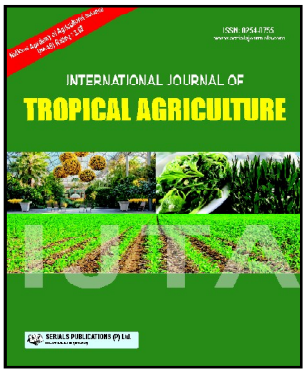

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Effect of Foliar Feeding of Gluconate and Edta Chelated Plant Nutrients on Chlorophyll Content of Bt Cotton

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Abstract: An experiment was conducted during 2009-10 and 2010-11 to find out the "Effect of foliar feeding of Gluconate and EDTA chelated plant nutrients on chlorophyll content of *Bt*-cotton" at Department of Soil Science and Agril Chemistry, VNMKV, Parbhani. The experiment includes seventeen treatment includes *viz.*,T_1-Zn Gluconate, T_2-Mn Gluconate, T_3-Cu gluconate,T_4- Fe Gluconate,T_5- Ca Gluconate,T_6- Mg Gluconate, T_7- combination of all Gluconate ,T_8- Zn-EDTA,T_9- Mn EDTA, T_{10}- Cu EDTA, T_{11}-Fe EDTA ,T_{12}-Ca EDTA, T_{13}-Mg EDTA, T_{14}-combination of all EDTA ,T_{15}- Govt.grade II, T_{16}- Water spray and T_{17}- Control replicated twice. The treatments were fertilized with 120:60:60 N,P_2O_5 and K_2O Kg ha^{-1}. 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 DAS. Quantitative analysis of chlorophyll was done by using DMSO as an extractant. Chlorophyll a, chlorophyll b and total chlorophyll content in leaves also influenced significantly due to different foliar feeding. The highest chlorophyll a, chlorophyll b and total chlorophyll was registered with the treatment Fe gluconate spray followed by Fe EDTA. The a, b and total chlorophyll showed increasing trend up to 100 DAS and decreased thereafter. The foliar feeding of Fe gluconate showed significant increase in plant pigments like chlorophyll 'a', chlorophyll 'b' and total chlorophyll and anthocynin content overall the treatments except Fe EDTA, Mg gluconate in leaves of Bt cotton.

Key words: Foliar feeding, gluconate, EDTA, chlorophyll content, cotton etc.

INTRODUCTION

Cotton (*Gosspium* spp.) is one of the most important commercial crops playing a key role in economical, political and social status of the world and so has retained its unique fame and name as the "King of fibers" and "White gold" because of its higher economical value among cultivable crops for quite a long period. It was the superiority of Indian cotton fabrics famed as "Web of woven mind" which attracted European countries to seek new trade routes to India. Indian economy continued to receive great support from the cotton industry, is one of the major industries in India contributing 12 per cent to the export basket with improved cotton productivity and other innovations. In the production line, India will be in a position to get more foreign exchange and earned Rs. 10270.21 crores from export of 83.00 lakh bales in 2009-10 (Cotton Advisory Board).

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. It constitutes one of the important milestones in the progress of agriculture crop production, as a natural phenomenon of nutrient uptake; it has existed with all form of plants life from their beginning. (www.groversminral. com). 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. It is a method of plant fertilization which involves applying fertilizer directly to the leaves in the form of solution which is spread on the tiny pores in the leaves allows the fertilizer to pass into the plant providing needed nutrition. Foliar nutrients are mobilized directly into plant leaves which are the goal of fertilization to begin with increasing the rate of photosynthesis in the leaves and by doing so stimulate nutrient absorption by plant roots. When the foliar plant food is sprayed on the leaves, it causes the plant metabolism to speed up. This causes the plant to demand more water and nutrients from the root system. It is this increase in water and nutrient sent by the roots that provides the potential for higher yield.

Foliar feeding is a reliable method of feeding plants when soil feeding is inefficient. Almost everything a plant requires to grow and develop is manufactured in the leaves. Hormones, metabolites, proteins, amino-acids the list goes on and they are all manufactured in specialized cells contained within the plants leaves. Most leaves have stomata either only on the underside or on both sides of the leaf. Foliar absorption is through the stomatas which are microscopic pores in the epidermis of the leaf. The leaf with its epidermis can also function as an organ that absorbs and exerts water and substance which may be dissolved in it, when the stomata are open, foliar absorption is easier.

