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Growth and nutrient uptake of cotton influenced by different cotton varieties to varied sowing dates and nutrient levels

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Abstract
The field experiment was conducted at Main Agricultural Research Station, Raichur on medium black soil during *kharif*, 2017 to study response of cotton (*Gossypium hirsutum* L.) varieties to varied sowing dates and nutrient levels. Among the varieties, BGDS-1063 produced significantly higher plant height and dry matter production per plant (126.62 cm and 288.22 g plant^{-1}) over SCS-793. Significantly higher plant height and dry matter production was noticed in case of cotton crop sown on 1st fortnight of July (128.14 cm and 292.60 g plant^{-1}) as compared with cotton sown on 2nd fortnight of July and similarly application of 150 per cent of recommended dose of fertilizer (RDF) noticed significantly higher plant height and dry matter production (129.33 cm and 294.80 g plant^{-1}) over 100 percent RDF. Similarly higher uptake of nutrients like Nitrogen, Phosphorous and Potassium was recorded significantly higher in BGDS-1063 (96.90 kgha^{-1}, 21.65 kgha^{-1} and 128.59 kg ha^{-1}) as compared with SCS-793. Among sowing dates early sown crop, crop sown on 1st fortnight of July noticed significantly higher uptake nutrient like nitrogen, phosphorous and potassium (98.01 kg ha^{-1}, 21.80 kg ha^{-1} and 129.53 kg ha^{-1}) compared with crop sown on 2nd fortnight of July and finally among application of 150 per cent recommended dose of fertilizer (RDF) registered significantly higher uptake nutrients like Nitrogen, Phosphorous and Potassium (97.14 kg ha^{-1}, 20.70 kg ha^{-1} and 122.95 kg ha^{-1}) over 100 percent RDF.

Keywords: cotton varieties, nutrient uptake, RDF, seed cotton yield

Introduction
Cotton, the 'white gold' or the 'king of fiber' is one of the most important cash crops of global importance and cultivated in tropical and subtropical regions of almost 70 countries of the world. It is the leading fiber crop of the world. Cotton is used as raw material in textile industry and this industry contributes about 14 per cent to the industrial production and 4 per cent of the GDP. India is one of the major producers of cotton in the world with largest acreage of 12.3 M ha, but productivity as low as 527 kg lint/ha as compared to global average of 735 kg lint/ha (Anonymous 2018) [1].

Supply of nutrients is the major limiting factor in cotton production and most of the soil in rainfed areas is not only thirsty but also hungry. It is well established fact that sufficient quantity of nutrients at proper time are needed for achieving high yield. The nutrient management in cotton is a complex phenomenon due to simultaneous production of vegetative and reproductive structures during the active growth phase. Cotton plant being a heavy feeder requires adequate supply of nutrients to optimize the seed cotton yield, quality and net profit in cotton production (Aladakatti *et al.*, 2011) [2].

In field, it is observed that optimum planting time and balanced nutrition of major nutrients is essential for harvesting higher yields. New cotton varieties *viz*. SCS-793 and BGDS-1063 are tested in 23 locations across the country with consistent superior performance. However these are likely to respond to higher fertilizer doses. Therefore, there is a need to establish the threshold level for these genotypes. Often sowing dates and recommended dose of fertilizer application to cotton varieties has resulted in inconsistent yield, exhibility nutrient deficiency symptoms and which is one of the main reasons for declining yield of Indian cotton cultivation.

To ensure good crop growth and development judicious use of various inputs and proper coordination of different agronomic practices are required and among all these practices, sowing time is very important to explore the genotypic potential in a particular agro-climatic region. The genotype selection is also an important component in any cropping system.

Materials and Methods
The field experiment was conducted during 2017-18 at Main Agricultural Research Station, Raichur, to study "Response of cotton (*Gossypium hirustum*) varieties to sowing dates and nutrient levels". The experiment laid out in factorial Randomized Complete Block Design (RCBD) with three replications comprised of 12 treatments.

Treatment details
Factor 1: Varieties
a. SCS-793 (V_1)
b. BGDS-1063 (V_2)

Factor 2: Sowing dates
a. 1st fortnight of July (D_1)
b. 2nd fortnight of July (D_2)

Factor 3: Fertilizer levels
a. 100% RDF (F_1)
b. 125% RDF (F_2)
c. 150% RDF (F_3)

