-II: Crop + Dairy , FS-III: Crop + Dairy + Goat and FS-IV: Crop + Poultry + Orchard . The maximum numbers of farm households (43.33%) were in FS-II followed by FS-IV (23.23%). On the basis of net returns per household, the most profitable farming system adopted under the rainfed situation was FS-III (Crop+Goat+Dairy) with Rs. 57600.95 per farm while on the basis of returns per rupee investment, it was FS-IV (Crop + Goat + Poultry) i.e. 1.57. On the other hand under irrigated situation, FS-I (Crop + Vegetable) was the most profitable farming system on net return basis (Rs. 147287) and returns per rupee investment i.e. 1.63.

Key Words : Cropping intensity, cost, farming system, returns and profitability.

India has made considerable progress in agriculture due to increasing production of cereals and other crops such as oilseeds, sugarcane, cotton and fruits and vegetables during the past four decades. This success has

1. Ph.D. Scholar and 2.-5. Professor.

been driven by several factors which include policy support, research and extension, production strategies, higher use of inputs and public investment in infrastructure. It has helped the country to face many contemporary and future challenges of food security of its vast population.The country's population is expected to reach 1660 million in the year 2050 and for which 349 million tonnes of food grains will be required. To meet this requirement there is a need to double the productivity of agricultural crops from the existing level of productivity. Since there is no further scope for horizontal expansion of land for cultivation of farm enterprises, the emphasis should be on vertical expansion by increasing the productivity using the available resources properly and choosing the best enterprise mix. In this context, farming system approach is one of the important solutions to face this particular situation, as in this approach the different enterprises can be carefully undertaken and the location specific systems developed based on available resources which will result into sustainable development. As the land resource is limited, production and productivity per unit area need to be increased in order to meet the growing demand for food. Integrated farming system (IFS) seems to be the possible solution to meet the continuous increase in demand for food, stability of income and diverse requirements of food grains, vegetables, milk, egg, meat etc. thereby improving the nutrition status of the small scale farmers with limited resources.

Farming system represents integration of farm enterprises such as cropping system, animal husbandry, fisheries, forestry, poultry etc. for optimal utilization of resources bringing prosperity to the farmer.

Rajasthan, the largest state of Indian union, occupies nearly 10.4 per cent geographical area of the country. Agriculture and allied activities accounted for nearly one fourth of the state domestic product against 14 per cent at national level. Therefore, agriculture despite all odds considered to be the main stay of rural masses in the state. The agriculture in most part of the state is rainfed and is prone to high production risk. In order to meet the farm and family requirement, the farmers in the state have evaluated different combinations of crop, livestock, horticulture, poultry etc. Food security always remains an uncompromising goal of farm level agriculture for rural masses in most part of the state. Accordingly, every region of the state has evaluated crop and livestock species suitable for the region.

Materials and Methods

Southern Rajasthan comprises of eight districts *viz*., Udaipur, Chittorgarh, Bhilwara, Rajsamand, Dungarpur, Banswara, Pratapgarh and Sirohi. These districts fall in agro-climatic region IV- A and IV- B. Among these districts Banswara is highly-tribal dominated district. Banswara district from IV-B was purposively selected for the study of integrated farming systems, as this district has high potential for development of agriculture and livestock. Multi stage random sampling plan was used. Two tehsil from Banswara districts were selected in such a way that one having highest proportion of irrigated area i.e. Banswara and other one having highest share of rainfed area i.e. Kushalgarh to total net sown area so that selected tehsils represented irrigated and rainfed farming systems in tribal areas. Fifteen farmers from each village were selected randomly. Thus a total sample of 60 households was selected from Banswara district, representing 30 each from rainfed and irrigated farming systems.

Both primary and secondary data were collected. The primary data were collected from selected farmers while the secondary data were collected from published sources. The data collected for the year 2012-13 were scrutinized, tabulated and analyzed by using different analytical tools.

Costs and returns estimation : The following method for estimation of costs and returns was used - Gross Cost = Total Variable Cost (TVC) + Total Fixed Cost (TFC), Gross Return = (Quantity of produce Prevailing price of produce + Quantity of by- produce Price of by-produce), Net return = Gross return - Total cost

Operational or variable costs : Operational costs were the actual costs incurred by the farmer along with incidental charges incurred towards labour and material costs. The various items of operational costs were seed, farmyard manure, fertilizers, plant protection chemicals, feeds and concentrates, fodder and straw, labour (hired labour and family human labour) interest on working capital, machine labour (hired and own) etc. Labour in all enterprises were converted into man-days by multiplying female and child labour by 0.70 and 0.50, respectively. Bullock labour, both owned and hired were accounted at the prevailing hire rates. The operational costs in terms of labour (human, bullock and machine) and other outputs (main and by-products) of one activity utilized as an input in the other activity within the integrated farming system were worked out to assess the cost effectiveness of different integrated farming system.

Fixed costs : The various items of fixed costs were land revenue, land rent and depreciation. The depreciation rates, life span and junk value for various agricultural implements and machinery were decided in consultation with the respondents. Consequently, the depreciation was calculated using the straight line method as shown below.

$$\text{Depreciation} = \frac{\text{Purchase value-Junk value}}{\text{Life span}}$$

Interest on fixed capital was calculated at the prevailing bank rate (12%) on the value of the farm and livestock assets.

Table 1. Existing farming system in rainfed area of Banswara district (per farm)

Farming system	No. of farmer	Gross cropped area (ha)	Cultivate of area (ha)	Cropping intensity (%)	Crops		Onion nursery		Live-stock (No.)	Goat (No.)	Poultry (No.)
					Name	Area (ha)	Name	Area (ha)			
FS-I	4	0.58	0.62	93.55	Maize	0.25	Onion	0.08			
C + V	(13.33)	(37.34)			Soybean	0.10	nursery				
					Paddy	0.15					
FS-II	13	0.85	0.90	94.44	Maize	0.45			3.06		
C + D	(43.33)	(18.67)			Soybean	0.20					
					Paddy	0.20					
FS-III	7	0.45	0.51	88.23	Maize	0.20			3.00	17.00	
C + D + G	(23.33)	(18.26)			Soybean	0.15					
					Black gram	0.10					
FS-IV	6	0.44	0.48	91.66	Maize	0.24					55.75
C + Po	(20.00)	(18.97)			Paddy	0.20					
Total	30	2.32	2.51	91.97		2.24		0.08	6.06	17.00	55.75
	(100.00)	(100)									

C-Crop, V-Vegetable, D-Dairy, Po-Poultry, G-Goat, Figures in parenthesis is percentage of column total

Returns : The returns from crop, livestock, goat rearing and poultry were estimated by multiplying the actual price realized to quantity sold by them and the quantities that was retained for seed or consumption was evaluated at the rates prevailing at the time of harvest. The same method was also followed for the evaluation of by-products of various enterprises.

Results and Discussion

Existing farming systems in the study area : In the farming system irrespective of the rainfed and irrigated condition, four farming systems were prominently observed. They were: FS-I : Crops + Vegetable (C+V), FS-II : Crops + Dairy (C+D), FS-III : Crops + Dairy+ Goat (C+D+G), FS-IV : Crops + Goat + Poultry + Orchard (C+G+ Po+O)

Farming systems in rainfed condition : Farming systems in Banswara district were studied in both the condition i.e. rainfed and irrigated. In rainfed condition of Banswara district, farmers took only crops (maize, soybean, paddy) and onion nursery in *kharif* season while in *rabi* season land were kept fallow due to unavailability of irrigation facilities. Maximum number of households (43.33%) were found in FS-II (C+D) as shown in Table 1.

Table 2. Existing farming system in irrigated area of Banswara district (per farm)

Farming system	Farmer (No.)	Gross cropped area (ha)	Cultivated area (ha)	Cropping intensity (%)	Crops		Onion nursery		Livestock (No.)	Orchard (No.)	Goat (No.)	Poultry (No.)
					Name	Area (ha)	Name	Area (ha)				
FS-I	8	1.60	0.86	186.04	Maize	0.30	Pea	0.06				
C + V	(26.67)	(26.85)			Paddy	0.25	Okra	0.18				
					Black gram	0.05	Brinjal	0.05				
					Wheat	0.40	Tomato	0.27				
							Green Coriander	0.04				
FS-II	10	2.16	1.10	196.36	Maize	0.45			3.50			
C + D	(33.33)	(36.24)			Soybean	0.25						
					Paddy	0.35						
					Black gram	0.10						
					Wheat	0.51						
					Mustard	0.50						
FS-III	8	1.20	0.63	190.47	Maize	0.35			2.60		11.55	
C + D + G	(26.67)	(20.13)			Black gram	0.15						
					Wheat	0.45						
					Mustard	0.25						
FS-IV	4	1.00	0.55	181.81	Maize	0.20				50.0		46.0
C + G + Po	(13.33)	(16.78)			Black gram	0.10						
					Paddy	0.20						
					Wheat	0.35						
					Barley	0.05						
					Mustard	0.10						
Total	30 (100)	5.96 (100)	3.14	188.67				0.60	6.10	50.0	11.55	46.0

C-Crop, V-Vegetable, D-Dairy, Po-Poultry, G-Goat, Figures in parenthesis is percentage of column total

The cropping intensity in rainfed condition varied from 88.23 to 94.44 per cent. The highest cropping intensity was observed in FS-II (C+ D) i.e. 94.44 per cent. In rainfed area, cropping intensity was low due to non-availability of irrigation facilities and farmers were forced to take crops only in one season. Gross cropped area was 2.32 ha of which highest fall under FS-II (C + D) i.e. 36.63 per cent of gross cropped area. Maize was main crop grown in all the farming systems in rainfed area followed by paddy, soybean and black gram. Only in one farming system (FS-I) onion nursery was raised. In FS-II households reared 3.06 dairy cattle while in FS-III average number of cattle and goats were 3.00 and 17.00, respectively. Farmers belonged to FS-IV adopted only poultry (55.75 average number of birds) in addition to crops. Similar findings were found by Baishya *et al*. (2007) and Sharma (2007).

Irrigated condition : In irrigated condition of Banswara district maximum number of households adopted FS-II (C+D) i.e. 33.33 per cent as depicted in Table 2. Cropping intensity in irrigated condition of Banswara district varied from 181.81 per cent in FS-IV (C+Po+O) to 196.36 per cent in FS-II (C+D). In this condition, cropping intensity was high as farmers have taken crops in both the seasons due to availability of irrigation facilities. Gross cropped was 5.96 hectare of which highest fall under FS-II (C+ D) i.e. 36.24 per cent of gross cropped area. Maize, paddy, wheat and rapeseed and mustard were the major crops of this area. Besides crops vegetables were also grown in both the season under FS-I. The non-crop enterprises adopted in addition to the crops in three farming systems were i.e. FS-II only dairy cattle, FS-III dairy cattle and goats and FS-IV poultry and orchard. In FS-II the average number of dairy cattle maintained on farms was 3.50 in addition to crops. The FS-III possesed both goat and dairy cattle. The average number of goats were 11.55 and dairy cattle were 2.60. FS-IV adopted both poultry and orchard. The average number of poultry birds were 46.0 and the average number of orchard plants were 50.0. Similar findings were also reported by Ravi Shankar *et al*. (2007), Singh *et al*. (2007) and Sharma (2007).

Table 3. Comparison of costs and returns in rainfed and irrigated farming systems in Banswara district (Rs. farm^{-1} year^{-1})

Particulars	Rainfed condition				Irrigated condition			
	FS-I	**FS-II**	**FS-III**	**FS-IV**	**FS-I**	**FS-II**	**FS-III**	**FS-IV**
Costs								
TVC	49952.65 (83.66)	100295.25 (86.97)	141277.25 (84.74)	71209.15 (74.69)	203116.10 (87.44)	233951.80 (86.01)	243916.15 (83.42)	201613.80 (80.97)
TFC	9754.50 (16.34)	15025.00 (13.03)	25439.50 (15.26)	24130.00 (25.31)	29173.87 (12.56)	38062.22 (13.99)	48493.12 (16.58)	47399.63 (19.03)
TC	59707.15 (100)	115320.25 (100)	166716.75 (100)	95339.15 (100)	232289.97 (100)	272014.02 (100)	292409.27 (100)	249013.43 (100)
Returns								
GR	84650.53	161595.60	224317.70	150087.00	379576.51	376280.90	410509.01	369815.75
NR	24943.38	46275.35	57600.95	54747.85	147286.54	104266.88	118099.74	120802.32
Returns rupee-1 investment	1.42	1.40	1.35	1.57	1.63	1.38	1.40	1.49

TVC=Total Variable Costs, TFC=Total Fixed Costs, TC=Total Costs, GR=Gross Return and NR=Net Return

Comparison of costs and returns in existing farming systems in the study area : Costs and returns in different farming systems adopted by the households in rainfed and irrigated condition of Banswara district were computed and presented in Table 3.

Rainfed condition : The comparison of costs and returns is presented in Table 3. The total cost in rainfed farming system was the lowest in FS-I and the highest in FS-III. It varied from Rs. 59707.15 in FS-I to Rs. 166716.75 in FS-III. Total variable cost as percentage of total cost varied from 74.69 in FS IV to 86.97 in FS-II. The total fixed cost among the four farming systems in Banswara district varied from 13.03 per cent to 25.31 per cent, respectively. The lowest total fixed cost was 13.03 per cent in FS-II. The highest total fixed cost i.e. 25.31 per cent was seen in FS-IV. The reason of highest total fixed cost in FS-IV was due to high investment for construction of pucca poultry shed. The net return among the four farming systems varied from Rs. 24943.38 in FS-I to Rs. 57600.95 in FS-III. The households in FS-I taken only *kharif* crops and onion nursery which gave lowest net returns whereas in FS-III farmers reared goat and dairy enterprises along with crop, gave highest net returns. The returns per rupee investment in the rainfed condition of Banswara district varied from Rs. 1.35 in FS-III to Rs. 1.57 in FS-IV. In all the farming systems the overall returns per rupee invested was more than one showed that all the systems were profitable in the district.

Thus, it can be concluded that on the net return and returns per rupee investment basis FS-III and FS-IV were found more profitable than other farming systems where livestock/ poultry is one of the component of these farming systems.

Irrigated condition : The comparison of costs and returns of different farming systems adopted in irrigated condition are presented in Table 3. Data shows that the total costs in irrigated farming system were the lowest in FS-I (Rs. 232289.97) and highest in FS-III (Rs. 292409.27). Total variable costs as percentage of total costs varied from 80.97 per cent in FS-IV to 87.44 per cent in FS-I. It can be observed that the total fixed cost among the four farming systems varied from 12.56 per cent (FS-I) to 19.03 per cent (FS-IV). The reason for the highest total fixed cost in FS-IV may be due to more investment required for the establishment of orchard and to construct pucca shed for goat and poultry birds. The net returns varied from Rs. 104266.88 (FS-II) to Rs. 147286.54 (FS-I). Returns per rupee investment varied from 1.38 (FS-II) to 1.63 (FS-I) in irrigated condition. The reason for getting higher net returns as well as returns per rupee investment in FS-I was due to growing of vegetables in this system which was more remunerative than dairy. The in-depth look of the table also showed that net return and returns per rupee investment in FS-I was more in irrigated condition. Thus, it was concluded that on the least cost, net returns and returns per rupee investment basis the FS-I was more profitable than other farming systems in the district. Similar result was found by Singh *et al.* (2007). All the systems under irrigated condition gave more than 1.38 per rupee invested.

Thus, based on the studies it can be concluded that in rainfed area of Banswara district the maximum number of households were adopted FS-II. Similarly in irrigated area of Banswara district four farming systems were prevailing i.e. FS-I: Crop + Vegetable, FS-II: Crop+ Dairy , FS-III: Crop + Dairy + Goat and FS-IV: Crop + Poultry + Orchard. The maximum numbers of farm households were in FS-II followed by FS-IV. On the basis of net return per household, the most profitable farming system adopted under the rainfed situation was FS-III while on the basis of returns per rupee investment, it was FS-IV. While under irrigated situation, FS-I was the most profitable farming system on net return basis and returns per rupee investment.

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Economic Analysis of Production of Marigold in Western Maharashtra

R. A. Kolambkar[1], R. R. Suryawanshi[2] and K. V. Deshmukh[3]
Department of Agricultural and Economics,
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402 (India)
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Abstract

The study revealed that, the per hectare cost of cultivation at Cost A was Rs. 108634.30, Cost B was Rs. 192352.27 and Cost C was Rs. 202046.40. Per hectare net return was Rs. 227206.60. Major items of cost were rental value of land (35.41%) followed by seedlings (29.98%) , human labour (12.69%) and interest on fixed capital (6.03%). Regarding the profitability of marigold cultivation, crop is found to be profitable at all the cost levels. Benefit-cost ratio at Cost A, Cost B and Cost C were 3.95, 2.23 and 2.12 respectively and per kilogram cost of production was worked out to be Rs. 16.22, kilogram^{-1} return Rs. 34.47 and kilogram^{-1} net profit was Rs. 18.24, respectively.

Key words : Cost A, Cost B and Cost C.

Marigold is a seasonal flower and can be grown round the year. Marigold flowers gained popularity amongst gardeners and dealers on its easy cultivation and wide adaptability. Both leaves and flowers are equally important from medicinal point of view. The essential oils of marigold find use in the perfume industry. (Jothi (2008) and Verma and Arya (2002)). Marigold are ideal for cut flowers, especially for making garlands. In popularity as cut flowers, marigolds probably ranks next only to jasmine in India. Marigold is also planted as the trap crop at border side to attract the insects attacking the main crop (Rao and Reddy, 2005).

1. Ph. D. student, 2. Professor and 3. Asso. Professor.

In India, during the year 2011 area under floriculture was (60487.6 hectares). The highest area under floriculture was found in Karnataka (20,780 hectares), followed by Tamil Nadu (16,745 hectares), West Bengal (13,720 hectares), Andhra Pradesh (8,420 hectares). These states together accounted for 98.64 per cent of the total area in the country. The export of flowers have increased from Rs. 14.80 crores in 1991-92 to Rs. 190.63 crores in 2000-2001 out of which Rs. 39.09 crores is the share of cut flowers. Karnataka alone accounts for nearly 75 per cent of total floriculture exports from the country at Rs. 10 million and rose dominating at 90 per cent.

The area under floriculture in Maharashtra during 2010-11 was is 15000 hectares, out of which marigold contributes 29 per cent share with an area of 4350 hectares. While the production of floriculture is 64,400 million tones out of which marigold contributes 33,488 million tones which account to about 52 per cent. Analysis of reasons for variation in the yield and fluctuations in income resulting from marigold cultivation in the command would be useful for the farmers of the India (Ghadge, 2004). Hence a study was undertaken with the objective to estimate cost and returns in marigold production.

Materials and Methods

The Kolhapur and Sangli district of Western Maharashtra were selected purposively for the present study on marigold. Both the district have medium to light type of soil with limited irrigation facilities. The area under marigold in Kolhapur and Sangli district was 1,025 and 1,138 hectares respectively, with an area of 135.23 and 154.00 hectares in Hatkanangale and Miraj tahsils of respective districts. Keeping in view highest acreage under marigold, Hatkanangale and Miraj tahsils were selected for the present study. From each tahsil three villages were selected purposively and from each village 10 sample farmers were selected randomly.

The list of the marigold cultivators was obtained from the revenue records maintained at village level of selected villages. The required number of cultivators from each village was selected randomly. In all, sixty marigold cultivator spread over in six villages formed the total sample size. The survey method of economic investigation was adopted for the work of data collection. A specially designed questionnaire for getting the information on cost of cultivation, marketing and other related aspects was used. The data was collected for the year 2011-2012 for summer season. The detailed information about the physical quantities of inputs and their costs, yields and returns were collected in respect of marigold from sample cultivators. The sowing varieties selected by sample farmers were Namdhari, Gold Coin Gold, Inca yellow, Inca orange, Inca gold and Thumbnail sunny, out of which share of Namdhari variety was 85 per cent.

The simple tabular analysis was carried out to work out the level of input utilization, per hectare cost of cultivation and cost of production of flowers. The collected data were compiled, tabulated and analyzed by using

Table 1. Village wise distribution of sample cultivators and area under marigold

Name of selected villages	Area under marigold covered by sample cultivators (ha)	Total number of sample cultivators selected from each village
Rukdi	5.33	10
Kumbhoj	4.38	10
Herale	4.32	10
Mallewadi	6.17	10
Toong	4.97	10
Erandoli	3.03	10
Total	28.20	60

standard Cost Concepts *viz*., Cost 'A', Cost 'B', and Cost 'C ' normally used in farm management studies.

Cost A = Cost 'A' includes the cost on account of hired human labour, hired and owned bullock labour, value of manures and fertilizers, planting material, insecticides and pesticides, irrigation charges, depreciation on implements and machinery, land revenue and cesses and interest on working capital.

