

Original Research Article

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## Agronomic Manipulation on Seed Cotton Yield and Nitrogen, Phosphorus and Potassium uptake in Compact Cotton cv. co 17

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### ABSTRACT

The manipulation of crop geometry along with different levels of N, P and K is a time tested agronomic techniques to enhance the yield potential of cotton. In addition to the above, to facilitate mechanical harvesting, field experiments were conducted during summer season of 2019 and *rabi* season of 2019-20. The experiments were laid out in split plot design replicated thrice with four plant spacing in main plots *viz.*, S<sub>1</sub>- 100 x 10 cm, S<sub>2</sub>- 75 x 15 cm, S<sub>3</sub>-60 x 15 cm and S<sub>4</sub>-45 x 15 cm and four levels of nutrient levels in sub plot *viz.*, Control (without fertilizers), F<sub>1</sub> - 100% RDF (80:40:40 kg of NPK ha<sup>-1</sup>), F<sub>2</sub> -125% RDF (100:50:50 kg of NPK ha<sup>-1</sup>) and F<sub>3</sub> -150% RDF (120:60:60 kg of NPK ha<sup>-1</sup>). The results from the pooled analysis (two season data) revealed that the nitrogen, phosphorus and potassium uptake were significantly influenced by the crop geometry and nutrient levels. The highest uptake of nitrogen 94.39 and 93.19 kg ha<sup>-1</sup> were recorded in S<sub>3</sub>F<sub>3</sub> (60 x 15 cm with 150%RDF-120:60:60 kg NPK ha<sup>-1</sup>) and in S<sub>1</sub>F<sub>3</sub> (100 x 10 cm with 150%RDF-120:60:60 kg NPK ha<sup>-1</sup>), respectively and were found to be on par with each other. These two treatments combination also registered highest uptake of phosphorous 15.47 kg ha<sup>-1</sup> in S<sub>3</sub>F<sub>3</sub> and 15.16 kg ha<sup>-1</sup> in S<sub>1</sub>F<sub>3</sub> and potassium 85.44 kg ha<sup>-1</sup> in S<sub>3</sub>F<sub>3</sub> and 84.24 kg ha<sup>-1</sup> in S<sub>1</sub>F<sub>3</sub>. The maximum seed cotton yield of 2475 kg ha<sup>-1</sup> was recorded in S<sub>3</sub>F<sub>2</sub> (60 x 15 cm with 125%RDF-10:50:50 kg NPK ha<sup>-1</sup>) followed by S<sub>1</sub>F<sub>2</sub> (60 x 15 cm with 150% RDF-120:60:60 kg NPK ha<sup>-1</sup>) which recorded 2395 kg ha<sup>-1</sup> and were found to be on par.

### Keywords

Compact cotton,  
Crop geometry,  
Levels of nutrients  
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## Introduction

Cotton (*Gossypium* spp.), the king of fibre or white gold, is one of the most important commercial crop of India. It is one of the most important cash crops next to food grains that play a vital role in Indian national

economy (Patel *et al.*, 2016). In India, cotton is grown over an area 105 lakh hectares with production 351 lakh bales and productivity of 568 kg lint ha<sup>-1</sup> (Parikar *et al.*, 2018). Cotton yield can only be increased through proper crop management practices of which optimum nutrient levels and plant population are most

important (Ali *et al.*, 2007). Optimizing plant density and fertilizer levels are, therefore, the target for improved management. The nutrient management in cotton is a complex phenomenon due to its long duration and in determining growth habit, where simultaneous production of vegetative and reproductive structure during the active growth phase takes place (Kharagkharate *et al.*, 2017). The NPK are key nutrients required in large quantities by all crop plants and classed as major nutrient elements for plants. Cotton growth, development and maturity are greatly influenced by NPK fertilizers application which ultimately increases yield components, yield and fiber quality (Shah *et al.*, 2017). The manipulation of crop geometry is a agronomic technique to improve yield and profitability of cotton. As plant density increases the cumulative demand for solar radiation, water and nutrient are increase and leading to more canopy cover and decreased soil water evaporation, is becoming popular to address water scarcity challenges (Hou *et al.*, 2007; Venugopalan *et al.*, 2014). Hence, an attempt has been made to study the uptake pattern of N,P and K as influenced by crop geometry and nutrients levels. In addition to the above, seed cotton yield was studied.