Three levels of fertilizer doses namely 80:40:40 NPK kg/ha (100% RDF), 100:50:50 NPK kg/ha (125% RDF) and 120:60:60 NPK kg/ha (150% RDF). Data on growth and yield parameters were recorded from five randomly selected plants in each treatment; seed cotton yield (kg/plot) was calculated from whole plot and converted into kg/ha, and Collected plant samples were thoroughly washed with distilled water and dried in hot air oven at 65 °C for 8 hrs. Dried samples were powdered in a mixer grinder to a considerable fineness before storing them in butter paper bags for further analysis and analysis were done using standard procedures. The nitrogen content was determined by the Kjeldahl method (Piper, 1966). The phosphorus content was determined by Vanado-molybdo phosphoric yellow colour method and absorbance was recorded at 430 nm with spectrometer (Piper, 1966). The potassium content was determined from the same diacid digested extract with the digital flame photometer (Piper, 1966). The uptake of nitrogen, phosphorus and potassium by cotton plant at harvest was computed using the formula,

$$\text{Uptake (kg/ha)} = \frac{\text{Nutrient concentration (\%) x Biomass (kg/ha)}}{100}$$

Results and Discussion

Growth Parameters and Seed cotton yield

The plant height, number of sympodial branches plant^{-1} and dry matter production plant^{-1} differed significantly among the different cotton varieties, varied sowing dates and with application of increased nutrient levels. Among cotton varieties BGDS-1063 recorded significantly higher plant height, number of sympodial branches and dry matter production per plant (126.62 cm, 23.65 and 288.22 g/plant) compared to the cotton variety SCS-793 (124.22 cm,1.69, 21.85 and 279.06 g/plant). Cotton crop sown on 1st fortnight of July registered significantly higher plant height, sympodial branches per plant and dry matter production per plant *viz*.(128.14 cm, 23.67 and 292.60 g/plant) compared to 2nd fortnight of July (122.69 cm, 21.83 and 274.68 g/plant) and finally among different nutrient levels, application of 150 per cent recommended dose of fertilizers noticed significantly higher plant height, sympodial branches and dry matter production per plant (129.33 cm, 23.57 and 294 g/plant) followed by application of 100 per cent recommended dose of fertilizers (121.05 cm, 22.13 and 272.65 g/plant) and however it was on par with application of 125 per cent recommended dose of fertilizers (125.87 cm, 22.55 and 283.47 g/plant) respectively. Plant height differed significantly with different sowing dates at 45, 90 and 135 DAS and at final picking (Table 1). At 45 DAS, crop sown on 1st fortnight of July recorded significantly higher plant height (31.90 cm) over crop sown on 2nd fortnight of July (27.46 cm). Similar trend was observed at 90, 135 DAS and at final picking. The reduction in plant height of late sown crop at all the growth stages might be due to shorter life span of the crop and early commencement of reproductive phase. These results confirm the findings of Brar and Singh (1994) [3] and Nehra and Chandra (2001) [9]. The decrease in number of sympodial branches per plant in later sowing dates of May 10th, May 20th and May 30th was due to poor growth and development of late sown crop (Galanopoulou - Sendouka *et al.,* 1980) as evident from less plant height.

Seed cotton yield of cotton variety BGDS-1063 (2143 kg/ha) was produced significantly higher as compared to SCS-793 (1690 kg/ha). Among the date of sowing, crop sown on 1st fortnight of July was recorded significantly higher seed cotton yield (2159 kg/ha) over crop sown on 2nd fortnight of July (1675 kg/ha). Significantly higher seed cotton yield were recorded with the application of 150 per cent RDF (2049 kg/ha) and it was followed by 125 per cent RDF (1958 kg/ha) over 100 per cent RDF (1744 kg/ha). The increase in the yield attributing characters with 150 per cent RDF might be due to significantly higher amount of dry matter accumulation in reproductive parts, leaf area and LAI up to the harvest. These results are in compliance with the findings of Bastia (2000), Solanke *et al.* (2000) [3] and Gadade *et al*. (2015). Significantly higher nitrogen uptake was recorded by BDGS 1063 (96.90 kg/ha) over SCS-793 (81.11 kg/ha). Among the different dates of sowing, crop sown on 1st fortnight of July registered significantly higher nitrogen uptake (98.01 kg/ha) over crop sown on 2nd fortnight of July (80.0kg/ha). Application of 150 per cent recommended dose of fertilizers noticed significantly higher nitrogen uptake (97.14 kg/ha) followed by 125 per cent RDF (90.69 kg/ha) over 100 per cent RDF (79.18 kg/ha).

Cotton variety BGDS-1063 was recorded significantly higher phosphorus uptake (21.65 kg ha^{-1}) was noticed over SCS-793 (17.07 kg/ha). Cotton crop sown, on 1st fortnight of July registered significantly higher phosphorus uptake (21.80 kg/ha) compared to crop sown 2nd fortnight of July (16.91 kg/ha). Among nutrient levels, application of 150 per cent recommended dose of fertilizers recorded significantly higher phosphorus uptake (20.70 kg/ha) over 100 per cent RDF (17.61 kg/ha) and it was on par with 125 per cent RDF (19.77 kg/ha).

