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Research Article

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Effect of soil and fertigation K application on the growth and yield of cotton (*Gossypium hirsutum* L.) under agro-climatic conditions of Bahawalnagar, Pakistan

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Keywords

Gossypium hirsutum; methods of K application, yield and yield components; Pakistan.

Abstract

A field experiment was conducted at farmer's field sites of Bahawalnagar district to study the response of cotton variety FH-142 to different methods of K application i.e. T_1.Soil application of K (recommended) i.e. 92 kg ha^{-1},T_2Fertigation of K after 30, 45, 60 and 75 days of sowing (15 days interval)and T_3Fertigation of K after 30, 37, 44, 51, 58, 65 and 72 days of sowing (7 days interval) on the yield and yield components during the year 2017 and 2018. The experiment was laid out in randomized complete block design with three replications. The results of Kharif 2017 revealed that T_3 proved as the best balanced fertilizer dose for higher seed cotton yield(2245 kg/ha) with higher number of bolls (28.2/plant) and boll weight (2.74g) followed by seed cotton yield (2165 kg ha^{-1}) , number of bolls (24.8/plant) and boll weight (2.53g) obtained with T_2 as against the minimum seed cotton yield of 2060 kg ha^{-1}, number of bolls (22.2/plant) and boll weight (2.23g) obtained with T_1. The trend of data of Kharif 2018 and Kharif 2017was statistically similar. The mean data indicated significant relationship (R^2=0.92,0.99) among boll number, boll weight and seed cotton yield during the year 2017-18. For sustainable cotton production, cotton growers may need to make split soil fertility programs with fertigation of potash except soil application.

Introduction

Cotton (*Gossypium hirsutum* L.) is a strategic crop to sustain economy of Pakistan. The country stands 4th largest producer, 3rd largest exporter, 4th largest consumer of cotton in the world. [1]

It contributes more than 60 percent to total foreign exchange earnings and about 8.5 percent to domestic edible oil needs (Anon. 2001). Despite this fact, the productivity of cotton is far low compared to other cotton producing countries.

In Pakistan cotton growers use a desirable amount of N (125 kg/ha) but use of K is negligible (0.7 kg/ha) (Reddy *et al.,* 2000). The less use of K fertilizer in cotton may have serious consequences. Cotton appears to be more sensitive to K deficiencies than many other crops, as the root system of cotton is less dense than that of other crops (Steel *et al.,* 1997, Topper *et al.,* 1992, Abdul-Malak *et al.,* 1996, Mithaiwala *et al.,* 1981). Nevertheless, the very low efficiency of the soil K application (20%) calls for an alternative approach of K fertilization practice, such as splitting the dose into several applications during the season. Potassium is one of the most important elements in plant nutrition. All living organisms require its large amounts for normal growth and development. Biochemical pathways in plants are attributed to the role of K. Potassium increases the photosynthetic rates of crop leaves, CO2 assimilation and facilitates carbon movement (Saleem, 2002). The experiments conducted in Indian Punjab showed that cotton crop absorbed a large quantity of potassium indicating that it was more than both nitrogen and phosphorus intake (Brar *et al.,* 1987). The trend of potassium removal by cotton crop indicates its heavy drain from Pakistani soils. The exploitation of soils is likely to lead to severe depletion of potassium which would eventually limit the efficiency of other nutrients (Malavolta, 1985). Malik *et al.,* 1989 reported that cotton crop could benefit from higher dosesof potassium fertilizers when applied at different times after sowing. This may be attributed to equilibria between various forms of potassium and degree of potassium fixation in soil (Mengel, and Kirby, 1982).Abd El-Mohsen *et al*.,(2015) investigated that the application of recommended dose of mineral N and K fertilizer (70 kg N fed^{-1} and 24 kg K_2O fed^{-1}) gave the highest values of plant height, number of open bolls $plant^{-1}$, boll weight, seed index, lint %, seed cotton yield $plant^{-1}$ and seed cotton yield fed^{-1}. Fertigation K applications in splits is instrumental in correcting nutrient deficiencies during the reproductive phase, whenever required. Thus, the potential of K fertilizers to enhance cotton production has been clearly demonstrated but is still far from being fully exploited. To maintain profitable production, cotton producers may need to change from traditional soil fertility programs to Fertigation K applications in splits. Optimal NPK fertilization is an important consideration for harvesting higher cotton yield, but farmers usually overuse nitrogenous fertilizer along with insufficient dose of phosphorus and potash. It is established fact that optimum nutritional requirement of cotton is of primary importance to boost its production. The mineral nutrition of cotton depends on both the cotton root's ability to explore the soil and ability to supply N, P and K nutrients on the soils *(Bisson et al, 1994). Soil* tests carried out in Pakistan showed a general lack of N, a wider spread deficiency of P and an occasional deficiency of K (Wahhab, 1985). Potassium fertilization increased cotton yield by 9% in 2 yr. of a 3-yr. study (Pettigrew, 2003).

