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Influence of Chelated Plant Nutition on Yield, Nutrient Concentration and Uptake of Bt-Cotton under Vertisols

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Abstract

The field experiments were conducted on experimental farm of Department of soil science and Agricultural Chemistry Vasantrao Naik Marathawada Krishi Vidyapeeth, Parbhani, during 2009-10 and 2010-11 entitled "Influence of chelated plant nutrition on yield, nutrient concentration and uptake of Bt cotton under Vertisols". The experiment was laid out in randomized block design with sixteen treatments replicated two times. The data on yield, nutrient content and nutrient uptake of Bt cotton as influenced by treatment combinations were determined periodically at 20 days interval and after harvest of crop. Amongst the foliar sprays treatment, Zn gluconate spray twice gave the best results. The relatively higher nutrient concentration (N, P, K, Zn, Fe, Mn and Cu) of macro and micronutrients was observed in treatment T_2 (Zn gluconate) at 40 to 80 DAS growth stages. The numerical data also revealed that from 100 DAS to at harvest the concentration of all nutrients started declining as crop progressed towards, its physiological maturity. The macro and micronutrient concentrations in plant at various growth stages found to be improved due to foliar spraying over control.

Key words : Yield, quality, plant nutrition, EDTA, gluconate, cotton, nutrients content and uptake etc.

Presently cotton cultivation in India covers an area of 121.91 lakh hectares in 2001-12 which accounts about one quarter of the global area of 35 million hectare under cotton. (Anonymous, 2008). Cotton cultivation impregnates its mark on the lives of 60 million people, offering 200-man days ha^{-1} of employment through its cultivation practices, trade and processing in India. It also contributes for more than 14 per cent of annual value addition of industrial production and more than 30 per cent of total exports and 4 per cent of its Gross Domestic Product (GDP). In the wake of new global trade and technological revolution in spinning and yarn manufacturing sector have more priority for global competitiveness of cotton fibre in terms of quality and cost. However, in India, cost of production is very high due to indiscriminate use of pesticides and chemical fertilizer. The nutrient supply is the second most important limiting factor in cotton production only after water. Most often soils in the rain fed area are not only thirsty but also hungry for the nutrients. Macronutrient deficiency in soil is one of the major causes for yield reduction for wide array of crops. Continuous cropping of high yielding varieties without proper substitution of inorganic fertilizers, non-addition of micronutrients, and less or no application of organic manures have caused excessive removal of essential nutrients from the soil reserves that eventually led to the deficiency of micronutrients in soils. Plant nutrition have traditionally considered the obvious way to feed plants is through the soil, where plant roots are meant to uptake water and nutrients but in recent years foliar feeding has been developed to supply plants with their nutritional needs. Foliar feeding is the application or feeding of a plant, a liquid plant nutrient or nutrient additive through the leaves instead of via the root. When the foliar plant food is sprayed on the leaves, it causes the plant

metabolism to speed up. Foliar feeding is a reliable method of feeding plants when soil feeding is inefficient. Foliar absorption is through the stomata which are microscopic pores in the epidermis of the leaf. It is one of the ways to replenish the required nutrient in critical growth stages and is a rapid and effective method of supplying the micronutrients. These micro-nutrients could be supplied through EDTA (Ethylenediamine Tetra Acetic Acid) which has property of forming stable soluble complexes with certain monovalent, divalent and trivalent metal ions. Recent development in foliar feeding for micronutrient found to decentralize around the gluconate salt. Micronutrient ion complexes with gluconate salt found to influence the easiness in its absorption by stomata. Gluconate is a salt of gluconic acid found naturally and is industrially manufactured by the fermentation of glucose typically not only by Aspergillus niger, but also by other fungi i.e., peniciliumas bacteria. Gluconate in its pure from is white to off white powder. These micronutrients are applied to the crop at two different critical stages i.e., at flowering (55 DAS) and at boll development (75 DAS) stage in case of cotton.

Materials and Methods

A research project "Influence of Chelated Plant Nutrition on Yield, Nutrient Content and Nutrient uptake Of Bt-Cotton Under Vertisols" was conducted during 2009-10 and 2010-2011 at Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. It was aimed to find out the influence of foliar feeding of micronutrient through gluconate and EDTA. Gluconate is a salt of gluconic acid, which helps to increase the efficiency of micronutrients and EDTA (Ethylene Diamine Tetra Acetic Acid) which has property of forming stable soluble complexes. The foliar application assumes greater importance as the nutrient are brought in the immediate vicinity of the metabolizing area i.e., foliage and also these nutrients are fast acting nutrients. The field experiments were conducted on Typic Haplusterts at Research Farm of Department of Soil Science and Agricultural Chemistry. The soil is characterized by black colour dominated by montmorillonite clay with high coefficient of expansion and shrinkage leads to deep cracking. The soils are formed from basaltic material. According to 7th approximation, the soils are classified as Typic Haplusterts (Malewar, 1977) and are included in Parbhani series. The topography of experimental plot was fairly level. In order to determine the soil properties of experimental soil before sowing the surface (0-22.5 cm depth) soil sample were collected from randomly selected spots covering experimental area. A composite soil sample was prepared and analysed for its various physico-chemical properties. The experimental soil was fine, Smectitic (Calcarious), Iso-hyperthermic Typic Haplusters. It was slightly alkaline in reaction (8.20 and 8.0), safe in soluble salt concentration (EC 0.117 to 0.113 dSm^{-1}) and medium in organic carbon content (6.70 and 6.50 g kg^{-1} for cotton crop during the year 2009 and 2010). The experiment was laid out in Randomized Block Design comprising sixteen (16) treatments replicated two (2) times in cotton crop. Recommended dose of fertilizer was applied to the crop (120:60:60 kg NPK ha^{-1}). The certified seed of cotton RCH-2 (BG-II) were sown in *kharif* season by dibbling one seed per hill at 90 x 60 cm distance.

