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Effect of foliar spray of nutrients on morphological and physiological parameters

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ABSTRACT : An experiment was conducted to determine the morphological and physiological parameters on RCH 134. Significantly higher seed cotton yield and bolls/plant were recorded in $MgSO_4$ (1%, 2 % urea + 2% DAP + 1% $MgSO_4$) followed by alternate spray of KNO_3 @ 1 per cent as compared to control and other treatments. Highest assimilation rate and internal CO_2 conc was recorded in urea (2%) + DAP (2%) + $MgSO_4$ (1%) alternate spray treatment. For plant height there were no significant differences amongst various treatments. Chlorophyll content was recorded max in urea + DAP + MOP treatment as compared to all other treatments. Excised leaf water loss was an indication of transpiration rate was significantly higher in KNO_3 (1%) and urea + DAP + MOP (Murate of potash) treatments. It was concluded that the higher seed cotton yield obtained due to higher number of bolls/plant and higher assimilation rate in urea (2%) + DAP (2%) + $MgSO_4$ (2%) alternate spray of $MgSO_4$ @ 1 per cent and KNO_3 (1%) treatments.

Key words: Cotton, nutrient, photosynthesis, transpiration, yield

Cotton has maintained its unique name and fame as the *"King of Fibres"* and *"White Gold"* because of its higher economical value among cultivable crops for quite a long period. India ranks first in area under cotton cultivation with an area about 8.32 million ha (Rajendran *et al.,* 2011). The nutrient requirements of cotton are well known, and methods of fertilizer application and other cultural practices resulting in optimum production have been developed over the past 50 years (Oosterhuis, 2001). Therefore, supplying optimal quantities of mineral nutrients and using balanced macro- and micronutrient doses to growing crop plants is one way to improve crop yields. The growth and yield of cotton is governed by the interaction of environment with the genetic makeup of the variety or hybrid, various inputs, such as water, fertilizer, pesticides etc. Under assured irrigation with use of plant growth regulator and foliar nutrients there is good scope for increasing productivity of summer cotton (Rajendran *et al.*, 2011).

There is a wealth of literature about foliar fertilization that was first used as long ago as 1844 to check plant chlorosis with foliar sprays of iron. Foliar application of specific nutrients is a method used to improve the efficiency of fertilizer use and increase yields. The basis for this is that certain fertilizer nutrients are soluble in water and may be applied directly to the aerial portions of plants. There are comprehensive studies on the nature and characteristics of the cotton leaf cuticle and the interaction with environmental stress summarized in a review of foliar fertilization in cotton by Oosterhuis and Weir (2009). The increased use of foliar fertilizers in crop production in the last decade is due to the changes in production philosophy. Researches showed that adding foliar nutrition to supplement soil applied fertilizers is used to correct its deficiency, to maintain optimum nutrition of a particular nutrient, to give the crop a nutritional boost at a critical juncture in it's life.

Foliar fertilizers support leaf nutrient levels that are drained as the plant shifts growth towards the bolls (Errington *et al.,* 2007). Newly released, high yielding transgenic cotton cultivars are said to have a higher nutrient demand during the boll-filling period (between flowering and maturity) due to their higher boll retention rate and larger boll load than conventional cultivars. During this period, nutrients are translocated from leaves to bolls, leading to speculation that foliar fertilization could be used as an effective tool for raising the nutrient status of the leaves at this critical period, and increasing the yield and fibre quality of the cotton crop (Sawan *et al.,* 2008). Hence, the present study was planned to find out the response of foliar application of different nutrients on seed cotton yield and different physiological parameters.