Potassium has been recognized as an important plant nutrient in cotton because of its high uptake rate and the relative efficiency of cotton as a K absorber (Kerby and Adams, 1985). An adequate K supply is crucial throughout the period of cotton growth and development (Makhdum et al., 2007) mainly due to its vital role in: biomass production (Zhao et al., 2001); enzyme activation; sucrose transport; starch and fat/oil synthesis; leaf area expansion; carbon dioxide (CO2) assimilation (Reddy et al., 2004); photosynthesis; leaf pressure potential; transpiration and water use efficiency (Pervez et al., 2004); boll weight and size; and lint yield (Akhtar et al., 2003). The need for K increases dramatically when bolls are set on the plant because they are the major sink for K (Leffler and Tubertini, 1976). The total K quantity taken up by the plant is related to the K available from soil and fertilizer (Kerby and Adams, 1985). Gormus (2002) reported that splitting K applications decreased yields and boll weight as compared with applying the whole rate. Keeping in view the significance of cotton in Pakistan, this study was conducted to see cotton response to soil and fertigation K application on the growth and yield of cotton.

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Materials and Methods

The experiment was conducted at farmer's field of Adaptive Research station Bahawalnagar in the first week of May during 2017and 2018to assess the response of cotton (cv. FH-142) to three treatments i.e. T_1.Soil application of K (recommended) i.e. 92 kg ha^{-1},T_2 Fertigation of K after 30, 45, 60 and 75 days of sowing (15 days interval) and T_3Fertigation of K after 30, 37, 44, 51, 58, 65 and 72 days of sowing (7 days interval) with recommended NP 170-114 kg ha^{-1}. The experiment was laid out in RCBD with three replications. Soil sample were collected before planting crop from the experimental sites and analysis carried out as per method (Ryan et al. (2001). The soil of the experimental sites was clay loam with alkaline pH(8.3), 0.74% organic matter, 0.047% N, 4.8ppmavailable phosphorous & 141 ppm available potash. The values demonstrated that soil was medium textured, alkaline in reaction, free of excessive soluble salts, low in organic matter, nitrogen and phosphorus. The potassium level was inadequate to harvest an economic yield. Cotton variety FH-142 was sown on a well prepared seed bed at 75 cm row to row and 22.5 cm plant to plant distances. Full dose of P_2O_5 114 kg ha^{-1} as single superphosphate was applied at planting and K as sulphate of potash was applied according to treatments and 170 kgN as urea was used in three equal splits. Pre-emergence weedicide i.e. pendimethaline and acetachlore @ 2.5 and1.25 lha^{-1} was applied to eradicate weeds. All required agronomic practices and plant protection measures were carried out accordingly. The seed cotton was harvested plot wise and finally converted into kg per hectare. Ten plants from each treatment were selected at random for counting number of bolls per plant and 25 bolls were collected from each treatment to measure boll weight. The average maximum temperature (44.7 C and 45.8ºC), minimum temperature (28.7°C and 29.45ºC) and total rainfall (104 mm and 76 mm), during 2017 and 2018, respectively were recorded during the crop growth period. The data on yield and yield components were subjected to statistical analysis and treatment differences were determined using LSD (Gomez and Gomez. 1984).

Results and Discussion

The results (Tables 1) revealed that seed cotton yield and its components varied significantly ($p<0.05$) with soil and fertigation K applicationduring 2017.

TABLE 1: Effect of soil and fertigation K application on the seed cotton yield in the agro-climatic conditions of Bahawalnagar during kharif 2017

Tr. No.	Treatments	No. of bolls $plant^{-1}$	Boll weight(g)	Yield (kg ha^{-1})
T_1	Soil application of K i.e. 92 kg $ha-^1$,with recommended NP 170-114 kg $ha-^1$	22.2C	2.23C	2060C
T_2	Fertigation of K after 30, 45, 60 and 75 days of sowing (15 days interval), with recommended NP 170-114 kg $ha-^1$	24.8B	2.53B	2165B
T_3	Fertigation of K after 30, 37, 44, 51, 58, 65 and 72 days of sowing (7 days interval) with recommended NP 170-114 kg $ha-^1$	28.2A	2.74A	2245A
	LSD	1.86	0.15	21.2

Means not sharing a common letter in column are significant at 5% probability level.