Nitrogen was given in two splits. Fifty per cent nitrogen was applied at the time of sowing and remaining 50 per cent was applied one month after sowing. Entire dose of phosphorus and potassium was applied at the time of sowing. Micronutrient sprays of gluconate and EDTA chelated plant nutrients were applied to the crop at the time of flowering i.e. at 55 DAS and second spray was applied at the time of boll development stage i.e. at 75 days after sowing.

Two plants were randomly selected from two observation line of each plot, tagged and all biometric observations were recorded. The data emerged out from the field experiment were analysed by analysis of variance and degree of freedom were partitioned into different variance, due to replication and treatments combinations. These were compared with error variance for finding out 'F' value and ultimately for testing the significance. The standard error (SE) for the treatment were calculated based on error variance whenever, the results were found to be significant, critical difference (CD) were calculated for comparison of treatment means at 5 per cent level of significance. Results were statistically analysed as per the method given in statistical method for agricultural workers by Panse and Sukhatme (1987).

Results and Discussion

Yield attributes of Bt Cotton

1. Number of bolls : The number of bolls plants^{-1} increased from 51.00 to 78.00 at harvest. The maximum number of bolls plant^{-1} were observed with treatment T_2 (Zn gluconate) and minimum in treatment T_1 (control). The result concluded that treatment T_2 (Zn gluconate) gave the highest number of bolls, followed treatment T_3, T_8, T_9, T_{13} and T_{12} and these treatments were also found at par with each other. The increase in number of bolls may be due to micronutrient applications which are involved in greater diversion of the metabolites to the fruiting parts, culminating in more boll production. This finding is in conformation with earlier reported by Venkatkrishna and Pothiraj (1994). Increasing value of NPK with micronutrients leads to increase number bolls plant^{-1} might be also due to availability of nutrients for longer period through two foliar sprays. The above findings are in agreement with the finding of Bhaskar (1993) and Malewar *et al*. (1999).

2. Boll weight : The boll weight of Bt cotton varied between 2.39 to 3.50 g. The highest boll weight was recorded with T_2 (Zn gluconate) and lowest in control treatment (T_1). The treatment T_2 (Zn gluconate) recorded highest boll weight (i.e. 3.50), which was on par with treatment T_3 (Zn EDTA), T_2 (Zn gluconate), T_8 (Fe gluconate) and T_9 (Fe EDTA) and significantly superior over the control. This might be due to accelerated mobility of photosynthates from source to sink as influenced by the application of zinc and iron. Similar observations were also made by Ahalawat (1974), Namdeo *et al*. (1992), Wankhede *et al*. (1994), Anonymous (1995), Hanumantha Reddy (1999) and Sasthri *et al*. (2000).

3. Cotton yield (Kg ha^{-1}) : The application of varied levels of foliar feeding of

Table 1. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on number of bolls plant^{-1}, boll weight (g boll^{-1}) and yield (Kg ha^{-1}) of Bt cotton

Treatment	No. of bolls plant^{-1}	Boll weight (g boll^{-1})	Yield (Kg ha^{-1})
T_1 - Control	51.00	2.39	1498.14
T_2 - Zn gluconate	78.00	3.50	2709.67
T_3 - Zn EDTA	77.00	3.47	2515.95
T_4 - Mn gluconate	65.50	3.05	2114.96
T_5 - Mn EDTA	67.25	3.10	2157.13
T_6 - Cu gluconate	59.25	2.84	1683.37
T_7 - Cu EDTA	56.75	2.78	1643.51
T_8 - Fe gluconate	72.25	3.29	2323.93
T_9 - Fe EDTA	71.75	3.23	2259.57
T_{10} - Ca gluconate	54.75	2.55	1610.47
T_{11} - Ca EDTA	53.50	2.48	1552.76
T_{12} - Mg gluconate	69.50	3.13	2191.83
T_{13} - Mg EDTA	71.25	3.16	2228.79
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	65.00	3.00	1919.59
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	63.75	2.88	1760.00
T_{16} - Government grade 2	65.75	2.89	2077.95
SE ±	2.61	0.08	94.91
CD at 5 %	9.15	0.29	332.84

micronutrients significantly influenced the cotton yield. The yield was ranged from 1498.14 to 2709.67 kg ha^{-1}. The data showed that application of Zn gluconate increase the cotton yield which was to the tune of 2709.67 kg ha^{-1}. However, it was on par with application of treatment T_3 (Zn EDTA) however, significantly superior over control (T_1), it can be concluded that due to foliar application of micronutrient there was increase in cotton yield. In cotton, the yield depends on the accumulation of photo assimilates and its partitioning in different parts of the plant. The yield is strongly influenced by the application of foliar micronutrient indicating the role of these micronutrients in increasing the yield through their effect on various morpho-physiological traits. Foliar micronutrients in known to increase the yield of cotton crop (Wankhade *et al.*, 1994 and Sasthri *et al.*, 2000). Application of zinc and iron enhanced seed cotton yield. This might be due to improved growth and yield attributing characters. Similar results were recorded by Chhabra *et al.* (2004) in cotton. Rajendran (2010) also concluded that foliar application of nutrient in alone or in combination has a great effect in improving the efficiency of utilization of nutrients and thereby improves the growth and seed cotton yield.

Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on N concentration and Uptake of Bt cotton

N concentration and uptake : The pooled grand mean varied from 2.04 to 2.21 per cent at 40 to 60 DAS, respectively. It clearly indicated that highest N concentration was noticed at 60 DAS and thereafter started declining toward maturity. In the year 2009-10, 2010-11 and pooled, application of Zn gluconate (T_2) proved to be superior in increasing the N concentration at 40 DAS. In pooled analysed data the treatment T_2 (2.29) was found to be significantly superior over the control and all other treatments and were on par with treatment T_3 (Zn EDTA). At 60 DAS, in both years and pooled data revealed that the

Table 2. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on N concentration of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	1.70	1.82	1.72	1.65	1.59	1.52
T_2 - Zn gluconate	2.29	2.48	2.31	2.22	2.15	2.04
T_3 - Zn EDTA	2.25	2.47	2.30	2.20	2.10	2.01
T_4 - Mn gluconate	2.16	2.31	2.24	2.08	2.02	1.87
T_5 - Mn EDTA	2.14	2.27	2.21	2.05	1.99	1.84
T_6 - Cu gluconate	1.92	2.09	1.97	1.84	1.77	1.68
T_7 - Cu EDTA	1.85	2.00	1.91	1.78	1.73	1.65
T_8 - Fe gluconate	2.19	2.43	2.28	2.16	2.11	1.93
T_9 - Fe EDTA	2.22	2.44	2.29	2.19	2.13	1.99
T_{10} - Ca gluconate	1.78	1.94	1.86	1.74	1.68	1.60
T_{11} - Ca EDTA	1.77	1.88	1.80	1.70	1.64	1.56
T_{12} - Mg gluconate	2.21	2.40	2.26	2.17	2.10	1.93
T_{13} - Mg EDTA	2.18	2.36	2.25	2.13	2.06	1.90
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	2.03	2.16	2.14	1.93	1.86	1.77
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	1.96	2.13	2.09	1.88	1.82	1.73
T_{16} - Government grade 2	2.11	2.21	2.18	1.96	1.92	1.81
SE ±	0.02	0.02	0.02	0.03	0.02	0.02
CD at 5 %	0.08	0.09	0.09	0.13	0.08	0.08
Grand mean	2.04	2.21	2.11	1.98	1.79	1.80

Table 3. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on N uptake of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	25.57	27.30	25.88	24.83	23.86	22.80
T_2 - Zn gluconate	62.12	67.46	62.70	60.35	58.33	55.49
T_3 - Zn EDTA	56.66	62.27	57.95	55.52	40.48	50.78
T_4 - Mn gluconate	45.76	48.98	47.45	44.26	43.03	39.69
T_5 - Mn EDTA	46.33	48.95	47.82	44.45	43.24	39.90
T_6 - Cu gluconate	32.41	35.26	33.17	31.01	29.96	28.43
T_7 - Cu EDTA	30.48	32.89	31.41	29.37	28.51	27.26
T_8 - Fe gluconate	51.10	56.70	53.11	50.34	36.42	45.12
T_9 - Fe EDTA	50.25	55.36	51.85	49.55	35.88	45.07
T_{10} - Ca gluconate	24.95	31.26	29.99	28.07	27.22	25.84
T_{11} - Ca EDTA	27.61	29.31	27.99	26.44	25.63	24.27
T_{12} - Mg gluconate	48.53	52.80	49.75	47.73	34.04	42.61
T_{13} - Mg EDTA	48.65	52.76	50.33	47.57	46.05	42.59
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	39.11	41.54	41.13	37.16	35.93	34.09
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	34.58	37.47	36.77	33.11	32.22	30.53
T_{16} - Government grade 2	43.90	45.92	45.39	40.85	40.03	37.81
SE ±	1.25	2.84	0.96	1.28	1.34	1.68
CD at 5 %	3.76	8.72	2.89	3.84	4.17	5.07
Grand mean	41.75	45.39	43.29	40.66	36.30	37.02

treatment T_2 (Zn gluconate) showed distinct results in improving N concentration. The N concentration at 60 DAS was ranged from 1.82 (T_1) to 2.48 (T_2). The treatment T_2 (Zn gluconate) resulted the highest N concentration and was significantly superior over control and rest of the treatments and was closely followed on par with treatment T_3 (Zn EDTA). At harvest stage the treatment T2 in both consecutive years and pooled data interfered that application of T_2 (Zn gluconate) treatment showed significantly higher rate of N concentration over the control (T_1) and other treatments and was with treatment T_3 (Zn EDTA). The decrease in concentration of nutrients at final stage of cotton this might be due to dilution effect caused by higher dry matter production.

P concentration and uptake : The pooled grand mean of the all treatments resulting in phosphorus concentration ranged from 0.46 to 0.64 per cent at an increasing rate from 40 to 80 DAS started declining from 100 DAS to at harvest of crop i.e. 0.51 to 0.33 per cent. In pooled, the data at 40 and 60 DAS to the tune of 0.35 to 0.59 per cent and 0.40 to 0.67 per cent. Higher P concentration was recorded in treatment T_2 (Zn gluconate) (0.59 and 0.65%) receiving zinc gluconate. It was significantly superior over control and the rest of the treatments except T_3 (Zn EDTA) (0.58 and 0.64%), T_9 (Fe EDTA) (0.57 and 0.62%), T_8 (Fe gluconate) (0.56 and 0.60%), T_{12} (Mg gluconate) (0.53 and 0.58) and T_{13} (Mg EDTA) (0.53 and 0.57%), respectively, which were on par with superior treatment. Highest rate and amount of concentration of phosphorus was noted, due to application of treatment T_2 (0.81 and 0.74) in both the years, respectively. The treatment T_2 (Zn gluconate) recorded distinctly superiority over control and treatments T_3 (0.79 and 0.73), T_9 (0.79 and 0.720, T_8 (0.76 and 0.71), T_{12} (0.78 and 0.71), T_{13} (0.74 and 0.70) and T_5 (0.70 and 0.67), respectively were found at par with superior treatment. At 100, 120 DAS and at harvest the P concentration rate

started declining toward the maturity of crop. In grand mean it pooled ranged from 0.51 to 0.33 per cent up to harvest. In this situation also, the treatment T_2 (Zn gluconate) showed significantly superior over the control and rest of treatments.