## Materials and Methods

Experiments were conducted at Central farm, Department of Agronomy, Agriculture College and Research Institute (TNAU), Madurai during summer season of 2019 (season I) and *rabi* season of 2019-20 (season II). The experiments were laid out in split plot design replicated thrice with four plant densities *viz.*, S<sub>1</sub>- 100 x 10 cm (1,00,000 plants ha<sup>-1</sup>), S<sub>2</sub>-75 x15 cm (88,888 plants ha<sup>-1</sup>), S<sub>3</sub>-60 x15 cm (1,11,111 plants ha<sup>-1</sup>) and S<sub>4</sub>-45 x15 cm (1,48,148 plants ha<sup>-1</sup>) in main plot and four levels of NPK *viz.*, Control (without fertilizers), F<sub>1</sub> - 100% RDF (80:40:40 kg of

NPK ha<sup>-1</sup>), F<sub>2</sub> -125% RDF (100:50:50 kg of NPK ha<sup>-1</sup>) and F<sub>3</sub> -150% RDF (120:60:60 kg of NPK ha<sup>-1</sup>) in sub plot. The compact cotton variety cv. CO 17 was used for the present investigation. The seed cotton yield was assessed in both season and were pooled prior statistical analysis. The whole plant dry weight including seed cotton yield was used for analysing nitrogen, phosphorous and potassium content (Jackson, 1973) and the uptake were calculated as per method suggested by Balakrishnan *et al.*, (2020) and expressed in kg ha<sup>-1</sup>.

## Results and Discussion

### Uptake of nutrients

#### Nitrogen (N)

Nitrogen (N) is an essential macronutrient that is required most consistently and in larger amounts than other nutrients for cotton production (Hou *et al.*, 2007). It is an essential element for canopy area development and photosynthesis (Wullschleger and Oosterhuis, 1990). Nitrogen fertilization had significant impacts on plant growth, lint yields and fiber quality (Boquet *et al.*, 1993; Bondada *et al.*, 1996). In the present investigation, data on nitrogen uptake observed in both season I and season II, pooled and statistically analysed (Table 1). Data on N uptake pertaining to the first season (summer season of 2019) revealed that it was significantly altered by spacing and nutrient levels. Among the various 60 x15 cm-1,11,111 plants ha<sup>-1</sup>(S<sub>3</sub>) recorded the highest nitrogen uptake (76.01 kg ha<sup>-1</sup>) and followed by 100 x 10 cm (S<sub>1</sub>) which recorded 76.68 kg N/ha and both S<sub>3</sub> and S<sub>1</sub> were found to be on par with each other. The lowest N uptake was registered by 88,888 plants ha<sup>-1</sup> (S<sub>2</sub>) of 69.77 kg ha<sup>-1</sup>. With regard to nutrient levels, application of 150%RDF-120:60:60 kg NPK ha<sup>-1</sup> (F<sub>3</sub>) recorded highest nitrogen

uptake (92.76 kg ha<sup>-1</sup>) and control (without fertilizer) registered the lowest N uptake (39.91 kg ha<sup>-1</sup>). The interaction effect was found to be significant. Data revealed that the maximum uptake of N (95.55 kg ha<sup>-1</sup>) was recorded in the treatment of combination of 60 x 15 cm with 150% RDF (S<sub>3</sub>F<sub>3</sub>) and was followed by S<sub>1</sub>F<sub>3</sub> (94.23 kg ha<sup>-1</sup>). However, both were found to be on par with each other. The minimum N uptake was recorded in S<sub>2</sub> C (40.01 kg ha<sup>-1</sup>).

In the case of season II (*rabi* season of 2019-20), the nitrogen uptake was significantly influenced by crop geometry as well as nutrient levels. Among the plant population, 60 x 15 cm-1,11,111 plants ha<sup>-1</sup> (S<sub>3</sub>) recorded the maximum uptake of 73.63 kg ha<sup>-1</sup> and it was followed by S<sub>1</sub> (72.15 kg ha<sup>-1</sup>) and both S<sub>3</sub> and S<sub>1</sub> were found to be on par with each other. The minimum uptake of 66.83 kg ha<sup>-1</sup> was registered in crop geometry of 75 x 15 cm-88,888 plants ha<sup>-1</sup> (S<sub>2</sub>). While analysing the data on N uptake in respect of nutrient levels, it was revealed that 150% RDF-120:60:60 kg NPK ha<sup>-1</sup> (F<sub>3</sub>) recorded the highest uptake (90.61 kg ha<sup>-1</sup>) and the lowest uptake of 37.90 kg ha<sup>-1</sup> registered in control (without fertilizer). The interaction effect was found to be significant. The highest N uptake was registered in the treatment combination of 60 x 10 cm along with 150% RDF (S<sub>3</sub>F<sub>3</sub>) which recorded a value of 93.22 kg ha<sup>-1</sup> and followed by S<sub>1</sub>F<sub>3</sub> (92.14 kg ha<sup>-1</sup>) and both were found to be on par with each other. The lower N uptake (39.17 kg ha<sup>-1</sup>) was recorded in treatment combination of 75 x 15 cm with nil fertilizer (S<sub>2</sub>C).