So, the foliar application assumes greater importance, as the nutrients are brought in the immediate vicinity of the metabolizing area *i.e.* foliage. Information regarding the effect of foliar feeding of cotton is inadequate, moreover use of chelated nutrients *e.g.* EDTA chalets and newly developed gluconate chalets required to be tested for their performance.

MATERIALS AND METHODS

A research project "Effect of foliar feeding of gluconate and EDTA chelated plant nutrients on chlorophyll content 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 analyzed 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 free calcium carbonate content was 48.00 to 36.00 g kg^{-1}. The available nitrogen, phosphorus and potassium content of experimental soil of cotton were 147.00 and 139.00 kg ha^{-1}, 8.9 and 10.20 kg ha^{-1}, 887.00 and 670.00 kg ha^{-1}, during 2009 and 2010, respectively and can be categorized as low in available N, medium in P_2O_5 and high in K_2O. Exchangeable Ca and Mg status were 27.30 and 24.48 C mol (p^+) $kg^{-1}$and 16.30 and 14.80 C mol (p^+) kg^{-1}, respectively. While, the micronutrient status like zinc, iron, manganese and copper content before administration of treatments were 0.56 and 0.53, 2.62 and 2.60, 15.17 and 13.08, 4.39 and 3.57 mg kg^{-1} during 2009 and 2010, respectively and rated as low in Zn and Fe and high in Mn and Cu. 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. Initial and periodical soil samples were collected at 40, 60, 80, 100, 120 DAS and at harvest stage of crop from surface layer (0.15 cm) of each treated plots of the layout. Soils were air dried, ground with wooden mortar and pestle and passed through 2 mm sieve. The sieved samples were stored in polythene bags with proper labeling for further analysis. Nutrient content in cotton plant as influenced by treatment combinations were determined periodically at 20 days interval and after harvest of crop. The samples were washed with the tap water and in detergent solution followed by distilled water. After cleaning, plants were dried in shade and subsequently in oven at 70°C for 12 hrs. The oven dried sample were ground in electrically operated grinder with stainless steel blade to maximum fineness. The powdered samples were stored in polythene packets with proper labeling and utilized for nutrient content studies. The quantitative analysis of chlorophyll was done by using DMSO as an extractant. The data emerged out from the field experiment were analyzed by analysis of variance and degree of freedom were partitioned into different variance, due to replication and treatments combinations. Results were statistically analyzed as per the method given in statistical method for agricultural workers by Panse and Sukhatme (1987).

RESULT AND DISCUSSION

The effect of foliar feeding of gluconate and EDTA chelated plant nutrients on chlorophyll content of Bt cotton

Chlorophyll 'a'

The data on chlorophyll 'a' content in cotton leaves, as influenced by foliar feeding of chelated plant nutrients at different time intervals for two consecutive years 2009-10 and 2010-11 and pooled and presented in Table 1.

Application of various micronutrients and their combinations has profound influence on chlorophyll 'a' content. Application of treatment T_8 (Fe gluconate) and T_9 (Fe EDTA) significantly increased the chlorophyll 'a' content which was 0.830 and 0.793 mg g^{-1} at 40 DAS. Further, the same treatments showed significantly higher chlorophyll 'a' at different growth stages of observation of Bt cotton over the control (T_1). Similarly, foliar application of Mg also helped to improve the chlorophyll content at all growth stages in both the years and in pooled.

It is to be noted here that even at harvesting stage application of Fe and Mg maintained higher chlorophyll concentration in the leaves of Bt cotton. This might be the reason of less reddening observed in these treatments.

Among the two salts used in the present investigation gluconate complexed nutrient had showed superiority over EDTA complexed nutrients.

Table 1
Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on chlorophyll 'a' (mg g^{-1}) of Bt cotton