Table 4. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on P concentration of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	0.35	0.40	0.45	0.41	0.31	0.27
T_2 - Zn gluconate	0.59	0.67	0.77	0.59	0.47	0.40
T_3 - Zn EDTA	0.58	0.64	0.76	0.58	0.46	0.39
T_4 - Mn gluconate	0.50	0.55	0.70	0.55	0.40	0.35
T_5 - Mn EDTA	0.48	0.54	0.68	0.53	0.39	0.34
T_6 - Cu gluconate	0.40	0.46	0.58	0.48	0.35	0.31
T_7 - Cu EDTA	0.40	0.45	0.54	0.47	0.34	0.30
T_8 - Fe gluconate	0.56	0.59	0.73	0.56	0.43	0.37
T_9 - Fe EDTA	0.57	0.62	0.75	0.58	0.45	0.38
T_{10} - Ca gluconate	0.39	0.43	0.52	0.45	0.33	0.29
T_{11} - Ca EDTA	0.37	0.42	0.49	0.43	0.32	0.28
T_{12} - Mg gluconate	0.53	0.58	0.74	0.57	0.42	0.37
T_{13} - Mg EDTA	0.53	0.57	0.72	0.55	0.41	0.35
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	0.42	0.50	0.63	0.50	0.37	0.32
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	0.41	0.48	0.60	0.50	0.36	0.32
T_{16} - Government grade 2	0.46	0.52	0.65	0.52	0.38	0.35
SE ±	0.02	0.03	0.04	0.02	0.02	0.03
CD at 5 %	0.07	0.12	0.16	0.10	0.09	0.07
Grand mean	0.46	0.52	0.64	0.51	0.38	0.33

Table 5. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on P uptake of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	5.26	6.09	6.84	6.17	4.77	4.07
T_2 - Zn gluconate	16.03	18.20	21.08	16.18	12.78	10.86
T_3 - Zn EDTA	14.63	16.12	19.17	14.76	11.61	9.83
T_4 - Mn gluconate	10.74	11.73	14.86	11.70	8.65	7.57
T_5 - Mn EDTA	10.50	11.67	14.81	11.60	8.48	7.50
T_6 - Cu gluconate	6.83	7.85	9.78	8.11	5.94	5.27
T_7 - Cu EDTA	6.66	7.50	8.98	7.75	5.72	5.05
T_8 - Fe gluconate	13.09	13.82	17.14	13.22	10.04	8.65
T_9 - Fe EDTA	12.94	14.03	17.14	13.17	10.21	8.73
T_{10} - Ca gluconate	6.28	7.03	8.41	7.37	5.46	4.79
T_{11} - Ca EDTA	5.76	6.55	7.64	6.79	5.10	4.47
T_{12} - Mg gluconate	11.83	12.81	16.41	12.57	9.37	8.26
T_{13} - Mg EDTA	11.83	12.71	16.09	12.44	9.32	7.97
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	8.18	9.74	12.12	9.63	7.22	6.31
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	7.31	8.57	10.58	8.94	6.50	5.70
T_{16} - Government grade 2	9.70	10.95	13.53	10.98	8.09	7.03
SE ±	1.73	1.17	1.49	1.19	0.79	0.70
CD at 5 %	5.20	3.56	4.47	3.64	2.46	1.45
Grand mean	9.85	10.96	13.41	10.71	8.08	7.00

K concentration and uptake : In both years experimentation and pooled analysis, the data at 40 DAS showed that treatment T_2 with 2.07, 1.90 and 1.94, respectively was significantly superior over treatment T1 (control) (1.48, 1.36 and 1.38, respectively. At 60 DAS,

Table 6. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on K concentration of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	1.38	1.52	1.55	1.75	1.65	1.54
T_2 - Zn gluconate	1.94	2.17	2.53	2.44	2.31	2.15
T_3 - Zn EDTA	1.90	2.15	2.46	2.40	2.26	2.13
T_4 - Mn gluconate	1.83	2.05	2.09	2.28	2.10	2.03
T_5 - Mn EDTA	1.79	1.95	1.99	2.24	2.08	1.96
T_6 - Cu gluconate	1.57	1.72	1.74	1.99	1.84	1.76
T_7 - Cu EDTA	1.54	1.69	1.71	1.93	1.79	1.70
T_8 - Fe gluconate	1.87	2.11	2.35	2.33	2.18	2.08
T_9 - Fe EDTA	1.89	2.14	2.40	2.35	2.20	2.11
T_{10} - Ca gluconate	1.48	1.61	1.64	1.89	1.74	1.65
T_{11} - Ca EDTA	1.45	1.58	1.60	1.83	1.70	1.61
T_{12} - Mg gluconate	1.87	2.13	2.27	2.34	2.18	2.09
T_{13} - Mg EDTA	1.86	2.09	2.17	2.31	2.14	2.06
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	1.68	1.81	1.87	2.11	1.95	1.86
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	1.63	1.76	1.81	2.06	1.90	1.82
T_{16} - Government grade 2	1.75	1.89	1.92	2.19	1.98	1.90
SE ±	0.13	0.11	0.05	0.03	0.014	0.06
CD at 5 %	NS	NS	0.20	NS	0.49	0.23
Grand mean	1.76	1.88	2.03	2.25	2.00	1.90