The results of the pooled analysis of both season revealed that N uptake was significantly influenced by the both plant population and nutrient levels. Comparing the plant populations, the optimum plant population of 60 x 15 cm-1,11,111 plants ha<sup>-1</sup> (S<sub>3</sub>) recorded the maximum on nitrogen

uptake (74.81 kg ha<sup>-1</sup>) and followed by 100 x 10 cm (S<sub>3</sub>) which recorded 73.27 kg ha<sup>-1</sup>. The minimum population of 88,888 plants ha<sup>-1</sup> (S<sub>2</sub>) registered the lowest uptake of nitrogen of 68.29 kg ha<sup>-1</sup>. In respect of fertilizer dose, application of 150% RDF-120:60:60 kg NPK ha<sup>-1</sup> (F<sub>3</sub>) recorded the highest N uptake 91.68 kg ha<sup>-1</sup>, while control (no fertilizer) recorded the lowest N uptake (38.90 kg ha<sup>-1</sup>).

Data on N uptake were significantly influenced by the interaction between spacing and nutrient levels. Similar the both seasons, S<sub>3</sub>F<sub>3</sub> (60 x 15 cm with 150% RDF) recorded the maximum N uptake (94.39 kg ha<sup>-1</sup>) and it was on par with S<sub>1</sub>F<sub>3</sub> (100 x 10 cm with 150% RDF) which registered 93.19 kg ha<sup>-1</sup>. The interaction of 75 x 15 cm with no fertilizer (S<sub>2</sub>C) recorded the lowest nitrogen uptake (36.29 kg ha<sup>-1</sup>). It was very well evident from the study that compact cotton cv. co 17 with 60 x 15 cm i.e., 1,11,111 plants/ha with 150% RDF i.e., 120:60:60 kg ha<sup>-1</sup> registered the highest nitrogen uptake. This treatment combination was closely followed by (100 x 10 cm – 1,00,000 plants/ha (S<sub>1</sub>) with F<sub>3</sub> (150% RDF) which registered a value of 93.19 kg ha<sup>-1</sup>. However both of them were on par with each other. Increased availability of nitrogen i.e., 120 kg ha<sup>-1</sup> with optimum plant population could be the probable reason for the enhanced uptake of nitrogen in these two treatment combinations (Nalayini and Manickam, 2018). The results of present study was in consonance with the findings of Jyothi and Hebsur (2017).

### **Phosphorous uptake**

Phosphorus is the second most limiting nutrient in cotton production after nitrogen. It is a constituent of cell nuclei, essential for cell division and development of meristematic tissue and has a well known impact on photosynthesis as well as synthesis of nucleic

acids, proteins, lipids and other essential compounds (Guinn, 1984; Taiz and Zeiger, 1991). In the present study, the phosphorous uptake was significantly affected by both plant population and fertilizer levels. In respect of summer season I (2019), analysing uptake of phosphorous due to crop geometry, it was very well evident that optimum plant population treatment 60 x 15 cm ( $S_3$ ) recorded the highest phosphorous uptake ( $11.89 \text{ kg ha}^{-1}$ ), followed by 100 x 10 cm ( $S_1$ ) which registered  $11.36 \text{ kg ha}^{-1}$  and were found to be on par with each other. The lowest P uptake ( $10.21 \text{ kg ha}^{-1}$ ) was recorded in spacing of 75 x 15 cm ( $S_2$ ). Comparing the nutrient levels, 150% RDF ( $F_3$ ) registered the highest P uptake ( $15.45 \text{ kg ha}^{-1}$ ) as against control (without nutrient application), recorded  $5.41 \text{ kg ha}^{-1}$ .

Interaction effect was found to be significant. Here again, similar to nitrogen, combination of 60 x 15 cm with 150% RDF- 120:60:60 kg NPK  $\text{ha}^{-1}$  ( $S_3F_3$ ) registered the highest P uptake ( $16.21 \text{ kg/ha}$ ), followed by the combination of 100 x 10 cm – 1,00,000 plants/ha with 150% RDF ( $S_1F_3$ ) which recorded  $15.87 \text{ kg ha}^{-1}$  and were found to be on par with each other. The lowest P uptake of  $4.76 \text{ kg ha}^{-1}$  was observed in the treatment combination of  $S_2C$ .

