Research Article Open Access

Response of Cotton to Foliar and Soil Applied Nutrients under Dera Ghazi Khan Conditions

Faiz Karim[1,*], Javed Iqbal[2], Muhammad Shabbir[1], Shuaib Kaleem[1], Masood Qadir Waqar[3]

[1]Adaptive Reesearch Farm, Dera Ghazi Khan, Pakistan.
[2] Department of Agronomy, Ghazi University, Dera Ghazi Khan, Pakistan.
[3] DAdaptive Research Punjab, Lahore, Pakistan.

Article History
Received
November 23, 2015

Published Online
March 31, 2016

Keywords:
Cotton,
Macronutrient,
Macronutrient,
Foliar Application

Abstract: A field research was conducted to investigate the response of foliar applied NPK (20:20:20), zinc (Zn) and boron (B) at different farmer fields to check the response of cotton crop under different agro-ecological conditions of Dera Ghazi Khan. Three treatments of foliar application including NPK (20: 20: 20 %) @ 625 g ha^{-1}, Zn as zinc sulphate (35 %) @ 500 g ha^{-1}, B as boric acid (17 %) @ 500 g ha^{-1} and control (227:87:92 kg ha^{-1} NPK) were analyzed. Availability of different nutrients influenced growth yield and quality traits of cotton. Foliar applied NPK fertilizer was helpful in gaining the highest number of bolls per plant (26.72), boll weight (2.31 g) and seed cotton yield (3873 kg ha^{-1}). In summary, foliar application of NPK nutrients seemed to be helpful for maintaining the good crop stand at all the locations under study of Dera Ghazi Khan.

***Corresponding authors:** Faiz Karim**:** mfaizkarim@gmai.com

Cite this article as: Karim, F., J. Iqbal, M. Shabbir, S. Kaleem, M.Q. Waqar. 2016. **Response of cotton to foliar and soil applied nutrients under Dera Ghazi Khan conditions.** *Journal of Environmental & Agricultural Sciences*. 7:14-18.

1. Introduction

Cotton is major kharif crop of Pakistan with 12.8 million bales production during 2014. Its share in GDP is 1.4 % (Economic Survey of Pakistan 2014). The average yield of cotton in Pakistan is very low as compared to the potential yield due to many factors. Imbalanced use of fertilizers is one of the key factors reducing the yield of cotton crop. Many farmers are not aware with the use of micronutrients which ultimately affects the yield. Extensive farming of crops with high micronutrient demands on alkaline calcareous soils that are low in organic matter has made Pakistan's soils deficient in Zn and B with localized deficiency in micronutrients (Jiskani, 2011). Adequate levels of micro- and macroinorganic nutrients are required for optimal growth (Ahmad et al., 2011). The scarcity of any nutrient in the soil can be a barrier to growth, even when all other nutrients are in excess in the soil (Soleymani and Shahrajabian, 2012).

The field scale deficiency of these nutrients in Pakistan has hampered seed-cotton productivity during the last decade (Ali, 2012) and it is predicted to get worse in the future. Soil application of Zn and B on calcareous soils is less efficient, as these nutrients remain inaccessible to plant roots due to the higher soil pH (Sajid et al., 2008). However, an alternative approach under such circumstances is foliar application of these nutrients (Rab and Haq, 2012). Foliar application of nutrients is highly beneficial, as crop benefits are achieved when the roots are unable to meet the nutrient requirement of the crop at a critical stage (Ebelhar and Ware, 1998).

Foliar N fertilization of cotton is a widely used production practice to augment soil-applied N fertilization programs (McConnell et al., 1998). In our soil, large amount of micro nutrients is present but deficiency cases happen due to the less accessibility to plants. Less availability of micro nutrients to plants is due to soil conditions and agronomic activities in Pakistan (NFDC, 1998). Deficiency of these nutrients influenced vegetative parts and resulted low crop yield (Tisdal and Nelson, 1993). Low levels of Zinc and Boron are reported in Pakistan and deficiency of some other nutrients is expected to occur in near future (Rashid, 1996). Soil application, foliar spray and fertigation are main application methods to prevail over the deficiency of these nutrients. Foliar spray is an efficient and economical practice due to uniform application and rapid response among these practices (Howard et al., 2000). All the micronutrients are antagonistic in their

behaviors with each other. Keeping the above review, it is hypothesized that foliar spray of NPK 20:20:20, Zinc sulphate 33% and Boric acid 17% can be helpful increasing growth, yield and quality characters of cotton in combination with basal dose of NPK.