Table 7. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on K uptake of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	5.26	6.09	6.84	6.17	4.77	4.07
T_2 - Zn gluconate	16.03	18.20	21.08	16.18	12.78	10.86
T_3 - Zn EDTA	14.63	16.12	19.17	14.76	11.61	9.83
T_4 - Mn gluconate	10.74	11.73	14.86	11.70	8.65	7.57
T_5 - Mn EDTA	10.50	11.67	14.81	11.60	8.48	7.50
T_6 - Cu gluconate	6.83	7.85	9.78	8.11	5.94	5.27
T_7 - Cu EDTA	6.66	7.50	8.98	7.75	5.72	5.05
T_8 - Fe gluconate	13.09	13.82	17.14	13.22	10.04	8.65
T_9 - Fe EDTA	12.94	14.03	17.14	13.17	10.21	8.73
T_{10} - Ca gluconate	6.28	7.03	8.41	7.37	5.46	4.79
T_{11} - Ca EDTA	5.76	6.55	7.64	6.79	5.10	4.47
T_{12} - Mg gluconate	11.83	12.81	16.41	12.57	9.37	8.26
T_{13} - Mg EDTA	11.83	12.71	16.09	12.44	9.32	7.97
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	8.18	9.74	12.12	9.63	7.22	6.31
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	7.31	8.57	10.58	8.94	6.50	5.70
T_{16} - Government grade 2	9.70	10.95	13.53	10.98	8.09	7.03
SE ±	1.73	1.17	1.49	1.19	0.79	0.70
CD at 5 %	5.20	3.56	4.47	3.64	2.46	1.45
Grand mean	9.85	10.96	13.41	10.71	8.08	7.00

the critically analysed pooled data revealed the non-significant result. Potassium concentration in Bt cotton at 80 DAS showed that in year 2009-10, 2010-11 and pooled the value of K concentration ranged from 1.61 to 2.36 per cent, 1.50 to 2.70 per cent and 1.55 to 2.53 per cent, respectively. Where in both years and pooled, it was fond that treatment T_2 with 2.36, 2.70 and 2.53 per cent, respectively emerged to be distinctly superior treatment over control and all other treatment. At 100 DAS the pooled data revealed the higher level of significance recorded in potassium concentration (i.e. 2.44 per cent) was with application of zinc gluconate to the Bt cotton crop. It proved to be significantly superior over control and rest of treatments. The treatment T_3 (Zn EDTA) (2.40 per cent) was on par with superior treatment. The data recorded at 120 DAS the potassium concentration doesn't reach up to the level of significance. At harvest stage pooled data resulted maximum K concentration in Bt cotton was observed in the plants, treated with Fe gluconate T_2 (2.13) foliar feeding followed treatment T_3 (2.13 per cent), T_9 (2.11%), T_8 (2.10%), T_{12} (2.09%) and T_{13} (2.06%).

Fe Concentration and uptake : At 40 DAS the results indicated doesn't reached up to the level of significance and recorded non-significant result. The pooled grand mean showed the increasing rate of iron concentration per cent from 60 DAS to 80 DAS (21.32 to 29.50 mg kg^{-1}) and there on started declining (i.e. 24.09 to 16.47 mg kg^{-1}) toward maturity of crop. At 60 and 80 DAS the pooled data states that the maximum absorption was recorded with the treatment T_2 (Zn gluconate) (25.98 and 36.50%) and was significantly superior over T_1 (control) (18.91 to 24.65 mg kg^{-1}) respectively. Both the stages of growth i.e. 100 and 120 DAS the two years data (2009-10 and 2010-11) revealed non-significant results. But when the data was critically analysed for pooled. It was observed that application of treatment T_2 (27.16 and 21.93 mg kg^{-1}) greatly effect in iron absorption in Bt cotton crop and was distinctly superior over the T_1 (control)

Table 8. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on Fe concentration of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	16.77	18.91	24.65	19.40	16.08	13.87
T_2 - Zn gluconate	23.03	25.98	36.50	27.16	21.93	19.07
T_3 - Zn EDTA	21.97	24.27	34.86	26.36	21.92	18.46
T_4 - Mn gluconate	20.10	21.64	30.76	23.55	19.81	17.11
T_5 - Mn EDTA	19.92	21.13	29.55	22.85	19.36	16.93
T_6 - Cu gluconate	18.07	20.01	26.47	21.07	17.72	15.20
T_7 - Cu EDTA	17.73	19.66	25.93	20.37	17.16	14.88
T_8 - Fe gluconate	21.41	23.13	32.67	25.84	20.95	17.90
T_9 - Fe EDTA	21.66	23.84	33.67	25.25	21.31	18.25
T_{10} - Ca gluconate	17.32	19.11	25.40	20.15	16.67	14.41
T_{11} - Ca EDTA	17.16	18.97	25.13	19.75	16.44	14.10
T_{12} - Mg gluconate	21.00	22.47	31.82	24.12	20.63	17.68
T_{13} - Mg EDTA	20.62	21.90	31.12	23.87	20.36	17.68
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	19.32	20.30	27.72	21.72	18.73	16.07
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	18.95	20.41	26.82	21.44	18.79	15.67
T_{16} - Government grade 2	19.50	20.93	28.95	22.66	19.24	16.54
SE ±	1.49	1.76	1.41	1.41	1.21	1.24
CD at 5 %	5.25	6.20	4.96	4.95	4.25	4.34
Grand mean	19.65	21.32	29.50	22.85	19.14	16.47

Table 9. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on Fe uptake of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	250.23	284.73	370.05	292.56	242.09	208.05
T_2 - Zn gluconate	622.80	706.15	993.11	740.21	595.51	518.05
T_3 - Zn EDTA	552.47	612.83	880.49	666.46	553.36	465.05
T_4 - Mn gluconate	424.66	460.48	650.97	499.93	420.21	362.20
T_5 - Mn EDTA	429.51	458.02	637.94	494.95	419.10	365.53
T_6 - Cu gluconate	302.64	338.88	446.52	356.16	299.07	256.05
T_7 - Cu EDTA	290.18	324.72	427.25	336.27	283.02	244.80
T_8 - Fe gluconate	497.29	540.80	761.51	590.52	488.13	416.16
T_9 - Fe EDTA	489.10	540.74	763.32	587.64	482.62	412.88
T_{10} - Ca gluconate	277.80	309.54	410.37	326.54	269.50	232.37
T_{11} - Ca EDTA	265.44	296.10	391.27	308.49	256.16	219.29
T_{12} - Mg gluconate	459.87	495.20	699.19	531.25	453.86	387.72
T_{13} - Mg EDTA	459.48	490.38	693.95	534.05	454.97	389.79
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	369.35	399.45	531.33	420.29	361.09	308.97
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	331.88	362.34	473.25	379.70	323.24	275.41
T_{16} - Government grade 2	404.11	437.65	602.17	472.94	401.29	344.23
SE ±	1.72	2.68	1.89	3.19	1.88	1.19
CD at 5 %	5.24	8.10	3.84	9.65	5.71	3.62
Grand mean	401.67	441.12	608.29	471.12	393.95	337.91