With respect to second season (*rabi* 2019-20),  $S_3$  (60 x 15 cm) registered the maximum phosphorous uptake ( $10.69 \text{ kg ha}^{-1}$ ) followed by  $S_1$  ( $10.31 \text{ kg ha}^{-1}$ ) and were found to be on par. The minimum phosphorous uptake ( $9.24 \text{ kg ha}^{-1}$ ) was observed in spacing of 75 x 15 cm ( $S_2$ ). Among the different nutrient levels,  $F_3$  (150%- 120:60:60 kg NPK  $\text{ha}^{-1}$ ) recorded the higher phosphorous uptake ( $14.05 \text{ kg ha}^{-1}$ ), while control (no fertilizer) registered the lowest phosphorous uptake ( $4.73 \text{ kg ha}^{-1}$ ). The interaction effect between crop geometry and nutrient levels was found to be significant. Similar to Nitrogen, the

highest P uptake ( $14.72 \text{ kg ha}^{-1}$ ) was registered in the treatment combination of  $S_3$  (60 x 15 cm) with  $F_3$  (150% RDF- 120:60:60 kg NPK  $\text{ha}^{-1}$ ), followed by  $S_1$  (100 x 10 cm) with  $F_3$  (150% RDF) which recorded  $14.44 \text{ kg ha}^{-1}$  of phosphorous and these two were found to be on par with each other. The lowest ( $4.76 \text{ kg ha}^{-1}$ ) phosphorous uptake was observed in  $S_2C$ .

Data on pooled analysis of both season revealed that it was significantly altered by both varied spacing and nutrient levels. Among the different spacing,  $S_3$  (60 x 15 cm) registered the maximum phosphorous uptake ( $11.28 \text{ kg ha}^{-1}$ ) which was followed by  $S_1$  (100 x 10 cm) which recorded  $10.83 \text{ kg ha}^{-1}$  of P and found to be on par with each other. With regards to varied fertilizer doses, application of 150% RDF ( $F_3$ - 120:60:60 kg NPK  $\text{ha}^{-1}$ ) registered the highest P uptake ( $14.75 \text{ kg ha}^{-1}$ ); whereas the lowest phosphorous uptake obtained in control plot ( $5.06 \text{ kg ha}^{-1}$ ). The interaction effect was found to be significant. The interaction of  $S_3F_3$  (60 x 15 cm with 150% RDF) recorded highest P uptake ( $15.47 \text{ kg ha}^{-1}$ ) and it was followed by  $S_1F_3$  (100 x 10 cm with 150% RDF) which revealed  $15.16 \text{ kg ha}^{-1}$  and found to be on par with each other. On the other hand, the treatment combination  $S_2C$  (75 x 15 cm with no fertilizer) recorded the lowest P uptake of  $5.25 \text{ kg ha}^{-1}$ . It was revealed from the present investigation that the increased phosphorous application increases the phosphorous ( $F_3$ ). This available phosphorous could have been exploited by the optimum plant population 1,00,000 plants/ha (100 x 10 cm) and 1,11,111 plants/ha (60 x 15 cm) and hence, these two treatment combination recorded the highest uptake of phosphorous than the other treatment. Similar positive response of cotton to phosphorous was observed by Ahmad *et al.*, (2009) and Gadhiya *et al.*, (2009).

**Table.1** Impact of crop geometries and nutrient levels on nitrogen and phosphorous uptake at harvest stage in compact cotton cv. CO 17 during summer 2019 (season I) and rabi 2019-20 (season II)