Cost B = Comprises of Cost 'A' plus the imputed rental value of owned land plus interest rate on owned fixed capital.

Cost C = This cost includes Cost 'B' plus imputed value of family labour charges. The family labour charges considered at rates prevailing in villages.

Results and Discussion

Selection of the study area : Village wise distribution of holding is as represented in Table -1. It was observed from Table -1 that highest area under marigold was in Mallewadi village (6.17 hectares) and lowest area was under Erondoli village (3.03 hectares).

Cost and return structure of marigold : The life period of the crop is 4 months. In view of this, an attempt has been made to analyze in detail per hectare use of inputs, cost of cultivation and profitability of the marigold flower.

Table 2. Per hectare cost of cultivation of Marigold

Cost items	Quantity	Rate (Rs.)	Value (Rs.)
Hired human labour (days)			
Male	65.45	100.49	6577.07 (3.25)
Female	138.5	67.63	9366.76 (4.64)
Bullock Power (days)	0.29	524.59	152.13 (0.08)
Machine charges (Hours)	35.15	73.53	2584.58 (1.28)
Seedlings (Nos.)	35633	1.7	60576.1 (29.98)
Manure (Quintals)	20.18	125.58	2534.20 (1.25)
Fertilizer (kg ha^{-1})			
N	136.4	16.72	
P	97.6	19.38	4681.77 (2.32)
K	61.26	8.32	
Irrigation charges	-	-	5900 (2.92)
Plant protection charges	-	-	5442.46 (2.69)
Working capital	-	-	97815.07 (48.41)
Interest on working capital @ 6%	-	-	5868.9 (2.90)
Depreciation on farm implements	-	-	4178.30 (2.07)
Land revenue and taxes	-	-	772 (0.38)
Cost A	-	-	108634.3 (53.77)
Rental value of land	-	-	71542 (35.41)
Interest on fixed capital @10%	-	-	12176 (6.03)
Cost B	-	-	192352.27 (95.20)
Family labour (days)			
Male	71.63	95.77	6860 (3.40)
Female	40.47	70.03	2834.11 (1.40)
Cost C	-	-	202046.4 (100)
Output (Qtls.)	124.52		429253

Per hectare cost of cultivation of marigold : To facilitate comparison the item wise per hectare cost of cultivation of the marigold of selected families was worked out and same is presented in Table-2. On examination of the cost data, it was observed that the per hectare total cost of cultivation, Cost C was Rs. 202046.4, in which , share of cost A and Cost B was 53.77 per cent and 95.20 per cent, respectively. The major item of Cost C was input cost, which alone shared 48.41 per cent. The major input was expenditure on seedlings (29.98%). The major item of Cost B was rental value of land (35.41%). The hectare^{-1} yield was obtained 124.52 quintals accounting to Rs. 429253 as gross income. The Benefit-cost ratio was estimated to 2.12 indicating there by cultivation of marigold in summer season in Kolhapur and Sangli district is profitable, the results are conformity with Khade (2004) and Sharma (2001).

Returns from marigold : The per hectare total cost, total produce, returns and net profit at various level of cost, at Cost A, at Cost B and Cost C were worked out. At the overall level the net returns at Cost C was Rs. 227206.6. The hectare^{-1} cost of cultivation work out to Rs. 202046.4. This shows that marigold is an economic crop to selected farmers with minimum cost and maximum returns, results conformity with Subramanyam (1983).

Per kg cost, returns and net profit : The kilogram^{-1} cost , returns and net profit were worked out and presented in Table-3. It is observed that the per kg cost of production was worked out to Rs. 16.23 and kg^{-1} net profit was found to Rs. 18.24 with kg^{-1} net returns of Rs. 34.47.

Table 3. Per kg costs, returns and net profit of sample families

Particulars	Value
Per kilogram cost (Rs.)	16.23
Per kilogram returns (Rs.)	34.47
Per kilogram net profit (Rs.)	18.24

Based on the present study it can be concluded that the per hectare cost of cultivation was Rs. 202046.4 and hectare^{-1} net returns was Rs. 227206.6. Major items of cost were rental value (35.41%), seedlings (29.98 per cent), human labour (12.69%) and interest on fixed capital (6.03%). Regarding the profitability of marigold cultivation, crop is found to be profitable at all the cost levels. Benefit-cost ratio at Cost A, Cost B and Cost C were 3.95, 2.23 and 2.12, respectively.

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Growth and Instability in Production of *Cumin* in Rajasthan

Vanpal Kumar Boyal[1], D. C. Pant[2], S. S. Burak[3], Ravindra Singh Shekhawat[4] and Jay Mehra[5]
Department of Agricultural Economics and Management,
Rajasthan College of Agriculture, MPUAT, Udaipur - 313 001 (India)
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Abstract

India is the largest producer, consumer and exporter of seed spices and spice products in the world. The spices production in India was 5744 thousand MT from an area of about 3070 thousand hectares in the year 2012-13. Growth rate of cumin production was found positive and significant only in Barmer district during period I and negative growth rates were recorded in Jalore, Jodhpur districts and Rajasthan during period I, Barmer district and Rajasthan during period II and Jalore district during overall period. The growth rates of area were significantly increased only in Barmer and Jodhpur districts during period I and overall period. Almost negative growth rates in productivity were observed from selected districts and Rajasthan during period I (except Barmer district), period II (except Jodhpur district) and Overall period (except Jalore district). The magnitude of instability in cumin crop was higher in production as compared to productivity and area except Barmer district (in context of 13 measure) during period I, where the variation in productivity was more. This showed that the destabilizing effect was more on production compared to area and productivity.

Key words : Area, cumin, growth, instability, production, rajasthan.

India is known as the "Home of Spices" and produces a large variety and quantity of spices. About sixty-three spices are grown in the country, which includes pepper (King of Spices), cardamom (Queen of Spices), chillies, ginger, turmeric, coriander, *cumin*, fenugreek and many others. The spices production in India is of the order of 5744 thousand MT from an area of about 3070 thousand hectares in the year 2012-13. Major growing belt of seed spices are spread from arid to semi-arid region covering large area of Rajasthan, Gujarat and parts of Madhya Pradesh. Among these states, Rajasthan and Gujarat have emerged as "Seed Spice Bowl of India" together contributing around 30 per cent of the total seed spices produced in the country.

In Rajasthan, area under seed spices was 720.6 thousand hectares and production was 860.9 thousand MT and in Gujrat, area under seed spices was 551.7 thousand hectares and production was 882.1 thousand MT in the year 2012-13. India is the largest producer of *cumin* accounting almost 91 per cent (394 thousand MT) of the world's production in the year 2012-13. It is also the largest consumer of *cumin*. India consumes almost 80-85 per cent of the *cumin* it produces while the remaining 15-20 per cent is exported. India is also the largest exporter of *cumin*.Gujarat and Rajasthan are the major *cumin* producing states in India. Uttar Pradesh and Madhya Pradesh produce small quantity of *cumin*.

Rajasthan is a leading producer of *cumin* accounting for 70 per cent of all India's output. Barmer, Jalore and Jodhpur together accounted for 67.66 per cent of the area and 76.15 per cent of the total production of *cumin* in the state of Rajasthan. There is scope for enhancing the value addition and export potential for *cumin* from Rajasthan by implementation of Agri Export Zone (AEZ) in

1., 4., 5. Research Scholar, 2. and 3. Professor.

these districts. The Agri Export Zone (AEZ) was established in the year 2005 for *cumin* in the districts of Jalore, Jodhpur, Barmer, Pali and Nagaur. The emphasis of the project is to co-ordinate the efforts of multiple agencies at the state level towards achieving higher production and exports.

Thus, it is worthwhile to study the past behaviour of changes in the area, production and productivity of *cumin*. It helps in planning future strategies and policy decision to stabilize growth under the situation of instability. It also helps to compare actual current performance of *cumin* with the expected ones (on the basis of the past performance) and analyse the causes of such variations, if any.

Materials and Methods

The study is based on secondary data. These secondary data of past years were collected from Directorate of Economics and Statistics, Jaipur, Rajasthan, Department of Agriculture, Government of Rajasthan, Jaipur, National Horticulture Board, Government of India and revenue records. To analyse the growth and instability in area, production and productivity of *cumin* in Rajasthan, districtwise data were collected during the period 1991-92 to 2010-11.

Three districts *viz*., Barmer, Jalore and Jodhpur for *cumin* crop were selected on the basis of highest average production of five years i.e. 2006-07 to 2010-11. To estimate the trends of growth in area, production and productivity of *cumin* crop in the state and major producing districts of the state, exponential function of the form $Y_t = ab^1$. Ut was used. Where Y_t is area production^{-1} productivity^{-1} of *cumin* in time period t, t is time element that takes the values 1, 2, 3, ... n, a and b are parameters to be estimated, and Ut is the error term, b = (1 + r), where 'r' is compound growth rate. The above equation can be rewritten as $Y_t = a\ (1 + r)^1$. Ut and logarithmic transformation of this equation we get Log Y_t = log a + t log (1 + r) + log Ut. The compound growth rate was obtained as r = [(Antilog of b) - 1] x 100. Student's 't' test was used to test the significance of the estimated compound growth rates.

The instability index in area, production and productivity of *cumin* in the state and major producing districts of the state for the period of 20 years i.e. from 1991-92 to 2010-11 was worked out through following measures. Instability index 1 (I_1) = SD/AM x 100 or $\sigma/\bar{X}$ x 100. Where SD and AM are standard deviation and arithmetic mean of area, production and productivity of the crop, respectively, for specified period. Instability index 2 (I_2) = SD*/AM* x 100 or $\sigma'/\bar{X}'$ x 100. Where SD* and MD* are standard deviation and arithmetic mean of detrended area, production and productivity of the crop, respectively, for specified period. Detrended values were worked out by assuming multiplicative model of the form of Y_{dt}=

Table 1. Compound growth rate of area, production and productivity for cumin crop (Per cent per annum)

District	Period I			Period II			Overall period		
	Area	Prodn	Yield	Area	Prodn	Yield	Area	Prodn	Yield
Barmer	11.85*	20.03***	7.31	-2.34	-10.05	-7.88	4.93*	4.85	-0.07
Jalore	-5.62	-7.66	-2.16	1.05	0.21	-0.82	-0.69	-0.37	0.33
Jodhpur	5.73**	-7.78	-12.68	3.79	4.57	0.75	6.51*	4.93	-1.49
Rajasthan	2.23	-1.03	-3.19	-2.95	-4.31	-1.40	2.22	0.80	-1.39

* Significant at 1 per cent level of significance *** Significant at 10 per cent level of significance

TSCR/T. Where Ydt is detrended value of area, production and productivity, T is trend, S is seasonal variation, C is cyclical variation and R is random variation. Instability index 3 (I_3) = $CV\sqrt{(1-R^2)}$. Where CV is coefficient of variance of area, production and productivity of the crop and R^2 is coefficient of multiple determination of the trend equation for original time series data on area, production and productivity.

Results and Discussion

Compound growth rate : The compound growth rates of area, production and productivity of *cumin* crop in selected districts and for the state as a whole for the period I (1991-92 to 2000-01), period II (2001-02 to 2010-11) and overall period (1991-92 to 2010-11) were worked out and depicted in Table 1. There was no significant growth in production and productivity of *cumin* spice in all the selected districts and state as a whole during period I, period II and overall period. However, significant increase in production of *cumin* crop was found only in Banner (20.03%) district during the period I which was due to positive and significant growth in area of 11.85 per cent per annum. Production of *cumin* spice decrease in Jalore district (-7.66%), Jodhpur district (-7.78%) and state as a whole (-1.03%) during period I which was due to negative growth in productivity under the crop by (-) 2.16, (-) 12.68 and (-) 3.19 per cent per annum, respectively. Production growth was also negative during period II in Barmer (-10.50%) district and state as a whole (-4.31%) which was due to negative growth in area of (-) 2.34 and (-) 2.95 per cent per annum, respectively.

During overall period, production growth rate was negative in Jalore district by (-) 0.37 per cent due to negative growth in area by (-) 0.69 per cent per annum. The area under *cumin* crop increased significantly in Barmer and Jodhpur districts during period I by 11.85 per cent and 5.73 per cent as well as during overall period by 4.93 and 6.51 per cent per annum, respectively. From the forgoing discussion it clearly indicate that the production of *cumin* increased only due to area expansion in all the district and state.

Instability in area of cumin in selected districts of Rajasthan : The instability estimated through different measures in area of *cumin* in the major producing districts of the state and for the Rajasthan state as a whole are given in Table 2. During period I, Jodhpur district emerged as highly unstable district in context of (37.63%) and I_3 (35.42%) measures, while Jalore district was found highly unstable district in context of I_1 (38.20%) measure. In the same period Barmer district was found lowest instable district with 32.92, 18.01 and 13.77 per cent instability in context of I_1, I_2 and I_3 measures, respectively. During period II, Jalore showed highest instability with 43.12, 43.20 and 43.12 per cent, while Barmer district had lowest instability with 30.05, 29.96 and 29.09 per cent with respect to I_1, I_2 and I_3 measures, respectively.

During overall period, instability analysis revealed that Jodhpur district was found highly unstable district with 49.22 per cent instability in context of I_1 measure, while Jalore district was highly unstable district with 39.68 and 39.59 per cent instability in context of I_2 and I_3, measures. Barmer district had lowest instability with 39.04, 30.29 and 30.76 per cent in context of I_1, I_2 and I_3 measures, respectively. The high and low instability in area under *cumin* crop was probable due to high price volatility. The instability in area under *cumin* crop was mainly governed by the profitability of the competing crops grown in that area.

Instability in production of cumin in selected districts of Rajasthan : The instability estimated through different measures in production of *cumin* in the major producing districts of the state and for the Rajasthan state as a whole are given in Table 3. Highest instability was noticed in Barmer district with 67.66 and 51.78 per cent in context of I_1 and I_2 measures, while Jodhpur district with 50.55 per cent instability in context of I_3 measure during period I. In the same period Jalore district showed lowest instability with 47.68, 37.45 and 40.80 per cent instability in context of II_1, I_2 and I_3 measures, respectively. During period II, Jalore district was found maximum instable with 60.08, 58.70 and 59.87 per cent instability in context of I_1, I_2 and I_3 measures, respectively while Jodhpur district was found minimum instability with 47.25, 44.82 and 43.04 per cent instability in context of I_1, I_2 and I_3 measures, respectively.

For the overall period, highest coefficient of variation in production was observed in Barmer

Table 2. Instability in area of cumin in selected districts of Rajasthan (in per cent)

District	**Instability measures**								
	Period I			**Period II**			**Overall period**		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Barmer	32.92	18.01	13.77	30.05	29.96	29.09	39.04	30.29	30.76
Jalore	38.20	18.02	15.98	43.12	43.20	43.12	39.73	39.68	39.59
Jodhpur	37.32	37.63	35.42	35.38	32.95	32.54	49.22	36.41	34.70
Rajasthan	30.16	26.61	30.01	37.45	36.96	35.77	38.34	36.64	36.48

Table 3. Instability in production of cumin in selected districts of Rajasthan (in per cent)

District	**Instability measures**								
	Period I			**Period II**			**Overall period**		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Barmer	67.66	57.78	44.42	52.58	52.64	43.41	60.55	57.79	57.70
Jalore	47.68	37.45	40.80	60.08	58.70	59.87	54.25	54.27	54.25
Jodhpur	52.88	51.22	50.55	47.25	44.82	43.04	59.13	44.82	50.10
Rajasthan	38.30	37.10	37.89	48.03	47.49	45.74	45.54	45.01	45.17

Table 4. Instability in productivity of cumin in selected districts of Rajasthan (in per cent)

District	**Instability measures**								
	Period I			**Period II**			**Overall period**		
	I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
Barmer	49.15	47.65	45.45	45.45	36.82	38.54	46.27	46.01	46.15
Jalore	25.46	24.46	24.53	38.06	37.28	37.70	33.12	32.74	32.97
Jodhpur	43.67	36.26	30.91	30.88	30.80	30.76	37.28	36.21	36.05
Rajasthan	16.70	14.52	13.70	32.16	31.15	31.66	24.71	24.46	23.74

district with 60.55, 57.79 and 57.70 per cent instability of I_1, I_2 and I_3 measures, respectively and lowest instability coefficient were found 44.82 and 50.10 per cent in context of I_2 and I_3 measures, respecting in Jodhpur district and 54.25 per cent in context of I_1 measure in Jalore district.

Instability in productivity of cumin in selected districts of Rajasthan : The estimated instability through different measures during different periods in productivity of *cumin* in the major producing districts of the state and for the Rajasthan state as a whole are given in Table 4. All the three measures of instability indicated that the productivity of *cumin* was maximum instable in Barmer district with respect to 49.15, 47.65 and 45.45 per cent and minimum in Jalore district with 25.46, 24.46 and 24.53 per cent in I_1, I_2 and I_3 measures, respectively, during period I. During period II, Barmer district was found high level of instability with 45.45 and 38.54 per cent in context of I_1 and I_3 measures, respectively, while Jalore showed 37.28 per cent in context of I_1. Jodhpur district having low level of instability with 30.88, 30.80 and 30.76 per cent instability in context of I_1, I_2 and I_3 measures, respectively.

During the overall period, Barmer district showed highest productivity instability of 46.27, 46.01 and 46.15 per cent and Jalore district showed lowest instability 33.12, 32.74 and 32.97 per cent in context to I_1, I_2 and I_3 measures, respectively.

Production of *cumin* in Barmer and Jodhpur districts and state as a whole increased non-significantly during overall period solely due to significant increase in area under the crop, while Jalore district had negative growth rate in production due to negative growth in area and productivity during period I. The area under the crop increased significantly in Barmer and Jodhpur districts in period I and overall period. Growth rates of area, production and productivity in Barmer district and state as a whole were found negative during period II. This implied that the existing technology was not able to sustain the existing level of production and productivity of the crop and there was an urgent need to evolve and popularize the new spices production technology in the state in general and *cumin* in particular.

The instability in area under *cumin* crop was found lower in Barmer district compared to the selected districts and state as a whole during period I, II and overall period (except in context of I_1 during period I and overall period). The coefficient of variation for *cumin* seed production has been higher for the selected districts compared to the state as a whole during period I, period II (Except Jodhpur district in all the three measures) and overall period (Except Jodhpur district in context of I2 measure). In Barmer district highest productivity instability was found by all the three measures in period I, II (except in context of I_2 measure) and overall period compared to the selected districts and Rajasthan state as a whole. The magnitude of instability in *cumin* crop was higher in production as compared to productivity and area except Barmer district (in context of Is measure) during period I, where the variation in productivity was more. This showed that the destabilizing effect was more on production compared to area and productivity.

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Effect of Weather Parameters on Incidence of Leaf Miner in Soybean

Sunanda Moka[1], M. G. Jadhav[2], P. R. Jaybhaye[3] and B. V. Asewar[4]
Department of Agricultural Meteorology,
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402 (India)
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Abstract

The peak incidence of leaf miner was observed during 36th MW sowing amongst all meteorological weeks (MW) sowing and in varieties; except 28th MW and 38th MW sowing for both the varieties (MAUS-158 and MAUS-71). Amongst the weekly incidence of leaf miner the highest incidence (1.42 larvae plant^{-1}) was observed in 27th and 29th MW sowing for MAUS-71 variety during 36th MW while, lowest incidence (0.02 larvae plant^{-1}) was observed in 26th MW sowing for MAUS-158. Leaf miner incidence was found negatively significant with T_{min} in 26th MW sowing for MAUS-158 and MAUS-71 and in 28th MW sowing for MAUS-71. Leaf miner incidence was found negatively significant with evaporation in 29th MW sowing for MAUS-158 and MAUS-71. The correlation in between leaf miner incidence and wind velocity was found negatively significant in 28th MW sowing for MAUS-71 and 26th MW sowing for MAUS-158. It means that leaf miner incidence mostly associated with Tmin, evaporation and wind velocity weather parameters and not variety of soybean.

Key words : Soybean, weather parameters, leaf miner, correlation.

Soybean (*Glycine max* (L).) is native of Asia. It is having high quantities of protein and fats. It is known as poor man's meat (Annonymous, 2005) due to its higher protein content. Leaf

1. Teaching Associate, 2. Associate Professor, 3. Assistant Professor and 4. Professor.

miner (*Aproaerema modicella*) causes a reduction in yield to the tune of 40 - 70 per cent in soybean (Singh and Hundal, 1982) and it usually causes 100 per cent damage to plant population and 75 per cent damage to leaflets (Shetgar and Thombre, 1984). The influence of weather factors not only on incidence of insect pest and diseases, epiphytes, but also affects on weeds, rodents and grazing animals and there association. It means that the weather effect directly or indirectly on pests. While, the incidence of some pests and diseases is directly influenced by weather elements (Rao, 2008). Under abiotic stress, crop management practices play an important role in deciding crop output in addition to the soil environment. The crop weather relationship could be better understood if the various aspects of environmental stress on crops are taken into account. Heavy and persistent rains and high humidity tend to reduce the pest population in groundnut and soybean, where as dry weather with bright sunshine hours and occasional rains leads to rapid build up of the pest (Gujarathi *et al.*, 1973).