2. Materials and Methods

Field experiments were conducted at different farmer's fields to check the response of foliar application of NPK 20: 20:20, Zn and B on cotton crop under agro ecological conditions of Dera Ghazi Khan zone in 2014. The experiment was conducted in three different sites and experiment was la Randomized Complete Block Design with four treatments and three replications. Field experiments were conducted in Qaim wala (Tehsil D.G.Khan) in Malana (Tehsil Kot Chuta) and in Talai Wala (Tehsil Jampur). Foliar spray applied at 75, 90 and 105 DAS in following treatments.

T_1: control (227:87:92 kg ha^{-1} NPK) Recommended dose soil applied

T_2: control + NPK 20:20:20 @ 625 g ha^{-1}

T_3: control + ZnSo4 33% @ 500 g ha^{-1}

T_4: control + Boric Acid 17 % @ 500 g ha^{-1}

Cotton variety MNH 886 was sown by chopa method on May, 2014. Data on plant height leave size, number of leaves per plant and leaf dry weight was taken. Crop was harvested and data on number of bolls, boll weight and yield was recorded. Crop was harvested at different pickings on September 8, October 14 and November 3, 2014. Fiber quality parameters were checked in Textile Laboratory, D.G.Khan,Pakistan.

Standard procedures were used for data collection on different growth, yield and fiber quality parameters. Data were subjected to analysis of variance using the MSTATC statistical software. Duncan's Multiple Range test (DMRT) was used to compare means at 5% probability level(Anonymous, 1986).

3. Results and Discussion

3.1 Growth Traits

Table1 reveals that plant height, number of leaves per plant, leaf area and leaf dry weight were increased significantly by the foliar spray of various nutrients with half of NPK fertilizer applied as a basal dose. Plant height at maturity was increased in all the treatments significantly as compared to control. T_2 (control + NPK 20:20:20 @ 625 g ha^{-1}) gave 135.22 cm plant height with 8.95 % increase followed by $ZnSO_4$ 33% and Boric Acid 131 and 127.22 cm with 6.02 and 3.23 % respectively in all three sites on average as compared to control of 123.11 cm plant height. These results are in agreement with those reported by Ahmed et al. (2006). Moreover number of leaves per plant were also increased by foliar spray of various nutrients in all treatments at three locations. maximum number leaves (37.66) were obtained by the foliar spray of NPK 20:20:20 with 22.39 % increase followed by ZnSo4 and boric acid (35.44 and 33.55) with 5.17 % and 9.03 % increase over control 30.77. This increase is due to more production of photosynthesis in leaves which give rise to more no of leaves by all nutrients. These results are in lines with the findings of Pettigrew (2008) who reported that potassium deficiency can lead to a reduction in both number of leaves and area of individual leaves. Leaf area in all the treatments was significantly increased as compared to control in all three sites. Large (39.77 cm) was measured in treatment with foliar spray of NPK 20:20:20 followed by zinc sulphate foliar spray (37.55 cm) and Boric acid foliar spray (36.44 cm) as compared to control (34.88 cm) on an average in all three sites. The highest increase in leaf area is 12 % over control by foliar spray of NPK 20:20:20 which at par with 7.65 % and 4.47 % increase in leaf by foliar spray of Zinc sulphate. Boric acid. Pettigrew (2008) summarized that potassium deficiency can cause reduction in both number of leaves and area of individual leaves dry weight of leaves in all the treatments was significantly influenced by foliar application of various nutrients. More dry weight (19.27 g) was weighed in the treatment where foliar spray of NPK 20:20:20 was applied. It was at par with dry weight (17.22 and 16.63 g) increased by foliar spray of zinc sulphate and Boric acid as compared to control (15.62 g). this increase in dry weight by foliar spray of NPK 20:20:20, Zinc sulphate and Boric acid is 23.36, 10.24 and 6.46 % as compared to control. These results are in agreement with those reported by Ahmed et al. (2006) and Zakaria et al. (2011)

3.2 Yield Traits

Table 2 revealed that the foliar spray of NPK 20:20:20 produced maximum number of bolls per plant 26.72 and gave 10.68 % increase with respect to zinc sulphate 33 % and boric acid 17 % (25.83 and 25.16) with 6.17 and 4.22 % increase over control (24.14) in three sites on average. This increase in number of bolls is due to the better use of all three macro nutrients NPK in well grind and soluble form. When this media is applied directly on leaves, the photosynthetic activity is increased.