Maximum seed cotton yield (2245kg ha^{-1}) during kharif 2017 (table 1) was obtained from T_3 i.e. Fertigation of K after 30, 37, 44, 51, 58, 65 and 72 days of sowing (7 days interval) with recommended NP 170-114 kg ha^{-1}followed by seed cotton yield 2165kg $ha^{-1}$from T_2as against the minimum seed cotton yield of 2060kg ha^{-1}obtained from T_1.The similar trend was observed with respect to boll weight and no. of bolls /plant during 2017.

Soil and fertigation K application in split also influenced number of bolls, boll weight and seed cotton yield significantly ($p<0.05$) during 2018. The results in Table 2behaved similarly with the results of Kharif 2017 and depicted thatT_3i.e. Fertigation of K after 30, 37, 44, 51, 58, 65 and 72 days of sowing (7 days interval) with recommended NP 170-114 kg ha^{-1}proved to be better in seed cotton yield(1993 kg/ha) , number of bolls/plant(22.4) and boll weight(3.21 g) followed by the seed cotton yield of 1918 kg ha^{-1}, no of boll.20.6/plant and boll weight 3.07 g in T_2 as against the minimum seed cotton yield of 1794 kg ha^{-1}, number of bolls 20.4/plant and boll weight 2.63 g with T_1. The results of Kharif 2017 were proved to better than Kharif 2018 due to higher number of bolls in relation to lesser temperature as compared to that of 2018. Significant relationship (R^2=0.92) was revealed between bollnumber and seed cotton yield (Fig.1) elucidated that seed cotton yield was linearly increased with increase in boll number. It was explained that seed cotton yield was linearly increased with increase in boll weight as significant relationship (R^2=0.99) indicated in Fig. 2. The same trend of results was observed in case of Table 3 with respect to seed cotton yield and boll weight except no. of bolls per plant varied non significantly in T1 and T2.For sustainable production, cotton growers may need to make split soil fertility programs with fertigation of potash except soil application.

The results are in agreement with (Makhdum et al., 2007), Zhao et al., 2001, (Leffler and Tubertini, 1976who concluded that fertigation of potash may enhance plant growth and subsequently seed cotton yield. The results are not in line with Gormus (2002) who reported that splitting K applications decreased yields and boll weight as compared with applying the whole rate.

TABLE 2 Effect of soil and fertigation K application on the seed cotton yield in the agro-climatic conditions of Bahawalnagar during kharif 2018

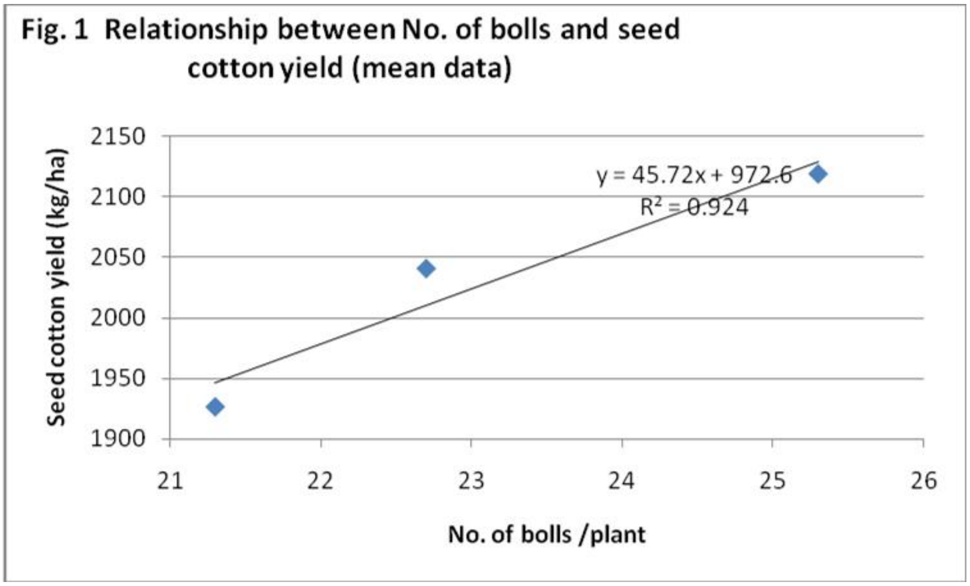
Tr. No.	Treatments	No. of bolls $plant^{-1}$	Boll weight(g)	Yield (kg ha^{-1})
T_1	Soil application of K i.e. 92 kg ha^{-1},with recommended NP 170-114 kg ha^{-1}	20.4B	2.63C	1794C
T_2	Fertigation of K after 30, 45, 60 and 75 days of sowing (15 days interval), with recommended NP 170-114 kg ha^{-1}	20.6B	3.07B	1918B
T_3	Fertigation of K after 30, 37, 44, 51, 58, 65 and 72 days of sowing (7 days interval) with recommended NP 170-114 kg ha^{-1}	22.4A	3.21A	1993A
	LSD	1.42	0.12	32.2

