E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(6): 164-166
Received: 02-03-2024
Accepted: 06-04-2024

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Performance of cotton cultivars under HDPS

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DOI: https://doi.org/10.33545/2618060X.2024.v7.i6Sc.836

Abstract
A field investigation was carried out at the Agricultural Research Station, Tornala (Professor Jayashankar Telangana State Agricultural University), Telangana, India during *kharif* season of 2021-22 to evaluate the performance of cotton cultivars under high density planting system (HDPS). It consisted of two cultivars *viz.,* ADB-39 under 60cmx20cm and NCS-2778 under 80cmx20cm spacing and the data was analysed through two sample t-test. The final plant population was higher with ADB 39 (77,579 plants ha^{-1}) than NCS 2778 (58,368 plants ha^{-1}). The hybrid NCS-2778 produced significantly higher boll weight (4.24 g) and kapas yield (2760 kg ha^{-1}) than variety ADB-39 (2485 kg ha^{-1}). Further, ginning % was also found to be significantly higher with NCCS-2778 than ADB-39 (31.7g). Though NCCS-2778 accrued higher cost of cultivation by ₹ 6207 ha^{-1}, it gave higher gross and net returns by ₹19,250 and 13,403 ha^{-1} than ADB-39. Thus, NCCS-2778 can be preferred hybrid than ADB-39 variety under HDPS in rainfed alfisols.

Keywords: Cotton, cultivars, high density planting, kapas yield, ginning percentage

1. Introduction
Cotton (*Gossypium hirsutum* L.) is one of the most important commercial crops in India. Cotton production in India is considered to have significant impact not only on the livelihoods of farmers and economy of the country but also on international trade. Even though India has 75% area of cotton cultivation is under *Bt* (GOI), but, productivity (442 kg ha^{-1}) is lower than world's average (808 kg ha^{-1}). Vigilant production and economic strategies are important for cotton growing farmers due to escalating cost of cultivation and stagnating productivity (Kumar *et al*., 2017). Among various factors, selection of potential genotypes along with plant densities play a vital role in increasing the productivity of cotton (Patel *et al*., 2016) [11]. In general, it was observed that lower plant densities produces high values of growth and yield attributes per plant, but yield per unit area was higher with higher plant densities (Namdeo *et al*., 1991; Dhoble *et al*., 1992; Sharma *et al*., 2001) [9, 2, 13]. Adoption of high density Planting System (HDPS) and newly released cultivars offers an alternate option for sustainable production with low cost. HDPS is generally referred as planting at closer spacing than the recommended spacing with a sole objective of maximizing the yield per unit area and it varies from genotype to genotype (Kumar and Ramachandra, 2019) [6]. Current cotton genotypes are of long-duration, tall and bushy requiring frequent pickings due to their extended growth habit, which escalates cultivation costs, especially with manual picking (Gunasekaran *et al*., 2020) [4] and also requires growth regulation in HDPS. Compact genotypes offer higher plant populations per unit area, enabling double cropping and mechanical harvesting (Baig *et al*., 2021) [1]. The majority of traits that define a genotype suitable for HDPS include shy branching, 10–15 bolls $plant^{-1}$, boll setting close to the main stem, bolls weighing 4–5 grams, uniform size and shape, all bolls bursting within 3-4 days, medium to superior medium fiber length with appreciable strength and a crop duration of 120 to 125 days to fit various cropping programs (Kumar *et al*., 2020) [7]. Adoption of HDPS with compact cultivars offers an alternate option for sustainable production with low cost. Among, cotton growing states in the India, Telangana stands 3rd in area (19.7 lakh hectares), 3rd in production (57.5 lakh bales) and 6th in productivity (495 kg ha^{-1}) (Indiastat, 2022-23). In view of dire need to enhance cotton production and productivity in Telangana, efforts are in progress to identify suitable cultivars under HDPS along with

associated agronomic package and availability of meagre information, the present research work carried out with an objective of evaluation and identification of cultivars suitable for high density planting system of cotton.