Table. 1: Growth of cotton crop as influenced by the foliar application of various nutrients under agro ecological conditions of Dera Ghazi Khan.

Treatments	Qaim wala				Notak				Talai wala				Average			
	Plant height (cm)	No of leaves	Leaf area (cm)	Leaf dry weight (g)	Plant height (cm)	No of leaves	Leaf area (cm)	Leaf dry weight (g)	Plant height (cm)	No of leaves	Leaf area (cm)	Leaf dry weight (g)	Plant height (cm)	No of leaves	Leaf area (cm)	Leaf dry weight (g)
T_1	120.7 c	31.0 c	35.0 c	15.5 c	123.0 d	29.66 c	34.0 c	15.3 d	125.7 d	31.7 c	35.7 d	16.1 d	123.1	30.8	34.88	15.6
T_2	129.0 a	37.6 a	39.0 a	19.4 a	135.7 a	36.33 a	39.0 a	18.8 a	141.0 a	39.0 a	41.3 a	19.7 a	135.2	37.7	39.77	19.3
T_3	125.0 b	36.3 b	38.0 ab	16.2 b	131.7 b	33.0 b	36.3 b	17.3 b	136.3 b	37.0 b	38.3 b	18.4 b	131.0	35.4	37.55	17.2
T_4	122.3 c	34.3 c	36.3 bc	16.0 b	128.3 c	31.00 c	36.3 b	16.5 c	131.0 c	35.3 b	36.7 c	17.2 c	127.2	33.6	36.44	16.6

Table. 2: Yield triats of cotton crop as influenced by the foliar application of various nutrients under agro ecological conditions of Dera Ghazi Khan.

Treatms	Qaim wala			Notak			Talai wala			Average		
	No of bolls	Boll weight	Yield	No of bolls	Boll weight	Yield	No of bolls	Boll weight	Yield	No of bolls	Boll weight	Yield
T_1	25.25 d	2.19 d	3558 d	24.03 d	2.27 d	3419d	23.15 d	2.25 d	3751 d	24.14 d	2.24 d	3576 d
T_2	28.23 a	2.27 a	3827 a	26.32 a	2.34 a	3728 a	25.62 a	2.31 a	4065 a	26.72 a	2.31 a	3873 a
T_3	26.96 b	2.23b	3734 b	25.75 b	2.31 b	3640 b	24.78 b	2.29 b	3967 b	25.83 b	2.28 b	3780 b
T_4	26.35 c	2.22 c	3660 c	25.16 c	2.29 c	3547 c	24.37 c	2.28 c	3885 c	25.16 c	2.26 c	3697 c

Table.3: Fiber quality attributes of cotton crop as influenced by the foliar application of various nutrients under agro ecological conditions of Dera Ghazi Khan.

Treatments	Qaim wala			Notak			Talai wala			Average		
	Fiber length	Fiber finess	Fiber strength	Fiber length	Fiber finess	Fiber strength	Fiber length	Fiber finess	Fiber strength	Fiber length	Fiber finess	Fiber strength
T_1	27.10 d	4.82 c	27.40 d	27.17 d	4.55 d	27.21 d	27.083 d	4.72 d	27.38 d	27.11	4.843	27.33
T_2	28.14 a	5.03 a	28.62 a	28.48 a	4.98 a	28.72 a	28.847 a	5.16 a	28.97 a	28.48	4.99	28.77
T_3	27.70 b	4.97 ab	27.76 c	27.69 b	4.82 b	28.09 b	27.933 b	4.96 b	27.97 b	27.77	4.88	27.94
T_4	27.45 c	4.96 b	27.96 b	27.45 c	4.72 c	27.69 c	27.547 c	4.86 c	27.70 c	27.48	4.80	27.78

The ready availability of NPK nutrients promotes better utilization for yield components. Boron deficiency in cotton may cause small, deformed bolls; poor fruit retention; and reduced lint yields (Roberts et al., 2000). Dewdar and Raddy (2013) concluded 13.72 % increase in number of bolls with 2% K_2O foliar application two times at early and peak boll formation stage as compared to control.

