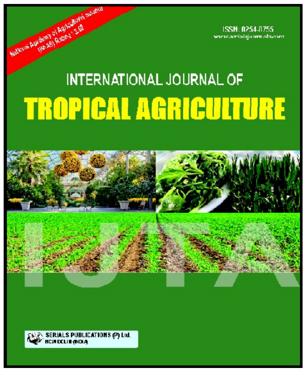

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Response of Chelated Plant Nutrition on Yield, Quality and Economices of Bt-Cotton under Vertisols of Maharashtra

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Abstract: The field experiments were conducted on experimental farm of Department of soil science and Agricultural Chemistry Vansantrao Naik Marathawada Krishi Vidyapeeth, Parbhani, during 2009-10 and 2010-11 entitled "Response of chelated plant nutrition on yield, quality and economics of Bt cotton". The experiment was laid out in randomized block design with sixteen treatments replicated two times. The data on yield, quality and economics 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 maximum return 163382.50 Rs ha^{-1} in 2009-10 and 104789.2 Rs ha^{-1} in 2010-11 was observed with treatment T_2 and minimum return 88096.18 Rs ha^{-1} in 2009-10 and 54652.55 Rs ha^{-1} in 2010-11 with control.The cost: benefit ratio was found more with the treatment T_2 *i.e.* Zn gluconate with 3.69 in 2009-10 and 2.37 in 2010-11. The minimum cost: benefit ratio was observed in control (T_1) treatment with 2.03 in 2009-10 and 1.26 2010-11.The economic utility of foliar application at two different growth stages was maximized with the use of Zn gluconate in Bt cotton.

Key words: Yield, quality, economics, plant nutrition, EDTA, gluconate, cotton, chelated nutrients etc.

INTRODUCTION

Cotton (*Gosspium* spp.) is one of merical crops playing a key role in economical, political and social status of the world. 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 way to replenish the required nutrient in critical growth stages and is a rapid and effective method of supplying the micronutrients. These micronutrients could be supplied through EDTA (Ethylendiamine 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. penicilium*as 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.

MATERIAL AND METHODS

A research project "Response of chelated plant nutrition on yield and economics of Bt cotton" 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 × 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).

RESULT AND DISSCUTION

In order to assess "Response of chelated plant nutrition on yield, quality and economics of Bt cotton. Field experiments were conducted at Research farm of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani with sixteen treatment and two replications in randomized block design for two consecutive years 2009-10 and 2010-11. The results emerged out of the experimentation, were statistically analysed, organized, appropriately tabulated, interpreted and discussed.

(A) Yield Attributes of Bt Cotton

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	*Number 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

The results presented in Table 1revealed that treatment difference due to foliar feeding of gluconate and EDTA chelated plant nutrients were significant throughout the growth stages of Bt cotton crop in production of number of bolls plant^{-1}.

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 data on effect on foliar feeding of gluconate and EDTA chelated plants nutrients on boll weight are presented in Table 1. 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 data revealed that 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. Similarobservations 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 data regarding effect foliar feeding of gluconate and EDTA chelated plant nutrients on yield of cotton are presented in Table 1.

The application of varied levels of foliar feeding of micronutrients significantly influenced the cotton yield.The yield were 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).

From the above results, 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 photoassimilates 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).

Sharma *et al.* (1990) obtained the foliar spray of multi-micronutrient proved highly beneficial for increase yield and yield attributes. It may be due to the sufficient availability of micronutrients by foliar feeding, which was not only an additional channel of nutrition but also means of regulating root uptake. Sharma *et al.* (1998) observed that foliar application of Zn (0.5 per cent) on 50 and 65 DAS gave seed cotton yield of 14.69 ha^{-1} compared with 11.82 q ha^{-1} without Zn.

Application of zinc and iron enhanced seed cotton yield. This might be due to improved growth and yield attributing characters. Similarresults 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.

(B) Quality Parameters of *Bt.* Cotton

1. Lint index

The lint index ranged from 2.64 to 4.06. During both the years, the results were non significant, but in pooled the result were found to be significant and the treatment T_2 was found distinctly superior over control (T_1). Further, treatments T_4, T_5, T_8, T_9, T_{12}, T_{13} and T_{16} also showed their significantly by giving higher lint index over control. Whereas, treatment T_6, T_7, T_{10}, T_{11}, T_{12} and T_{15} were at par with control. These results clearly showed that addition of the zinc, manganese, iron and magnesium in fertilizer application schedule are important.

2. Ginning percentage (%)

The pooled value of ginning percentage ranged from 30.47 to 34.34 per cent with an average 32.44 per cent ginning out turn in Table 2. Foliar application of Zn, Mn, Fe, and Mg either through gluconate of EDTA improved the ginning out turn. However, it could not reach to the level of significance.

The ginning out turn parameter was governed mostly by genetic factors and hence remained more or less constant. These results were on the similar lines as that of Gaddime (2003) in cotton.

3. Test weight

Test weight ranged from 6.05 to 8.18 g per 100 seed and the results were significant. The treatment T_2 (Zn gluconate) was superior over the control and was at par with rest of the treatments except Cu gluconate and Ca gluconate foliar spray and treatment T_{14} (all nutrient EDTA).

