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Level of Potassium Affects Concentration and Uptake of Nutrients in Bt. cotton.

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ABSTRACT

The present study was carried out at the farm of Krishi Vigyan Kendra, Sirsa in a sandy loam soil, low in organic carbon and nitrogen, medium in phosphorus with medium to high potash levels. *Bt.* cotton (var. Bioseed-6588) seed was sown in two soils with varying potassium (K) levels. The treatments comprised of T_1 - $N_{175}P_{60}$, T_2 - $N_{175}P_{60}$ + Water Spray, T_3 - $N_{175}P_{60}$+ 1% foliar spray of KNO_3, T_4 - $N_{175}P_{60}$+ K_{30}, T_5 - $N_{175}P_{60}$+ K_{30}+1% foliar spray of KNO_3, T_6 - $N_{175}P_{60}$+K_{60} and T_7 - $N_{175}P_{60}$+K_{60}+ 1% foliar spray of KNO_3. The two foliar sprays were done at the time of early and peak boll development stages. Application of K increased the N content in the plant parts. P content in different plant parts decreased in all the treatments over treatment where only recommended dose of N and P applied. The relative K concentration in plant parts followed the order: leaves > bur > seed > stems. The mean N uptake in various plant parts in medium K fertility soil was lower as compared to the same in high K fertility soils. The mean P uptake was slightly higher in high K fertility soils as compared to the medium K fertility soils. The uptake showed a decreasing rate as the level of K increased.

Key Words: K levels, KNo3 foliar spray, NPK concentration, NPK uptake.

INTRODUCTION

Cotton is the most important cash crop in India which has a major share in the raw material for the textile industries. Thus, cotton plays a dominant role in the industrial and agricultural economy of the country. Introduction of transgenic cotton in Indian agriculture has resulted in an immense increase in seed cotton yield. This economically viable technology (Mehta *et al*, 2009) of *Bt.* cotton has helped significantly in increasing the net income of farmers. The maximum yield potential of *Bt.* cotton hybrid can only be achieved with suitable agronomic practices like plant geometry and optimum fertilization over the years (Devraj *et al*, 2011).

Cotton is a heavy feeder and removes a large quantity of nutrients from the soil thus crop nutrition forms a crucial components of cotton production (Kaur *et al*, 2007). To cater the uptake needs of these crops, soil reserves alone are not sufficient, hence needs to supply them through chemical fertilizers. However, the fertilizers applied are either insufficient or imbalanced and not based on soil supply capacity after suitably taking into consideration the fertilizer contribution and crop requirements that is leading to un-sustainability of the production systems. Nitrogenous and phosphoric fertilizers are more emphatically used by the farmers leading to an imbalanced nutrient supply ratio.

MATERIALS AND METHODS

The present study was carried out at the farm of Krishi Vigyan Kendra, Sirsa. The experimental soil was sandy loam in texture, slightly alkaline in reactions, low in organic carbon and nitrogen, medium in phosphorus with medium to high potash levels. The *Bt.* cotton (var. Bioseed-6588) seed was sown in two soils with varying K fertility with three replications and seven treatments and the design was RBD. In the experiment *Bt.* cotton (var. Bioseed-6588) was sown. The treatments were

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Table 1. N concentration (%) and uptake (kg/ha) in various plant parts.