Experiments conducted at three sites depicted that all the treatment were significantly at par with control. T_2 (control + NPK 20:20:20 @ 625 g ha^{-1}) showed maximum boll weight (2.31 g) with 3.12% increase followed by T_3 : (control + ZnSo4 33% @ 500 g ha^{-1}) and boric T_4: (control + Boric Acid 17 % @ 500 g ha^{-1}) (2.28 and 2.26) with 1.78 % and .89 % increase on an average basis as compared to control 2.24 g.

Bednarz and Oosterhuis (1996) reported that modern cotton cultivars have higher yields and bigger boll loads but less K in storage prior to boll development, which could account for unpredictable appearance of premature senescence. Potassium is required in larger amounts than any other mineral element except nitrogen, but in crops like cotton particularly during the boll formation period, potassium uptake is more than that of nitrogen. These results are in agreement with the conclusions of Dewdar and Raddy (2013) who reported 15.67 % increase in boll weight with 2 % K_2O application as compared to control.

3.3 Fiber Quality Traits

Results depicted that the application of NPK 20:20:20 at early and peak flowering stage (60 and 75 DAS) caused higher values as compared to other treatments Table 3. Maximum fiber length 28.48 mm was measured by foliar application of NPK 20;20;20 with 5% increase with reverence to Zinc sulphate and boric acid 27.77 and 27.48 mm at 2.43 and 1.36 % increase respectively as compared to control 27.11. This shows that the foliar application of NPK 20;20;20 influenced more on fiber length as compared to Zinc sulphate and Boric acid. These findings are line with the results of Kumar et al. (2011) and Aladakatti et al. (2011) who indicated the improvement in fiber length by the foliar application of K. Fiber fineness of cotton crop was also influenced by the foliar spray of all nutrients applied. Highest value (4.99) of NPK 20;20;20 with 6.39 % increase followed by zinc sulphate 33% and boric acid (4.88 and 4.84) with 4 and 3.19 % respectively on average basis in three sites. Fiber fineness influenced by the foliar application; of K. is due the well supply of Potassium and other nutrients at flowering time. Kumar et al. (2011) and Aladakatti et al. (2011) reported that the improvement in fiber length, fiber fineness and fiber strength is attributed to foliar application of K at flowering. Fiber strength of cotton crop at all three sites was increased by foliar feeding of nutrients significantly. More fiber strength 28.77 was observed by foliar spray of NPK 20;20;20 with 5.26 % increase as followed by zinc sulphate 33% and boric acid 17 % (27.94 and 27.78) with 2.23 and 1.64 % increase with respect to control 27.33 in all three sites on average basis. This might be due to the better photosynthetic rate; better translocation of nutrients. These results are in agreement with findings of Aladakatti et al. (2011) who reported that the improvement in fiber strength is attributed to foliar application of K at flowering.

4. Conclusion

Cotton plants when supplied NPK basal dose with NPK foliar applied increased growth, yield and quality traits as compared to control (Basal dose only) in Dera Ghazi Khan, reason behind may the foliar applied NPK in combination showed synergistic effect on cotton production.

Acknowledgement: Authors sincerely acknowledge valuable guidance from Dr. Muhammad Faisal Bilal (Assistant Professor), Department of Agriculture, Government College University Faisalabad Layyah Campus, Layyah, Pakistan, to improve this research paper.

Competing Interests: The authors declare that there is no potential conflict of interest.

References

Ahmad, I, M. Asif, A. Amjad and S. Ahmad. 2011. Fertilization enhances growth, yield, and xanthophyll contents of marigold. Turk. J. Agric. Forest. 35: 641–648.

Ahmed, G.A., M.S. Hassanein and M.M. El- Gazzar. 2006. Growth and yield response of two wheat cultivars to complete foliar fertilizer compound "Dogoplus". Egypt. J. Appl. Sci. Res. 2(1):20-26.

Aladakatti, Y.R., S.S. Hallikeri, R.A. Nandagavi, N.E. Naveen, A.Y. Hugar and D. Blaise. 2011. Yield and fiber qualities of hybrid cotton (*Gossypium hirsutum*) as influenced by soil and foliar application of potassium. Karnataka J. Agric. Sci. 24(2):133-136.