An experiment was conducted during *kharif,* 2011 at Research Farm of Cotton Section, CCS Haryana Agricultural University, Hisar on *Bt* cotton RCH 134 in a randomized block design with 3 replications having row to row and plant to plant spacing 67.5 x 60 cm. Plant density was 2/sq m from emergence to last picking and 2 seeds were sown/hill. The observations were recorded on 11 morphological and physiological parameters at crop maturity level in the first week of November. Recommended package and practices were followed in growing healthy crop. Effect of various treatments on height (at maturity) with 10 treatments with different nutrient combination *i.e.* T_1 (Control), T_2 (Water spray), T_3 (Urea spray @ 2%), T_4 (DAP @ 2%), T_5 (MOP @ 2%), T_6 ($MgSO_4$ @ 1%), T_7 (Urea @ 2% + DAP@ 2% alternate spray), T_8 (Urea @ 2% + DAP @ 2% + $MgSO_4$ @ 1% alternate spray), T_9 (Urea @ 2% + DAP @ 2% + MOP @ 2% alternate spray) and T_{10} (KNO_3 @ 1%) chlorophyll content (at 95 DAS by Single Photon Avalanche Diode, from the fourth leaf by SPAD 502 Plus model), bolls/plant, boll weight, yield/plant, seed cotton yield, excised leaf water loss (ELWL) was recorded. Excised leaf water loss was computed by the formula:

$$\text{ELWL} = \frac{\text{Fresh weight} - \text{weight after 6 h}}{\text{Fresh weight} - \text{dry weight}} \times 100$$

Observations on gas exchange parameters *viz.* transpiration rate of water (mmol/m/s), rate of assimilation of CO_2 (μmol m/s), stomatal conductance (mol/m/s) and intercellular CO_2 (ppm) was also determined from the fourth leaf from the top at 100DAS using an open system LCA-4 ADC portable infrared gas analyzer (Analytical Development Company, Hoddeson, England) in morning.

The experiments results revealed that there was significantly higher seed cotton yield and bolls/plant in T_6, T_8 alternate spray and T_{10} as compared to control and other treatments (Table 1). There was significant difference in responses to foliar applications of mixed fertilizers "cocktails" to cotton. The growth and yield of cotton depends strongly upon the availability of nitrogen because N is involved in numerous fundamental processes such as protein synthesis, photosynthesis, carbon partitioning, as well as enzyme and hormonal activity (Oosterhuis, 2001). Brar and Tiwari (2004) reported an increase in the yield of cotton by 22, 27 and 36 per cent by foliar application of KCl, urea and KNO_3, respectively. Furthermore, Hodgson and MacLeod (2006) also reported proportionate increase in the yield of cotton (2.8, 5.9, 8.4 and 10.5 kg/h) due to foliar spray of nitrogen. Similarly, foliar spray of KNO_3 on cotton crop resulted in additional yield and reduced boll shedding. (Brar *et al.,* 2008 and Rajendran *et al.,* 2010). The foliar application of urea (2%) + DAP (2%) + $MgSO_4$ (1%) given at boll formation stage also reduced the leaf reddening in *Bt* cotton. Jabeen and Ahmad (2011) reported that foliar supply of KNO_3 to the salt treated plants may reduce toxic ions uptake as well as improve K and N status of salt treated plants. Thus, supply of essential mineral elements as foliar spray (nitrogen, potassium) contributed towards an increase in growth (Jabeen and Ahmad, 2009). The developing fruit load (the sink) has a high requirement for nutrients, N, P and K in particular, and this demand is not always completely met by the soil especially when adverse conditions occur, and as root growth declines. To prevent square drop, improving boll setting, enhance boll development and boll weight, for improving lint quality and pest and

Table 1. Effect of foliar spray of nutrients on yield and yield components of cotton (RCH 134 *Bt*)

Treatment	Bolls/ plant	Boll weight (g)	Yield/ plant (g)	Seed cotton yield (kg/ha)
T_1	42.0	2.92	121	2562
T_2	45.0	3.04	135	2808
T_3	47.0	3.02	142.1	2901
T_4	46.3	3.00	137.5	2870
T_5	45.0	3.13	141.0	2870
T_6	52.0	2.91	148.4	3086
T_7	48.0	2.86	138.0	2916
T_8	54.0	2.83	152.0	3132
T_9	48.6	2.89	141.2	2932
T_{10}	52.0	2.83	146.7	3055
P=0.05	2.2	0.09	5.4	112