2. Materials and Methods

The experiment was carried out during *kharif* 2021-22 at Agricultural Research Station, Tornala (Professor Jayashankar Telangana State Agricultural University, Hyderabad) which comes under Central Telangana Zone in the state of Telangana. The soil of the experimental site was red sandy loam in texture with a pH of 6.7 and EC of 0.30 of dSm^{-1}. It was low in organic carbon (0.42%), low N (240.5 kg ha^{-1}), medium in available phosphorus (21.2 kg ha^{-1} P_2O_5) and available potash (225.0 kg ha^{-1} K_2O). The total rainfall received during the cropping season was 734.8 mm in 42 rainy days. 08-07-2021 to 31-11-2021 rainfall: 268.9+179.2+172.1+48.6+66 (11+12+12+4+3).

The experiment was laid out with two cultivars popular in Telangana *viz.,* V1: ADB 39 and V2: NCS-2778 duly allocating large experimental area i.e. 48.0mx24.0m for each cultivar. Since ADB-39 is a variety, it was raised with a spacing of 60cmx20cm and NCCS-2778 was grown with a spacing of 80cmx20cm as it is a hybrid, as recommended under high density planting system (HDPS) of cotton. For ease of data recording and statistical analysis, this area was divided into 10 equal sampling units each representing one replication. The data was analysed using two sample t-test. The ADB-39 variety was released from Professor Jayashankar Telangana Agricultural University, Telangana particularly for high density planting in rainfed marginal soils. It is a short, compact plant type with a crop duration of 150 to 170 days. It's boll weight between 3.0 g and 4.5 g and has yield potential of 25-28 q ha^{-1}. It yields long staple fibers measuring 25.0 to 27.5 mm in length, exhibiting good strength at 20.6 g tex^{-1} and has a ginning percentage of 36%. The cultivar NCS-2778 (BG-II) also called as Armita, is an early maturing with compact growth with ginning percent of 34-35%. It has high tolerance to thrips and whiteflies and moderate tolerance to jassids and is suitable for high density planting. A seed rate of 7.5 kg ha^{-1} was used and the sowing was done on 08-07-2021 at a spacing of 80 cm x 20 cm. The recommended fertilizer dose is 120:60:60 $NP_2O_5K_2O$ kg ha^{-1} was applied with entire dose of phosphorus as basal. The N and K_2O doses were applied in equal splits at 20, 40, 60 and 80 DAS. A healthy crop was raised duly adopting all the recommended agronomic practices and need based plant protection measures as suggested by PJTSAU, Hyderabad, Telangana. The growth, yield and economics observations were recorded as per standard procedures. Five tagged plants in each sampling unit were used for recording the data in a non-destructive way. The plant height (cm) was measured from the ground surface to the top most growing point at harvest. Further, the average number of monopodial branches $plant^{-1}$ which are exact replicas of the main stem and do not directly bear flowers and bolls were recorded. Further, sympodial branches which arise above the developing shoots and expand horizontally while bearing flowers at each node were also counted per plant basis. The total number of bolls from the five tagged plants were counted, averaged and expressed as no. of bolls $plant^{-1}$. The seed cotton obtained from bolls of tagged plants in each plot was weighed, averaged and expressed as boll weight in g $boll^{-1}$. In case of seed cotton yield (kg ha^{-1}), after picking, seed cotton obtained from each treatment in net plot plus the yield of seed cotton obtained from tagged plants in net plots in each cultivar was weighed in g $plot^{-1}$ and yield was converted into kg ha^{-1}.

Ginning Percentage: It is weight of the lint expressed as percentage to the weight of seed cotton (or kapas) (Santhanam, 1976) [12] and was calculated with the following formula.

$$\text{Ginning percentage} = \frac{\text{Weight of lint (g)}}{\text{Weight of seed cotton (g)}} \times 100$$

Gross returns (₹ ha^{-1}): Gross returns was calculated on the basis of economic yield and their existing MSP price during *kharif* 2021-2022 are taken. The following formula is used for calculation of gross return.

Gross return (₹ ha^{-1}) = Kapas yield x Market price (₹ kg^{-1})

Net returns (₹ ha^{-1}): Net returns are the income obtained after subtraction of cost of cultivation (₹ ha^{-1}) from gross returns (₹ ha^{-1}).