Materials and methods

The investigation was carried out during *kharif* season 2011-2012, on the experimental farm, Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, (19°16'N latitude, 76°47' E longitude and 409 m MSL) with an objective to find out the relationship between the incidence of leaf miner and weather parameters in soybean. The experiment was laid out in split plot design with three replications and four sowing week *viz.*, first sowing (26th MW) , second sowing (27th MW), third sowing (28th MW) and fourth sowing (29th MW) in main plots and two soybean cultivars *viz.*, MAUS-158 and MAUS-71 in sub plots with three replications. Numbers of damaged leaves were counted from 10 randomly selected plants from net plot. Population of leaf miner was recorded weekly

Table 1. Population of leaf miner recorded on soybean crop under different dates of sowing

M.W.	Number of Larvae plant^{-1}							
	26th MW sowing		27th MW sowing		28th MW sowing		29th MW sowing	
	MAUS-158	MAUS-71	MAUS-158	MAUS-71	MAUS-158	MAUS-71	MAUS-158	MAUS-71
28	0.02	-	-	-	-	-	-	-
29	0.05	-	-	-	-	-	-	-
30	0.10	0.15	0.25	-	-	-	-	-
31	0.12	0.50	0.30	0.50	0.10	0.15	0.10	0.30
32	0.20	0.70	0.60	0.75	0.50	0.55	0.50	0.80
33	0.50	0.75	0.75	0.93	0.65	0.75	0.75	0.92
34	0.70	0.90	1.05	1.07	0.85	0.98	0.93	0.98
35	0.73	1.03	1.12	1.36	1.00	1.05	1.11	1.30
36	1.33	1.40	1.40	1.42	1.06	1.10	1.28	1.42
37	1.06	1.30	1.05	1.13	1.20	1.13	1.20	1.25
38	0.85	1.06	0.78	1.10	1.33	1.20	1.05	1.10
39	0.40	0.90	0.25	0.93	0.80	1.00	0.80	0.98
40	-	-	-	0.50	0.40	0.85	0.58	0.80
41	-	-	-	-	0.20	0.50	0.20	0.40
42	-	-	-	-	-	-	0.10	0.20
Mean	0.50	0.73	0.90	0.84	0.79	0.71	0.96	0.87

and then the averages were worked out. The peak period of population of leaf miner was recorded. Correlation between environmental factors *viz*., rainfall, rainy days, temperature (maximum and minimum), relative humidity morning (RH-I) and evening (RH-II), evaporation, bright sunshine hours and wind velocity and population of leaf miner was worked out. Simple correlation was carried out between weather parameters and development of leaf miner population to estimate the extent of their association with yield of soybean.

Results and discussion

Incidence and population : The incidence of leaf miner in soybean was observed (Table 1) initially in all the treatments (i.e. sowing weeks and variety) from 31st MW period and it continued up to 39th MW. While, in 28th and 29th MW period incidence was observed in 26th MW sowing for MAUS-158 and in 30th MW period it was observed in 26th and 27th MW sowing for both the varieties. The data given in table 1 revealed that during the whole crop growing period of soybean crop at Parbhani in all the sowing weeks and varieties, the leaf miner was found increasing continuously from first incidence MW to 36th MW period except in 28th MW sowing; it increased up to 38th MW period. Secondly, peak incidence of leaf miner was observed in 36th MW period in all the sowing weeks (MW sowing) and all varieties except in 28th MW sowing in the both varieties and it was found in 38th MW period.

Seasonal mean leaf miner incidence on soybean crop was observed highest (0.96 larvae plant^{-1}) in 29th MW sowing and lowest (0.50 larvae plant^{-1}) in 26th MW sowing for MAUS-158. However, amongst the weekly incidence of leaf miner highest incidence on soybean was observed (1.42 larvae plant^{-1}) during 36th MW period in 27th and 29th MW sowing for MAUS-71. The lowest incidence of leaf miner (0.02 larvae plant^{-1}) was observed in 26th MW sowing for MAUS-158.

These results are in confirmatory with Chattopadhyay *et al*., (2012) and Durai Raj (2007) who stated that the activity of all pests initiated in the month of August and attained their peaks in month of September and early October.

Correlation : Correlation in between weather parameters and incidence of leaf miner in soybean during *kharif* season 2011-12 were worked out and it is given in Table 2. It was

Table 2. Correlation coefficient between weather parameters and incidence of leaf miner on soybean

Weather parameters	26th MW Sowing		27th MW Sowing		28th MW Sowing		29th MW Sowing	
	MAUS-158	MAUS-71	MAUS-158	MAUS-71	MAUS-158	MAUS-71	MAUS-158	MAUS-71
Rain fall (mm)	-0.198	-0.501	-0.002	-0.141	-0.363	0.054	0.025	-0.014
Rainy days	-0.332	-0.442	0.114	0.118	-0.328	0.056	0.409	0.367
Tmax. (°C)	-0.138	-0.194	-0.384	-0.350	-0.108	-0.367	-0.106	0.006
Tmin. (°C)	-0.830*	-0.825*	-0.605	-0.500	-0.431	-0.610*	0.142	0.215
RH - I (%)	0.189	-0.028	0.384	0.245	0.004	0.356	0.151	0.040
RH - II (%)	0.137	0.027	0.456	0.491	-0.192	0.380	0.410	0.348
Evp. (mm)	0.058	0.008	-0.273	-0.466	0.212	-0.167	-0.555*	-0.513*
B.S.S (hrs day^{-1})	0.383	0.273	-0.127	-0.276	0.149	-0.068	-0.524	-0.495
W.V. (km h^{-1})	-0.649*	-0.423	0.488	-0.298	-0.281	-0.549*	-0.368	-0.317

*,** Significant at 5 and 1 percent probability level respectively.

revealed that the infection of leaf miner in soybean crop was not influenced by the variety. It is because of that the both varieties (*viz.*, MAUS-158 and MAUS-71) were found infested by leaf miner. Hence, infection of soybean crop by leaf miner was found irrespective of variety and influenced by weather. It may be due to changing weather condition during crop growth period due to different sowing weeks. Difference in sowing weeks provides different weather condition to crop and leaf miner growth and development. The weather parameters minimum temperature (T_{min}) was found negatively significant with leaf miner in 26th MW sowing for MAUS-158 (r = -0.830), for MAUS-71 in 26th MW sowing (r = -0.825) and in 28th MW sowing (r = -0.610). While, evaporation showed negatively significant correlation with leaf miner incidence in 29th MW sowing of MAUS-158 (r = -0.555) and MAUS-71 (r = -0.513). Whereas, the negative correlation between wind velocity and incidence of leaf miner was found in 28th MW sowing for MAUS-158 variety (r = -0.549) and 26th MW sowing for MAUS-158 (r = -0.649). It means that with decreasing minimum temperature, evaporation and wind velocity incidence of leaf miner on soybean found to be increased.

It is clearly understood from the above observations that the incidence of leaf miner in *kharif* soybean showed significantly negative correlation with minimum temperature, evaporation and wind velocity. Peak incidence of leaf miner damage was observed during 36th MW period (1.42 larvae plant^{-1}) and higher incidence period was observed from 35th to 38th MW period. Hence, it is concluded that the incidence of leaf miner in soybean are influenced by weather condition and not by the variety. As varying weather, infestation of leaf miner per cent varies and it may be controlled by controlling microclimatic condition with adopting the techniques for weather modification.

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Identification of Deoni Cattle by Muzzle Printometry

P. T. Damane[1] and S. S. Chopade[2]
College of Veterinary and Animal Sciences, Udgir - 413 517 (India)
(Received : 10-05-2014)

Abstract

The study was undertaken on 95 Deoni animals (male and female) of various ages at Deoni Cattle Breeding Farm, College of Veterinary & Animal Sciences, Udgir (Maharashtra). All animals were divided in to 13 different age groups ranging from 0-6 months to 109 months and above age groups, The muzzle of Deoni cattle showed significant increase from 0-6 month to 37-48 month age groups suggesting that the muzzle of Deoni cattle exhibited fast and noticeable growth from birth up to the age group of 37-48 month. After this age the muzzle of Deoni cattle did not show noticeable growth. The various muzzle characteristics of the muzzle of Deoni cattle showed reduction in numbers as the age advances; however, trend of reduction in numbers was not uniform. Identification chart developed on the basis of muzzle grooves, muzzle characteristics and muzzle measurements of each animal proved to be efficient tool of identification of Deoni cattle at various age groups.

Key words : Deoni cattle, age groups, muzzle prints, muzzle measurements, muzzle characteristics and identification.

Deoni cattle, by virtue of their appearance and phenotype are believed to be developed by crossing of local and Gir cattle before 280-285 years back. As early as 1930 and ever before, Deoni cattle were known as Dongerpati or Dongari. The name Deoni evolved from Deoni taluka of Latur district in Maharashtra. Deoni cows are producing on an average 900 kg of milk lactation^{-1} and bullocks are useful for agricultural and other draft operations. Deoni cattle play very important role in boosting economic development of the people of this region through mixed farming or dairy farming. The Government organizations are helping needy farmers through supply of dairy animals on loan basis. Insurance companies insured these animals through insurance schemes. However, in want of permanent and perfect identification of animals, the beneficiaries mislead the insurance companies and took undue advantage of the schemes. This is happening as the existing identification methods like tattooing; branding; ear/neck tagging etc. are mostly temporary and having many disadvantages. The research findings put forth by some research workers suggested that muzzle prints of animals as finger prints in human beings could be used as permanent method of identification (Miller and West, 1972; Sisson and Grossman, 1975; Pandey, 1979). It is proved that muzzle prints are obtained easily, need very short time, economical, not inhumane to animals and remain constant after 2-3 years of age (Pandey, 1979; Ravikumar, 1994). In view of the paramount importance of Deoni cattle and very scanty work on the identification the present investigation was undertaken.

1. M. V. Sc. student and 2. Associate Professor.

Material and Methods

The study was undertaken on 95 Deoni animals (male and female) of various ages at Deoni Cattle Breeding Farm, College of

Veterinary and Animal Sciences, Udgir (Maharashtra). All animals were divided in to 13 different age groups ranging from 0-6 months to 109 months and above age groups. The muzzle prints of Deoni cattle were obtained by the technique described by Mishra and Dave (1989) and Mishra *et al*. (1995) and the muzzle measurements and muzzle characteristics of each muzzle print were studied for identification of each animal.

Results and Discussion

Muzzle measurements : The minimum basal length, upper length, central length and distance between nostrils of the muzzle was 3.69, 3.81, 3.67 and 2.42 cm, respectively noticed in 0-6 month calves of Deoni cattle. The maximum values for the same was 6.96, 8.43, 8.07 and 5.02 cm, respectively found in 109 and above month age group Deoni cattle. The linear and significant ($P < 0.01$) increase in basal length, central length and distance between nostrils was noticed from 0-6 month up to 37-48 month age group of Deoni cattle. However, upper length increased significantly up to the age group of 61-72 months. Basal length, central length and distance between nostrils of the muzzle of Deoni cattle showed fast and continuous growth from birth up to 4 years of age and after this the growth was very slow, steady and meagre. However, upper length showed growth up to the age of 6 years. It is observed that the muzzle measurements showed an increasing trend with the advancement of age of Deoni cattle. Except upper length, all muzzle measurements significantly increased up the age of 4 years indicating faster growth of the muzzle. Yadav (1991), Mugale *et al*. (1992), Singh (1998) and Chopade and Khire (2009) found an increasing trend of muzzle measurements with the advancement of age suggesting that most of the

Table 1. Muzzle measurements and area of muzzle print of Deoni cattle at various age groups

Age group (month)	Basal length (cm)	Upper length (cm)	Central length (cm)	Distance between nostrils (cm)	Area of muzzle print (cm^2)
0-6	3.69 ± 0.10^{h}	3.81 ± 0.23^{i}	3.67 ± 0.19^{h}	2.42 ± 0.14^{f}	9.04 ± 1.01^{h}
07-12	4.21 ± 0.15^{g}	4.67 ± 0.14^{h}	4.45 ± 0.25^{g}	3.15 ± 0.11^{e}	14.14 ± 1.08^{g}
13-18	4.98 ± 0.19^{f}	5.72 ± 0.15^{g}	5.42 ± 0.19^{f}	3.36 ± 0.12^{e}	18.30 ± 1.30^{f}
19-24	5.20 ± 0.25^{f}	6.30 ± 0.46^{f}	5.96 ± 0.21^{e}	3.64 ± 0.09^{d}	21.76 ± 1.26^{e}
25-30	6.03 ± 0.15^{e}	6.57 ± 0.11^{e}	6.32 ± 0.11^{d}	3.96 ± 0.15^{c}	25.00 ± 0.89^{d}
31-36	6.31 ± 0.13^{d}	6.84 ± 0.09^{e}	6.75 ± 0.05^{c}	4.24 ± 0.12^{b}	28.64 ± 0.90^{c}
37-48	6.56 ± 0.15^{c}	7.24 ± 0.11^{d}	6.92 ± 0.11^{c}	4.44 ± 0.17^{b}	30.77 ± 1.63^{c}
49-60	6.72 ± 0.12^{bc}	7.55 ± 0.08^{c}	7.56 ± 0.10^{b}	4.81 ± 0.14^{a}	36.49 ± 1.58^{b}
61-72	6.91 ± 0.07^{ab}	8.05 ± 0.09^{b}	7.82 ± 0.17^{a}	4.84 ± 0.14^{a}	38.04 ± 1.92^{a}
73-84	6.94 ± 0.10^{ab}	8.34 ± 0.10^{a}	8.04 ± 0.10^{a}	4.94 ± 0.13^{a}	39.77 ± 1.58^{a}
85-96	6.86 ± 0.09^{ab}	8.42 ± 0.09^{a}	8.06 ± 0.09^{a}	5.00 ± 0.09^{a}	40.33 ± 1.17^{a}
97-108	6.91 ± 0.06^{ab}	8.40 ± 0.11^{a}	8.05 ± 0.09^{a}	4.96 ± 0.22^{a}	40.01 ± 2.00^{a}
109 and above	6.96 ± 0.06^{a}	8.43 ± 0.05^{a}	8.07 ± 0.05^{a}	5.02 ± 0.09^{a}	40.60 ± 0.82^{a}
F Test	Significant	Significant	Significant	Significant	Significant
SE	0.131	0.147	0.141	0.145	1.400
CD (0-01)	0.327	0.364	0.342	0.353	3.434
CD (0-05)	0.244	0.273	0.262	0.267	2.597

Mean having common superscripts does not differ significantly with in column muzzle measurements increased maximum during the growing phase. Prabhat Kumar and Nagpaul (2005) studied on 296 Karan Fries cows and also reported increment in various muzzle measurements during their growing phase of life. The observations noticed for muzzle measurements of Deoni cattle at various age groups are in agreement with the findings of Yadav (1991), Mugale *et al*. (1992), Singh (1998), Prabhat Kumar and Nagpaul (2005) and Chopade and Khire (2009).

Area of muzzle : The central length and distance between nostrils of the muzzle decided the area of muzzle. The youngest group of Deoni cattle (0-6 month) exhibited 9.04 sq. cm. area of muzzle which was minimum and it was increased maximum to 40.60 sq. cm. in the oldest group (109 and above month). However, significant ($P<0.01$) increase in area of muzzle of Deoni cattle was observed up to 5 years (49-60 month) of age indicating the faster and noticeable growth of muzzle up to this age.

Muzzle characteristics : The variation in number of beads, clustered beads and ridged beads counted at 2 x 2 cm sector of muzzle print was found from 32.40 to 10.20, 17.42 to 4.60 and 6.42 to 4.10, respectively in 0-6 month to 109 and above month age group of Deoni cattle. As the age of Deoni cattle advances the muzzle characteristics of muzzle decreased in numbers. However, the trend of decrease in numbers of muzzle characteristics was not linear and uniform. The number of beads of muzzle showed significant ($P<0.01$) decrease up to the age group 49-60 month with exception in few age groups. Significant decrease in number of clustered beads of muzzle was seen in different age groups of Deoni cattle but trend of reduction was not uniform. It is seen that the number of beads, clustered beads and ridged beads of the muzzle showed decreasing trend from 0-6 month to 109 and above month age groups of Deoni cattle but there was no uniformity in reduction of numbers. Mishra and Dave (1989) observed statistical difference ($P<0.01$) in total number of beads in a square of 2.5 x 2.5 cm dimension of muzzle in each age group of animals. They also noticed decrease in number of beads in all sectors with age advancement. Jain (1993) reported that different types of beads were higher in younger groups of calves as compared to older groups. Singh and Patel (2004) noticed that total converted beads were maximum in younger animals of Gir and Kankrej cattle than older. Mean muzzle beads, clustered beads and ridged beads showed a downward trend. However, the decline was not linear while, total converted beads, the representative of all muzzle characteristics showed a declined trend as the age advances. Chopade (2007) studied the muzzle characteristics at 2 x 2 cm sector drawn at base of the muzzle of Crossbred,

Table 2. Muzzle characteristics of Deoni cattle at various age groups

Age group (month)	Beads (Nos.)	Clustered beads (Nos.)	Ridged beads (Nos.)
0-6	28.42 ± 1.17^{b}	17.42 ± 0.95^{a}	6.42 ± 0.57^{a}
07-12	23.42 ± 0.92^{cd}	14.14 ± 0.77^{b}	6.42 ± 0.57^{a}
13-18	32.40 ± 1.50^{a}	6.60 ± 0.93^{d}	6.20 ± 0.73^{ab}
19-24	24.20 ± 1.43^{c}	6.80 ± 1.16^{d}	5.40 ± 0.93^{abc}
25-30	21.75 ± 0.88^{d}	7.25 ± 0.65^{d}	5.12 ± 0.48^{cd}
31-36	15.30 ± 0.75^{e}	8.25 ± 0.55^{c}	5.30 ± 0.43^{bc}
37-48	13.40 ± 1.21^{f}	8.80 ± 0.86^{c}	5.00 ± 0.71^{cd}
49-60	10.70 ± 0.76^{g}	7.40 ± 0.37^{d}	4.10 ± 0.41^{d}
61-72	12.00 ± 1.13^{fg}	6.71 ± 0.68^{d}	4.57 ± 0.48^{cd}
73-84	11.80 ± 0.66^{fg}	6.20 ± 0.66^{d}	4.60 ± 0.40^{cd}
85-96	13.00 ± 1.05^{f}	4.80 ± 0.37^{e}	4.80 ± 0.58^{cd}
97-108	10.50 ± 0.88^{g}	4.66 ± 0.56^{e}	4.45 ± 0.11^{cd}
109 and above	10.20 ± 0.56^{g}	4.60 ± 0.41^{e}	4.47 ± 0.44^{cd}
FTest	Significant	Significant	Significant
SE	1.020	0.710	0.576
CD (0-01)	2.501	1.744	-
CD (0-05)	1.885	1.310	1.063

Mean having common superscripts does not differ significantly with in column

Gaolao, Sahiwal and Non-descript cattle at various age groups and observed significant differences (P<0.01) in number of clustered beads, ridged beads and total converted beads, except beads only. Crossbred cows showed uniformity in reduction in number of muzzle characteristics as the age of animal advances but other breeds did not show uniformity. The result obtained on muzzle characteristics of the muzzle of Deoni cattle were in agreement with the findings of Mishra and Dave (1989), Jain (1993), Singh and Patel (2004) and Chopade (2007).

Identification of Deoni cattle : An identification chart was developed on the basis of muzzle grooves, muzzle characteristics and muzzle measurements of the muzzle print of each Deoni animal. Combined identification chart based on code value of muzzle groove and number of muzzle characteristics and muzzle measurements increased the accuracy of identification and proved an efficient tool of identification of Deoni cattle. Muzzle measurements and muzzle characteristics in different sectors of muzzle of Deoni cattle are age dependent and hence, the length of time between muzzle print taken and muzzle print utilized for identification should be kept in mind. Pandey (1979) studied on 500 pairs of muzzle prints of cattle and buffaloes and classified them on the basis of presence and absence of groove for identification. Singh (1998) suggested classification of muzzle prints on the basis of muzzle groove and characteristics like beads, clustered beads, ridged beads and codes were given to individual muzzle. An identification chart was developed on the basis of muzzle code values. It is concluded from the results that; (i) the muzzle of Deoni cattle showed significant increase from 0-6 month up to 37-48 month age groups suggesting that the muzzle of Deoni cattle exhibited fast and noticeable growth from birth up to 4 years of age. After this age, the muzzle did not show noticeable growth (ii) various muzzle characteristics of the muzzle showed reduction in numbers as the age of Deoni cattle advances; however, trend of reduction in numbers was not uniform, (iii) Identification chart developed on the basis of muzzle grooves, muzzle characteristics and muzzle measurements of each animal proved to be efficient tool of identification of Deoni cattle at various age groups.