Ali, E.A. 2012. Effect of iron nutrient care sprayed on foliage at different physiological growth stages on yield and quality of some durum wheat (*Triticum durum* L.) varieties in sandy soil. Asian J. Crop Sci. 4: 139–149.

Anonymous. 1986. MSTATC. Microcomputer Statistical Programme. Michigan State University, Michigan, Lansing, USA.

Bednarz, C.W. and D.M. Oosterhuis. 1996. Partitioning of potassium in the cotton plant during the development of a potassium deficiency. J. Plant Nutr. 19: 1629-1638.

Dewdar M. D. H. and M. M. Rady. 2013. Influence of soil and foliar applications of potassium fertilization on growth, yield and fiber quality traits in two *Gossypium barbadense* L. varieties. Afr. J. Agric. Res.. 8(19): 2211-2215.

Ebelhar, M.W. and J.O. Ware. 1998. Summary of cotton yield response to foliar applications of potassium nitrate and urea, In: Proceedings of 1998 Beltwide Cotton Production Research Conference, National Cotton Council of America, Memphis., p. 683-687.

Govt. of Pakistan. 2014. Economic Survey of Pakistan, Ministry of Finance, Govt. of Pakistan. p. 26-27 available online, http://www.finance.gov.pk/survey_1213.html

Howard,D.D., M.E. Essington, C.O. Gwathmey and W.M. Percell. 2000. Buffering of Foliar Potassium and Boron Solutions for No-tillage Cotton Production. J. Cotton Sci. 4:237-244.

Jiskani, M, 2011. Imbalanced nutrition causes a-biotic and increases biotic disease in crops. URL:http://www.pakissan.com/english/allabout/farm inputs/fertilizers/imbalanced.nutrition.causes.shtml

Kumar J, K.C. Arya, M.Z. Sidduqe. 2011. Effect of foliar application of KNO_3 on growth, yield attributes, yield and economics of hirsutum cotton. J. Cotton. Res. Dev. 25(1):122-123.

McConnell, J.S., W.H. Baker and R.C. Kirst Jr. 1998. Yield and petiole nitrate concentrations of cotton treated with soil-applied and foliar-applied nitrogen. J. Cotton Sci. 2:143-152.

NFDC. 1998. Micronutrients in agriculture: Pakistan Perspective. Status Report, NFDC publication No. 4/98, Islamabad..

Pettigrew, W.T. 2008. Potassium influences on yield and quality production for maize, wheat, soybean and cotton. Physiol. Plant. 133(4):670-681.

Rab, A., and I. Haq. 2012. Foliar application of calcium chloride and borax influences plant growth, yield, and quality of tomato (*Lycopersicon esculentum* Mill.) fruit. Turk. J. Agric. Forest. 36: 695–701.

Rashid, A. 1996. Nutrient indexing of cotton in Multan district and boron and zinc nutrition of cotton. Micronutrient: Project Annual Report 1994-1995. NARC, Islamabad. p: 76.

Roberts, R.K., J.M. Gersman and D. D. Howard. 2000. Soil- and Foliar-Applied Boron in Cotton Production: n Economic Analysis. J. Cotton Sci. 4:171-177.

Sajid, A., A.R. Khan, G. Mairaj, M. Fida and S. Bibi. 2008. Assessment of different crop nutrient management practices for yield improvement. Aust. J. Crop Sci. 2: 150–157.

Sekhon, N. K. and S. B. Singh. 2013. Plant nutrient status during boll development and seed cotton yield as affected by foliar application of different sources of potassium. Am. J. Plant Sci. 4(7):34324.

Soleymani, A., M.H. Shahrajabian. 2012. The effects of Fe, Mn and Zn foliar application on yield, ash and protein percentage of forage sorghum in climatic condition of Esfahan. Int. J. Biol. 4-3: 92-96.

Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J.L. 1993. Soil fertility and fertilizers. 5th Ed. Macmillan Publishing Company, New York, USA.1993.

Zakaria, M.S., M.H. Mahmoud, A.H. El-Guibali. 2011. Influence of potassium fertilization and foliar application of zinc and phosphorus on growth, yield components, yield and fiber properties of Egyptian cotton (*Gossypium barbadense* L.). J. Plant Ecol. 1(4):259-270.