Nutrient uptake						
Treatments	Nitrogen uptake (kg ha <sup>-1</sup> )			phosphorous uptake (kg ha <sup>-1</sup> )		
Crop geometry	Season I	Season II	Pooled	Season I	Season II	Pooled
<b>S<sub>1</sub> (100 x10 cm)</b>	74.41	72.15	73.27	11.36	10.31	10.83
<b>S<sub>2</sub> (75 x15 cm)</b>	69.77	66.83	68.29	10.21	9.24	9.72
<b>S<sub>3</sub> (60 x15 cm)</b>	76.01	73.63	74.81	11.89	10.69	11.28
<b>S<sub>4</sub> (45 x15 cm)</b>	72.11	69.78	70.94	10.79	9.73	10.25
<b>SEd</b>	0.78	0.91	0.75	0.22	0.19	0.17
<b>CD (p=0.05)</b>	1.91	2.23	1.84	0.53	0.46	0.42
<b>Nutrient levels</b>						
<b>C (nil nutrient)</b>	39.91	37.90	38.90	5.41	4.73	5.06
<b>F<sub>1</sub> (100% RDF)</b>	75.23	71.69	73.45	10.46	9.32	9.89
<b>F<sub>2</sub> (125% RDF)</b>	84.40	82.19	83.29	12.92	11.87	12.39
<b>F<sub>3</sub> (150% RDF)</b>	92.76	90.61	91.68	15.46	14.05	14.75
<b>SEd</b>	1.20	1.21	0.81	0.21	0.14	0.12
<b>CD (p=0.05)</b>	2.48	2.50	1.63	0.43	0.30	0.24
<b>Interaction</b>						
<b>S<sub>1</sub>C</b>	41.01	39.17	40.09	5.61	4.89	5.25
<b>S<sub>1</sub> F<sub>1</sub></b>	76.68	73.52	75.10	10.78	9.64	10.21
<b>S<sub>1</sub> F<sub>2</sub></b>	85.70	83.78	84.74	13.19	12.28	12.73
<b>S<sub>1</sub> F<sub>3</sub></b>	94.23	92.14	93.19	15.87	14.44	15.16
<b>S<sub>2</sub> C</b>	37.62	34.95	36.29	4.76	4.32	4.54
<b>S<sub>2</sub> F<sub>1</sub></b>	70.55	66.22	68.39	9.53	8.42	8.98
<b>S<sub>2</sub> F<sub>2</sub></b>	81.53	78.81	80.17	12.01	11.02	11.52
<b>S<sub>2</sub> F<sub>3</sub></b>	89.38	87.32	88.35	14.53	13.21	13.87
<b>S<sub>3</sub> C</b>	42.14	40.43	41.29	6.05	5.21	5.63
<b>S<sub>3</sub> F<sub>1</sub></b>	79.42	75.97	77.70	11.42	10.21	10.82
<b>S<sub>3</sub> F<sub>2</sub></b>	86.92	84.89	85.91	13.86	12.62	13.24
<b>S<sub>3</sub> F<sub>3</sub></b>	95.55	93.22	94.39	16.21	14.72	15.47
<b>S<sub>4</sub>C</b>	38.87	37.05	37.96	5.20	4.51	4.86
<b>S<sub>4</sub> F<sub>1</sub></b>	74.25	71.04	72.65	10.11	9.02	9.57
<b>S<sub>4</sub> F<sub>2</sub></b>	83.44	81.26	82.35	12.60	11.57	12.09
<b>S<sub>4</sub> F<sub>3</sub></b>	91.86	89.77	90.82	15.24	13.81	14.52
<b>SEd</b>	2.22	2.29	2.30	0.42	0.31	0.35
<b>CD (p=0.05)</b>	4.62	4.76	4.78	0.65	0.87	0.73

**Table.2** Impact of crop geometries and nutrient levels on potassium uptake at harvest stage and seed cotton yield of compact cotton cv. CO 17 during summer 2019 (season I) and *rabi* 2019-20 (season II)

Treatments	Potassium uptake (kg ha <sup>-1</sup> )			Seed cotton yield (kg ha <sup>-1</sup> )		
Crop geometry	Season I	Season II	Pooled	Season I	Season II	Pooled
<b>S<sub>1</sub>(100 x10 cm)</b>	63.75	61.81	62.78	1801	1676	1739
<b>S<sub>2</sub>(75 x15 cm)</b>	57.51	54.79	56.15	1582	1458	1520
<b>S<sub>3</sub>(60 x15 cm)</b>	65.68	63.40	64.53	1884	1747	1816
<b>S<sub>4</sub>(45 x15 cm)</b>	60.34	58.89	59.61	1344	1239	1292
<b>SEd</b>	1.02	0.73	0.73	34	31	28
<b>CD (p=0.05)</b>	2.50	1.80	1.80	84	75	70
<b>Nutrient levels</b>						
<b>C (nil nutrient)</b>	36.61	35.38	35.99	858	792	825
<b>F<sub>1</sub>(100% RDF)</b>	57.02	53.76	55.38	1914	1770	1842
<b>F<sub>2</sub>(125% RDF)</b>	70.90	68.91	69.90	2216	2053	2135
<b>F<sub>3</sub>(150% RDF)</b>	82.77	80.84	81.80	1623	1506	1565
<b>SEd</b>	0.92	1.13	0.71	25	21	19
<b>CD (p=0.05)</b>	1.91	2.34	1.42	52	43	29
<b>Interaction</b>						
<b>S<sub>1</sub>C</b>	37.58	36.14	36.86	830	761	796
<b>S<sub>1</sub> F<sub>1</sub></b>	58.72	55.41	57.07	2134	1989	2062
<b>S<sub>1</sub> F<sub>2</sub></b>	73.71	72.22	72.97	2485	2304	2395
<b>S<sub>1</sub> F<sub>3</sub></b>	84.99	83.48	84.24	1754	1649	1702
<b>S<sub>2</sub>C</b>	33.68	32.22	32.95	733	677	705
<b>S<sub>2</sub> F<sub>1</sub></b>	51.90	48.76	50.33	1978	1826	1902
<b>S<sub>2</sub> F<sub>2</sub></b>	66.50	62.56	64.53	2343	2165	2254
<b>S<sub>2</sub> F<sub>3</sub></b>	77.97	75.63	76.80	1273	1164	1219
<b>S<sub>3</sub>C</b>	39.44	38.32	38.88	901	836	869
<b>S<sub>3</sub> F<sub>1</sub></b>	62.14	58.72	60.43	2202	2033	2118
<b>S<sub>3</sub> F<sub>2</sub></b>	74.67	72.15	73.41	2563	2387	2475
<b>S<sub>3</sub> F<sub>3</sub></b>	86.48	84.39	85.44	1869	1731	1800
<b>S<sub>4</sub>C</b>	35.72	34.85	35.29	966	892	929
<b>S<sub>4</sub> F<sub>1</sub></b>	55.31	52.13	53.72	1343	1230	1287
<b>S<sub>4</sub> F<sub>2</sub></b>	68.72	68.72	68.72	1471	1355	1413
<b>S<sub>4</sub> F<sub>3</sub></b>	81.62	79.84	80.73	1596	1478	1537
<b>SEd</b>	1.90	2.10	2.00	55	48	42
<b>CD (p=0.05)</b>	3.95	4.36	4.16	123	106	85