(19.40 and 16.08 mg kg^{-1}), respectively. The treatments T_3 (26.36 and 20.89 mg kg^{-1}), T_8 (25.84 and 20.95 mg kg^{-1}) T9 (25.25 and 21.31 mg kg^{-1}) T_{12} (24.12 and 20.63 mg kg^{-1}) T_{13} (25.87 and 20.36 mg kg^{-1}), respectively were at par with superior treatment. At harvest the data during both years i.e. 2009-10, 2010-11 and pooled the data recorded statistical non significance.

Mn concentration and uptake : At 40 and 60 DAS the data indicated the non-significant results. The grand mean when observed critically resulted in increasing Mn concentration from 40 to 80 DAS which ranged from (2.74 to 3.44 mg kg^{-1}). During the two consecutive years 2009-10, 2010-11 and pooled the data varied from 2.85 to 4.27, 2.77 to 4.18 and 2.81 to 4.22 mg kg^{-1}, respectively. It is evident from the data successive increase in magnesium absorption was observed due to application of zinc gluconate (T_2) and was significantly superior over control and was at par treatments T_3 (Zn EDTA), T_8 (Fe gluconate), T_9 (Zn EDTA), T_{12} (Mg gluconate), T_{13} (Mg EDTA) and T_4 (Mn gluconate). The grand mean from 100 DAS to at harvest started decreasing with crop leading towards maturity and was varied from 3.06 to 2.74 to pooled data. In the pooled data of 100 and 120 DAS ranged from 2.57 to 3.54 and 2.41 to 3.66. In both stages of growth, it was clearly indicative that treatment T_2 (3.54 and 3.66) stood top in increasing manganese concentration in Bt cotton crop and recorded statistical significance over T_1 (2.57 and 2.41 mg kg^{-1}), T_{11} (2.65 and 2.47 mg kg^{-1}), T_{10} (2.74 and 2.53 mg kg^{-1}), T_7 (2.83 to 2.58) and T_6 (2.93 and 2.65 mg kg^{-1}) and at par with rest of treatment.

Zn concentration and uptake : The results obtained after the pooled analysis for 40 and 60 DAS revealed to the tune of (17.45 to 24.43 mg kg^{-1}) and (27.66 to 41.17 mg kg^{-1}), respectively. Treatment T_2 (24.43 and 41.17 mg kg^{-1}) greatly influenced the absorption of

Table 10. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on Mn concentration of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	2.08	2.21	2.81	2.57	2.41	2.30
T_2 - Zn gluconate	2.89	3.08	4.22	3.54	3.36	3.21
T_3 - Zn EDTA	2.83	3.05	4.10	3.48	3.32	3.13
T_4 - Mn gluconate	2.56	2.75	3.57	3.27	3.02	2.82
T_5 - Mn EDTA	2.48	2.68	3.46	3.21	2.94	2.77
T_6 - Cu gluconate	2.25	2.42	3.07	2.93	2.65	2.49
T_7 - Cu EDTA	2.21	2.36	3.01	2.83	2.58	2.47
T_8 - Fe gluconate	2.74	2.91	3.81	3.38	3.23	3.01
T_9 - Fe EDTA	2.78	3.04	3.98	3.44	3.29	3.09
T_{10} - Ca gluconate	2.15	2.30	2.94	2.74	2.53	2.41
T_{11} - Ca EDTA	2.12	2.26	2.87	2.65	2.47	2.36
T_{12} - Mg gluconate	2.69	2.92	3.82	3.38	3.17	2.95
T_{13} - Mg EDTA	2.61	2.82	3.61	3.32	3.10	2.90
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	2.35	2.55	3.24	3.11	2.82	2.64
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	2.32	2.49	3.15	3.01	2.73	2.58
T_{16} - Government grade 2	2.42	2.61	3.35	3.14	2.89	2.71
SE ±	0.19	0.17	0.15	0.15	0.15	0.05
CD at 5 %	NS	0.60	0.55	0.55	0.53	0.19
Grand mean	2.61	2.65	3.44	3.06	2.90	2.74

Table 11. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on Mn uptake of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	31.33	33.22	42.16	38.56	36.17	34.50
T_2 - Zn gluconate	78.92	83.70	114.58	96.14	91.18	87.22
T_3 - Zn EDTA	71.47	76.96	103.32	87.71	83.76	78.89
T_4 - Mn gluconate	53.49	58.35	75.65	69.35	64.06	59.76
T_5 - Mn EDTA	52.84	57.86	74.78	69.44	63.63	59.78
T_6 - Cu gluconate	37.67	40.81	51.85	49.60	44.75	42.56
T_7 - Cu EDTA	36.21	38.85	49.55	46.75	42.45	40.73
T_8 - Fe gluconate	63.09	67.63	88.79	78.73	75.27	69.93
T_9 - Fe EDTA	62.29	68.79	90.06	77.92	74.59	69.80
T_{10} - Ca gluconate	34.61	37.11	47.43	44.29	40.81	38.97
T_{11} - Ca EDTA	32.99	35.15	44.71	41.32	38.43	36.79
T_{12} - Mg gluconate	58.29	64.17	83.66	74.24	69.57	64.64
T_{13} - Mg EDTA	57.63	63.03	80.54	74.13	69.13	64.62
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	44.61	49.04	62.39	60.10	54.22	50.71
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	40.40	43.91	55.63	53.21	48.19	45.53
T_{16} - Government grade 2	49.86	54.41	69.76	65.58	60.25	56.34
SE ±	0.09	0.21	0.05	0.29	0.07	0.05
CD at 5 %	0.30	0.68	0.19	0.91	0.22	0.18
Grand mean	50.35	54.56	70.93	64.19	59.78	56.29

zinc overall other treatment and was distinctly superior over the treatment T_1 (control) (i.e. 17.45 and 27.66 mg kg^{-1}), respectively. The pooled data recorded statistical significance. It

was observed that the rate of absorption was increasing from 40 to 60 DAS as compare to rest of growth stage of Bt cotton crop. The pooled grand mean started declining after 80