Treatments	*40 DAS*	*60 DAS*	*80 DAS*	*100 DAS*	*120 DAS*	*At harvest*
T_1-Control	0.369	0.451	0.666	0.827	0.746	0.582
T_2-Zn gluconate	0.647	0.748	1.015	1.245	1.086	0.905
T_3-Zn EDTA	0.580	0.684	0.890	1.183	1.000	0.825
T_4-Mn gluconate	0.555	0.664	0.863	1.162	0.977	0.852
T_5-Mn EDTA	0.621	0.723	0.989	1.219	1.056	0.875
T_6-Cu gluconate	0.536	0.640	0.847	1.130	0.952	0.788
T_7-Cu EDTA	0.603	0.698	0.911	1.199	1.030	0.853
T_8-Fe gluconate	0.807	0.873	1.209	1.402	1.195	1.064
T_9-Fe EDTA	0.772	0.846	1.182	1.380	1.164	1.045
T_{10}-Ca gluconate	0.406	0.485	0.702	0.858	0.790	0.628
T_{11}-Ca EDTA	0.388	0.464	0.688	0.838	0.769	0.609
T_{12}-Mg gluconate	0.747	0.826	1.157	1.352	1.143	0.974
T_{13}-Mg EDTA	0.722	0.804	1.079	1.322	1.115	0.953
T_{14}-Zn, Mn, Cu, Fe, Ca and Mg gluconate	0.460	0.532	0.745	0.951	0.851	0.663
T_{15}-Zn, Mn, Cu, Fe, Ca and Mg EDTA	0.477	0.554	0.772	0.974	0.872	0.693
T_{16}-Government grade 2	0.493	0.574	0.796	1.051	0.891	0.722
SE +	0.009	0.01	0.008	0.009	0.01	0.009
CD at 5%	0.03	0.36	NS	0.03	0.05	0.03
Grand mean	0.57	0.66	0.91	1.131	0.977	0.814

Chlorophyll 'b'

The results on chlorophyll 'b' in Bt cotton leaves as influenced by foliar feeding of chelated plant nutrient are presented in Table 4.

Chlorophyll b content in leaves of Bt cotton on an average was highest at 100 DAS (1.13 mg g^{-1}) and found to be decreased with growth of cotton crop. Maximum chlorophyll b content was observed in treatment T_8 (Fe gluconate), which was distinctly superior over control (T_1) and other treatments.

The periodical synthesis of chlorophyll b indicated the trend of its increase from 40 to 100 DAS and thereafter its rate was found to be dropped till at harvest. The result on total chlorophyll content in cotton leaves as influenced by application of foliar feeding of chelated plant nutrients are complied in Table 4.

Application of Fe gluconate significantly influenced on total chlorophyll content at 40, 60, 80 and 100 DAS during both the experimental years. Similarly, the pattern of total chlorophyll synthesis showed that it increased up to 100 DAS and later on declined with advancement in age of the crop.

It was observed form pooled data of 40, 60, 80 and 100 DAS, the maximum total chlorophyll content and it was recorded in treatment T_8 (Fe gluconate) and minimum in treatment T_1 (control). Treatment T_8 (Fe gluconate) was found to be significantly superior over the control and at par with treatment T_9 (Fe EDTA).

Table 2
Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on chlorophyll 'b' (mg g^{-1}) of Bt cotton

Treatments	*40 DAS*	*60 DAS*	*80 DAS*	*100 DAS*	*120 DAS*	*At harvest*
T_1-Control	0.197	0.235	0.436	0.471	0.302	0.171
T_2-Zn gluconate	0.297	0.361	0.569	0.580	0.450	0.259
T_3-Zn EDTA	0.288	0.342	0.551	0.564	0.423	0.232
T_4-Mn gluconate	0.296	0.337	0.548	0.562	0.413	0.226
T_5-Mn EDTA	0.289	0.356	0.560	0.576	0.442	0.250
T_6-Cu gluconate	0.289	0.333	0.543	0.554	0.403	0.224
T_7-Cu EDTA	0.294	0.346	0.556	0.572	0.433	0.242
T_8-Fe gluconate	0.358	0.407	0.597	0.621	0.498	0.307
T_9-Fe EDTA	0.345	0.405	0.591	0.610	0.485	0.292
T_{10}-Ca gluconate	0.244	0.258	0.468	0.498	0.329	0.180
T_{11}-Ca EDTA	0.244	0.252	0.453	0.486	0.316	0.176
T_{12}-Mg gluconate	0.320	0.393	0.587	0.599	0.475	0.283
T_{13}-Mg EDTA	0.306	0.387	0.582	0.591	0.468	0.275
T_{14}-Zn, Mn, Cu, Fe, Ca and Mg gluconate	0.271	0.280	0.499	0.522	0.352	0.200
T_{15}- Zn, Mn, Cu, Fe, Ca and Mg EDTA	0.271	0.289	0.509	0.531	0.363	0.208
T_{16}-Government grade 2	0.279	0.304	0.521	0.538	0.375	0.214
SE +	0.008	0.007	0.01	0.009	0.01	0.01
CD at 5%	0.02	0.02	0.04	0.03	0.03	0.04
Grand mean	0.286	0.330	0.536	0.555	0.408	0.234

Total Chlorophyll

The second best treatments were foliar application of Mg through gluconate and EDTA. So, it was very clear from the data recorded on chlorophyll content that chlorophyll 'a' 'b' and total chlorophyll synthesis was more in the treatment received Fe and Mg.