## Potassium uptake

Potassium is an essential macroelement for all living organisms required in large amounts for normal plant growth and development (Marschner, 1995). In higher plant cytoplasm, K is the dominant cation and is commonly found to be in concentrations ranging from 80 to 150 mM (Blevins, 1985). Its primary role is as an enzyme activator. It has been implicated in over 60 enzymatic reactions (Evans and Sorger, 1966) which are involved in many processes in the plant such as photosynthesis, respiration, carbohydrate metabolism, translocation and protein synthesis. Potassium balances charges of anions and influences their uptake and transport. Another major role of K is in photosynthesis (Steven, 1985) by directly increasing leaf growth and leaf area index, and therefore, CO<sub>2</sub> assimilation (Wolf *et al.*, 1976). Potassium increases the outward translocation of photosynthate from the leaf (Ashley and Goodson, 1972). In the present investigation, the potassium uptake was significantly influenced by both crop geometry and levels of nutrients (Table 2). In respect of summer season 2019 (season I), analysing the data pertaining to the plant spacing revealed that 60 x 15 cm (S<sub>3</sub>) recorded the highest K uptake (65.68 kg ha<sup>-1</sup>) which was followed by 100 x 10 cm (S<sub>1</sub>) recorded 63.75 kg ha<sup>-1</sup>; Whereas crop geometry of 75 x 15 cm (S<sub>2</sub>) registered the K lowest uptake (57.51 kg ha<sup>-1</sup>). Among the sub plot treatments (nutrient levels), application of 150% RDF- 120:60:60 kg NPK ha<sup>-1</sup> (F<sub>3</sub>) recorded the highest K uptake (82.77 kg ha<sup>-1</sup>) as against control plot (without fertilizer) which recorded the lowest K uptake (36.61 kg ha<sup>-1</sup>). The interaction effect was found to be significant. With regards to interaction effect, the treatment combination of 60 x 15 cm with 150% RDF (S<sub>3</sub>F<sub>3</sub>) registered the highest K uptake (86.48 kg ha<sup>-1</sup>) and was followed by S<sub>1</sub>F<sub>3</sub> (84.99 kg ha<sup>-1</sup>) and were found to be on par with each other. The lower K uptake was

reported from the plants which received no fertilizers (control) in 75 x 15 cm (S<sub>2</sub>) which registered 33.68 kg ha<sup>-1</sup>.

In the case of *rabi* season of 2019-20 (season II), crop geometry was significantly influenced the K uptake. The highest K uptake (63.40 kg ha<sup>-1</sup>) was registered in S<sub>3</sub> (60 x 15 cm) and was followed by S<sub>1</sub> (61.81 kg ha<sup>-1</sup>) and were found to be on par with each other. The lowest uptake (54.79 kg ha<sup>-1</sup>) was registered in 45 x 15 cm (S<sub>4</sub>). With regard to fertilizer levels, 150% RDF- 120:60:60 kg NPK ha<sup>-1</sup> (F<sub>3</sub>) recorded the maximum K uptake (80.84 kg ha<sup>-1</sup>) as against control (nil nutrient application) which recorded 35.38 kg/ha. Similar to first season, here again, significant interaction was observed between crop geometry and fertilizer levels. The treatment combination of 60 x 15 cm with 150% RDF (S<sub>3</sub>F<sub>3</sub>) registered the highest K uptake (84.39 kg ha<sup>-1</sup>) followed by S<sub>1</sub>F<sub>3</sub> (83.48 kg ha<sup>-1</sup>) and these two treatments were on par with each other. The lowest uptake of K (32.22 kg ha<sup>-1</sup>) was registered by 75 x 15 cm with no fertilizer (S<sub>2</sub>C).