Table 12. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on Zn concentration of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	17.45	27.66	20.72	17.96	14.73	13.91
T_2 - Zn gluconate	24.43	41.17	28.46	25.14	20.62	19.47
T_3 - Zn EDTA	23.50	39.85	27.73	24.10	19.64	18.28
T_4 - Mn gluconate	20.68	33.34	25.95	21.57	17.67	16.21
T_5 - Mn EDTA	20.45	32.57	25.60	21.38	17.21	16.19
T_6 - Cu gluconate	18.32	29.91	22.97	19.44	15.87	14.94
T_7 - Cu EDTA	18.15	29.40	22.72	19.08	15.40	14.61
T_8 - Fe gluconate	22.60	37.31	26.99	22.88	18.87	17.31
T_9 - Fe EDTA	23.02	38.34	27.37	23.69	19.61	17.61
T_{10} - Ca gluconate	17.96	28.29	21.87	18.46	15.09	14.32
T_{11} - Ca EDTA	17.71	27.92	21.33	18.14	15.01	14.01
T_{12} - Mg gluconate	22.10	36.50	26.84	22.35	18.39	16.81
T_{13} - Mg EDTA	21.05	35.00	26.16	21.77	18.03	16.52
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	19.72	31.19	23.84	20.10	16.44	15.36
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	19.43	31.08	23.48	19.91	16.31	15.22
T_{16} - Government grade 2	20.06	31.42	25.29	20.45	16.91	15.82
SE ±	0.16	0.23	0.19	1.03	1.53	1.12
CD at 5 %	0.57	0.81	0.68	3.61	5.37	3.94
Grand mean	20.41	33.17	24.83	21.02	17.25	16.04

Table 13. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on Zn uptake of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	263.31	413.35	311.54	270.50	221.67	208.85
T_2 - Zn gluconate	666.28	1121.89	772.71	684.51	560.97	528.63
T_3 - Zn EDTA	593.73	1006.04	699.48	608.29	503.44	459.64
T_4 - Mn gluconate	440.56	715.49	551.35	459.36	375.74	341.15
T_5 - Mn EDTA	443.88	705.20	555.19	464.20	373.44	349.69
T_6 - Cu gluconate	309.49	504.99	388.43	329.66	268.52	251.72
T_7 - Cu EDTA	299.49	484.19	375.04	315.65	254.03	240.66
T_8 - Fe gluconate	528.03	865.01	630.08	534.09	441.04	402.40
T_9 - Fe EDTA	522.48	869.17	620.93	537.08	444.75	396.68
T_{10} - Ca gluconate	290.86	457.57	353.17	299.80	244.20	231.49
T_{11} - Ca EDTA	276.63	435.16	333.25	283.45	234.11	217.99
T_{12} - Mg gluconate	486.81	803.16	590.80	493.25	404.94	366.66
T_{13} - Mg EDTA	471.55	782.41	585.44	487.89	403.64	366.97
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	380.98	603.94	462.02	389.72	318.54	294.88
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	343.43	550.83	416.52	353.64	289.13	268.10
T_{16} - Government grade 2	419.52	657.26	529.50	428.15	353.80	328.96
SE ±	2.99	1.91	2.02	2.52	0.99	1.23
CD at 5 %	9.02	5.78	6.10	7.61	3.00	3.74
Grand mean	421.06	685.98	510.96	433.70	355.74	328.40

DAS to at harvest and was to tune to 24.83 to 16.04 mg kg^{-1}. During the both years and pooled the data varied from 21.56 to 29.10, 19.88 to 27.83 and 20.72 to 28.46 mg kg^{-1}, respectively. The treatment T2 (Zn gluconate) recorded statistical significance over control and rest of all treatment. At 100 DAS the pooled results revealed that application of zinc gluconate had greater role in zinc absorption by Bt cotton crop. But the rate was reducing towards maturity. Treatment T_2 (25.14 mg kg^{-1}) stood first over control but was at par with T_3 (24.10 mg kg^{-1}), T_9 (23.69 mg kg^{-1}), T_8 (22.88 mg kg^{-1}), T_{12} (22.35 mg kg^{-1}) and T_{13} (21.77 mg kg^{-1}). The pooled data at 120 DAS and at harvest revealed statistical significance. The treatment T_2 (Zn gluconate) (20.62 and 19.47%) influenced the zinc concentration significantly over control.

Cu Concentration and uptake : The pooled grand mean was to the tune 3.53 to 4.79 mg kg^{-1} at 40 to 80 DAS, which showed an increasing trend as crop proceed and recorded maximum at 80 DAS.