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Quality Assessment of Lassi Blended with Finger Millet (*Eleusine caracana*) Flour

P. S. Paradhi[1], R. J Desale[2] and K. D. Chavan[3]
Department of Animal Science and Dairy Science,
Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722 (India)
(Received : 10-05-2014)

Abstract

The present study was undertaken to explore the possibility of utilizing the finger millet flour for preparation of *lassi*. On the basis of pre-experimental trials, 20 per cent water, 10 per cent sugar and 2,3, and 4 per cent levels of finger millet flour were finalized to admix in the *lassi*. The *lassi* samples were evaluated for chemical, sensory and microbiological qualities using standard procedures. The mean fat, protein, ash, total sugar, total solids and lactic acidity ranged from 1.82 (T_3) to 2.70 (T_0), 3.20 (T_0) to 4.18 (T_3), 0.73 (T_0) to 0.85 (T_3), 14.45 (T_0) to 16.26 (T_3), 21.06 (T_0) to 23.11 (T_3) per cent and 0.74 (T_3) to 0.88 (T_0) per cent LA, respectively. All chemical constituents of the different *lassi* samples had significant influence due to addition of various levels of finger millet flour. Microbiological quality of all lassi samples remain within the limit of standards. Taking into consideration chemical composition, sensory quality and microbiological quality of *lassi* prepared by blending 3 per cent finger millet flour was found superior over rest of the treatments.

Key words : *Lassi*, finger millet flour, chemical quality, sensory quality, microbiological quality.

Lassi is one of the important ideal fermented milk product for serving with hot dishes as it helps the body to digest the food. Addition of a little turmeric powder to it is believed to be a folk remedy for gastroenteritis. *Lassi* is not only perfect as a morning smoothie, but it is also relished as a hot weather refreshment to beat the scorching heat and it acts as an energizing liquid meal or it provides relief after eating a delicious but hot spicy meal. Thus, *lassi* is a digestive aid for the afternoon meal; it settles the upset stomach and it is the perfect cooling agent (Anonymous, 2006).

There are many new products (so called of refreshing nature) flooding the market but the benefits of *lassi* cannot be replaced by any other drink. Moreover, *lassi* does not have any side effect. Therefore, it is appropriately said that *lassi* is a natural stress buster. Being

1. M.Sc. (Agri.) student, 2. Asst. Prof. and 3. Asso. Prof.

therapeutically valuable and delicious in taste; it is very popular among all age groups.

'*Chaah*' or '*Mattha*' also called as '*lassi*' refers to desi buttermilk, which is the byproduct obtained while churning curdled whole milk with crude indigenous devices for the production of desi butter (De. 1997).

Fermented milk products refer to the group of milk products in which microorganisms play an important role and bring about desirable changes in their flavour, body and texture and colour and appearance. A few such microorganisms may be mentioned as; *Lactococcus lactis* ssp. l*actis, Streptococcus salivarious sap. thermophilus, Lactobacillus delbrueckii ssp. bulgaricus*, etc. The popularity of fermented milk products is due to their pleasant taste and therapeutic value. Lactic acid bacteria or starter organisms have the property of producing lactic acid from lactose by a process called fermentation. The therapeutic and nutritional significance of lactic acid bacteria and fermented milk products and particularly *lassi* has been already identified.

Most of the research related to *lassi* has been centered on technology development. Recently, there has been an increasing trend of fortifying the milk products with fruit or vegetable extracts. Value addition of milk and milk products enhances consumer acceptability, their nutritive quality and these products fetch higher prices in the market which ultimately leads to socio - economic development of the producers as well as processors.

Finger millet is a rich source of calcium (300-350 mg), phosphorus (283 mg) and iron (3.9 mg) per 100 grams (Gopalan *et al*., 2000). The protein content of finger millet is about to 7.7 per cent. The finger millet has well balanced amino acid profile and is a good source of methionine, cystine and lysine. It also contains about 72 per cent carbohydrates, a high proportion of which is in the form of non starchy polysaccharides and dietary fiber (3.6%) which helps in prevention of constipation and lowering of blood glucose levels. It is also a rich source of vitamins *viz*., thiamine, riboflavin, folic acid and niacin.

Materials and Methods

Milk : Composite samples of crossbred cow's milk were obtained from the herd maintained at RCDP on Cattle, Department of Animal Science and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri.

Water : Clean potable drinking water was used for preparation of *lassi* throughout the study period.

Cane sugar : Good quality commercial grade cane sugar was used as a sweetener in *lassi*.

Finger millet : Good quality finger milletgrains was purchased from local market.

Chemical analysis of milk

Fat : Fat content was determined by Gerber's method as per procedure stated in IS: 1224 (Part-I) 1977.

Protein : Nitrogen content was determined by as per the procedure of Menefee and Overman (1940). This was multiplied by 6.38 to obtain protein percentage.

Ash : Ash content was determined as per procedure given in IS:1479 (Part-II) 1961.

Total solids (TS) : Total solids were determined as per procedure given in IS:1479 (Part-II) 1961.

Acidity : Acidity (% LA) was determined as per procedure stated in IS:1479 (Part-I) 1960.

Chemical analysis of finger millet

The percentage of proteins, carbohydrates and ash content in finger millet was determined as per the procedures given by Ranganna (1977).

Starter culture : Freeze dried LF-40 starter culture was procured from the National Collection of Dairy Culture (NCDC), Division of Dairy Microbiology, NDRI, Kamal and was used in the study.

Experimental trials : On the basis of the results of pre- experimental trials, addition of water (20%), sugar (10%), levels of finger millet flour *viz*., 2, 3 and 4 per cent in the *lassi* were finalized for experimental trials.

Technology for preparation of *lassi* : *Lassi* samples were prepared as per the procedure described by Gupta and Kulkarni (1983). The composite whole milk was taken in a stainless steel container. It was preheated to 35°C filtered and heat treated at 85°C for 10 minutes. Milk was cooled down to room temperature. Active dahi starter culture was inoculated undei aseptic conditions at the rate of 1.5 per cent and mixed thoroughly. The inoculated milk was incubated at 30°C temperature for 12 hrs. The coagulum of dahi was broken down and water, sugar and finger millet flour were added into it for the preparation of *lassi*.

Sensory evaluation of *lassi* : *Lassi* samples prepared under this study during pre-experi mental and experimental trials were organoleptically evaluated by the panel of six semi-trained judges adopting 9 point Hedonic scale.

A score card given by Dharampal and Gupta (1985) with slight modifications (Ashwani, 1992) was used lor sensory evaluation of *lassi*.

Chemical analysis of *lassi*

Fat : Fat content was determined using Gerber method as per procedure stated in IS:1224 (Part-I) 1977.

Protein : Nitrogen content was determined by semi - micro kjeldahl method as described by Menefee and Overman (1940). It was multiplied by 6.38 to get protein percentage.

Total sugar : Total sugar was determined using Lane and Eynon's method (1923) modified by Ranganna (1977).

Ash : Ash content was determined as per procedure given in IS:1479 (Part-II) 1961.

Total solids : Total solids were determined as per procedure given in IS:1479 (Part-II) 1961.

Acidity : Acidity (% LA) was determined as per procedure stated in IS:1479 (Part-I) 1960.

Microbial evaluation of *lassi*

Standard plate pount (SPC) : Standard Plate Count (SPC) was determined by adopting standard procedure mentioned by Amin (1997).

Yeast and mould count (YMC) : Yeast and Mould Count (YMC) was determined as per procedure described in IS: 5403(1969).

Coliform count : Coliform count of *lassi* samples was determined as per procedure described in IS:5550 (1970).

Preparation of media : Different media like SPCA, PDA, MA. LPA and MRS were prepared as per the procedures explained by Amin (1997).

Preparation of dilution blanks : The dilution blanks of 9 ml portions were made from phosphate buffer solution to glass test tubes (18 x 150 mm). The tubes were plugged with cotton and autoclaved at 121°C for 15 minutes.

Sampling of *lassi* : Respective lot of *lassi* sample was mixed thoroughly to make the contents homogeneous. One gram of the representative sample was taken, transferred to the test tube containing 9 ml phosphate buffer solution. Several serial dilutions were then made in 9 ml dilution blanks.

Plating : Appropriate dilutions of the respective samples were transferred to sterile petriplates in duplicate. Plates were poured with respective media. Most aseptic condition was observed to avoid contamination in this case.

The plates were incubated at optimum growth temperatures and period mentioned in respective procedures. After incubation period, the colonies were counted.

Statistical design : The research data was tabulated and statistically analyzed by using Completely Randomized Design (CRD) as described by Snedecor and Cochran (1967).

Results and Discussion

On an average the cow whole milk contains 3.82 per cent fat, 3.80 per cent protein, 4.25 per cent lactose, and 12.57 per cent total solids, respectively. Finger millet flour used for preparation of *lassi* had 6.30 per cent protein, 72.00 per cent carbohydrates and 0.89 per cent ash content.

Chemical composition *lassi*

Fat : It reveals from Table 1 that the average fat percentage was significantly highest (2.70%) in T_0 treatment prepared without blending of finger millet flour (control *lassi*) where as it was lowest (1.82%), in T_3 treatment *lassi* prepared with addition of 4 per cent finger millet flour.

As the proportion of finger millet flour was increased in *lassi*, its fat content decreased and treatments differed significantly. Jangle *et al.* (2011) also reported that as the proportion of custard apple pulp was increased in *lassi*, its fat content decreased significantly. This might be due to low fat content of finger millet flour. Similar observations on fat content of *lassi* were recorded by Pagote and Balchandran (1993). They reported that the values of fat content was reduced from 3.25 to 2.54 per cent while studying the effect of butter milk on *lassi* by direct acidification of milk. Patil (2001) recorded 3.33 per cent fat reduction while preparation of guava yoghurt from cow milk.

Table 1. Chemical composition of *Lassi* samples

Treatment	Fat (%)	Protein (%)	Ash (%)	Total sugar (%)	Total soilds (%)	Acidity (%)
T_0	2.70^{d}	3.20^{a}	0.73^{a}	14.43^{a}	21.06^{a}	0.88^{d}
T_1	2.34^{bc}	3.60^{b}	0.75^{ab}	14.83^{b}	21.53^{h}	0.84^{c}
T_2	2.18^{b}	4.04^{c}	0.82^{c}	15.51^{c}	22.55^{bc}	0.78^{h}
T_3	1.82^{a}	4.18^{d}	0.85^{cd}	16.26^{d}	23.11^{d}	0.74^{a}
S.E. ±	0.05	0.04	0.01	0.02	0.09	0.007
CD at 5%	0.16	0.12	0.03	0.06	0.27	0.02
Result	*	*	*	*	*	*

* = Significant

Protein : It is observed that the mean protein content (Table 1) in different *lassi* samples T_0, T_1, T_2 and T_3 were 3.2, 3.6, 4.04, 4.18 per cent, respectively. The protein content of *lassi* samples differed significantly due to addition of finger millet flour.

The protein content of finger millet *lassi* increased as increase in the level of finger millet flour in the *lassi*. This might be due to high protein content in finger millet.

The average protein content was significantely highest in T_3 treatment prepared with addition of 4 per cent finger millet flour where as lowest in T_0 treatment prepared without addition of finger millet flour. The values of protein content in the *lassi* observed in this investigations are comparable with the results of Jadhav (1991) who reported the values of protein content in plain buttermilk was between 3.204 to 3.507 per cent.

Ash : The values presented in Table 1 for ash content of *lassi* samples samptes T_0, T_1, T_2 and T_3 were 0.73. 0.75, 0.82, and 0.85 percent, respectively. It was further observed that with increase in the level of finger millet flour there was increase in the ash content of the sample. The ash content in *lassi* samples differed significantly due to addition of finger millet flour.

Total sugar : It is observed (Table 1) that the mean total sugar content of *lassi* samples of T_0, T_1, T_2 and T_3 were 14.43, 14.83, 15.51 and 16.26 per cent, respectively and differed significantly due to addition of finger millet flour. The total sugar content of finger millet *lassi* increased as increase in the level of finger millet flour.

Total solids : From the Table 1, it is observed that the total solids content of T_0, T_1, T_2 and T_3 *lassi* samples were 21.06, 21.53, 22.55 and 23.11 per cent, respectively and differed significantly due to addition finger millet flour in *lassi* samples and among the treatments.

The total solids content of finger millet *lassi* increased as increase in the level of finger millet flour. This might be due to the higher total solid of finger millet flour. Jadhav (1991) also reported the increased trend of total solids content in butter milk ranged from 15.30 to 17.28 per cent.

Acidity : From the Table 1 it was observed that the acidity content of T_0, T_1, T_2 and T_3 was 0.88, 0.84, 0.78 and 0.74 per cent L.A, respectively. The acidity content of finger millet *lassi* decreased as increase in the level of finger millet flour.

Table 2. Sensory quality of *Lassi* samples

Treatment	Colour and appearence	Flavour	Body and texture	Acidity	Overall acceptability
	(Sensory score out of 9)				
T0	7.97^{a}	7.23^{a}	7.11^{a}	7.21^{ab}	7.39^{ab}
T1	7.66^{c}	7.30^{b}	7.49^{b}	7.24^{b}	7.41^{c}
T2	7.545^{b}	7.56^{d}	8.02^{d}	7.33^{d}	7.54^{d}
T3	7.17^{a}	7.31^{bc}	7.60^{c}	7.19^{a}	7.37^{a}
S.E. ±	0.04	0.01	0.02	0.09	0.007
CD at 5%	0.12	0.04	0.08	0.03	0.02
Result	*	*	*	*	*

* = Significant

The higher acidity content was observed in the *lassi* sample T_0 (0.88%) while lower acidity content was in T_3 (0.74%) and all *lassi* samples differed significantly among themselves.

Observations on acidity content of *lassi* samples were recorded to 0.80 to 0.85 per cent by De (1980).

Sensory quality of *lassi*

Colour and appearance : From the Table 2 it is observed that the mean sensory score for colour and appearance for the T_0, T_1, T_2 and T_3 samples of *lassi* was 7.97, 7.66, 7.54 and 7.17, respectively and which differed significantly due to addition of finger millet flour in *lassi*.

The colour and appearance of *lassi* samples decreased significantly with increase in the level of finger millet flour. This might be due to roasting treatment given to finger millet flour.

Flavour : It is one of the important parameter of sensory quality of any product. The sensory quality of *lassi* to different treatments was categorized as "excellent ". The mean sensory score (Table 2) ranged from 7.31 (T_3) to 7.56 (T_2). The level of addition of finger millet flour in the *lassi* samples significantly ($P < 0.05$) affected the flavour of the product. The mean sensory score for the *lassi* samples of T_0, T_1, T_2 and T_3 were 7.23, 7.30, 7.56 and 7.31, respectively, which also differed significantly ($P < 0.05$) among each other.

The flavour score for *lassi* samples increased with increase in the level of finger millet flour. This might be due to roasting treatment to finger millet flour.

Body and texture : From the Table 2, it was observed that the body and texture scores for the T_0, T_1, T_2 and T_3 *lassi* were 7.11, 7.49, 8.02 and 7.60, respectively which differ significantly ($P < 0.05$).

The body and texture score of finger millet *lassi* increased due to addition of finger millet flour. This might be due to thick consistency developed to the product by absorption of water by finger millet flour during preparation of the product.

The observations of this study are comparable with the reports of Jagtap (1998), Sonawane (1998) and Patil (2001), they reported the declining trend in the scores along with increased level of incorporation of fruit pulp/juices.

Acidity : From the Table 2 it is revealed that the acidity score for T_0, T_1, T_2 and T_3 *lassi* was 7.2 1, 7.24, 7.33 and 7.1, respectively. The acidity of finger millet *lassi* increased with increase in the level of finger millet flour. This might be due to addition of finger millet flour.

The acidity score for T_2 sample was highest while lowest score was observed in the sample T_3 and the treatment T_0 and T_1 were on par with each other.

Hapase (2004) who noticed that higher acidity score for the sample of the *lassi* prepared with addition of 10 per cent mango pulp than 8 per cent level.

Overall acceptability : From the Table 2

Table 3. Microbiological quality of *Lassi* samples

Treatment	SPC (10^2 cfu ml^{-1})	E. coli (cfu ml^{-1})	YMC (10^2 cfu ml^{-1})
T_0	13.20b	4.00c	10.26abc
T_1	4.00cd	3.40bc	10.24ab
T_2	10.80a	1.60a	8.94a
T_3	15.80d	2.80b	11.10abcd
S.E. ±	0.36	0.25	0.19
CD at 5%	1.08	0.76	0.58
Result	*	*	*

* = Significant

it is observed that the overall acceptability score for samples T_0, T_1, T_2 and T_3 was 7.39, 7.41, 7.54 and 7.37, respectively. Which differ significantly ($P < 0.05$) due to addition of finger millet flour in the *lassi*. The overall acceptability score of *lassi* samples increased with increase in the level of finger millet flour up to certain level. The highest overall acceptability score was observed in the sample treatment T_2 prepared by addition of 3 per cent finger millet flour while lowest in the T_3, prepared by addition of 4 per cent finger millet T_0 and T_1 were at par with each other.

Microbiological quality *lassi*

Standard plate pount (SPC) : From the Table 3 it was observed that the Standard Plate Counts for the treatment samples T_0, T_1, T_2 and T_3 were 13.20, 14.00, 10.80 and 15.80 x 10^2 cfu ml^{-1}, respectively which differ significantly ($P<0.05$).

***E. coli* :** The presence of coliforms in dairy products are suggestive of insanitary conditions or practices followed during manufacturing and inadequate care taken during post processing. From the Table 3, it is observed that the coliform counts in the *lassi* samples T_0, T_1, T_2 and T_3 were 4.0, 3.4, 1.60 and 2.8 cfu ml^{-1}, respectively. The *lassi* samples differed significantly among each other. The highest coliform counts was observed in treatment T_0. While lowest counts were in treatment T_2. Treatment T_0, T_1, and T_2 were on par.

Yeast and mould (YMC) : From the Table 3, it is seen that the yeast and mould counts (YMC) of T_0, T_1, T_2 and T_3 were 10.26, 10.24. 8.94 and 11 cfu ml^{-1}, respectively. The lowest YMC count was noticed in treatment T_2 and which was also on par with treatment T_0, T_1 and T_3.

From the present investigation it could be concluded that better quality *lassi* can be prepared with addition of 3 and 4 per cent finger millet flour. It may also be concluded that good quality with more acceptability *lassi* could be prepared by addition of finger millet flour.

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RESEARCH NOTES

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Morphological Characters as Selection Criteria for Yield Improvement in Mungbean [*Vigna radiata* (L.) Wilczek]

Mungbean (*Vigna radiata* (L.) Wilczek) is one of the important and widely cultivated crop in different seasons in India. The variability of a biological population is an outcome of genetic constitution of individuals making up that population in relation to prevailing. environment. A survey of genetic variability with the help of suitable parameters such as genotypic coefficient of variation, heritability and genetic advance are absolutely necessary to start an efficient breeding program. Selection of superior parents exhibiting better heritability and genetic advance for various characters is an essential prerequisite for any yield improvement programme. Knowledge of interrelationships among yield and its components towards yield will help the breeder in formulating the breeding and selection strategy but the earlier work on genetic variation for different morphological characters for pulses in general and greengram in particular is scanty. Moreover such studies were made on limited number of collections and particular location thus present experiment was conducted with an objective to study genetic variation and character association in mungbean.