Treatment	N seed			N Stem			N Leaves			N burr		
	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean
T_1 ($N_{175}P_{60}$)	2.20 (34.37)	2.30 (48.53)	2.25 (41.45)	0.60 (12.45)	0.63 (14.36)	0.62 (13.41)	1.70 (5.39)	1.90 (6.21)	1.80 (5.80)	0.67 (2.87)	0.69 (3.31)	0.68 (3.09)
T_2 ($N_{175}P_{60}$ + Water Spray)	2.22 (35.88)	2.35 (50.82)	2.29 (43.35)	0.61 (13.33)	0.63 (15.82)	0.62 (14.57)	1.87 (6.81)	2.00 (7.42)	1.94 (7.11)	0.69 (3.63)	0.71 (4.21)	0.70 (3.92)
T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	2.30 (44.28)	2.41 (54.21)	2.36 (49.24)	0.62 (14.23)	0.66 (17.46)	0.64 (15.84)	1.90 (7.01)	2.05 (7.87)	1.98 (7.44)	0.73 (4.45)	0.73 (5.07)	0.73 (4.76)
T_4 ($N_{175}P_{60}$ + K_{30})	2.39 (50.54)	2.48 (54.98)	2.44 (52.76)	0.62 (15.50)	0.66 (17.87)	0.64 (16.68)	1.89 (7.33)	2.04 (7.77)	1.97 (7.55)	0.73 (5.20)	0.74 (5.60)	0.74 (5.17)
T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3)	2.45 (54.72)	2.49 (57.70)	2.47 (56.21)	0.63 (16.58)	0.68 (19.23)	0.66 (17.91)	1.95 (8.03)	2.15 (8.98)	2.05 (8.51)	0.76 (5.58)	0.78 (6.31)	0.77 (5.76)
T_6 ($N_{175}P_{60}$ + K_{60})	2.52 (58.71)	2.42 (56.88)	2.47 (57.79)	0.64 (17.05)	0.67 (19.09)	0.66 (18.07)	1.96 (8.36)	2.05 (9.85)	2.01 (9.10)	0.75 (6.26)	0.76 (6.26)	0.76 (5.92)
T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3)	2.59 (63.86)	2.44 (57.75)	2.52 (60.80)	0.65 (18.05)	0.69 (19.76)	0.67 (18.90)	1.99 (9.61)	2.14 (11.13)	2.07 (10.37)	0.77 (4.68)	0.77 (6.52)	0.77 (6.39)
Mean	2.38 (48.91)	2.41 (54.41)		0.62 (15.31)	0.66 (17.65)		1.89 (7.08)	2.05 (8.46)		0.73 (0.22)	0.74 (5.33)	
C.D.(p= 0.05) Soil fertility	N.S. (2.34)			0.01 (0.50)			0.03 (0.29)			0.01 (0.41)		
Treatments	0.19 (4.38)			0.03 (0.93)			0.05 (0.54)			0.02 (N.S.)		
Interaction	N.S. (6.20)			N.S. (N.S.)			N.S. (0.76)			N.S. ()		

(Parenthesis represents uptake)

comprised of T_1 - $N_{175}P_{60}$, T_2 - $N_{175}P_{60}$ + Water Spray, T_3 - $N_{175}P_{60}$+ 1% foliar spray of KNO_3, T_4 - $N_{175}P_{60}$+ K_{30}, T_5 - $N_{175}P_{60}$+ K_{30}+1% foliar spray of KNO_3, T_6 - $N_{175}P_{60}$+K_{60} and T_7 - $N_{175}P_{60}$+K_{60}+ 1% foliar spray of KNO_3. The two foliar sprays were done at the time of early and peak boll development stages. Yield attributes like plant population, number of bolls per plant, boll weight, seed cotton yield per plant and per hectare was determined. The data were analyzed statistically by applying the analysis of variance Technique as suggested by Cochran and Cox (1950).

Pre and post harvest surface (0-15cm) soil samples were collected from each treatment and analysed for available N by alkaline permanganate method (Subbiah and Asija, 1956), P was extracted by the method of Olsen *et al* (1954). With 0.5 N NaHCO3 (pH 8.5), and K was determined by using flame photometer as described by USDA Hand Book No. 60 (Richards, 1954). International Pipette method (Piper, 1950) was used for mechanical analysis. Soil EC and pH was determined in 1:2: soil: water suspension by using EC meter and pH meter, respectively.