Scrutiny of the data revealed that at 40 DAS the copper concentration varied from 3.01 to 4.21, 3.00 to 4.10 and 3.00 to 4.15 in 2009-19, 2010-11 and pooled respectively. Treatment T_2 (Zn gluconate) significantly influenced the copper concentration over the control (T_1) and was significantly superior over control. While at 60 and 80 DAS in pooled analysed data, it varied between 3.12 to 4.28 and 3.90 to 5.50 mg kg^{-1}, respectively. Same trend of superiority i.e. of Zn gluconate was observed over the control. The pooled grand mean started declining form 100 DAS toward harvesting which was to the tune from 3.83 to 3.58. Both the years i.e. 2009-10, 2010-11 and pooled the data at 100 DAS ranged from 3.26 to 4.38, 3.17 to 4.27 and 3.21 to 4.32 mg kg^{-1}, respectively. Pooled data revealed that maximum Cu absorption was observed with Bt cotton crop treated with T_2 (Zn gluconate) (4.32

Table 14. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on Cu concentration of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	3.00	3.12	3.90	3.21	3.07	3.00
T_2 - Zn gluconate	4.15	4.28	5.50	4.32	4.09	4.03
T_3 - Zn EDTA	4.11	4.21	5.32	4.28	4.02	3.99
T_4 - Mn gluconate	3.79	3.75	4.75	4.02	3.76	3.74
T_5 - Mn EDTA	3.69	3.67	4.66	3.95	3.69	3.67
T_6 - Cu gluconate	3.33	3.33	4.25	3.55	3.33	3.35
T_7 - Cu EDTA	3.24	3.20	4.15	3.45	3.27	3.27
T_8 - Fe gluconate	4.04	4.04	5.06	4.18	3.90	3.91
T_9 - Fe EDTA	4.09	4.11	5.21	4.25	3.98	3.93
T_{10} - Ca gluconate	3.16	3.20	4.07	3.35	3.20	3.18
T_{11} - Ca EDTA	3.08	3.15	3.98	3.27	3.14	3.11
T_{12} - Mg gluconate	3.98	3.96	5.01	4.17	3.92	3.86
T_{13} - Mg EDTA	3.88	3.83	4.87	4.09	3.84	3.81
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	3.52	3.50	4.45	3.74	3.51	3.51
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	3.41	3.42	4.35	3.65	3.41	3.43
T_{16} - Government grade 2	3.62	3.59	4.55	3.85	3.57	3.59
SE ±	0.12	0.11	0.11	0.08	0.09	0.08
CD at 5 %	0.44	0.40	0.41	0.29	0.32	0.30
Grand mean	3.53	3.66	4.79	3.83	36.05	3.58

Table 15. Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on Cu uptake of Bt cotton

Treatments	40 DAS pooled	60 DAS pooled	80 DAS pooled	100 DAS pooled	120 DAS pooled	At harvest pooled
T_1 - Control	45.03	46.80	58.48	48.23	46.05	44.95
T_2 - Zn gluconate	112.71	116.41	149.23	117.32	111.05	109.25
T_3 - Zn EDTA	103.61	106.26	120.55	107.87	101.33	100.40
T_4 - Mn gluconate	80.23	79.41	100.79	85.07	79.76	79.24
T_5 - Mn EDTA	79.63	79.26	100.84	85.23	79.73	79.21
T_6 - Cu gluconate	56.09	56.24	71.68	59.79	56.18	56.47
T_7 - Cu EDTA	53.23	53.74	68.38	56.76	53.78	53.81
T_8 - Fe gluconate	94.01	94.03	117.83	97.29	90.88	90.93
T_9 - Fe EDTA	92.60	93.22	117.97	96.07	90.28	88.87
T_{10} - Ca gluconate	50.92	51.60	65.67	54.12	51.64	51.27
T_{11} - Ca EDTA	47.92	49.06	61.97	50.86	48.89	48.29
T_{12} - Mg gluconate	87.26	86.92	110.07	91.31	86.25	84.68
T_{13} - Mg EDTA	86.60	85.54	108.72	91.22	85.81	85.04
T_{14} - Zn, Mn, Cu, Fe, Ca and Mg gluconate	67.57	67.44	85.71	71.90	67.61	67.49
T_{15} - Zn, Mn, Cu, Fe, Ca and Mg EDTA	59.93	60.32	76.73	64.34	59.96	60.39
T_{16} - Government grade 2	75.10	74.73	94.85	80.08	74.70	74.65
SE ±	0.98	1.04	1.78	2.08	1.65	0.98
CD at 5 %	2.99	3.19	3.60	6.32	12.41	2.95
Grand mean	74.53	75.06	94.34	78.59	73.99	73.43

mg kg^{-1}) and was significantly superior over T_1 (control) (3.21 mg kg^{-1}) and was at par with treatments like T_3 (Zn EDTA), T9 (Fe EDTA), T_8 (Fe gluconate), T_{12} (Mg gluconate) and T_{13} (Mg EDTA). The pooled results obtained during 120 DAS and at harvest showed significant impact of zinc gluconate in maximizing the Cu absorption in Bt cotton crop. Treatment T_2 (4.09 and 4.03 mg kg^{-1}) was proved to be distinctly superior over T_1 (control) (3.07 and 3.00 mg kg^{-1}).

Conclusions

Micronutrients play a very important role in crop production and its deficiency in soil is one of the major causes for yield reduction. So, there is an urgent need to target the problem correctly and specially for precise fertilizer management. From above finding it can be concluded that, the treatment T_2 (Zn gluconate) showed a greater number of bolls per plant followed by treatment T_3 (Zn EDTA). The maximum number of bolls were observed after 120-135 days and thereafter there was a decline in the boll formation. The maximum boll weight was observed with treatment Zn gluconate. Spraying of Zn gluconate, Zn EDTA and Fe and Mg nutrients have produced more seed cotton yield. The foliar feeding of gluconate and EDTA chelated plant nutrients found to be effective in increasing the yield attributes viz., number of bolls, boll weight and seed cotton yield. Among the chelated nutrient sprays gluconate complexed nutrients found superior over EDTA chelated nutrients and government grade 2. The relatively higher nutrient concentration (N, P, K, Zn, Fe, Mn and Cu) of macro and micronutrients was observed in treatment T_2 (Zn gluconate) at 40 to 80 DAS growth stages. The numerical data also revealed that from 100 DAS to at harvest the concentration of all nutrients started declining as crop progressed towards, its

physiological maturity. Treatment T_3 (Zn EDTA), T_8 (Fe gluconate), T_9 (Fe gluconate), T_{12} (Mg gluconate) and T_{13} (Mg EDTA) were found to be at par with spray of Zn through gluconate salt.

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