Potassium uptake of cotton variety BGDS-1063 (128.59 kg/ha) was recorded significantly higher compared to SCS-793 (101.41 kg/ha). Among the sowing dates, crop sown on 1st fortnight of July was registered significantly higher potassium uptake (129.53 kg/ha) over crop sown on 2nd fortnight of July (100.47 kg/ha). Significantly higher potassium uptake were noticed by application of 150 per cent RDF (122.95 kg/ha) and it was followed by 125 per cent RDF (117.45 kg/ha) over 100 per cent RDF (104.61 kg/ha).

Application of RDF increased the concentration of nutrient ions in the soil solution and availability of sufficient nutrients might have helped in higher nutrient uptake. Significantly, higher uptake of nitrogen, phosphorus and potassium (97.14, 20.70 and 122.95 kg/ha, respectively) was recorded with application 150 per cent RDF when compared with 100 per cent RDF and and it was followed by 125 per cent RDF (79.18, 17.61 and 104.61 kg/ha; 90.69, 19.77 and 117.45 kg/ha, respectively). These results are in accordance with the findings of Katkar *et al.* (2002) [6], Krishnegowda (2004) [7], and Sisodia and Khamparia (2007) [10].

Conclusion

Soil fertility is one of the most important factor which influences crop productivity. The yields can be maximized only when the soil has capacity to supply sufficient nutrients in balanced proportion, which require optimum fertilizer application. Based on the results of the study conducted to evaluate Nutrient uptake and seed cotton yield, it could be concluded that by increased nutrient Levels upto150 per cent RDF gives higher seed cotton yield and nutrient over 100 per cent RDF and it was on par with 125 per cent RDF.

Table 1: Growth attributes of cotton varieties as influenced by sowing dates and nutrient levels.

Treatments	Plant height (cm)	Leaf area (cm^2)	Leaf area index	Dry matter production per plant (g/plant)
Cotton Genotypes				
V_1	126.62	66.06	1.22	288.22
V_2	124.22	64.13	1.19	279.06
SEm±	0.78	0.37	0.02	0.694
CD@5%	1.61	0.76	0.04	1.439
Sowing Dates				
D_1	128.14	66.91	1.24	292.6
D_2	122.69	63.27	1.17	274.68
SEm±	0.78	0.37	0.02	0.694
CD@5%	1.61	0.76	0.04	1.439
Nutrient Levels				
F_1	129.33	66.84	1.24	294.8
F_2	125.87	65.23	1.21	283.47
F_3	121.05	63.21	1.17	272.65
SEm±	0.95	0.45	0.02	0.85
CD@5%	1.98	0.93	0.05	1.76

Table 2: Yield attributes and nutrient uptake of cotton varieties as influenced by sowing dates and nutrient levels

Treatments	Sympodial branches per plant	Seed cotton yield (kg/ha)	Nitrogen uptake (kg/ha)	Phosphorous uptake (kg/ha)	Potassium uptake (kg/ha)
Cotton Genotypes					
V_1	21.85	1690	81.11	17.07	101.41
V_2	23.65	2143	96.90	21.65	128.59
SEm±	0.19	39.61	2.25	0.40	2.37
CD@5%	0.4	82.15	4.68	0.83	4.92
Sowing Dates					
D_1	23.67	2159	98.01	21.80	129.53
D_2	21.83	1675	80	16.91	100.47
SEm±	0.19	39.61	2.25	0.40	2.37
CD@5%	0.4	82.15	4.68	0.83	4.92
Nutrient Levels					
F_1	22.13	1744	79.18	17.61	104.61
F_2	22.55	1958	90.69	19.77	117.45
F_3	23.57	2049	97.14	20.70	122.95
SEm±	0.24	48.51	2.76	0.49	2.91
CD@5%	0.49	100.61	5.73	1.01	6.03

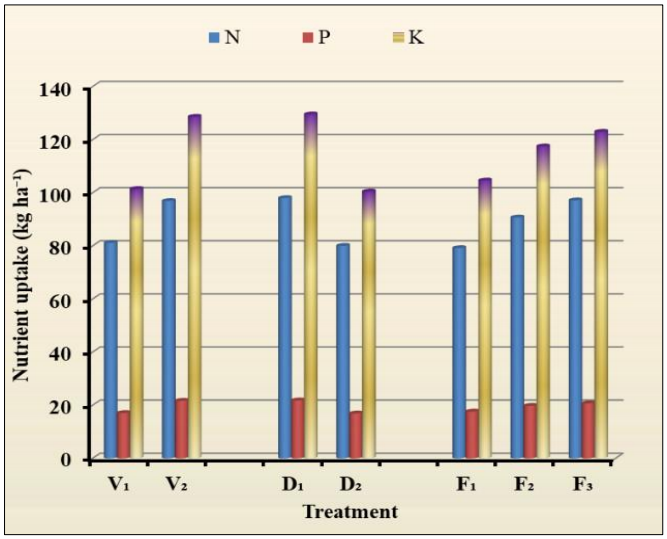

Fig 1: Uptake of nitrogen, phosphorus and potassium (kg/ha) of cotton varieties as influenced by date of sowing and nutrient levels.

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