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Demonstration and evaluation of the response of potassium nutrition and irrigation frequencies on the growth and yield of seed cotton in ecological zone of Rahim Yar Khan.

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Keywords

Potassium,
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Abstract

A field experiment was conducted to study the effect of potassium nutrition and irrigation frequencies on the yield and yield components of cotton. The experiment was conducted at Adaptive Research Farm Rahim Yar Khan District during the Kharif season 2016-17. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The different doses of fertilizer K i.e (31, 62, 94 and 125 kg/ha) with different irrigational levels i.e (6 irrigations, 5 and 4 irrigations) significantly affected the plant population/m^2, plant height (cm), number of mature bolls/plant, seed cotton boll weight (g), and seed cotton yield kg/ha. The various doses of fertilizer and irrigations was significantly affected almost all the characters related to growth and yield of B.T cotton variety FH-142. The average of two years result revealed that significant maximum plant population/m^2 i.e 5.4, plant height (cm) i.e 149.6, number of bolls/plant i.e 27, boll weight (g) i.e 3.7 and maximum seed cotton yield i.e 3869.6 kg/ha was obtained when fertilizer K was applied @ 125 kg/ha with 6 irrigations levels.

Introduction

Cotton plays a major role in earning foreign exchange .The cotton crop production accounts for 1.5 percent in GDP and 7.1 percent in agriculture value addition. Textile industry fetched foreign exchange of US$ 10.22 billion. The cropped area of cotton stood at 2961 thousand hectares, showing an increase of 5.5 percent over last year's area of 2806 thousand hectares (Anonymous, 2015). In textile manufacturing, it produces seeds with a potential multi product base such as hulls, oil and lint (Ozyigit et al. 2007).

Fertilizers occupy vital position in raising seed cotton yield. Experiments proved that an optimal yield could only be produced with the balanced application of all major nutrients (Ahmad, 1998). Cotton requires 150 to 200 kg K ha^{-1}, as much as nitrogen (N) or even more (Brar et al., 1987; Hodges, 1992; Rochester, 2007). Potassium is an important nutrient for cotton; it can increase cotton productivity by increasing number, size, and weight of bolls and improve fiber quality properties such as length, strength, and micromere (Cassman et al., 1990; Oosterhuis et al., 2013).

Potassium is essential for the growth and development of cotton crop. Potassium increases water efficiency, affects the speed of almost all plant biological systems, and affects fiber properties such as micromere, length, and strength. Potassium is considered to be an important mineral nutrient element for the plants after nitrogen which needs to be applied in sufficient amount to produce healthy and productive crop (IRRI 2007). Potassium plays a foremost role in translocation of carbohydrates, photosynthesis, water relations, resistance against insects and diseases and sustain balance between monovalent and divalent cations (Brar and Tiwari, 2004). Additionally, an adequate K supply can increase water use efficiency of cotton and reduce the incidence and severity of pest and disease attacks (Minton and Ebelhar, 1991; Prabhu et al., 2007). El- Ashry et al. (2005) reported that negative effects of drought on wheat growth can be diminished by foliar application of potassium. Plants translocate the potassium to all parts of plant and in turn yield per plant is increased. Howard et al. (2000) observed that foliar fertilization may be helpful to correct up potassium deficiencies when root growth and nutrient uptake are restricted. However, where supply of nutrients and soil potassium uptake is insufficient for plant demand foliar application of fertilizer may provide plenty of nutrients for plant growth (Pettigrew et al., 2000). Bolls are the major sink for K, thus the need for K increases at flowering through fruiting (Read et al., 2006; Mullins and Burmester, 2010). Cotton is more sensitive to low soil K than most other major field crops such as soybean [Glycine max (L.) Merr.], corn (*Zea mays* L.), and wheat (*Triticum aestivum* L.) (Cope, 1981; Kerby and Adams, 1985) because of its less dense root systems, and even K deficiency in cotton can occur in soils not considered low in K (Cassman et. al., 1989). In the last two decades, widespread K deficiencies have been documented throughout several leading cotton producing countries including China (Dong et al., 2004), India (Sekhon and Singh, 2013) and Pakistan (Akhtar et al., 2003; Zia-ul-hassan et al., 2014). Cotton (*Gossypium hirsutum* L.), the king of natural fibers, is of prime importance in the economy of many countries, providing renewable natural fiber resources for the global textile industry (Zhang et al., 2015).Cotton to water deficit stresses include reductions in leaf area index (LAI), reduction in leaf size and thickness, alterations in thickness and chemical makeup of leaf cuticles, accumulation of compatible solutes (proline, glycinebetaine), reduction in plant height, and changes in solar tracking of leaves (Burke, et al., 1985, Ehleringer and Hammond, 1987, He, et al., 2007, Lv, et al., 2007, Oosterhuis, et al., 1991a, Oosterhuis, et al., 1991b, Zhang, et al., 2011). Optimum levels of micro and macro inorganic nutrients are required for normal growth and supplements give improvements. Low yield of cotton in Pakistan is due to many crop husbandry problems such as low or more plant population, water shortage, low seed rate, improper fertilizer management, weed infestation, insect pest and disease problems (Ahmed et al., 2009).