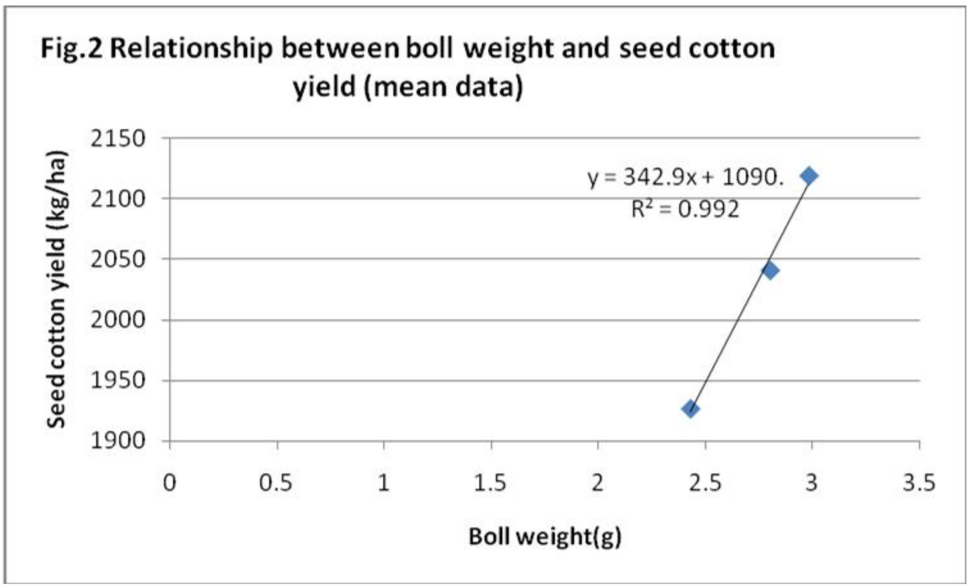
Means not sharing a common letter in column are significant at 5% probability level.

TABLE 3: Average Effect of soil and fertigation K application on the seed cotton yield in the agro-climatic conditions of Bahawalnagar during kharif 2017 and 2018

Tr. No.	Treatments	No. of bolls $plant^{-1}$	Boll weight(g)	Yield (kg ha^{-1})
T_1	Soil application of K i.e. 92 kg ha^{-1},with recommended NP 170-114 kg ha^{-1}	21.3B	2.43C	1927C
T_2	Fertigation of K after 30, 45, 60 and 75 days of sowing (15 days interval), with recommended NP 170-114 kg ha^{-1}	22.7B	2.80B	2041B
T_3	Fertigation of K after 30, 37, 44, 51, 58, 65 and 72 days of sowing (7 days interval) with recommended NP 170-114 kg ha^{-1}	25.3A	2.98A	2119A
	LSD	1.23	0.14	41.3

Means not sharing a common letter in column are significant at 5% probability level.





Conclusion

This study revealed that fertigation of K with seven days interval is better than merely soil method of K application. in cotton substantially improved the number of bolls per plant and seed cotton yield. Increase in yield and yield components was mainly due to increased K use efficiency which helps translocation of various metabolites such as sugar, cellulose, etc. triggered by the enzymatic activation for increased photosynthetic efficiency which leads to increase in seed cotton yield.

References

1. Abdul-Malak, K.K.I. and E.A. Mukrum. 1996. The proper dose of potassium fertilizer and its application timing for Giza 83 cotton grown in upper Egypt. Annals Agric. Sci. Ain., Shmas Univ. Cairo, Egypt. 41:663-670.
2. Akhtar, M.E., A. Sardar, M. Ashraf, M. Akhtar, and M.Z. Khan. 2003. Effect of Potash Application on Seed Cotton Yield and Yield Components of Selected Cotton Varieties. Asian J. Plant Sci. 2:602-604.
3. Anonymous (2001) Agricultural Statistics of Pakistan. Ministry of Food, Agriculture and Livestock (MINFAL), Islamabad, Pakistan, pp 12–13
4. Ashraf Abd El-AalaAbd El-Mohsen, Mohammed Abd El-Azim Ahmed. 2015. The effect of applying different fertilizer regimes on productivity and profitability of Egyptian cotton under middle Egypt conditions. Advance in Agriculture and Biology, 4: 31–38.