Particular	Medium K Fertility	High K Fertility
Sand (%)	57.4	57.2
Silt (%)	29.3	29.4
Clay (%)	13.3	13.4
pH (1:2)	8.2	8.2
EC	0.17	0.2
Organic Carbon	0.25	0.30
Available N(kg/ha)	224	227
Available P205(kg/ha)	12	12
Available K20(kg/ha)	260	390

In plant samples, Leaf, stem, khokri (Bur) , and seed samples were digested separately in a diacid mixture using sulphuric and perchloric acid in 4:1 ratio and N, P and K were analysed in the digested plant material by the following methods. The critical differences were obtained at 5% level of significance as described by Panse and Sukhatme (1961)

RESULTS AND DISCUSSION

Nutrient concentration and uptake (kg/ha)

Nitrogen

The mean N content in the leaves, stems, bur and seed in the high K fertility soil was significantly increased over that in medium K fertility soil. Within the K levels, there was no significant

Table 2. P concentration (%) and uptake (kg/ha) in various plant parts.

Treatment	P Seed			P Stem			P leaves			P Burr		
	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean
$T_1 (N_{175}P_{60})$	0.81 (12.64)	0.81 (17.07)	0.81 (14.86)	0.080 (1.66)	0.080 (1.82)	0.080 (1.74)	0.19 (0.59)	0.18 (0.60)	0.19 (0.60)	0.10 (0.45)	0.08 (0.40)	0.09 (0.42)
$T_2 (N_{175}P_{60}$ + Water Spray)	0.80 (12.90)	0.79 (17.04)	0.79 (14.97)	0.080 (1.76)	0.080 (2.00)	0.080 (1.88)	0.20 (0.73)	0.19 (0.69)	0.19 (0.71)	0.12 (0.65)	0.09 (0.51)	0.11 (0.58)
$T_3 (N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	0.79 (15.15)	0.78 (17.59)	0.79 (16.37)	0.079 (1.80)	0.079 (2.10)	0.079 (1.95)	0.20 (074)	0.18 (0.70)	0.19 (0.72)	0.10 (0.59)	0.10 (0.72)	0.10 (0.65)
$T_4 (N_{175}P_{60} + K_{30})$	0.78 (16.47)	0.78 (17.22)	0.78 (16.84)	0.078 (1.96)	0.078 (2.10)	0.078 (2.03)	0.19 (0.74)	0.17 (0.65)	0.18 (0.69)	0.09 (0.57)	0.10 (0.73)	0.09 (0.65)
$T_5 (N_{175}P_{60} + K_{30}$ + Foliar spray of 1% KNO_3)	0.78 (17.33)	0.77 (17.86)	0.77 (17.60)	0.078 (2.05)	0.078 (2.19)	0.078 (2.12)	0.18 (0.74)	0.18 (0.74)	0.18 (0.74)	0.09 (0.64)	0.09 (0.70)	0.09 (0.67)
$T_6 (N_{175}P_{60} + K_{60})$	0.77 (17.95)	0.76 (17.86)	0.77 (17.91)	0.079 (2.10)	0.077 (2.18)	0.078 (2.14)	0.20 (0.75)	0.18 (0.85)	0.19 (0.70)	0.08 (0.60)	0.07 (0.57)	0.08 (0.59)
$T_7 (N_{175}P_{60}+K_{60}$+Foliar-spray of 1% KNO_3)	0.79 (19.44)	0.77 (18.15)	0.78 (18.79)	0.078 (2.17)	0.077 (2.20)	0.078 (2.19)	0.21 (1.01)	0.17 (0.88)	0.19 (0.95)	0.07 (0.54)	0.07 (0.62)	0.07 (0.58)
Mean	0.79 (15.98)	0.78 (17.54)		0.079 (1.93)	0.078 (2.09)		0.20 (0.73)	0.18 (0.73)		0.09 (0.58)	0.09 (0.61)	
C.D.(p= 0.05) Soil fertility	N.S. (0.34)			N.S. (0.05)			0.01 (N.S.)			N.S. (N.S.)		
Treatments	0.02 (0.64)			N.S. (0.10)			N.S. (0.10)			N.S. (0.07)		
Interaction	N.S. (0.90)			N.S. (N.S.)			N.S. ()			N.S. (N.S.)		