Bt cotton crop treated with Fe gluconate (T_8) and Fe EDTA (T_9) treatment showed maximum synthesis of total chlorophyll and the minimum total chlorophyll was recorded with treatment T_1 (control). The treatments T_{12} (Mg gluconate) and T_{13} (Mg EDTA) were found at par with superior treatment at all the stages.

The highest chlorophyll content in leaves recorded with the supply of micronutrient treatment particularly T_8 (Fe gluconate) and T_9 (Fe EDTA) is in accordance with the results reported by Jadhav *et al.* (2004). Patil and Malewar (1994) also observed highest content of total chlorophyll in cotton leaves with the supply of nitrogen, iron and Zn.

The higher values of total chlorophyll recorded with supply of Mg in the present study confirm the findings of Jaylalita and Narayanan (1996). Further, Akarte *et al.* (1985), Jayalalitha and Narayanan (1996) observed that Mg deficient cotton plant shows purplish red and orange interveinal pigmentation in older leaves as well as chlorophyll content drastically reduced due to Mg deficiency. Dhoble *et al.* (2004) observed the high total chlorophyll concentration at grand growth stages of wheat and cotton.

Table 3
Effect of foliar feeding of gluconate and EDTA chelated plant nutrient on total chlorophyll (mg g^{-1}) of Bt cotton

Treatments	*40 DAS*	*60 DAS*	*80 DAS*	*100 DAS*	*120 DAS*	*At harvest*
T_1-Control	0.552	0.682	1.320	1.672	1.261	0.786
T_2-Zn gluconate	0.932	1.146	1.647	2.037	1.631	1.189
T_3-Zn EDTA	0.855	1.076	1.576	1.971	1.560	1.099
T_4-Mn gluconate	0.824	1.054	1.553	1.941	1.532	1.080
T_5-Mn EDTA	0.904	1.123	1.619	2.015	1.603	1.155
T_6-Cu gluconate	0.803	1.027	1.538	1.915	1.506	1.057
T_7-Cu EDTA	0.884	1.104	1.595	1.993	1.586	1.130
T_8-Fe gluconate	1.166	1.266	1.771	2.203	1.794	1.346
T_9-Fe EDTA	1.140	1.245	1.754	2.180	1.769	1.316
T_{10}-Ca gluconate	0.605	0.723	1.385	1.727	1.327	0.837
T_{11}-Ca EDTA	0.576	0.705	1.354	1.708	1.293	0.816
T_{12}-Mg gluconate	1.110	1.227	1.730	2.151	1.740	1.297
T_{13}-Mg EDTA	1.084	1.203	1.709	2.122	1.710	1.269
T_{14}-Zn, Mn, Cu, Fe, Ca and Mg gluconate	0.672	0.866	1.469	1.783	1.369	0.921
T_{15}- Zn, Mn, Cu, Fe, Ca and Mg EDTA	0.701	0.890	1.483	1.805	1.396	0.955
T_{16}-Government grade 2	0.725	0.912	1.504	1.830	1.422	0.977
SE +	0.01	0.01	0.01	0.01	0.01	0.01
CD at 5%	0.04	0.03	NS	0.04	0.05	0.06
Grand mean	0.846	1.016	1.563	1.941	1.531	1.077

CONCLUCTION

Chlorophyll a, chlorophyll b and total chlorophyll content in leaves also influenced significantly due to different foliar feeding. The highest chlorophyll a, chlorophyll b and total chlorophyll was registered with the treatment Fe gluconate spray followed by Fe EDTA. The a, b and total chlorophyll showed increasing trend up to 100 DAS and decreased thereafter.

The foliar feeding of Fe gluconate showed significant increase in plant pigments like chlorophyll 'a', chlorophyll 'b' and total chlorophyll and anthocynin content overall the treatments except Fe EDTA, Mg gluconate in leaves of Bt cotton.

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