5. Bisson, P., M. Cretenet and E. Jallas. 1994. Nitrogen, phosphorous and potassium availability in the soil, physiology of assimilation and use of these nutrients by the plant. Proceeding World Cotton Research Conference, 1**:** 115–124.
6. Brar, M.S., A.S. Brar, P.N. Takkar and T.H. Singh. 1987. Effect of potassium supply on its concentration in plant and on yield parametersof American cotton (*Gossypium hirsutum* L.). J. Potassium Res.3(1):149-154.
7. Gomez KA, AA Gomez (1984). Statistical Procedures for Agricultural Research. 2nd Ed. John Wiley and Sons, P 680.
8. Gormus, O. 2002. Effects of Rate and Time of Potassium Application on Cotton Yield and Quality in Turkey. J. Agron. Crop Sci. 188:382-388.
9. Kerby T.A., and F. Adams. 1985. Potassium Nutrition of Cotton. *In:* Potassium in Agriculture. Amer. Soc. Agron., Madison, WI. p. 843-860.
10. Leffler H.R., and B.S. Tubertini. 1976. Development of Cotton Fruit, II: Accumulation and Distribution of Mineral Nutrients. Agron. J. 68:858-861.
11. Makhdum, M.I., H. Pervez, and M. Ashraf. 2007. Dry Matter Accumulation and Partitioning in Cotton (*Gossypium hirsutum* L.) as Influenced by Potassium Fertilization. Biol. Fert. Soils 43:295-301.
12. Malavolta, E. 1985. Postassium status of tropical and sub-tropical region soils. Potassium in Agriculture. R.D. Menson (ed.). ASA/CSS/.SSSA/, Madison, wt. USA. p. 163-200.
13. Malik, K. N. A., M. I. Makhdum, M. B. Mirza and F.I. Chaudhry. 1989. Preliminary observations on potassium nutrition of cotton in silt and clayloam soils. The Pak. Cottons. 33 (3): 132-144.
14. Mengel, K. and E.A. Kirby. 1982. Principles of Plant Nutrition. International Potash Institute, Bern, Switzerland. p. 435-441.
15. Mithaiwala. I.K., M. J. Mirbahar, A.A. Channa and M. H. Arain. 1981.Effect of fertilizers on the yield of long staple variety K-68/9 in Guddu Barrage Area. The Pak. Cottons. 25:73-79.
16. Pervez, H., M. Ashraf, and M.I. Makhdum. 2004. Influence of Potassium Rates and Sources on Seed Cotton Yield and Yield Components of some Elite Cotton Cultivars. J. Plant Nutr. 27:1295-1317.
17. Reddy, K.P., H.F. Hodges and J. Varco. 2000. Potassium nutrition of cotton. Bulletin 1094. Mississippi Agricultural and Forestry Experiment Station, Mississippi
18. Reddy, K.R., S. Koti, G.H. Davidonis, and V.R. Reddy. 2004. Interactive Effects of Carbon Dioxide and Nitrogen Nutrition on Cotton Growth, Development, Yield and Fibre Quality. Agron. J. 96:1148-1157.
19. Ryan J, G. Estefan, A. Rashid (2001) Soil and Plant Analysis Laboratory Manual. International Center for Agricultural Research in the Dry Areas (ICARDA), Islamabad, Pakistan, P 172.
20. Saleem, M.T. 2002. Fertilizer review 2002. Pakistan Situation. Farming Outlook. 1:24-27.
21. Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. Principles and Procedures of Statistics. A biometrical approach.3rd Ed. McGraw HillBook. Int. Co. New York. p:172-177.
22. Toper, G.R., Bridge and M.W. Ebelhar. 1992. Variety response to surface, deep banded and split applications of potassium. Proc. Belwide Cotton Conf. Cotton Soil Management and Plant Nutrition Conference, USA. 3:139.
23. Wahhab, A. 1985. Crop response to fertilizer and soil data interpretation. FAO Project NFDC/069/ Pakistan
24. Zhao, D., D.M. Oosterhuis, and C.W. Bednarz. 2001. Influence of Potassium Deficiency on Photosynthesis, Chlorophyll Content, and Chloroplast Ultrastructure of Cotton Plants. Photosynthetica 39:103-109.

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