disease tolerance, potassium (K) application in association with nitrogen and magnesium had proved efficient. As cotton boll numbers increased and bolls enlarged, there is a tremendous translocation demand on potassium (K) in the leaves adjacent to each boll. Reddy *et al.*, (2004) and Read *et al.*, (2006) stated that increase in boll weight may be contributed by additional potassium nutrition along with nitrogen. Furthermore, foliar application of potassium showed significant increase in number of bolls, boll weight and yield/plant and ginning outturn percentage (Waraich *et al.*, 2011). Phosphorus uptake could not occur without magnesium and *vice versa*. So, magnesium is essential for phosphate metabolism, plant respiration and the activation of several enzyme systems. Highest assimilation rate and internal CO_2 concentration was recorded in T_{10} (Table 2). As, it has been established that all plant nutrients are absorbed through the leaves of plants and absorption is remarkable rapid for some nutrients. For plant height there were no significant differences amongst various treatments (Table 3).

Maximum chlorophyll content was recorded in T_8 as compared to all other treatments (Table 3). Increase in leaf chlorophyll was related to raising N, Mg, and Fe in leaves. These elements have key roles in chlorophyll structure and synthesis. Leaf chlorophyll was in relation with leaf nitrogen, because photosynthetic proteins comprised more than half of leaf nitrogen. The role of potassium in ionic

Table 2. Effect of foliar spray of nutrients on various photosynthetic parameters of cotton (RCH 134 *Bt*)

Treat-ment	Assim-ilation (µmol m/s)	Trans-piration (µmol m/s)	Internal CO_2 (ppm)	Stomatal condu-ctance (molm/s)	WUE
T_1	3.01	0.67	199.67	0.4	4.49
T_2	3.63	0.58	232.00	0.4	6.26
T_3	4.64	0.53	207.67	0.3	8.75
T_4	2.41	0.37	244.33	0.2	6.51
T_5	4.02	1.11	233.67	0.6	3.62
T_6	3.33	0.87	212.33	0.5	3.83
T_7	3.63	0.93	212.33	0.5	3.90
T_8	5.56	0.60	151.00	0.3	9.27
T_9	2.81	0.92	189.67	0.4	3.05
T_{10}	3.10	0.89	192.67	0.3	3.48
P=0.05	0.294	0.108	6.197	N.S.	

Table 3. Effect of foliar spray of nutrients on various physiological parameters of cotton (RCH 134 Bt)

Treatment	Height (cm)	Chlorophyll content (SPAD %)	ELWL (%)
T_1	154.44	17.77	14.07
T_2	156.11	15.43	15.19
T_3	175.00	15.40	14.53
T_4	168.33	15.33	16.89
T_5	171.11	18.03	13.75
T_6	178.00	19.73	17.04
T_7	172.22	16.57	13.89
T_8	169.17	15.73	16.03
T_9	165.00	22.90	18.52
T_{10}	162.78	17.47	19.76
P=0.05	N.S.	3.71	3.78

balance is reflected in nitrate metabolism. Spray with potassium resulted in an increase in leaf potassium content which was accompanied by increased rates of photosynthesis, photorespiration and RuBP carboxylase activity. Photorespiration is beneficial, because the reutilization of CO_2 could be done which allowed better crop growth and yield. Hence there was considerable improvement in growth even under saline conditions. The results of present investigation are in agreement with the findings of many workers. Treated leaves contained higher element concentration as compared to non sprayed plants even under saline condition. Application of the high K rate combined with Zn and/or P application increased dry matter yield of cotton plants (shoots) at 105 days after sowing, as well as K, Zn and P content as well as total chlorophyll concentration, over that obtained with the high K rate or Zn and/or P alone. Favorable effects on cotton productivity and quality accompanied the application of high K rate, Zn and P (Sawan *et al.*, 2008). Excised leaf water loss (ELWL) an indication of transpiration rate was significantly higher in T10 and T9. It is known that potassium increased the guard cell turgidity resulting in opening of stomata which may result in higher transpiration rate.

It can be concluded that the higher seed cotton yield obtained due to higher number of bolls/plant and higher assimilation rate in T_8, T_6 and T_{10}. Combined effects were more significant.

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