Table 2
Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on lint index, ginning percentage (%), test weight (g) and oil content (%)

Treatment	*Lint index*	*Ginning percentage (%)*	*Test weight (g)*	*Oil content (%)*
T_1-Control	2.64	30.47	6.05	16.52
T_2-Zn gluconate	4.06	34.34	8.18	17.88
T_3-Zn EDTA	4.03	33.86	8.05	17.22
T_4-Mn gluconate	3.66	32.40	7.38	16.66
T_5-Mn EDTA	3.84	32.87	7.55	17.03
T_6-Cu gluconate	3.24	31.48	6.69	16.96
T_7-Cu EDTA	3.36	31.82	6.77	17.08
T_8-Fe gluconate	3.99	33.85	8.00	17.80
T_9-Fe EDTA	3.92	33.52	7.70	17.52
T_{10}-Ca gluconate	3.00	31.08	6.40	16.74
T_{11}-Ca EDTA	2.87	30.82	6.30	16.66
T_{12}-Mg gluconate	3.80	33.01	7.55	17.16
T_{13}-Mg EDTA	3.89	33.22	7.65	17.26
T_{14}-Zn, Mn, Cu, Fe, Ca and Mg gluconate	3.52	32.06	7.17	17.36
T_{15}-Zn, Mn, Cu, Fe, Ca and Mg EDTA	3.49	31.96	6.98	17.23
T_{16}-Government grade 2	3.70	32.27	7.17	17.46
SE +	0.26	1.17	0.30	1.15
CD at 5 %	0.90	4.11	1.05	4.02

4. Oil content

Oil content of Bt cotton values ranged from 16.52 to 17.22 per cent with an average of 17.57. The treatment T_2 (Zn gluconate) was found to be numerically higher in producing oil over the control (T_1). However, the said treatment was at par with all.

The slight improvement in oil content due to foliar application of micronutrients might have helped in increased rate of photosynthesis along with active absorption of various nutrients and translocations of photosynthates to the site of storage organ.

Table 3
Effect of foliar application of gluconate and EDTA chelated plant nutrient on economic of Bt cotton.

Treatments	*Added cost (Rs ha-1)*	*Added return (Rs ha-1)*	*ICBR ratio (C:B ratio)*
T1-Control	43396.96	71374.365	1.65
T2-Zn gluconate	44296.96	134085.85	3.03
T3-Zn EDTA	43796.96	124044.01	2.83
T4-Mn gluconate	44296.96	103411.15	2.34
T5-Mn EDTA	44196.96	105227.58	2.38
T6-Cu gluconate	44296.96	81193.26	1.84
T7-Cu EDTA	43796.96	79073.83	1.81
T8-Fe gluconate	44296.96	114238.09	2.58
T9-Fe EDTA	44296.96	110740.63	2.50
T10-Ca gluconate	43796.96	77040.98	1.76
T11-Ca EDTA	44296.96	74147.14	1.68
T12-Mg gluconate	43696.96	107166.87	2.45
T13-Mg EDTA	44296.96	108939.39	2.46
T14-Zn, Mn, Cu, Fe, Ca and Mg gluconate	44596.96	94013.70	2.11
T15- Zn, Mn, Cu, Fe, Ca and Mg EDTA	44696.96	85651.00	1.92
T16-Government grade 2	44096.96	101334.11	2.30

(C) Cost: Benefit Ratio

Amongst the foliar sprays treatment, Zn gluconate spray twice gave the best results. The maximum return 134085.85Rs ha^{-1}was observed with treatment T_2 and minimum return 71374.36Rs ha^{-1} with control.

The cost: Benefit ratio was found more with the treatment T_2 *i.e.* Zn gluconate with 3.03. The minimum cost:benefit ratio was observed in control (T_1) treatment with 1.65.

From the above results it was observed that two sprays of Zn glucoante at 55 and 75 days after sowing were helpful in increasing added returns and cost:benefit ratio than control.

The similar findings were also observed by Namdeo *et al.* (1992), Manjunath (2004) and Kolte (2008).

Amongst the foliar sprays treatment, Zn gluconate spray twice gave the best results. The maximum return 163382.50 Rs ha^{-1} in 2009-10 and 104789.2 Rs ha^{-1} in 2010-11 was observed with treatment T_2 and minimum return 88096.18 Rs ha^{-1} in 2009-10 and 54652.55 Rs ha^{-1} in 2010-11 with control. Thecost:benefit ratio was found more with the treatment T_2 *i.e.* Zn gluconate with 3.69 in 2009-10 and 2.37 in 2010-11. The minimum cost:benefit ratio was observed in control (T_1) treatment with 2.03 in 2009-10 and 1.26 2010-11.From the above results it was observed that two sprays of Zn glucoante at 55 and 75 days after sowing were helpful in increasing added returns and cost:benefit ratio than control. The similar finding were also observed by Namdeo *et al.* (1992), Manjunath (2004) and Kolte (2008).

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 more 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 quality parameters *viz.*, staple length and ginning percentage found to be improved due chelated nutrients sprays, but could not reach to the level of significance. Among the treatments Zn gluconate spray found to be distinctly superior over the control (T_1), T_{10} (Ca gluconate) and T_{11} (Ca EDTA) and at par with remaining treatments spraying of Zn, Fe and Mg gluconate and EDTA found to significantly superior over control and was at par with rest of treatments in test weight and oil content. The economic utility and ICBR ratio (C:B ratio) of foliar application at two different growth stages were maximized with the use of Zn gluconate in Bt cotton.

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