Keeping in view the significant of cotton in Pakistan this study was conducted to see cotton response to varying levels of potassium and irrigation frequencies.

Materials and Methods

The experiment was conducted at Adaptive Research Farm Rahim Yar Khan during 2016 and 2017 to determine the effect of potassium nutrition and irrigation frequencies on the yield and yield components of cotton. The experiment was laidout in Randomized Complete Block Design (RCBD) with three treatments and repeated thrice. Soil sample were collected before planting crop from plough lair of the experimental sites and analysis carried out as per method (Jackson 1962). The soil of the experimental sites was sandy loam with alkaline pH (8.2), 0.73% organic matter, 0.042% N, 4.3ppm available phosphorous & 140ppm available potash. Experimental treatments comprised of three irrigational (I) levels (6, 5 and 4 irrigations) with four different doses of fertilizer K i.e (31, 62, 94 and 125kg/ha). Seed bed was prepared by cultivating the field for two times with tractor mounted cultivated each followed by planking. The cotton B.T variety FH-142 was sown on sandy loam soil. Sowing was done on well prepared seed bed 1st week of May in two years. With the help of single row cotton drill by maintaining 2.5 feet row spacing and 12 inch plant to plant distance was maintained by thinning at 6 inch height of the cotton plant. Over all eight irrigation were applied and weeds were controlled through weedicides. Insecticides were applied to control the sucking insects (Whitefly, Thrips, Jassid, & Mites) and boll worms (Pink boll worm). All other agronomic practices were kept normal and uniform for all the treatments. Plant population/m^2 was counted after three weeks of sowing. Plant height (cm) of randomly selected plots from each plot was measured at the time of last picking and average height was calculated. The total number of bolls on the randomly selected plants picked at the time of each picking was counted. Thus total number of bolls on the plants was obtained by summing up the bolls picked during all pickings and average of number of bolls per plant was calculated. For boll weight (g), three samples each of 100 seeds from each plot were weighted and finally averaged. Average boll weight (g) was calculated by dividing the total plants seed cotton yield with respective number of bolls per plant. Seed cotton picked from selected plants during all the pickings was weighted in grams using electric balance. After that the yield of seed cotton per plant was calculated. Seed cotton yield kg ha-^{1} was computed from seed cotton yield per plot. Data collected on different parameters were analyzed statistically by using M STAT-C programme (Anonymous,1986) for analysis of variance and means were separated using Fisher's protected least significant difference (LSD) test at 5% probability level (steel *et al*., 1997).

Results and Discussion

Plant population (m^{-2})

Data concerning average number of germination counts is shown in Table 1 during both years 2016 and 2017. Statistical analysis of the data revealed that the effect of various doses of fertilizer (K) have significant results on germination counts for the both growing seasons. Average maximum germination counts were recorded as 5.6, 5.4 and 5.2 in T_4 where K fertilizer dose was applied @ 125kg/ha with 6 irrigations levels followed by T_3 5.3, 5.1 and 5.1 where K was applied @ 94kg/ha with 5 irrigations levels. On the other hand, lowest value was recorded as 5.0, 4.8 and 4.9 in T_1 where K was applied @ 31kg/ha with 4 irrigations levels. That means fertilizer dose T_4 produces maximum average germination and I_1 (6) irrigations produce maximum germination. Potassium is considered to be an important mineral nutrient element for the plants after nitrogen which needs to be applied in sufficient amount to produce healthy and productive crop (IRRI 2007).

Plant height (cm):

Fertilizer doses significantly increased plant height. Application of fertilizer K @ 125 kg ha^{-1} resulted in proportionate increase in the plant height of cotton variety FH-142 as mentioned in Table-1. The taller plants (152, 150 and 147cm) were recorded on cotton variety where fertilizer K was applied @ 125kg/ha as in T_4 and maximum height was observed with 6 irrigations levels during both years average results followed by T_3 149, 146 and 143 where K was applied @ 94kg/ha with 5 irrigations levels. On the other hand, lowest value was recorded as 139,135 and 134 where K dose was 31 kg/ha with 4 irrigations levels. That means fertilizer dose T_4 produces maximum average plant height (cm) and I_1 (6) irrigations levels. These results are in agreement with those of Rochester *et al*. (2001) that plant height in cotton is related to nitrogen, phosphorus and potash applications.