The experimental material for the present investigation consisted 20 genotypes including check varieties which were obtained from Indian Institute of Pulses Research (IIPR), Kanpur under All India Coordinated Research Project on MULLARP Crops (ICAR). The present experiment was conducted in randomized block design at Field Experimentation Centre, Department of Genetics and Plant Breeding, Allahabad during *kharif*, 2012. Recommended cultural practices were followed to raise a good crop. Five competitive plants from each genotype were randomly selected for recording observations for ten characters *viz*., days to 50 per cent flowering, plant height (cm), number of primary branches plant^{-1}, number of clusters plant^{-1}, number of pods plant^{-1}, days to maturity, number of seeds pod^{-1}, pod length (cm), seed

Table 1. Coefficient of variation, heritability and genetic advance for 10 yield contributing characters of mungbean

Characters	Coefficient of variation		Heritability (bs) (%)	Genetic advance	Genetic advance as per cent of mean
	Genotype	Phenotype			
Days to 50% flowering	2.42	3.91	38	1.25	3.09
Plant height (cm)	10.28	12.12	72	10.47	17.95
Primary branches	4.57	5.97	59	0.35	7.21
Clusters plant^{-1}	2.11	3.34	40	0.13	2.75
Pods plant^{-1}	9.81	15.85	38	0.99	12.50
Days to maturity	2.37	4.02	35	1.85	2.87
Seeds pod^{-1}	3.21	6.61	24	0.35	3.21
Pod length	2.49	3.61	48	0.24	3.53
Seed index	16.96	22.22	58	0.94	26.66
Seed yield	16.75	24.15	48	1.03	23.93

index (g), and seed yield plant^{-1} (g). Analysis of variance was carried out as per standard procedure (Fisher, 1936), genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) (Burton, 1952), heritability (Burton and Devane, 1953), genetic advance (Lush, 1949) and genotypic and phenotypic correlation (Al-Jibouri *et al.*, 1958) were estimated.

The analysis of variance revealed highly significant differences for all characters under study, indicating the presence of sufficient variability among genotypes. In general, phenotypic coefficient of variation (PCV) values were higher than genotypic coefficient of variation (GCV) values, which indicated the effect of environment on the expression of characters (Table 1). High PCV and GCV were recorded for seed index and seed yield plant^{-1}. Loganathan *et al.* (2001) reported high phenotypic (PCV) and genetic (GCV) coefficients of variation for single plant yield, indicating greater scope of selection for this traits.

All characters showed maximum heritability. Maximum genetic advance as percent of mean was recorded for seed index (26.66%) and seed yield plant^{-1} (23.93%), whereas, minimum genetic advance as percent of mean was observed for clusters plant^{-1} (2.75%). Lavanya and Singh (2005) reported high estimates of genetic advance as percent of mean for seed yield plant^{-1} and seed index.

Seed yield plant^{-1} had positive and significant association with primary branches plant^{-1} (Table 2). Plant height had significant and positive association with pod length at phenotypic level. Among other *inter se*

Table 2. Estimates of correlation coefficients of yield component characters with seed yield in mungbean at genotypic and phenotypic levels

Characters	**Level**	**Plant height**	**Primary branches plant^{-1}**	**Clusters plant^{-1}**	**No. of pods plant^{-1}**	**Days to maturity**	**No. of seeds pod^{-1}**	**Pod length**	**Seed index**	**Seed yield plant^{-1}**
Days to 50% flowering	rg	-0.496**	-0.312*	-0.579**	-0.308*	0.737**	0.325*	-0.328*	0.011	-0.646**
	rp	-0.317*	-0.063	-0.112	-0.033	0.289*	-0.182	-0.163	-0.040	-0.278*
Plant height	rg		0.028	-0.041	0.034	-0.203	-0.542**	-0.783**	-0.198	0.491**
	rp		0.002	0.002	0.052**	-0.111	-0.173	0.440**	-0.166	0.216
Primary branches plant^{-1}	rg			0.291*	0.494**	-0.571**	-0.616**	-0.163	0.229*	0.504**
	rp			0.016	0.347**	-0.381**	-0.208	-0.066	0.084	0.314*
Clusters plant^{-1}	rg				-0.207	0.143	-0.393**	0.053	0.551**	0.146
	rp				-0.264*	-0.068	0.106	-0.052	0.024	0.092
Pods plant^{-1}	rg					-0.674**	-0.108	-0.458**	-0.177	0.371**
	rp					-0.015	0.061	-0.280*	0.042	0.210
Days to maturity	rg						-0.126	-0.549**	-0.080	-0.355**
	rp						-0.040	-0.195	0.109	-0.261*
Seeds pod^{-1}	rg							-0.469**	0.176	-0.149
	rp							0.032	0.001	0.007
Pod length	rg								-0.300*	-0.180
	rp								-0.199	-0.014
Seed index	rg									0.239
	rp									0.118

* and ** significant at 5% and 1% level of significance respectively

associations, days to 50 per cent flowering with days to maturity days to maturity with days to 50 per cent flowering, number of primary branches with pods plant^{-1} and seed yield plant^{-1}, number of pods plant^{-1} with primary branches plant^{-1}, pod length with plant height and number of seeds pod^{-1} with seed index had high significant associations at phenotypic level. The findings of the present investigation are supported by Longanathan *et al*. (2001) and Ahmed and Lavanya (2005).

The characters seed index reported high genotypic coefficient of variation (GCV) and seed yield per plant reported high phenotypic coefficient of variation (PCV). High heritability in broad sense was recorded for plant height and high genetic advance as percent mean observed for seed index. Seed yield plant^{-1} exhibited significant and positive correlation with plant height, primary branches plant^{-1} and pods cluster^{-1}. Hence characters should be given top priority during selection for mungbean yield improvement.

A. N. Shinde
Roopa Lavanya G.
N. D. Shihare

Department of Genetics and Plant Breeding,
SHIATS, Allahabad - 211 007 (India)
August 31, 2013.

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Effect of Irrigation Scheduling and Topping Management on Yield and Yield Contributing Characters of Summer Sesamum

Sesamum is called as queen of oilseeds and one of the most important ancient edible oil seed crop grown in India. The production potential of summer sesamum is more as compared to *kharif* and *rabi* sesamum as the incidence of diseases and pest is minimized. Irrigation water management in relation to scheduling of irrigation is most important as water availability is the main constraint in summer season. There are also evidences that summer sesamum is giving very good response to topping management by minimizing apical dominance and thereby enhancing branching. Nipping of the terminal bud at 30 days after sowing significantly increased the sesamum seed yield of 849 kg ha^{-1} (Korhale *et al*. 2012).

A field investigation was carried out at Agronomy farm, College of Agriculture, Pune during summer 2013 to know the effect of irrigation scheduling and topping management on growth contributing characters and yield of summer sesamum. The soil of the experimental field was clay loam in texture. The field experiment was laid out in split plot design with nine treatment combinations and three replications. Main plot treatments consist of irrigation scheduling i.e. I_1: irrigation at 0.75 IW/CPE ratio, I_2 :irrigation at 1.00 IW/CPE ratio and I_3 : irrigation at 1.25 IW/CPE ratio. The gross plot size was 4.5 x 4.5 m^2. The RDF of sesamum is 60 Kg N:40 Kg P_2O_5 : 20 kg K_2O ha^{-1}. Fifty per cent of recommended nitrogen (60 kg ha^{-1}) and 100 per cent P_2O_5 and K_2O (20 kg ha^{-1}) were applied as basal dose. The remaining 50 per cent of the nitrogen was top dressed at 30 DAS.The result of irrigation schedule and topping management is presented in Table 1.

Plant height : There were significant differences in plant height due to different irrigation schedules from 30 days onwards up to harvest. Significantly maximum plant height (75.9 cm) of sesamum was recorded at I_3 i.e. irrigation at 1.25 IW/CPE ratio than rest of the treatments. This might be due to sufficient amount of moisture and efficient utilization of moisture (Zagade and Chavan, 2009).

Among the toppings treatments, the maximum plant height was recorded with no topping (78.2 cm) as compared to the topping done at 30 and 45 DAS. After topping the apical dominance declined this resulted in less height. The interaction effects between irrigation scheduling and topping management on mean plant height were found significant at all the stages of crop growth except 30 DAS (Table 2).

Number of functional leaves plant^{-1} : Number of functional leaves differed

Table 1. Mean plant height (cm), number of functional leaves, number of branches, leaf area and yield of sesamum at harvest as influenced by different

Treatment	Plant height (cm)	No. of functional leaves	No. of branches	Leaf area (cm^2)	Yield (kg ha^{-1})		
					Seed	Straw	Bio-logical
Main plot treatments (I) - Irrigation scheduling at							
I_1 : 0.75 IW/CPE ratio	74.2	106.2	9.6	87.4	744.8	1397.3	2142.1
I_2 : 1.00 IW/CPE ratio	74.9	108.4	9.7	88.8	809.2	1456.5	2265.7
I_3 : 1.25 IW/CPE ratio	75.9	109.7	9.9	90.6	869.1	1516.7	2430.7
Mean	75.0	108.1	9.7	88.9	807.7	1471.8	2279.5
S.E.±	0.1	0.26	0.10	0.11	8.0	42.3	53.2
C.D. at 5%	0.3	0.72	0.29	0.32	22.2	117.3	159.6
Sub plot treatments (T) - Topping management							
T_1 : No topping	78.2	102.3	9.0	81.5	670.3	1206.5	1876.8
T_2 : Topping at 30 DAS	72.1	114.2	10.6	96.9	904.8	1685.3	2590.1
T_3 : Topping at 45 DAS	74.6	107.8	9.9	88.4	848.0	1523.7	2371.7
Mean	75.0	108.1	9.8	89.6	807.7	1471.8	2285.5
S.E.±	0.07	0.50	0.13	0.10	9.3	44.6	54.3
C.D. at 5%	0.14	1.09	0.28	0.22	20.3	97.3	162.9
Interaction (I x T)							
S.E.±	0.1	0.86	0.22	0.17	16.1	77.4	94.2
C.D. at 5%	0.2	NS	0.48	0.38	35.2	NS	NS

significantly due to different irrigation schedules at all the intervals except 30 DAS. The higher number of functional leaves (159.3) was observed with the irrigation scheduling at I_3 i.e. irrigation scheduling at 1.25 IW/CPE ratio which was superior over I_1 and I_2 irrigation treatments. This was due to better utilization of moisture resulted in better vegetative growth (Sarkar *et al*., 2010).

The number of functional leaves plant^{-1} was significantly influenced by topping management. Among the topping managements, the maximum number of functional leaves plant^{-1} were observed with topping at 30 DAS (163.6) as compared to no topping and topping at 45 DAS. This was due to timely topping and topping at 45 DAS seems to be somewhat late (Kathiresan, 1999).

The interaction effect between irrigation scheduling and topping management on number of functional leaves plant^{-1} was found to be non-significant at all the stages of growth.

Number of branches plant^{-1} : The mean number of branches plant^{-1} was significantly influenced by different irrigation schedules at all the stages except at 30 DAS.The mean number of branches plant^{-1} (9.9) was significantly the highest with I_3 treatment i.e. irrigation at 1.25 IW/CPE ratio as compared to I_1 and I_2 treatments. This was due to efficient utilization of moisture resulted in better vegetative and productive growth (Domber *et al*., 2010).

Terminal topping of plant showed significant effect on mean number of branches plant^{-1}. Topping of terminal shoot reduced the apical dominance which resulted in producing more lateral branches. Topping at 30 DAS recorded the highest number of branches i.e. 10.6 as compared to no topping and topping at 45 DAS (Korhale *et al*., 2012).

The interaction effect (Table 2) between irrigation scheduling and topping managements were found significant at 45, 90 DAS and at harvest. The number of branches plant^{-1} was significantly influenced by interaction between irrigation treatments I_3 and topping T_1 and the highest values were recorded as 9.9 and 10.6, respectively.

Table 2. Yield and yield contributing character as influenced by interaction between irrigation scheduling and topping management at harvest

Topping management	Irrigation scheduling at			
	I_1: 0.75 IW/ CPE ratio	**I_2: 1.00 IW/ CPE ratio**	**I_3: 1.25 IW/ CPE ratio**	**Mean**
Plant Height				
T_1 : No topping	77.16	78.40	79.33	78.29
T_2 : Topping at 30 DAS	71.18	72.17	73.21	72.18
T_3 : Topping at 45 DAS	74.34	74.31	75.28	74.64
Mean	74.22	74.96	75.94	
S.E.±	0.12			
C.D. at 5%	0.27			
Number of branches				
T_1 : No topping	8.36	8.81	9.27	8.81
T_2 : Topping at 30 DAS	10.03	9.90	11.12	10.35
T_3 : Topping at 45 DAS	9.58	9.54	9.77	9.63
Mean	9.32	9.42	10.05	
S.E.±	0.22			
C.D. at 5%	0.48			
Leaf area				
T_1 : No topping	80.18	81.34	83.14	81.56
T_2 : Topping at 30 DAS	95.15	97.10	98.48	96.91
T_3 : Topping at 45 DAS	87.00	88.14	90.15	88.43
Mean	87.45	88.86	90.69	
S.E.±	0.17			
C.D. at 5%	0.38			
Seed yield				
T_1 : No topping	593.94	640.24	776.87	670.35
T_2 : Topping at 30 DAS	855.91	916.79	941.73	904.85
T_3 : Topping at 45 DAS	784.77	870.59	888.66	848.01
Mean	744.88	809.24	869.09	
S.E.±	16.19			
C.D. at 5%	35.28			

Leaf area plant^{-1} : The significant effect of irrigation scheduling on leaf area plant^{-1} was noticed. Significantly the highest leaf area plant^{-1} (108.2 cm^2) was noticed with I_3 i.e. irrigation at 1.25 IW/CPE ratio than rest of the treatments i.e. I_1 and I_2 (Zagade and Chavan, 2009).

Topping of the terminal buds at 30 DAS showed significant effect on leaf area plant^{-1}. Topping of terminal buds at 30 DAS increased the number of secondary branches plant^{-1} which ultimately increased leaf area plant^{-1} (115.5 cm^2). Similar results were reported by Korhale *et al*., 2012.

Interaction effect (Table 2) between irrigation scheduling and topping management at 30 DAS with every irrigation schedule produced significantly higher leaf area as compared to topping at 45 DAS and no topping treatments at all the growth stages. Based on present study it can be concluded that at I_3 (1.25 IW/CPE ratio) and topping done at 30 DAS produced more leaf area plant^{-1} (98.48 cm^2).

Based on present study it can be concluded that application of irrigation water scheduled at 1.25 IW/CPE ratio recorded significantly higher growth characters *viz*., plant height (75.94 cm), number of branches plant^{-1} (10.00), number of functional leaves plant^{-1}, (159.31) and maximum leaf area plant^{-1} (108.2 cm^2) and yield (869.09 kg ha^{-1}). Topping done at 30 DAS showed higher growth parameters than other topping treatments *viz*., T_0 i.e. no topping and T_2 i.e. topping at all the growth stages of crop growth except 30DAS and seed yield (904.8 kg ha^{-1}).

Different irrigation schedules showed significant effect on the seed, straw and biological yields (Table 1). Maximum seed (869.09 kg ha^{-1}), straw (1561.7 kg ha^{-1}) and biological yields (2430.7 kg ha^{-1}) were obtained when irrigation was scheduled at I_3 i.e. 1.25 IW/CPE ratio (I_3).This might be due to efficient utilization of moisture and nutrients favourably enhanced the growth and yield attributes resulted in increased yields. Khade *et al*. (1996) reported that irrigation scheduled at 1.00 IW/CPE ratio gave significantly higher grain yield of sesamum than irrigation scheduled at 0.50 IW/CPE ratio.

Topping at 30 DAS recorded significantly higher seed, straw and biological yields (Table 1). Maximum seed (904.8 kg ha^{-1}), straw (1685.3 kg ha^{-1}) and biological yields (2590.1 kg ha^{-1}) were obtained when topping done at 30 DAS. Topping of terminal buds enhanced the growth of secondary branches and increased the number of capsules plant^{-1} which resulted in increased yields. Nipping the terminal bud at 25 days after sowing produced maximum seed yield (1.45 t ha^{-1}) of sesamum over no nipping (Sarkar *et al*., 2005). Nipping of the terminal bud at 25 days after sowing significantly increased seed yield (764 kg ha^{-1}) of sesamum crop (Ramanathan and Chandrashekhran, 1998). Terminal clipping done at 35 DAS favourably improved the yield traits and yield of the sesamum variety SVPR - 1 over terminal clipping done at 15, 25 and 45 DAS and no clipping (Kokilavani *et al*., 2007).

Interaction effect between different irrigation scheduling and topping management treatments was significant only for seed yield (Table 2). The seed yield was significantly higher when topping was done at 30 DAS (904.85 kg ha^{-1}).

K. D. Gorad
A. A. Shaikh
S. V. Bagade
H. P. Khedkar

Division of Agronomy, College of Agriculture,
Pune - 411 005 (India)
December 15,2013.

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Influence of Biofertilizers and Chemical Fertilizers on Yield and Nutrient Uptake of Chickpea grown on Inceptisol

Biofertilizers a cost effective renewable energy source plays a crucial role in reducing the use of chemical fertilizers and increasing the crop yields, besides maintaining soil fertility (Govindarajan, 2001). Biofertilizers used in conjunction with chemical fertilizers, organic manures and crop residues improves the crop productivity and nutrient use efficiency (Mahajan *et al.,* 2003).

Though biofertilizers cannot replace chemical fertilizers but certainly are capable of reducing their input to a considerable extent. However, the response to application varies with agro-ecological conditions which suggest to evolve region specific quality biofertilizers. Keeping in view their potential, and cheapness and eco-friendly technology needs to be developed for their use (Gautam and Pant, 2001).

Chickpea occupies 15 per cent cultivated area of the world. It is world third pulse crop, fifth legume and fifteenth grain crop having cultivated over 10 million hectares. The area and production in the world is very uneven out of 207 countries, 45 countries grow chickpea but a dozen of chickpea growing countries contribute 96 per cent of the global production. India grows chickpea on an area about 48.90 lakh hectares producing 35.22 lakh metric tonnes grains with average productivity of 740 kg ha^{-1}. In India, chickpea is a major pulses crop contributes about 50 per cent of total pulses production of India (Singh, 2003).

The present investigations was carried out by conducting a field experiment at College of Agriculture, Latur during *rabi* 2005. The composite initial soil sample was analyzed for different physico-chemical properties by following standard analytical procedures. The experimental soil was clayey in texture (21.45% sand, 24.50% silt and 54.05% clay). The soil is having pH : 8.1, EC:0.65 dSm^{-1}, organic carbon 7.8 mg kg^{-1} (Jackson, 1973). The $KMNO_4$-N (Subbaiah and Asija, 1956), 0.5 M $NaHCO_3$- P (Olsen *et al.*, 1954) and NN NH_4OAC - K (Hanway and Heidal, l952.) contents were 210.5, 18.55 and 335.47 kg ha^{-1}, respectively. The initial soil *Rhizobium* population was 3.7 x 10^2 cfu g^{-1} (Using serial dilution method, Subbarao, 1988).

The experiment was laid out in factorial randomized block design (FRBD) with three main treatments consisting of control, 75 per cent recommended dose of fertilizer and recommended dose of fertilizers. Whereas, the sub treatments were *Rhizobium* inoculation, PSB inoculation and *Rhizobium* + PSB inoculation. There were 12 (twelve) treatment combinations imposed to chickpea.

The seed treatment to chickpea with *Rhizobium* @ 250 g 10^{-1} kg seed and PSB @ 250 g 10^{-1} kg seed were carried out before sowing. The sufficient quantity of water and *Rhizobium* culture were mixed thoroughly in order to get viscous paste. The culture of PSB was thoroughly mixed in jaggary solution (100 g jaggary dissolved in 1 liter of water) and treated with seed before sowing. The treatment wise required chickpea seed was treated with *Rhizobium*, PSB and *Rhizobium* + PSB biofertilizers, respectively.

The required quantity of chemical fertilizer were applied as basal dose to chickpea. The nodule count was carried out at 50 per cent flowering (45 days) of chickpea. The nutrient concentrations and dry matter was assessed for uptake of nitrogen, phosphorus and potassium at harvest of chickpea. The *Rhizobium* and PSB population was also determined at harvest of chickpea.

Nodulation : The active nodule on chickpea roots was significantly influenced by the *Rhizobium* and chemical fertilizers at 50 per cent flowering. The mean nodule count was significantly higher (33.41) in *Rhizobium* + PSB combine seed treatment followed by *Rhizobium* (28.78) and PSB (27.41) which were at par with each other over absolute control treatment (25.76). The application of recommended dose of fertilizer recorded significantly higher active nodule count (29.90) of chickpea as against 75 per cent RDF (28.88). The dual inoculation of *Rhizobium* + PSB along with recommended dose of fertilizer was found significantly superior over the inoculation of only *Rhizobium* or PSB. The higher nodulation in dual inoculation of *Rhizobium* + PSB was might be due to the release of some growth hormones. PSB might have positive effects on microbial metabolic activity in the rhizosphere soil. The integrated application of *Rhizobium* + PSB along with chemical fertilizers stimulated the nodulation phenomenon. The interactions of dual inoculation of *Rhizobium* + PSB in presence of chemical fertilizer were found effective for enhancing the nodulation phenomenon.