The pooled analysis of both season revealed that it followed trend similar to that of both seasons. Among the plant populations, 1,11,111 plants/ha (S<sub>3</sub>) registered the maximum K uptake (64.53 kg ha<sup>-1</sup>) followed by population of 1,00,000 plants/ha (S<sub>1</sub>) which recorded 62.78 kg ha<sup>-1</sup>. These treatments were found to be on par with each other. The lowest K uptake registered by 75 x 15 cm (S<sub>2</sub>) which recorded 56.15 kg ha<sup>-1</sup>. Fertilizer level significantly enhanced the K uptake and F<sub>3</sub> (150% RDF- 120:60:60 kg NPK ha<sup>-1</sup>) recorded the maximum K uptake (81.80 kg ha<sup>-1</sup>). The untreated plot (control) registered the lowest K uptake (35.99 kg ha<sup>-1</sup>). The interaction effect was found to be significant. Similar to the other two seasons, the pooled analysis also registered the highest uptake of K (85.44 kg ha<sup>-1</sup>) in S<sub>3</sub>F<sub>3</sub>, followed

by 100 x 10 cm along with 150% RDF(S<sub>1</sub>F<sub>3</sub>) which recorded 84.24 kg ha<sup>-1</sup> and were on par with each other. The lowest K uptake (32.95 kg ha<sup>-1</sup>) was registered in the treatment combination of Spacing of 75 x 15 cm with no fertilizer (S<sub>2</sub>C). It was well documented from the present study that increased level of fertilizer application increases the potassium uptake. This may be due to the fact that application of K increases K<sup>+</sup> availability in the soil which was efficiently absorbed by the optimum plant population in both S<sub>1</sub> and S<sub>3</sub> and resulted in highest uptake of K in these two treatment combination than the others. The above results are in close conformity with the findings of Mullins and Burmester (1990), Modhvadia *et al.*, (2012) and (Hiwale *et al.*, 2018).

### Seed cotton yield

Seed cotton yield is the result of translocation efficiency of biomass into the economic yield. It is the combined effect of various yield components under particular environmental conditions. It is evident from the data illustrated in Table 2 that both varying plant spacing and different nutrients level had significant effect on seed cotton yield. The seed cotton yield of summer season of 2019 (season I) indicated that plant spacing significantly influenced the seed cotton yield. Spacing of 60 x 15 cm (S<sub>3</sub>) recorded the highest seed cotton yield (1884 kg ha<sup>-1</sup>), followed by 100 x 10 cm (S<sub>1</sub>) recorded 1804 kg ha<sup>-1</sup>. However, S<sub>1</sub> and S<sub>3</sub> were on par with each other. The lowest yield of seed cotton (1344 kg ha<sup>-1</sup>) was registered in crop geometry of 45 x 15 cm (S<sub>4</sub>). Nutrient levels strongly influenced the seed cotton yield. Among the treatments, 125% RDF-100:50:50 kg NPK ha<sup>-1</sup> (F<sub>2</sub>) registered the maximum seed cotton yield of 2216 kg ha<sup>-1</sup>; whereas the lower seed cotton yield (858 kg ha<sup>-1</sup>) was obtained from the untreated control. The interaction effect between treatments of main plot and sub plot

was found to be significant. It is evident from the data that 60 x 15 cm with 125% RDF-100:50:50 kg NPK ha<sup>-1</sup> (S<sub>3</sub>F<sub>2</sub>) has been judged as the best treatment combination as it registered the (2563 kg ha<sup>-1</sup>) highest seed cotton yield and it was followed by 100 x 10 cm with 125% RDF (S<sub>1</sub>F<sub>2</sub>) which recorded the second best seed cotton yield of 2585 kg ha<sup>-1</sup>. However, 60 x 15 cm with 125% RDF (S<sub>3</sub>F<sub>2</sub>) and 100 x 10 cm with 125% RDF (S<sub>1</sub>F<sub>2</sub>) were on par with each other. The plants from unfertilized control plot recorded the lowest seed cotton yield of 733 kg ha<sup>-1</sup>.