No. cotton bolls per plant:

Fertilizer doses were significantly affected on no. of cotton bolls/plant. Application of fertilizer K @ 125 kg ha^{-1} resulted in proportionate increase in no. of bolls of cotton variety FH-142 as mentioned in Table-1. The no. of bolls/plant (29, 27 and 25) were recorded on cotton variety where fertilizer K was applied @ 125kg/ha as in T_4 and maximum no. of bolls/plant was observed with 6 irrigations levels during both years average results followed by T_3 27, 24 and 21 where K was applied @ 94kg/ha with 5 irrigations levels. On the other hand, lowest value was recorded as 22, 20 and 19 where K was applied @ 31 kg/ha with 4 irrigations levels. That means fertilizer dose T_4 produces maximum average no. of bolls/plant and I_1 (6) irrigations produce maximum no.of bolls/plant.

Boll weight (g):

Average boll weight is one of the major components of seed cotton yield in cotton. Data given in Table-1 indicates that K was non significantly influenced boll weight. Maximum boll weight (3.9, 3.7 and 3.6 g) was recorded where K was applied @ 125 kg ha^{-1} with 6 irrigations levels during both years average results. The minimum boll weight (3.1, 3.0 and 2.9g) was observed in case of K @ 31 with 3 irrigations levels. Seed cotton weight $boll^{-1}$ and seed cotton yield ha^{-1} have been found affected by NPK application at various doses (Nehra *et al*. 1986; Khan *et al*. 1993).

Seed cotton yield kg ha^{-1}:

Data pertaining to seed cotton yield per hectare as influenced by different doses of K as mentioned in Table-1 indicates that K had significant effect on the seed cotton yield per hectare. Maximum seed cotton yield per hectare (3906, 3883 and 3820 kg ha^{-1}) was recorded where K @ 125 kg ha^{-1} on FH-142 cotton variety with 6 irrigations levels followed by T_3 3827, 3799 and 3750 where K was applied @ 94kg/ha with 5 irrigations levels. On the other hand, lowest value was recorded as 3622, 3610 and 3601 kg/ha where fertilizer K dose was 31 kg/ha with 4 irrigations levels. That means fertilizer dose T_4 produces maximum average seed cotton yield (kg/ha) with I_1 (6) irrigations levels. These results are supported by Elayan (1992) who reported that NPK influenced seed cotton yield ha^{-1}. Additionally, an adequate K supply can increase water use efficiency of cotton and reduce the incidence and severity of pest and disease attacks (Minton and Ebelhar, 1991; Prabhu et al., 2007).

Table 1: The effect of various doses of potassium fertilizer and irrigation frequencies on the growth and yield of seed cotton during 2016 and 2017 (Average values).

Years 2016-17	Treatments	Average germination counts (m^{-2})	Average plant height (cm)	No. of Bolls/plant	Boll weight (g)	Average seed cotton yield (kg/ ha)
I_1	T_1	5.0d	139d	22d	3.1d	3622d
	T_2	5.2c	145c	25c	3.5c	3784c
	T_3	5.3b	149b	27b	3.7b	3827b
	T_4	5.6a	152a	29a	3.9a	3906a
LSD		**0.89**	**3.37**	**1.09**	**Non-significant**	**50.60**
I_2	T_1	4.8d	135d	20d	3.0d	3610d
	T_2	5.0c	144c	21c	3.3c	3750c
	T_3	5.1b	146b	24b	3.5b	3799b
	T_4	5.4a	150a	27a	3.7a	3883a
LSD		**0.74**	**3.34**	**1.07**	**Non-significant**	**44.22**
I_3	T_1	4.9d	134d	19d	2.9d	3601d
	T_2	5.1c	140c	21c	3.3c	3700c
	T_3	5.1b	143b	21b	3.3b	3750b
	T_4	5.2a	147a	25a	3.6a	3820a
LSD		**0.87**	**3.30**	**1.05**	**Non-significant**	**52.10**

Conclusions

The results concluded that various doses of potash fertilizer have varied effects on seed cotton yield and other growth parameters. It has significantly ($p<0.05$) affected germination, plant height, no.of bolls/plant, boll weight and yield during both years of the study. K when applied @ 125 kg/ha has improved seed cotton yield (3622, 3610 and 3601 kg/ha) with irrigations levels (6, 5 and 4) over 2 years in comparison with other doses. Therefore under ecological zone of Rahim Yar Khan, K dose 125 kg/ha with 6 irrigations levels for cotton crop can be recommended for better production.

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