(Parenthesis represents uptake)

difference in N concentration in the respective treatment. The nitrogen content of stems and seed significantly increased in the treatments T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3) to T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3) over treatment where only recommended dose of N and P applied. In all the treatments, the N status in plant parts was significantly higher over treatment where only recommended dose of N and P applied. The higher N content in plant parts due to increased K levels may be attributed to the synergetic effects of K-fertilizer on absorption of N by various plant parts. These results were in line with those obtained by Makhdum *et al* (2007) who reported increased N concentration of 33.3, 33.3, 30.1, 6.6 and 4.4 per cent in burs, lint, seed, stems and leaves, respectively with application of 250 kg K/ha compared to K unfertilized treatment. The N uptake in various plant parts was in the order: khokri< leaves< stems <seed. Figure 7 indicates that the mean N uptake in various plant parts in medium K fertility soil (4.68, 7.08, 15.31 and 48.91 in bur, leaves, stems and seed respectively) was lower as compared to the same in high K fertility soils viz: 5.33, 8.46, 17.65 and 54.41 kg/ha. The contribution of various plant parts towards the N uptake was 6.15, 9.31, 20.15 and 64.37 per cent of the total N uptake in the medium K fertility soil. In the high K fertility soil the contribution was to the tune of 6.20, 9.85, 20.55 and 63.37 percent of the total nitrogen uptake in Khokri, leaves, stems and seed respectively.

Phosphorus

The mean P content in the different plant parts in high K fertility soil was more than that in medium K fertility soils. However, as compared to treatment where only recommended dose of N and P applied, the K content numerically decreased with increase in K levels. These results were in line with those observed by Makdhum *et al* (2007) who found a negative correlation coefficient between K and P concentration maintain by various plant the reason being an antagonistic interaction between the two elements. Figure 8 indicates that the mean P uptake was slightly higher in high K fertility soil as compared to the medium K fertility soils. The P uptake in various plant parts was in the order: bur < leaves < stems < seed. The uptake showed a decreasing rate as the level of K increased. In the medium K fertility soil, P uptake by bur, leaves, stems and seed was 0.58, 0.73, 1.93 and 15.98 kg/ha, respectively, which was 3.01, 3.79, 10.04 and 83.14 percent of the total P uptake. In high K fertility soils, P uptake by khokri, leaves, stems and seed was 0.61, 0.73, 2.09 and 17.54 kg/ha, respectively, which contributed 2.90, 3.48, 9.96 and 83.64 percent of the total P uptake. The slight decrease in medium K soil over high K as attributed to more dry matter in these treatments otherwise the P content in plant parts was adversely affected by increased K application.

Potassium

The K content of leaves, stems, bur and seed in the higher K fertility soil was higher over medium K fertility soil in the respective treatments. The mean K content in various plant parts in high K fertility soil was significantly increased over medium K fertility soil. The relative K concentration in plant parts were followed the order: leaves > bur > seed > stems. The mean K concentration in various plant parts increased linearly with an increase in level of K fertilizer. These results are in line with those obtained by Makhdum *et al.*, (2007) who found that the application of 250 kg K/ha increased K concentration of 73.7, 43.8, 43.2, 39.1 and 24.2 percent in burs, seed, stems, lint and leaves, respectively as compared to K- unfertilized treatments. These results are in line with Aladakatti *et al* (2011) also recorded higher concentration of K in leaf, stem, but and seed with application of K as compared to the treatments without application of potassium.

The mean K uptake was highest in T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3) treatment which measured 10.72, 15.03, 21.16 and 30.07 kg/ha in leaves, bur, stems and seed respectively. Soil and foliar applied potassium significantly increased the

Table 3. K concentration (%)and uptake in various plant parts (kg/ha).