The seed cotton yield of second season (*rabi* season of 2019-20) was found to be lower than the first season crop. Favourable climatic condition prevailed during the summer season of 2019 might be the probable reason for higher seed cotton yield in first season. Lower temperature and poor sunlight are the probable causes which might have been the limiting factor for lower seed cotton yield in the second season (*rabi* season of 2019-20). Analysing the seed cotton yield performance due to the crop geometry, it was revealed that spacing of 60 x 15 cm (S<sub>3</sub>) recorded significantly the highest seed cotton yield (1747 kg ha<sup>-1</sup>) and it was followed by 100 x 10 cm (S<sub>1</sub>) of 1676 kg ha<sup>-1</sup> and both S<sub>3</sub> and S<sub>1</sub> were found to be on par with each other; whereas the lowest seed cotton yield (1239 kg ha<sup>-1</sup>) was obtained in the spacing of 45 x 15 cm (S<sub>4</sub>). With regard to nutrient levels, application of 125% RDF- 100:50:50 kg NPK ha<sup>-1</sup> (F<sub>2</sub>) recorded significantly the highest seed cotton yield (2053 kg ha<sup>-1</sup>) and the lowest seed cotton yield (792 kg ha<sup>-1</sup>) in control. The interaction effect was found to be significant. Similar to the previous season, here again, the treatment combination of 60 x 15 cm with 125% RDF (S<sub>3</sub>F<sub>2</sub>) registered the maximum seed cotton yield (2387 kg ha<sup>-1</sup>), followed by 100 x 10 cm with 125% RDF (S<sub>1</sub>F<sub>2</sub>) of 2304 kg ha<sup>-1</sup> and both S<sub>3</sub>F<sub>2</sub> and S<sub>1</sub>F<sub>2</sub> were on par with each other. The lowest seed cotton yield

(677 kg ha<sup>-1</sup>) was obtained in 75 x 15 cm (S<sub>2</sub>C).

The pooled data of both seasons revealed that the crop geometry as well as nutrient levels had significant effect on seed cotton yield. Among the spacing, 60 x 15 cm (S<sub>3</sub>) recorded the highest (1815 kg ha<sup>-1</sup>), followed by 100 x 10 cm (S<sub>1</sub>) registered the seed cotton yield of 1738 kg ha<sup>-1</sup> and the treatments S<sub>3</sub> and S<sub>1</sub> were found to be on par with each other. The lowest seed cotton yield of 1291 kg ha<sup>-1</sup> was obtained in plots from closer spacing 45 x 15 cm with higher populations. Nutrient levels significantly altered the seed cotton yield. Fertilizer application @ 125%- 100:50:50 kg NPK ha<sup>-1</sup> (F<sub>2</sub>) recorded the higher seed cotton yield (2134 kg ha<sup>-1</sup>) as against the control (without fertilizer) which registered lowest seed cotton of 824 kg ha<sup>-1</sup>.

It could be inferred from the pooled analysis that the highest seed cotton yield (2475 kg ha<sup>-1</sup>) was recorded in S<sub>3</sub>F<sub>2</sub> (60 x 15 cm with 125% RDF- 100:50:50 kg NPK ha<sup>-1</sup>) and it was followed S<sub>1</sub>F<sub>2</sub> (100 x 10 cm with 125% RDF- 100:50:50 kg NPK ha<sup>-1</sup>) which recorded 2395 kg ha<sup>-1</sup>. This could be probably due to the fact that optimum plant population (S<sub>3</sub> and S<sub>1</sub>) could have utilized the applied N, P and K. In this study, the uptake of N, P and K was found to be high in 150% RDF 120:60:60 kg NPK ha<sup>-1</sup> (F<sub>3</sub>). But all the absorbed nutrients are not effectively used for boll formation and cotton productivity. However, S<sub>4</sub> (45 x 15 cm) spacing accommodating higher plant population could resulted in reduced yield due to intra plant competition for nutrition, space, air and light. Hence, higher plant population and nutrient levels unable to increase the seed cotton yield as they limit the yield components. That is why S<sub>1</sub> and S<sub>3</sub> with 125% RDF (F<sub>2</sub>-100:50:50 kg NPK ha<sup>-1</sup>) could optimize the effective utilization of bio-resources and hence higher cotton productivity. This was in accordance

with the earlier findings of Paslawar *et al.*, (2015) and Parlawar *et al.*, (2017).

On the basis of two seasons data, it could be concluded that application of 120:60:60 kg NPK ha<sup>-1</sup> with 11,11,111 plants/ha (60 x 15 cm) and 120:60:60 kg NPK ha<sup>-1</sup> with 1,00,000 plants/ha (100 x 10 cm) recorded higher N, P and K uptake than the other treatments. However, the higher seed cotton yield of 2475 kg ha<sup>-1</sup> and 2395 kg ha<sup>-1</sup> were obtained in the treatment combinations of 60 x 15 cm with 125% RDF- 100:50:50 kg NPK ha<sup>-1</sup> (S<sub>3</sub>F<sub>2</sub>) and 100 x 10 cm with 125% RDF- 100:50:50 kg NPK ha<sup>-1</sup> (S<sub>1</sub>F<sub>2</sub>) respectively. However, these two treatment combinations were not differed statistically.

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