Net return (₹ ha^{-1}) = Gross returns (₹ ha^{-1}) - Cost of cultivation (₹ ha^{-1})

Benefit: Cost Ratio (BCR): It is the ratio of gross returns (₹ ha^{-1}) to the cost of cultivation (₹ ha^{-1}).

$$\text{BCR} = \frac{\text{Gross returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

3. Results and Discussion

The data in Table 1 indicated that, plant height (cm), no. of monopodial branches, sympodial branches and total no. of branches $plant^{-1}$ and and no. of bolls $plant^{-1}$ were not significantly affected by the two cultivars evaluated under HDPS. The final plant population and kapas yield (1% level), boll weight and ginning % (at 5% level) were significantly influenced by cultivars. ADB-39 recorded a significantly higher plant population ha^{-1} (77,579 plants ha^{-1}) compared to NCS-2778 (58,368 plants ha^{-1}). Significantly higher kapas yield (2760 kg ha^{-1}) was obtained with NCS-2778 which is 11.1% more than that of ADB-39 (2485 kg ha^{-1}). It was primarily due to significantly more boll weight (4.24 g) and higher ginning percentage with NCS-2778 (33.9%) than ADB-39 (4.08, 31.7g). The boll weight is the major yield component in *G. hirsutum* cotton under rainfed conditions (Singh *et al*., 1983) [14]. Seed cotton yield ha^{-1} is the product of number of bolls per unit area and individual boll weight (Pandagale *et al*., 2020) [10]. Such results were earlier published by Gouthami *et al*. (2023) [3] according to whom, NCS-2778 with more boll weight (5.2) and seed cotton yield (2845 kg ha^{-1}) showed significant superiority to Bt Suraj (2151 kg ha^{-1}), WGCV-79 (2310 kg ha^{-1}) and ADB-39 (2288 kg ha^{-1}) under Telangana edapho-climatic conditions The differences in yield potential among genotypes can be attributed to a variety of physiological processes, which are influenced by the interplay between the plant's genetic composition and the surrounding environmental conditions (Udikeri and Shashidhara, 2017) [15]. Regarding economics, despite higher cost of cultivation (₹ 97,499 ha^{-1}) by ₹ 6,072 ha^{-1}, higher gross (₹ 1,93,200 ha^{-1}), net returns (₹ 95,701 ha^{-1}) and B:C (1.98) were accrued with NCS-2778 compared to ADB-39 (₹ 1,73,950 ha^{-1}, ₹82,658 ha^{-1} and 1.91, respectively.) under high density planting system of cotton.

Table 1: Performance of cotton cultivars under HDPS (*Kharif* 2021)

Cultivars	Final Population (ha^{-1})	Plant height (cm)	No. of sympodial branches $plant^{-1}$	No. of monopodial branches $plant^{-1}$	No. of total branches $plant^{-1}$	No. of bolls $plant^{-1}$	Boll weight (g)	Total Kapas yield (kg ha^{-1})	Ginning (%)	Gross returns (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C ratio
ADB 39*	77579	93.4	11.3	2.5	13.8	13.3	4.09	2485	31.7	173950	91292	82658	1.91
NCCS 2778**	58368	95.3	11.4	2.4	13.7	12.3	4.24	2760	33.9	193200	97499	95701	1.98
t-cal value	23.379**	-0.434	-0.303	0.780	0.277	1.514	-2.105*	-3.872**	-2.635*				
Probability	.000	.669	.765	.445	.785	.147	.050	.001	.017				

NS: Non-significant
*=Significant at 5% level
**=Significant at 1% level

4. Conclusion
From the foregoing results, it could be concluded that cultivation of NCS-2778 hybrid with 80cmx20cm spacing under high density planting system was proved productive and profitable than ADB-39 due to realisation of higher kapas yield and net income.

5. Way Forward
Additionally, future field studies can concentrate on canopy management, particularly the timing of growth regulator and defoliant applications. In the Indian context, it is also essential to promote mechanization for cotton harvesting and baling, ensuring that the quality of cotton fiber remains uncompromised.

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