Nutrient uptake : The inoculation of biofertilizers and application of chemical fertilizers to chickpea significantly influenced the uptake of nitrogen, phosphorus and potassium.The dual inoculation of *Rhizobium* + PSB to chickpea seed along with recommended dose of fertilizers recorded significantly higher nitrogen (18.23 kg ha^{-1}), phosphorus (9.0 kg^{-1} ha^{-1}) and potassium (37.44 kg ha^{-1}) uptake over separate inoculation of *Rhizobium* or PSB. The application of recommended dose of fertilizers and 75 per cent RDF recorded statistically at par result for nitrogen (16.76 and 14.68 kg ha^{-1}) phosphorus (8.56 and 7.85 kg ha^{-1}) and potassium (36.54 and 32.71 kg ha^{-1}) uptake by chickpea, respectively. The inoculation of

Rhizobium reported higher chickpea nitrogen uptake (15.49 kg ha^{-1}) over PSB inoculation (14.98 kg ha^{-1}) and chemical fertilizer (14.17 kg ha^{-1}) application. Whereas, the phosphorus uptake was found higher with PSB inoculation (8.08 ka ha^{-1}) over *Rhizobium* inoculation (7.86 kg ha^{-1}) irrespective of application of chemical fertilizer. Further, the dual inoculation of *Rhizobium* + PSB recorded significantly higher uptake of potassium (34.64 kg ha^{-1}) over separate inoculation of *Rhizobium* (33.76 kg ha^{-1}) and PSB (33.27 kg ha^{-1}) irrespective of chemical fertilizer application.

The interaction of dual inoculation of *Rhizobium* + PSB was found superior over separate inoculation of *Rhizobium* or PSB. The higher nitrogen uptake with *Rhizobium* inoculation might be due to enhancement of population of *Rhizobium* bacteria in soil. Whereas, the seed inoculation of PSB might have enhanced the consistence and stable availability of phosphorus in soil. The PSB inoculation might have released some organic acid and hormones there by increased mineralization of phosphorus led to solubilisation of occluded 'P'. Further, PSB might have stimulated the metabolic activity of microbial cells which helped in mobilization of phosphorus. Similar results were also reported by Kumar *et al.* (2000).

Yield : The grain yield of chickpea was significantly influenced by the biofertilizers inoculation along with chemical fertilizers. The grain yield increased from 23.32 to 28.0 q ha^{-1} when chemical fertilizers along with biofertilizers used. The higher grain yield (26.99 q ha^{-1}) recorded with dual inoculation of *Rhizobium* + PSB followed by separate inoculation of only *Rhizobium* (26.13 q ha^{-1}) which was at par with PSB inoculation (25.07 q ha^{-1}). The interaction effects of biofertilizers and chemical fertilizers was found non significant. The higher grain yield in dual inoculation of *Rhizobium* and PSB was might be ascribed due to synergistic effect of *Rhizobium* and PSB in legumes. Further, the phosphorus solubilizing bacteria might have stimulating effect for increasing the solubilization of fixed P either by clay or Ca. The similar effect of *Rhizobium* and PSB was reflected in higher uptake of P by chickpea. Similar results were also reported by Tripathi *et al*. (1999) and Meena *et al*. (2003).

An application of dual inoculation of *Rhizobium* and PSB using newly developed adhesive (15% Jaggary solution boiled for 4 to 6 minutes) to chickpea crop has significantly increased the growth parameter of chickpea crop like nodulation, uptake of major nutrients (N, P, K) and yield. The survival of introduced *Rhizobium* and PSB was significantly improved in rhizosphere soil. These parameters were tested in presence of RDF and 75 per cent RDF. Hence the results are suitable for an ad-hoc research recommendations. Confirmation of these results through multi-location trials and front line demonstrations has been suggested for final recommendation of Agricultural technology for the benefit of farmers.

N. B. Ghube
R. S. Raut
A. B. Jadhav
N. D. Rathod

Department of Soil Science and Agricultural Chemistry
Vasantrao Naik Marathwada Agricultural University
Parbhani - 431 402 (India)
March 3, 2014.

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Optimizing Spacing for Pigeonpea + Soybean Intercropping under Protected Irrigation

Pigeonpea (*Cajanus cajan* (L.) Millsp.) in Maharashtra occupies an area of 11.15 lakh ha with total production of 9.29 lakh tones producing on an average productivity of 833 kg ha^{-1} (Anonymous, 2008). Maharashtra state is a leading producer of pigeonpea at national level and constitutes nearly 34 per cent area and also shares equal contribution in total production of pigeonpea. Though India is largest producer of pulses, large quantity of pulses is being imported every year from other countries to fulfill the demand of our country. To become a self-sufficient in pulses production, the development of new technology is essential in pulses particularly in high potential crops like pigeonpea. Secondly, its growth and yield is limited by a number of factors. Among the different agronomic practices limiting the yield, choice of suitable method of establishment and geometry is one of the important limiting factor.

The pigeonpea growth and yield is also substantially influenced by soil type, plant geometry as well as varieties used for cultivation (Anonymous, 1984). Therefore, the experiment was carried out to study the effect of spacing for medium duration pigeonpea under protected irrigation.

The present investigation was carried out at Agronomical Research Farm, Agricultural

Research Station, Badnapur, Dist. Jalna during *kharif* 2012. The experiment was laid out in split plot design with three replications. The gross plot size was 7.2 m x 3.6 m and net plot sizes were 3.6 m x 2.7 m and 4.5 m x 2.7 m, respectively for 90,120 and 150 cm row spacings. The experiment comprised of 15 treatment combinations of three row spacing, two plant spacing and two varieties with two sole crops of pigeonpea and one sole crop of soybean as an intercrop. The sowing was done on 11-07-2012 by dibbling using BSMR 736, BSMR 853 pigeonpea and JS 335 soybean as an intercrop in interspace of pigeonpea rows. In 90 cm row spacing of pigeonpea two rows of soybean, in 120 cm row spacing of pigeonpea three rows of soybean and in 150 cm row spacing of pigeonpea four rows of soybean was sown. The soil of the experimental plot was clayey in texture with 0.35% organic carbon, 79:11:650 kg ha^{-1} of available NPK and well drained having moderately alkaline reaction (pH 7.72). One protective irrigation was applied at flowering stage as there was the moisture stress due to scanty rainfall. The recommended fertilizers were applied to the main crop at the rate of 25:50:00 kg ha^{-1} as basal dose at the time of sowing. Similarly, crop protection measures were adopted as per the recommendations. The crop was harvested on 15-01-2013. The data on grain yield was analyzed statistically according to Panse and Sukhatme (1967) and presented. The total rainfall received during *kharif* 2012 was 518 mm distributed in 27 rainy days which was less than normal i.e. 80% only adversely affected the growth as well as yield of the crop drastically.

Spacing : The effect of row spacing as well as plant spacing were statistically non significant on pigeonpea equivalent yield (PEY). But among the row spacing, the highest PEY (1197 kg ha^{-1}) was recorded by sowing the

Table 1. Pigeonpea equivalent yield (PEY) of soybean as influenced by different row spacing, plant spacing and varietie

Treatment	PER (kg ha^{-1})
Row Spacing (R)	
R_1 - 90 cm	1197
R_2 - 120 cm	1019
R_3 - 150 cm	1058
SE ±	3.67
CD at 5%	NS
Plant spacing (P)	
P_1 - 30 cm	1104
P_2 - 45 cm	1077
SE ±	1.19
CD at 5%	NS
Varieties (V)	
V_1 - BSMR 736	1173
V_2 - BSMR 853	1003
SE ±	3.51
CD at 5%	10.80
Interactions	
R x P SE ±	20.68
CD at 5%	71.00
R x V SE ±	61.00
CD at 5%	187.00
P x V SE ±	50.00
CD at 5%	NS
R x P x V SE ±	9.00
CD at 5%	NS
CV%	14.00
GM	1056

Table 2. Interactions between row spacing and plant spacing on PEY

Plant spacing Row spacing	PEY (kg ha^{-1}) 30 cm	45 cm	Mean
R_1 - 90 cm	1175	1219	1197
R_2 - 120 cm	976	1062	1019
R_3 - 150 cm	1160	951	1056
Mean	1104	1077	1091
SE ±	20.68		
CD at 5%	71.00		

Table 3. Interactions between row spacing and varieties

Variety Row spacing	PEY (kg ha^{-1})		Mean
	BSMR 736	BSMR 853	
R_1 - 90 cm	1426	987	1197
R_2 - 120 cm	1065	973	1019
R_3 - 150 cm	1048	1064	1056
Mean	1173	1008	1091
SE ±	61.00		
CD at 5%	187.00		

crop at 90 cm closer row spacing as compared to wider spacing of 120 cm (1019 kg ha^{-1}) and 150 cm row spacing (1058 kg ha^{-1}). The higher PEY at 90 cm row spacing might be due to higher plant population in the treatment as compared to other two row spacing. But, the crop sown at 120 cm row spacing recorded less PEY as compared to 150 cm row spacing, even though the plant population was more in 120 cm row spacing. This might be due to competition for different nutrients space and sunlight. Islam *et al.* (2012) reported that closer row spacing gave significantly higher seed yield than wider spacing.

In case of plant spacing, the crop sown at 30 cm closer plant spacing recorded maximum PEY (1104 kg ha^{-1}) as compared to 45 cm wider plant spacing (1077 kg ha^{-1}) which might be due to more plants in unit area. The lowest PEY was recorded by sowing pigeonpea crop at higher plant spacing of 45 cm with lesser plants in unit area.

Varieties : The effect of varieties on pigeonpea equivalent yield was statistically significant. The variety BSMR 736 recorded significantly higher pigeonpea equivalent yield (1173 kg ha^{-1}) as compared to BSMR 853 which recorded less yield (1003 kg ha^{-1}).

Table 4. Grain yield, PEY (kg ha^{-1}), GMR, NMR, B: C ratio and LER of pigeonpea as influenced by different spacing

Treatments	Row propor-tion	Grain yield (kg ha^{-1})			GMR RS	NMR RS	B:C ratio	LER
		Pigeo-pea	Soy-bean	PEY				
T_1 - 90 x 30 cm BSMR 736 (37037 plants ha^{-1})	2:2	766	786	1489	49196	34986	2.46	3.78
T_2 - 90 x 30 cm BSMR 853 (37037 plants ha^{-1})	2:2	486	799	860	30926	16716	1.18	1.21
T_3 - 20 x 30 cm BSMR736 (27777 plants ha^{-1})	2:3	587	799	1322	43679	29799	2.15	3.16
T_4 - 120 x 30 cm BSMR853 (27777 plants ha^{-1})	2:3	334	926	1115	40095	26215	1.89	2.50
T_5 - 150 x 30 cm BSMR736 (22222 plants ha^{-1})	2:4	389	624	962	31784	19364	1.56	2.22
T_6 - 150 x 30 cm BSMR853 (22222 plants ha^{-1})	2:4	260	864	989	35564	23144	1.86	2.13
T_7 - 90 x 45 cm BSMR 736 (24691 plants ha^{-1})	2:2	394	840	1167	38558	24348	1.71	2.52
T_8 - 90 x 45 cm BSMR 853 (24691 plants ha^{-1})	2:2	358	710	957	34414	20204	1.42	2.31
T_9 - 120 x 45 cm BSMR 736 (18518 plants ha^{-1})	2:3	524	727	1194	39450	25570	1.84	2.84
T_{10} - 120 x 45 cm BSMR 853 (18518 plants ha^{-1})	2:3	486	760	1127	40527	26647	1.92	2.87
T_{11} - 150 x 45 cm BSMR 736 (14814 plants ha^{-1})	2:4	354	595	901	29769	17349	1.40	2.05
T_{12} - 150 x 45 cm BSMR 853 (14814 plants ha^{-1})	2:4	270	867	1001	35996	23576	1.90	2.17
T_{13} - Sole Pigeonpea BSMR 736 (55555 plants ha^{-1})	-	276	-	276	9119	-3051	0.25	-
T_{14} - Sole Pigeonpea BSMR 853 (55555 plants ha^{-1})	-	257	-	257	9242	-2928	0.24	-
T_{15} - Sole Soybean	-	-	772	681	23495	12085	1.06	-
SE ±		19	87	80				-
CD at 5%		58	NS	231				-
CV%		09	19	15				-
G. Mean		389	775	953				-

Interactions : The interactions between row spacing and plant spacing as well as row spacing and varieties were found to be statistically significant. The spacing of 90 cm x 45 cm recorded significantly highest pigeonpea equivalent yield of 1219 kg ha^{-1} which was at par with 90 x 30 cm spacing (1175 kg ha^{-1}) and 150 x 30 cm spacing (1160 kg ha^{-1}). The lowest pigeonpea equivalent yield was obtained by 150 x 45 cm spacing (951 kg ha^{-1}).

The variety BSMR 736 sown at 90 cm row spacing recorded significantly higher pigeonpea equivalent yield (1426 kg ha^{-1}) as compared to all other treatments followed by pigeonpea variety BSMR 736 sown at 120 cm row spacing recorded higher pigeonpea equivalent yield (1065 kg ha^{-1}) but it was at par with all other treatment combinations.

Monetary returns : The sowing of pigeonpea variety BSMR 736 at 90 x 30 cm spacing accommodating 37,037 plants ha^{-1} recorded highest gross monetary returns (Rs. 49196 ha^{-1}), net monetary returns (Rs. 34986 ha^{-1}) and benefit cost ratio (2.46) as well as land equivalent ratio (3.78). Islam *et al.* (2012) reported that the highest net returns (Rs. 24340.73 ha^{-1}) as well as net returns per rupee investment (Rs. 2.22/-) was recorded on closed spaced early sown crop. As the season received 20% less rainfall during crop growth period, the gross monetary returns of sole crops (55,555 plants ha^{-1}) were very less (BSMR 736 and BSMR 853 obtained Rs. 9119 ha^{-1} and Rs 9242 ha^{-1}, respectively) recording negative net monetary returns of pigeonpea (BSMR 736 and BSMR 853 obtained Rs. 3051 ha^{-1} and Rs. 2928 ha^{-1}, respectively) due to long duration of pigeonpea crop as compared to short duration intercrop crop. The second best treatment was sowing of pigeonpea veriety BSMR 736 at 120 cm x 30 cm spacing accommodating 27,777 plants ha^{-1} recording maximum net monetary returns (Rs. 29799 ha^{-1}) and benefit cost ratio (2.15) as well as land equivalent ratio (3.16). The lowest benefit cost ratio was found in sole pigeonpea variety BSMR 736 (0.25) as well as sole pigeonpea variety BSMR 736 (0.24). Similarly, the lowest land equivalent ratio was recorded by sowing crop at 150 cm x 45 cm spacing using BSMR 736 variety accommodating 14,814 plants ha^{-1}.

Based on present study it can be concluded that pigeonpea variety BSMR 736 recorded significantly higher yield (1173 kg ha^{-1}) than BSMR 853 (1008 kg ha^{-1}). The spacing 90 x 45 cm recorded significantly highest yield of 1219 kg ha^{-1}. The variety BSMR 736 sown at 90 cm row spacing recorded significantly higher yield (1426 kg ha^{-1}) over all other treatments. The sowing of pigeonpea crop at 90 x 30 cm spacing recorded highest gross monetary returns, net monetary returns, benefit cost ratio and land equivalent ratio.

H. D. Pawar
D. K. Patil
V. K. Gite

Agricultural Research Station,
Badnapur - 431 202 (India)
May 10, 2014.

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Effect of Different Levels of Fertilizer on Yield, Economics and Nutrient Uptake by Wheat Varieties Under Late Sown Condition

Wheat (*Triticum aestivum* L.) is the world's most widely cultivated food crop providing ample food calories and protein for more than one thousand million human beings in the world. Common wheat is grown across a wide range of environment around the worlds. Among major cereals, globally wheat ranks first in area and production. Wheat occupies 25 per cent production out of total food grain production. In Maharashtra area under wheat is 12.53 million hectares and production is 23.71 million tonnes (Anonymous, 2009). In wheat, time of sowing is one of the important aspects for obtaining good yields. It has marked influence on the yield of wheat. In fact, the optimum time of sowing depends on the type of variety (duration), weather conditions, land preparation and availability of inputs. The growth and yield of late sown wheat is less as compared to timely sown irrigated wheat. Sowing of wheat is delayed generally due to late harvest of some *kharif* crops and resulted in poor yield. The delayed sowing also affect the efficiency of inputs such as fertilizer and water. However, the adoption of improved agronomic practices, suitable varieties and fertilizer dose can increase crop productivity. Considering this view, the present investigation was carried out.

Field experiment was conducted during *rabi* season of 2009-2010 at Department of Agronomy, VNMKV, Parbhani. The experiment design was split plot with three replications. Four levels of fertilizers were main

Table 1. Growth, grain and straw yield, cost of cultivation, gross returns, net returns (Rs. ha^{-1}) and B:C ratio as influenced by different treatments

Treatment	Plant height $plant^{-1}$	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio
Fertilizer levels (F)							
F_1 - 80:40:40 kg NPK ha^{-1}	67.22	18.01	26.60	16304	28322	12020	1.73
F_2 - 100:50:50 kg NPK ha^{-1}	68.55	19.94	29.33	17974	31372	13398	1.74
F_3 - 120:60:60 kg NPK ha^{-1}	70.66	24.52	32.94	18100	38028	19928	2.10
F_4 - 150:75:75 kg NPK ha^{-1}	69.16	22:15	30.71	19000	34056	15056	1.79
SE±	0.22	1.0	0.76	-	128.59	72.64	0.009
CD at 5%	0.68	3.01	2.30	-	384.93	214.47	0.028
Varieties (V)							
V_1 - SKFPS 645	68.25	19.79	28.68	17651	31083	13558	1.75
V_2 - NIAW-34	68.87	20.02	29.88	17651	31150	13251	1.76
V_3 - LOK-1	69.58	23.67	31.12	17651	36600	18526	2.07
SE±	0.16	0.62	0.38	-	807.77	86.69	0.007
CD at 5%	0.49	3.75	1.15	-	241.80	259.51	0.02
Interaction (F x V)							
SE±	0.32	1.25	0.77	-	161.55	173.39	0.015
CD at 5%	NS	NS	NS	-	NS	NS	NS
G.M.	68.89	21.15	29.81	17761	32944	15112	1.84

plot treatment and three different wheat varieties were put to sub-plot treatment. The soil was alkaline in reaction (pH 8.02), poor in organic carbon (0.98%), low in available nitrogen (153.60 kg ha^{-1}), medium in available phosphorus (14.83 kg ha^{-1}) and high in potassium (562.64 kg ha^{-1}). All the recommended dose of fertilizers were applied at the time of sowing. Sowing was done on 30th December 2009 by hand sowing method at 22.5 cm row to row distance with weighed quantity of seed for each row and harvested on 2nd April 2010. Seed rate of 125 kg ha^{-1} was used for all three varieties. Immediately after sowing irrigation was given to experimental plot. The total rainfall received during experimental period was 43.6 mm. Biometric observations were recorded by selecting five plants randomly from each plot.

The application of fertilizer level 120:60:60 kg NPK ha^{-1} recorded significantly higher plant height (70.66 cm plant^{-1}). The mean plant height was significantly higher in variety LOK-1 (69.58 cm) over the SKFPS- 645 and NIAW-34 at all growth stages (Table 1).

In case of grain and straw yield, application of 120:60:60 kg NPK ha^{-1}, recorded significantly the highest grain (24.52 q ha^{-1}) and straw (32.94 q ha^{-1}) yield than 80:60:60 kg NPK ha^{-1}, 100:50:50 kg NPK ha^{-1} and was at par with 150:75:75 kg NPK ha^{-1}.

Grain and straw yield were significantly influenced by different varieties. Variety LOK-1 produced significantly higher grain yield (23.67 q ha^{-1}) than SKFPS-645 but it was at par with NIAW-34. The straw yield was significantly influenced by varieties, LOK-1 produces significantly higher straw yield (31.12 q ha^{-1}), than SKFPS-645 and NIAW-34. Similar results were found by Kumpawat and Rathore (1995).

The gross and net returns were significantly influenced by fertilizer, levels shown in Table 1. Significantly highest gross and net returns (19928 Rs ha^{-1}) were obtained with application of 120:60:60 kg NPK ha^{-1}. The benefit: cost ratio was also highest with application of 120:60:60 kg NPK ha^{-1} and it was found significantly higher over rest of the fertilizer levels. Whereas the increasing levels of fertilizer increased the input costs and reduce the net monetary return and Benefit : cost ratio. Similar results were reported by Azad *et al.* (1998) and Pandey *et al.* (1989).