Treatment	K seed			K Stem			K Leaves			K burr		
	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean	Medium K fertility	High K fertility	Mean
T_1 ($N_{175}P_{60}$)	1.15 (17.96)	1.17 (24.66)	1.16 (21.31)	0.62 (12.87)	0.65 (14.82)	0.64 (13.85)	1.67 (5.29)	2.01 (6.57)	1.84 (5.93)	1.45 (6.25)	1.51 (7.21)	1.48 (6.73)
T_2 ($N_{175}P_{60}$ + Water Spray)	1.16 (18.77)	1.19 (25.75)	1.18 (22.26)	0.63 (13.77)	0.67 (16.73)	0.65 (15.25)	1.70 (6.18)	2.06 (7.64)	1.88 (6.91)	1.48 (7.76)	1.52 (8.97)	1.50 (8.36)
T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	1.17 (22.53)	1.20 (26.98)	1.19 (24.75)	0.65 (14.91)	0.68 (17.99)	0.67 (16.45)	1.74 (6.41)	2.11 (8.10)	1.92 (7.26)	1.54 (9.43)	1.57 (10.86)	1.56 (10.15)
T_4 ($N_{175}P_{60}$ + K_{30})	1.19 (25.13)	1.22 (27.04)	1.21 (26.09)	0.68 (17.00)	0.71 (19.13)	0.69 (18.07)	1.86 (7.21)	2.15 (8.19)	2.01 (7.70)	1.59 (10.38)	1.64 (12.36)	1.62 (11.37)
T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3)	1.20 (26.75)	1.23 (28.52)	1.22 (27.64)	0.69 (18.16)	0.72 (20.26)	0.71 (19.21)	1.91 (7.87)	2.21 (9.23)	2.06 (8.55)	1.61 (11.01)	1.66 (13.36)	1.64 (12.19)
T_6 ($N_{175}P_{60}$ + K_{60})	1.22 (28.43)	1.25 (29.38)	1.24 (28.90)	0.72 (19.18)	0.75 (21.37)	0.74 (20.27)	1.96 (8.36)	2.24 (10.75)	2.10 (8.06)	1.74 (13.00)	1.80 (14.77)	1.77 (13.88)
T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3)	1.23 (30.31)	1.26 (29.82)	1.25 (30.07)	0.74 (20.55)	0.76 (21.76)	0.75 (21.16)	1.98 (9.58)	2.28 (11.86)	2.13 (10.72)	1.77 (14.46)	1.85 (15.61)	1.81 (15.03)
Mean	1.19 (24.27)	1.22 (27.45)		0.68 (16.63)	0.71 (18.87)		1.83 (6.84)	2.15 (8.91)		1.60 (10.33)	1.65 (11.88)	
C.D.(p= 0.05) Soil fertility	0.03 (0.67)			0.01 (0.51)			0.03 (0.28)			0.03 (0.48)		
Treatments	0.05 (1.26)			0.03 (0.95)			0.05 (0.53)			0.05 (0.89)		
Interaction	N.S. (1.78)			N.S. (N.S.)			N.S. (0.75)			N.S. (N.S.)		

(Parenthesis represents uptake)

K uptake. In the high K fertility soil, the K uptake by the leaves, bur, stems and seed was 8.91, 11.88, 18.87 and 27.45 kg/ha, respectively, which was about 13.27, 17.70, 28.11 and 27.45 percent of the total K uptake by the *Bt*. cotton crop. In the medium K fertility soil, the K uptake by the leaves, bur, stems and seed was measured 6.84, 10.33, 16.63 and 24.27 kg/ha, respectively, which contributed about 11.77, 17.78, 28.63 and 24.27 percent of the total K uptake by the *Bt*. cotton crop. Figure 9 indicates that the K uptake by different plant parts in the high K fertility soil was more than that in the medium K fertility soil. The nitrogen uptake in various plant parts was in the order: leaves < bur < stems < seed.

CONCLUSION

The mean N content in the leaves, stems, bur and seed in the high K fertility soil was significantly higher over that in medium K fertility soil. Application of K increased the N content in the plant parts. P content in different plant parts decreased in all the treatments over treatment where only recommended dose of N and P applied. The K content in leaves, stems, bur and seed in the higher K fertility soil was higher over medium K fertility soil in the respective treatments. The K application significantly affected the K content. The relative K concentration in plant parts followed the order: leaves > bur > seed > stems. The mean P uptake was slightly higher in high K fertility soils as compared to the medium K fertility soils. The mean K uptake was highest in T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3) treatment.

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