Maximum gross returns and net returns were found in variety LOK-1 over rest of the varieties SKFPS-645 and NIAW-34. Highest benefit cost ratio (2.03) was found in variety LOK-1 than rest of the varieties. The data on N, P, K uptake of wheat as influenced by different treatment was presented in Table 2. Chemical analysis indicated that the uptake of nitrogen, phosphorus, and potassium increased

Table 2. Mean uptake of nitrogen, phosphorus and potassium (kg ha^{-1}) of wheat as influenced by different treatment

Treatment	Uptake (kg ha^{-1})		
	Nitro-gen	Phosp-horus	Potas-sium
Fertilizer levels (F)			
F_1 - 80:40:40 kg NPK ha^{-1}	75.11	9.07	60.77
F_2 -1 00:50:50 kg NPK ha^{-1}	87.00	12.34	64.77
F_3 - 120:60:60 kg NPK ha^{-1}	99.08	15.55	68.72
F_4 - 150:75:75 kg NPK ha^{-1}	108.67	17.77	72.06
SE±	0.73	0.15	0.28
CD at 5%	2.19	0.45	0.84
Varieties (V)			
V_1 - SKFPS 645	88.50	12.77	64.99
V_2 - NIAW-34	92.23	13.68	66.37
V_3 - LOK-1	96.66	14.56	68.04
SE±	0.66	0.12	0.19
CD at 5%	1.99	0.38	0.59
Interaction (F x V)			
SE±	1.33	0.03	0.39
CD at 5%	NS	NS	NS
G.M.	92.46	13.67	53.32

with increasing levels of fertilizer. Uptake was more with application of 150:75:75 kg NPK ha^{-1} over rest of the fertilizer levels.The uptake of nitrogen, phosphorus and potassium was found maximum in LOK-1 than variety SKFPS-645 and NIAW-34.

Based on present study it can be concluded that the fertilizer level 120:60:60 kg NPK ha^{-1} was found beneficial in improving yield, highest benefit: cost ratio as compared to 80:40:40 kg NPK ha^{-1},100:50:50 kg NPK ha^{-1} and 150:75:75 kg NPK ha^{-1} under late sown condition. Chemical analysis indicated that the uptake of nitrogen, phosphorus, and potassium increased with increasing levels of fertilizer, uptake was more with application of 150:75:75 kg NPK ha^{-1} over rest of the fertilizer levels. Highest grain yield (23.67 q ha^{-1}), straw yield (31.12 q ha^{-1}), benefit :cost ratio, the uptake of nitrogen, phosphorus and potassium was found in variety LOK-1 than SKFPS-645 and NIAW-34.

S. T. Kale
D. N. Gokhale
S. R. Kadam
P. N. Karanjikar

Department of Agronomy
VNMKV, Parbhani - 431 402 (India)
June 10, 2014.

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Genetic Evaluation of Exotic Rice Germaplasm (*Oryza sativa* L.) for Grain Yield and other Component Characters

Rice (*Oryza sativa* L.) is one of the most important staple food crop. More than half of the world's population depends on rice for food calories and protein, especially in developing countries. It offers a great wealth of materials for genetic studies because of its wide ecological distribution, wider adaptability and enormous variation encountered for morphological and physiological characters. In order to obtain higher productivity, genetic improvement of the crop is prime need.

The study of genetic variability in any crop would help in the genetic improvement of yield and desirable characters. It will facilitate the identification of proper genotypes for a particular agro-climatic zone. Selection of high yielding varieties based only on grain yield will not be much effective unless adequate information on genetic parameters are available to formulate hybridization and selection programme for further improvement. Therefore, the present investigation was made with an objective to identify the elite genotypes for yield and quality parameters.

The experiment was conducted during *kharif* 2011 in a Randomized block design with three replications at Field Experimentation Centre Department of Genetics and Plant Breeding, SHIATS, Allahabad. The transplanting was done by adopting a spacing of 20 cm between rows and 15 cm between plants. Fertilizers were applied @ 120:80:60 (N:P:K kg ha^{-1}). Intercultural operations were done to raise the crop uniformly. Observations were recorded on five randomly selected plants in each replication for days to 50 percent flowering, plant height (cm), number of tillers $hill^{-1}$, number of panicles $hill^{-1}$, panicle length (cm), number of spikelets $panicle^{-1}$, flag leaf length (cm), flag leaf width (cm), test weight (g), days to maturity, biological yield $hill^{-1}$ (g), harvest index and grain yield $hill^{-1}$ (g). The data were analyzed for genetic parameters such as PCV and GCV were calculated by the formula given by Burton, 1952, heritability in broad sense (h^2) by Lush, 1949 and genetic advance as percent of mean (genetic gain) (Johnson *et al.*, 1955).

Analysis of variance showed high significant differences for 13 quantitative characters studied, indicating that there is ample scope for selection of promising lines from present gene pool for yield. Mall *et al.* (2005) also revealed highly significant differences among all the genotypes for all the characters.

Maximum PCV and GCV were observed for grain yield $hill^{-1}$ followed by biological yield $hill^{-1}$ and number of spikelets $panicle^{-1}$ (Table 1). Idris *et al.* (2012) and Paul *et al.* (2011) earlier reported high PCV and GCV for grain yield $plant^{-1}$.

Broad sense heritability estimates revealed that all the characters exhibited high heritability *viz.*, test weight (100), flag leaf length (100) followed by number of spikelets $panicle^{-1}$ (99.9), plant height (99.9), panicle length (99.9). Saxena *et al.* (2005) reported that heritability was high for 1000-seed weight, plant height, total number of spikelets and panicle length, indicating the possibility of improving such characters through selection.

Heritability along with genetic advance would be more useful tool in predicting the resultant effect from selection of the best genotypes for yield and some of its components in rice. It is very difficult to judge whether observed variability is highly heritable or not. Moreover, knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of a character into future generations (Kumar and Shukla, 2002). Number of spikelets $panicle^{-1}$ (80.05) exhibited

Table 1. Estimates of genetic parameters for 13 characters in rice

Characters	GCV	PCV	Heritability (bs) (%)	Genetic advance	GA as % of mean
Days to 50% flowering	7.74	7.83	97.7	13.75	15.76
Plant height	15.49	15.50	99.9	36.63	31.90
Flag leaf length	14.76	14.76	100	11.09	30.41
Flag leaf width	12.94	12.96	99.7	0.42	26.63
No. of tillers $hill^{-1}$	13.55	13.79	96.6	3.21	27.44
No. of panicles $hill^{-1}$	13.12	13.37	96.2	2.50	26.51
Panicle length	8.220	8.22	99.9	4.57	16.92
No. of spikelets $panicle^{-1}$	22.43	22.44	99.9	80.05	46.20
Days to maturity	5.81	5.87	97.9	13.86	11.85
Biological yield $hill^{-1}$	28.23	28.33	99.4	34.13	57.98
Harvest Index	11.54	11.56	99.6	8.47	23.73
Test Weight	13.99	13.99	100	6.55	28.82
Grain yield $hill^{-1}$	31.00	31.09	99.4	13.36	63.67

high genetic advance followed by plant height (36.63 cm) and biological yield hill^{-1} (34.13 g). Shift in gene frequency towards superior side under selection pressure is termed as genetic advance. Johnson *et al.* (1955) suggested that estimates of heritability and genetic advance should be considered together for more reliable conclusions. High estimates of heritability coupled with high to moderate value of genetic advance as percent of mean was observed for number of spikelets panicle^{-1} (99.9 and 80.05) and plant height (99.9 and 36.63), respectively suggesting that there was preponderance of additive gene action for the expression of these characters. These observations find support from Anjaneyulu *et al.* (2010) where number of grains panicle^{-1} and plant height recorded high heritability coupled with high genetic advance, indicating the reliability of these characters for selection.

The present study concludes that there are significant differences for all the characters. High GCV and PCV were observed for grain yield plant^{-1} and high heritability for all the characters. High estimates of heritability coupled with high to moderate values of genetic advance as percent of mean was observed for number of spikelets per panicle, plant height indicating that these characters can be used as selection indices for rice improvement.

L. Naresh
G. Suresh Babu
D. P. Warkad
G. Roopa Lavanya

Department of Genetics and Plant Breeding
SHIATS, Allahabad - 211 007 (India)
June 19, 2014.

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Impact of National Horticulture Mission on Beneficiaries

National Horticulture Mission (NHM) is a Centrally Sponsored Scheme to promote holistic growth of horticulture sector, enhance horticulture production, improves nutritional security, generate employment opportunities for skilled and unskilled unemployed rural youths and thereby provide income support to the farm households. Horticulture development in Maharashtra state has geared up by implementation of NHM. Maharashtra has made a significant achievement in fruit production in last 10 years. In order to study benefits received and impact of NHM on the beneficiary farmers of selected tahsils *viz*., Baramati, Indapur and Junnar of Pune district was undertaken for the present study.

The study was purposively conducted in these three tahsils having maximum number of beneficiaries of NHM producing the major fruit crops *viz*., banana and grapes. The list of beneficiary farmers was obtained from Taluka Agriculture Officers of selected tahsils. From these three tahsils, total 15 villages and 120 beneficiary farmers were selected for the study. Data was collected personally with the help of structured interview schedule and analyzed with appropriate statistical tools.

Personal and socioeconomic characteristics : The information regarding personal and socioeconomic characteristics of beneficiary farmers revealed that near about half (49.17%) of beneficiary farmers were from old age group followed by middle age group 37.50 per cent. As regards to education, 39.17 per cent had completed higher secondary education followed by primary and secondary education (25.00 and 23.33%), respectively. All (100%) of the respondents had farming occupation. More than half (51.67%) respondents had medium land holding (1.01 to 3.00 ha) followed by small land holding (up to 1.00 ha) ie 39.17 per cent of the respondents. In case of annual family income majority (73.33%) of the respondents had medium annual income i.e. Rs. 2.01 to 9.00 lakh followed by 14.17 per cent of the respondents having high income i.e. above 9.01 lakh. Almost equal number of the respondents

Table 1. Distribution of respondents according to the benefits obtained from NHM

Programme	Cost (norms)	Yes		No		Economics			
						Complete		Partial	
		No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Plantation infrastructure and development									
Small Nursery (lha)	Rs. 3.00 lakh unit-1	120	100	0	0	0	0	120	100.00
Establishment of new gardens (ha.)									
Fruits (Perennials)	Rs. 30,000 ha-1	120	100	0	0			120	100.00
HRD									
Farmers training	83	69.17	37	30.83	83	69.17			
Farmers Study tour	45	37.5	75	62.5	45	37.5			
Wholesale markets	upto Rs. 100.00 crores	120	100		0				

Table 2. Distribution of respondents according to the Impact of NHM on beneficiaries

Category	Annual income			
	Bef-ore	**Per cent**	**Af-ter**	**Per cent**
Change in annual income				
Upto Rs. 1,00,000	13	10.83	1	0.83
Rs. 1,00,001 to 4,00,000	54	45.00	41	34.17
Rs. 4,00,001 and above	53	44.17	78	65.00
Total	120	100.00	120	100.00
Change in wage employment				
Man days				
Up to 177 days	13	10.83	0	0.00
178 days to 259	99	82.50	7	5.83
260 days and above	8	6.67	113	94.17
Total	120	100.00	120	100:00
Increase in cultivable area/land holding				
Cultivable area				
Up to 0.5 ha.	0	0.00	17	14.17
0.6 to 1.00 ha.	0	0.00	15	12.50
1.01 ha. and above	0	0.00	4	3.33
Total	0	0.00	36	30.00

(47.50 and 46.67%) fall in high and medium category for use of mass media for seeking the information regarding NHM. Majority (71.67%) of the respondents had farming experience of 18 to 40 years, followed by 15.83 per cent had farming experience upto 17 years.

Benefits obtained from NHM : Data pertaining to benefits received from the NHM by the respondents stated that all (100%) the farmers has established small nursery (1.00 ha), established perennial fruit new gardens and taken partial economic benefits of NHM under the infrastructure development component. Similar findings were reported by Mankar *et al*. (2013).

Majority (69.17%) of the farmers had undergone the training and 37.50 per cent of the farmers attended farmers' study tour under HRD component and all (100.00%) the farmers sold their produce in the wholesale markets.

Impact of NHM on beneficiaries : The impact of NHM on beneficiaries was studied in terms of change in annual income, wage employment, technology adoption and increase in cultivable area under fruit crop. Data from table 3 indicated that almost 44.17 per cent of the farmers had annual income of Rs. 4 lakh

Table 3. Distribution of beneficiaries according to the constraints faced by the respondents about NHM

Statement	N=120	
	Frequency	**Per cent**
It was very critical procedure to take benefit of NHM	3	2.50
Unavailability of high quality seedlings	4	3.33
Seedlings damage in transportation	2	1.67
Government granted private nurseries provided small and low yielding seedlings	8	6.67
Nursery owners were charged extra price to provide high quality seedlings	4	3.33
They does not provide enough technical information at proper time for the plantation of fruit crop	92	76.67
They does not provide enough technical information at proper time for the plantation of fruit crop	9	7.50
They do not provide technical training and practical demonstration	7	5.83
Increasing mortality of fruit crop due to pest and diseases	41	34.17
Increasing mortality of fruit crop due to sunlight, rain and wind	61	50.83
Unable to protect seedling from wild animals due to lake of fencing	47	39.17
Grants provided by governments are not enough	97	80.83
The limits consider by government for expenditure are not enough	108	90.00

Table 4. Distribution of respondents according to the suggestions made by the respondents about NHM

Suggestions	No. of respondents	
	Frequency	Per cent
Subsidy should get on time and at its earliest	112	93.33
High yielding varieties should be developed to sustain in the changing climate	97	80.83
All the Fruit crop growers should get government subsidy	78	65.00
Banana produce should get minimum support price Rs. 10 kg^{-1}	54	45.00
Dwarf banana varieties should get in NHM	48	40.00
Subsidy on Drip should be increased	107	89.16
Insecticides and Fertilizers prices should be reasonable and must be easily available	103	85.83
Government should continue NHM for maximum period	116	96.66

and above but after taking the benefits of NHM, 65.00 per cent farmers agreed that their annual income increased to Rs. 4 lakh and above. Almost all (94.17%) farmers told that their work days have been increased to 260 days and above through NHM. Similar results were reported by Mankar *et al*. (2013).

Fourteen per cent of the farmers said that they have observed increase in cultivable area up to 0.5 ha. All (100%) the respondents stated that there is more change in technology adoption as they had used contour sowing method, biological bunds for land improvement, as well as drip irrigation method, applied recommended fertilizer dose and plant protection methods for rejuvenation of old orchards .

Constraints faced by the respondents : Ninety per cent of the farmer beneficiaries stated that the expenditure limits set by government are inadequate, while 80.83 per cent of the farmers stated that provision of grants by the government is inadequate whereas 76.67 per cent beneficiaries complained that they are unable to plant expected fruit crop variety (Table 3).

Suggestions made by the respondents about NHM : Data showed (Table 4) that more than 80 per cent of the respondents suggested that Government should continue NHM for maximum period, subsidy should be given on time and at earliest, subsidy on drip should be increased, insecticides and fertilizers prices should be reasonable and must be easily available and high yielding varieties should be developed to sustain in the changing climate.

The present study indicates positive impact on its beneficiaries in terms of increased income, land use, work days, technology adoption etc. However, to promote nutritional security maximum fruit, flower, plantation crops must be covered under NHM in Maharashtra. Also there is a need to create awareness among beneficiaries for availing other benefits of NHM, initiatives should be taken for infrastructure development.

Swati Khandave
Pallavi Suryawanshi

Dept.of Extension education,
College of Agriculture,
Pune - 411 005 (India)
July 20, 2014.

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Chemical Weed Control in Maize (*Zea mays*) and its Effect on the Bacterial Population in Soil

Chemical weed control is gaining importance due to high cost of labour and non availability of labour in time. Further due to very high efficiency of newly released herbicides its use is intensified. Presently, sequence application and combi-products or tank mix application of herbicides are being followed for effective weed control. Patel *et al*. (2006) reported that pre-emergence application of pendimethalin at 0.5 kg ha^{-1} with atrazine at 0.5 kg ha^{-1} gave significantly lower density of monocot and broad leaved weeds at all the intervals and also recorded higher grain yield of maize as compared to all other treatments. Similar, observations were reported by Walia *et al*. (2007). Sparling *et al*., (1998) reported that atrazine is considered to be moderately persistent in soil with a half-life ranging from one month to greater than one year. Nitrogen released from atrazine metabolism serves as nitrogen source for atrazine-degrading bacteria (Bichat *et al*. 1999). Impact of sequence and combined application of herbicides on soil microbes needs to be tested. Hence, present investigation was under taken to study the effect of herbicides on soil microbes apart from growth, yield and control of weeds.

The field experiment was conducted at Agricultural Research Station, Malnoor, Surpur taluk, Karnataka state during *kharif* seasons of 2013-14 in randomized block design with 13 treatments *viz*., T_1 : pre-emergence application of atrazine 50EC @1.25 kg ha^{-1}, T_2 : pre-emergence application of pendimethalin 30EC @ 1.5 kg ha^{-1}, T_3 : pre-emergence tank mix application of atrazine 0.625 kg ha^{-1} + pendimethalin 30 EC @ 0.75 kg ha^{-1}, T_4 : Sequential application of atrazine 50EC @1.25 kg ha^{-1} followed by (fb) 2, 4-D sodium salt 80 WP @ 2 kg ha^{-1}, T_5 : Sequential application of atrazine 50EC @1.25 kg ha^{-1} fb Metsulfuran methyl 20EC @ 4 g ha^{-1}, T_6 : Sequential application of atrazine 50EC @1.25 kg ha^{-1} fb hand weeding at 30 DAS, T_7 : Sequential application of pendimethalin 30EC @ 1.5 kg ha^{-1} fb 2, 4-D sodium salt 80 WP @ 2 kg ha^{-1}, T_8 : Sequential application of pendimethalin 30EC @ 1.5 kg ha^{-1} fb Metsulfuran methyl 20EC @ 4 g ha^{-1}, T_9 : Sequential application of pendimethalin 30EC @ 1.5 kg ha^{-1} fb hand weeding at 30 DAS, T_{10} : Farmers practice (intercultivation (IC) at 20DAS + hand weeding (HW) at 40 DAS), T_{11} : Hand weeding twice (20 and 40 days after sowing (DAS), T_{12} : Weed free check and T_{13} : Weedy check. The soils of the experimental site was medium black clay soil with pH 8.1 and the available N, P and K was 243 kg ha^{-1}, 34 kg ha^{-1} and 292 kg ha^{-1}, respectively. Maize genotype, Hema was sown with a spacing of 60 x 30 cm. A recommended fertilizer dose of 150: 75: 37.5 kg NPK ha^{-1} was applied. The gross and net plot size was 5.4 x 4.8 m^2 and 3.0 x 3.0 m^2, respectively. The weed density and weed dry weight were recorded at 60 DAS by putting a quadrate at random in each plot and presented in m^2. The weed control efficiency and weed index was calculated by the formula given by Kalhapure *et al*. (2014). Other agronomic practices are carried out as per the recommendations.

Effect of various treatments on weed population was assessed at 60 days after sowing of maize crop. Predominant weeds in experimental site were *Dactylonium aegyptium, Dinebra retroflexa, Panicum repens, and Setaria verticiliata, among grasses; Cyperus rotundus as sedge and*

Commelina benghalensis, Convolvulus arvensis, Corchorus trilocularis, Digera arvensis, Euphorbia geniculata, Flaveria australasica, Malvastrum coromandelianum, Parthenium hysterophorus L, *Phyllanthus niruri, Physalis minima and Xanthium strumarium* L. among broad leaved weeds. The data (Table 1) revealed that weed management practices reduced the weed count and weed dry weight significantly over weedy check. Pre-emergence tank mix application of atrazine 0.625 kg ha^{-1} + pendimethalin 30 EC @ 0.75 kg ha^{-1} (T_3) recorded the lowest weed count (2.33 m^{-2}) and closely followed by sequential application of pendimethalin 30EC @ 1.5 kg ha^{-1} fb metsulfuran methyl 20EC @ 4 g ha^{-1} (T_8) (3.94 m^{-2}). These treatments were significantly superior than other treatments indicating the efficiency of treatments in controlling weeds. The presently recommended herbicide, atrazine @ 1.25 kg ha^{-1} recorded a weed count of 8.62 m^{-2} that was on par with pendimethalin 30EC @ 1.5 kg ha^{-1} (9. 13 m^{-2}). These two treatments recorded higher weed count than combined or sequence application of herbicides or hand weeding thrice and farmers method indicating only one application of pre-emergence herbicide was not sufficient to take care of the weeds.

The dry weight of weeds followed similar trend to that of weed count. Pre-emergence tank mix application of atrazine @ 0.625 kg ha^{-1} + pendimethalin 30 EC @ 0.75 kg ha^{-1} (T_3) showed the lowest dry weight of weeds (4.51 g m^{-2}) followed by T_8 (4.72 g m^{-2}), T_5 4.92 g m^{-2} and T_7 (5.40 g m^{-2}). These treatments were on par with each other but significantly superior over rest of the treatments. Similar results were reported by Walia, *et al*. 2007. This was mainly due to less weed count and poor growth of weeds as a result of synergistic effect of combination of herbicides. Pre-emergence application of

Table 1. Effect herbicides on weed attributes, plant height, yield attributes, yield, economics and bacterial population

Treatment	Total weed count m^{-2}	Dry weight of weeds (g m^{-2})	Weed control efficiency (%)	Weed index (%)	Plant height (cm)	Seeds cob^{-1}	100 seed weight (g)	Grain yield (kg ha^{-1})	Net returns (Rs. ha^{-1})	B:C	Bacterial population (10^4 cfu g^{-1})
T_1	8.62(73.33)	7.09(49.33)	74.7	25.7	192.2	370	31.52	4962	46467	3.26	24.40
T_2	9.13(84.00)	7.90(61.87)	68.2	19.1	184.0	322	30.12	5407	50695	3.27	17.50
T_3	2.33(5.33)	4.51(19.60)	89.9	0.0	208.5	392	34.55	7621	81452	4.80	8.30
T_4	4.76(22.67)	6.21(37.60)	80.7	1.8	194.1	330	27.25	6562	66667	4.04	12.80
T_5	4.90(26.67)	4.92(23.60)	87.9	53.4	168.0	242	24.53	3111	21099	2.01	15.10
T_6	6.89(46.67)	6.76(44.93)	76.9	21.2	190.3	340	26.06	5262	48622	3.17	26.10
T_7	5.20(30.67)	5.40(28.53)	85.4	30.1	190.9	350	29.00	4670	39045	2.63	18.20
T_8	3.94(16.00)	4.72(21.47)	89.0	59.1	172.0	245	25.05	2733	13396	1.57	13.30
T_9	5.47(32.00)	6.55(42.00)	78.4	4.2	190.2	330	27.44	6399	65187	3.57	28.40
T_{10}	6.46(41.33)	6.51(41.47)	78.7	16.2	189.6	320	26.08	5599	52587	3.57	26.42
T_{11}	6.08(36.00)	6.68(43.73)	77.6	12.4	185.6	322	29.57	5851	51969	3.43	18.40
T_{12}	2.50(5.33)	1.75(2.13)	-	0.0	200.0	398	32.65	6681	71179	3.34	20.12
T_{13}	12.20(148.0)	13.99(194.8)	0.0	67.0	179.2	249	24.15	2207	10780	1.57	17.10
S.E.±	2.16	0.89	-	-	1.9	39	1.1	516	-	-	-
CD at 5%	19.60	7.65	-	-	5.6	114	3.22	1506	-	-	-

IC-inter cultivation, HW-hand weeding, fb-followed by atrazine 50EC @1.25 kg ha^{-1} and pendimethalin 30EC @ 1.5 kg ha^{-1} controlled the weeds up to 30 DAS very efficiency later there was germination and growth of weeds.

Weed control efficiency (WCE) denotes the control of weeds in respective treatments. It was observed that the highest WCE was found in the tank mix application of atrazine @ 0.625 kg ha^{-1} + pendimethalin 30 EC @ 0.75 kg ha^{-1} (89.9%) followed by T_8 (89%), T_5 (87.9%) and T_7 (85.4%). The better WCE was due to better control of weeds in these treatments. The results are in confirmation with Kannur (2008)

Weed index is the yield reduction compared to the highest yielding treatment. Among the weed control treatments, T_3 showed the minimum weed index (0.0) followed by T_4 (1.8%) and T_9 (4.2%). The lower weed index in T_3 may be attributed to better control of weeds due to tank mix application of atrazine and pendimethalin that favored the better growth of the crop which increased the grain yield of maize crop compared to weedy check that recorded the maximum index of 67 per cent indicating the reduction of grain yield due to the presence of weeds through out the crop growth period. Even though T_5 and T_8 showed higher WCE, the weed index was high (53.4% and 59.1%, respectively) due to lower grain yields as a result of phytotoxicity of metsulfuron methyl.

The grain yield was directly influenced by weed index and yield attributes. The highest grain yield of 6562 kg ha^{-1} was receded in T_3 followed by T_4 (6562 kg ha^{-1}) and T_9 (6399 kg ha^{-1}). These treatments were on par with each other but significantly superior over other treatments. These results are in conformity with Shantveerayya Hawaldar (2011). These treatments attained higher seeds cob^{-1} and 100 seed weight. It was mainly due to minimum crop weed competition through out the crop growth period, thus enabling the crop for maximum utilization of nutrients, moisture, light and space. The results are in conformity with the finding of Sinha *et al*. (2005).

The efficiency of any herbicide is assessed finally by economics. The data revealed that T_3 recorded the highest net returns (Rs. 81452 ha^{-1}) and benefit cost ratio (4.80) followed by T_4 (Rs. 66667 ha^{-1} and 4.04, respectively) and T_9 (Rs. 65187 ha^{-1} and 3.57, respectively). These treatments were on par with each other but significantly superior over other treatments. This was attributed higher grain yield as a result of efficient weed control and comparatively lesser cost of cultivation. The weed free check even though achieved higher grain yield (6681 ha^{-1}), recorded lower net returns (Rs.71179 ha^{-1}) and benefit cost ratio (3.34) due to high cost of cultivation incurred for repeated weeding.

Application of herbicides not only affect the target weeds but also the microbial communities present in soils, and these non-target effects may reduce the performance of important soil functions. These critical soil functions include organic matter degradation, the nitrogen cycle and methane oxidation (Hutsch, 2001). Further, herbicidal decomposition depends on the type of herbicide, its dose, herbicide combinations, as well as on the physical and chemical soil properties, soil moisture and temperature and agronomic practices. The study showed that application of herbicide (single or in combination) generally reduced the bacterial population. Pre-emergence tank mix application of atrazine @ 0.625 kg ha^{-1} + pendimethalin 30 EC @ 0.75 kg ha^{-1} (T_3) showed the lowest bacterial population of 8.30. This indicates that combination of these two chemicals exhibited synergistic effect controlled weeds effectively for long period and affected soil bacteria. Konstantinovia *et al*. (1999)

reported that higher doses of atrazine and alachlor decreased the total number of bacteria, ammonifiers and azotobacters and they reduced dehydrogenase activity. However, application of herbicide followed by agronomic practices like hand weeding i.e. T_6 (26.10) and T_9 (28.40) recorded similar bacterial population as that of farmers practice (26.42), hand weeding thrice (18.40) and weed free check (20.12).

A. S. Channabasavanna
K. Tamil Vendon
H. Rajakumar

University of Agricultural Sciences,
Agricultural Research Station,
Malnoor - 585 215 (India)
July 20, 2014.

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Knowledge Level of Clean Milk Production Techniques by the Dairy Cattle Owners

Livestock enterprise plays a crucial role in improving socio-economic conditions of dairy cattle owners. There are several aspects of dairy development but one of important aspects is clean milk production. Although, livestock enterprise is gaining so much importance to the recent years, the productivity of milch animals in India is very much discouraging. Therefore, it is essential to have appropriate action in technology dissemination coupled with raising the knowledge and adoption of clean milk production practices by dairy cattle owners to achieve resounding success. The main aims to create necessary infrastructure for production of quality milk at the farmer's level up to the points of consumption, improve milking procedure at the farmer's level, train and strengthen to create mass awareness about

Table 1. Distribution of dairy cattle owners according to their knowledge level regarding clean milk production techniques

Level of knowledge	Frequency	Per-cent
Low (up to 14 score)	22	22.00
Medium (between 14.1 to 17 score)	73	73.00
High (17.1 and above score)	05	05.00
Total	100	100.00

importance of clean milk production. Milking is an art requiring experience and skill. Milking should be conducted gently, quietly, quickly, cleanly and completely. Cleanliness of animal sheds, cleanliness of animals, cleanliness of milkers and milking pails, milking methods, transportation of milk from farm to dairy are important operations to adopt by the dairy farmers. So an attempt has been made to study the knowledge level of clean milk production practices.

The present investigation was under taken in Akola district of Maharashtra State. Three Tahsils from district were selected on the basis of maximum population of milch animals and maximum number of milk collecting centers. The 7 villages *viz*., two from Akola, two from Barshitakli and three from Akot Tahsil were selected on the basis of maximum adoption of milch animals. A list of dairy farmers was obtained from the respective milk collecting centers. Thus 100 dairy cattle owners were selected as respondents for this study. Interview schedule was developed keeping in view the

Table 2. Distribution of dairy cattle owners according to their technique wise knowledge of clean milk production

Particulars	Knowledge	
	Yes	Per cent
Animal shed and environment		
Washing of shed	92	92
Proper drainage system in shed	100	100
Proper aeration in shed	99	99
Application of water to sweep shed before and after milking	06	06
Animal care		
Daily washing of animal	74	74
Culling of animals	90	90
Use of clean drinking water	100	100
Milker and milking method		
Washing of hand before milking	100	100
Clean cloth wearing at the time of milking	87	87
Teats washing before milking	100	100
Trimming of nails of milker	100	100
Allowing of calf to suckle at the beginning of milking	100	100
Milking utensils		
Daily washing and drying of utensils	100	100
Use of lid to cover utensils after milking	100	100
Use of hot water for utensils washing	100	100
Draining of utensils immediately after washing	100	100
Milking machine	52	52
Storage and transport		
Storage of milk in cool containers in cool and shady place	100	100
Transportation of milk to collection centre within 2 to 3 hours after milking	100	100

objectives of the study. The respondents were interviewed personally either at their home or at their dairy farm and data were collected.

It is observed from the Table 1 that more than two-third (73.00%) of the dairy cattle owners had medium level of knowledge regarding clean milk production practices, while 22.00 and 5 per cent of dairy cattle owners had low and high level of knowledge regarding clean milk production practices, respectively.

All the respondents had knowledge about proper drainage system in the shed, followed by 99.00 per cent of the respondents had knowledge about proper aeration in the shed (Table 2). About 92 per cent of the respondents had knowledge of washing of shed for clean milk production purpose. Only 6 per cent of the respondents had knowledge about application of water to sweep shed before and after milking.

As regards knowledge of animal care, all the respondents had knowledge about use of clean drinking water to the milch cattle, followed by 90 per cent of the respondents had knowledge of culling of animals from the herd to avoid spread of pathogens and diseases and 74.00 per cent of the respondents had knowledge of daily washing of animal for clean milk production purpose. As regards milker and milking methods, all the respondents had knowledge of washing of hand before milking, teats washing before milking, trimming of nails and allowing the calf to suckle at the beginning of milking for clean milk production. Followed by 87 per cent respondents had knowledge about clean cloth wearing at the time of milking.

As regards milking utensils in clean milk production practices, all the respondents had knowledge about daily washing and drying of utensils, use of lid to cover utensils after milking, use of disinfectant or hot water for utensils washing, draining of utensils immediately after washing. These practices had prime importance in clean milk production. Half (52%) of the respondents had knowledge of using milking machine. Further, it is revealed that all of the respondents had knowledge of storage of milk in cool containers in cool and shady place and transportation of milk to collection centre within 2 to 3 hours after milking.

Thus, it can be concluded that dairy cattle owners had medium to low level of knowledge regarding clean milk production practices. All respondents were having complete knowledge of proper drainage system in shed, use of clean drinking water for animals, washing of hand before milking, washing teats before milking, trimming of nails, allowing the calf to suckle at the beginning of milking, washing and drying of utensils daily, use of lid to cover utensils after milking, use of hot water for utensils washing, draining of utensils immediately after washing, storage of milk in cool containers in cool and shady place and transportation of milk to milk collection centre within 2 to 3 hours after milking.

S. R. Katre
K. U. Bidwe
P. K. Wakle

Dr.Panjabrao Deshmukh Krishi Vidyapeeth,
Akola - 444 104 (India)
September 7, 2014

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Host Range of *Fusarium roseum*, a Causal Agent of Gummy Stem Blight of Bottle Gourd [*Lagenaria siceraria* (Mol.) Standl].

Thirty six plants of different groups like cucurbits, beans, pulses, cereals, oilseeds, vegetables, etc. were selected for this study on the basis of their susceptibility to different *Fusarium* spp. and availability. The plants having approximately same age (35 days) were inoculated by micro-droplet inoculation technique (MDIT) and mycelia bit inoculation method (MBIM) under glasshouse conditions.

Out of 36 inoculated plants, 23 plants showed infection of disease. While, bitter gourd, wal, french bean, cluster bean, green gram, black gram, cowpea, bajra, jowar, finger millet, groundnut, cotton and cabbage were free from the disease. Thus, the results indicated that the pathogen *F. roseum* from bottle gourd was non host specific as in addition to its own host it infected ridge gourd, sponge gourd, round gourd, snake gourd, cucumber, muskmelon, watermelon, red pumpkin, moth bean, pea, chickpea, wheat, sesame, soybean, sunflower, tomato, onion, garlic, chilli, brinjal, coriander and fenugreek. Therefore, there is danger of survival of this pathogen on these crops that may serve as collateral hosts.

Bottle gourd [*Lagenaria siceraria* (Mol.) Stand] is grown commercially in a few states of India and has some share in gourd cucurbitaceous vegetables. Before 2003, gourd vegetables were grown on 4.05 lakh hectares in India (More and Shinde, 2003). The bottle gourd is found to be badly infected with gummy stem blight (GSB) disease on farmers' fields in Ahemadnagar, Pune and other districts of Maharashira. About 30 to 50 per cent losses in yield have been found to be caused due to the disease. The microscopy studies showed the presence of *Fusarium roseum* Link in the diseased samples. The literature revealed that very meager work on GSB of bottle gourd has been carried out in India. Looking to the devastating nature of the disease, lack of disease management practices and need of the farmers in future, the present studies were undertaken.

The study was undertaken to determine the ability of *F. roseum* from bottle gourd plant to infect other plants besides its own host, which could be helpful in controlling the disease or preventing the reoccurrence of disease by suggesting the suitable cultural practices.

The seeds and seedlings of different vegetables for host range study were collected from All India Co-ordinated Vegetable Improvement Project (AICVIP), M.P.K.V., Rahuri and seed sale counter and Seed Pathology Unit, M.P.K.V., Rahuri.

The study was undertaken to determine the ability of *F. roseum* from bottle gourd to infect other plant species besides its own host. Thirty six plants (Table 1) of different groups (cucurbits, beans, pulses, cereals, oilseeds, vegetables, etc.) were selected for this study on the basis of their susceptibility to different *Fusarium* spp. and availability. The plants having approximately same age (35 days) were inoculated by micro-droplet inoculation technique (MBIT) and mycelial bit inoculation method (MBIM) on healthy seedlings of different host species previously grown/planted in pots containing sick soil of the fungus under glasshouse conditions.

Microdroplet inoculation technique (MDIT) : Thirty five days old healthy plants under study were inoculated by atomizer with

Table 1. Reaction of different hosts against *F. roseum* causing GSB of *L. siceraria*

Local name of host	Botanocal name	Germi-nation (%)	Incidence of GSB (%)	Remarks
I. Cucurbits				
Bitter gourd	*Momordicae horantia* L.	100	0.00	F
Bottle gourd	*Lagenaria siceraria* (Mol.) Standl.	93.3	100	S
Cucumber	*Cucumis sativus* L.	100	93.3	S
Muskmelon	*Cucumis melo* L.	100	40.0	S
Red pumpkin	*Cucurbita moschata* Dutch ex. Poir.	100	53.3	S
Ridge gourd	*Luffa acutangula* Roxb.	100	20.0	S
Round gourd	*Citrullus vulgaris* var. *fistula*	93.3	66.7	S
Snake gourd	*Trichosanthes anguina* L.	93.3	80.0	S
Sponge gourd	*Luffa cylindrical* (L.) Roem	100	33.3	S
Watermelon	*Citrullus vulgaris* Schred. ex. Eckl. and Zeyh.	100	100	S
II. Pulses / Beans				
Black gram	*Phaseolus mungo* Rixb.	100	0.0	F
Chickpea	*Cicer arietinum* L.	100	100	S
Cluster bean	*Cyamopsis tetragonoloba* (L.) Taub.	100	0.0	F
Cowpea	*Vigna sinensis* Savi.	93.3	0.0	F
French bean	*Phaseolus vulgaris* L.	80.0	0.0	F
Green gram	*Phaseolus aureus* Roxb.	100	0.0	F
Moth bean	*Phaseolus acontifolius* Jacq	100	13.3	S
Pea	*Pisum sativum* L.	93.3	100	S
Wal	*Dolichus lablab*	80.0	0.0	F
III. Cereals				
Bajara	*Penisetum typhoides* (Burm.) & M.	100	0.0	F
Finger millet	*Abelmoschus esculentus* (L.) Moench.	100	0.0	F
Jowar	*Sorgum bicolor*	100	0.0	F
Wheat	*Triticum aestivum* L.	100	100	S
IV. Oil seeds				
Groundnut	Arachis hypogaea L.	100	0.0	F
Sesame	*Sesamum indicum* L.	100	100	S
Soybean	*Glycine max* Merr.	100	100	S
Sunflower	*Helianthus annus* L	100	100	S
V. Vegetables				
Brinjal	*Solanum melongena* L.	100	93.3	S
Cabbage	*Brassica oleracea* L	100	0.0	F
Chilli	*Capsicum anum* L.	100	36.7	S
Coriander	*Coriandrum sativum* L.	100	100	S
Fenugreek	*Trigonella foenumgraecum* L.	100	100	S
Garlic	*Allium sativum* L.	100	100	S
Onion	*Allium cepa* L.	100	100	S
Tomato	*Lycopersicon esculentum* Mill.	100	100	S
VI. Others				
Cotton	*Gossypium hirsutum*	100	0.0	F

S = Susceptible, F = Free, GSB = Gummy stem blight spore suspension (10^5 spores ml^{-1}) of 10 days old culture of *F. roseum* at collar portion and stem at nodes and internodes by slight injury with xanthium.

Mycelial bit inoculation method (MBIM) : The inoculation was done on different plant parts *viz*., leaves, collar, nodes and internodes by placing mycelial bits of 5 mm size from 10 days old culture grown on PDA on injured areas. The sterilized wet cotton swabs were covered on inoculated portions.

The inoculations were done in triplicates with adequate uninoculated control plants in each host plant tested. Congenial condition for disease development was maintained by covering inoculated plants with polythene bags for 24 and 48 hrs before and after inoculation, respectively. The observations on symptom expression and further development of disease were recorded at 48 hrs interval since inoculation up to 15 days from inoculation.

Different 36 host plants (Table 1) including cucurbits, beans, pulses, cereals, oilseeds, and vegetables were tested for their susceptibility to *F. roseum in vivo*. Out of these tested plants, 23 were infected by the pathogen. *F. roseum* infected all cucurbits, except bitter gourd. The maximum disease incidence of 100 per cent was noted on bottle gourd and watermelon. This was followed by cucumber (93.30%), snake gourd (80.00%), round gourd (66.70%), red pumpkin (53.30%), muskmelon (40.0%), spong gourd (33.30%) and ridge gourd (20.0%).

Among the beans, pea had 100 per cent incidence followed by bean (13.30%). While, French bean, cluster bean and wal were free from the incidence. All tested pulses *viz*., green gram, black gram and cowpea were free from the disease except chickpea that showed 100 per cent incidence. In cereals, wheat and among oilseed crops, soybean, sesame and sunflower totally succumbed to the disease. While, groundnut and cotton were disease free. Among the vegetable crops, tomato, onion, garlic, coriander and fenugreek had 100 per cent incidence. This was followed by brinjal (93.30%) and chilli (36.70%) whereas, cabbage was free.

Thus, the results indicated that the pathogen *F. roseum* from bottle gourd was non-host specific as in addition to its own host, it infected other 22 plants from diverse groups i.e. cereals, pulses, oil seeds, beans, cucurbits and vegetables. These results are in agreement with several scientists (El-Zayat *et al*., 1990; Brun and Jacques, 1991; Carone *et al*., 1991; Blain *et al*., 1991; Chat, 1992 and Gangarde, 2003) who isolated and proved pathogenicity of *F. roseum* on varied plant species indicating the non-host specificity of the pathogen. In addition, Jiskani (2010) reported that most of root infecting fungi including *Fusarium* spp. were found to attack many cultivated plants and parasitized 36 hosts in Pakistan that is in consonance with present findings.

C. S. Thakare
A. P. Gaikwad

Department of Plant Pathology, PGI,
Mahatma Phule Krishi Vidyapeeth,
Rahuri - 413 722 (India)
September 7, 2014.

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