RESEARCH ARTICLE

PERFORMANCE OF NUTRIENTS ON COTTON GROWN IN POLYPROPYLENE BAGS

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Received-09.12.2021, Revised-04.01.2022, Accepted-15.01.2022

Abstract: A field investigation to evaluate the impact of foliar spray of nutrients (NPK, micronutrients and NPK + micronutrients) on Bt-cotton was conducted in the research field of Jawaharlal Neharu Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, Madhya Pradesh, India during July-2020 to January-2021. Foliar spray of NPK, micronutrients and NPK + micronutrients was the three treatments evaluated against the control. The plants growth indicators recorded were plant height, thickness of stem and number of sympoidal branches; while yield indicators were number of bolls, width of bolls, fibre+seed cotton yield and plant biomass as fuelwood. The mean plant height (MPH) was highest (67.6cm) for micronutrients on 55th day after sowing (DAS) *i.e.*, before the foliar spray of treatments. The MPH was highest on plants treated with NPK. It was 113.7cm, 132.4cm and 137.6cm on 85th, 130th and 180th DAS. Similarly, the highest mean thickness of stem (14.67mm), mean number of sympoidal branches (29.71 plant^{-1}), mean number of bolls (62.14 plant^{-1}), mean width of boll (36.50mm), mean weight of fibre+ seed (270.00g) and mean weight of plant biomass (727.14g plant^{-1}) was also recorded under foliar spray of NPK. There was no significant difference among the treatments for mean thickness of stem and mean weight of fibre+seed.

Keywords: Cotton, Polypropylene bags, Doubling of farmers income, Nutrients, Foliar application, Stem thickness

INTRODUCTION

Cotton is a widely grown fibre crop in more than 70 countries. China, the United States, India, Pakistan, Uzbekistan, Australia, Brazil, Greece, Argentina, and Egypt are the major cotton-producing countries (ISAAA, 2016). In India, cotton is cultivated in 9 mha and stands first in acreage (Passricha et al. 2020). China has become one of the countries with the highest lint yield of cotton. In 2012-13, the average lint yield was 769 kg ha^{-1} in the world, while it was 1438 kg ha^{-1} in China. It was 45, 113 and 194 percent higher than that in the US, Pakistan and India respectively (USDA, 2013). In India, cotton is grown on 12.29m ha area. Andhra Pradesh (6.6m ha), Karnataka (6.4m ha), Haryana (6.1m ha), Madhya Pradesh (5.6m ha), Rajasthan (4.5m ha) and Maharashtra (4.2m ha) are the major cotton growing states of India (Anon, 2018). Cotton is a high input crop (Singh and Arora, 2015) due to use of chemical fertilizers, pesticides and costly seeds.

Cotton is mostly cultivated by small farmers in India, generally as rainfed crop. The average cost of cultivation of cotton is Rs 69,956 per ha. (Reddy *et al*. 2018); while, the net return is about Rs 61,974.09 per ha. (Shelke *et al*., 2016). The productivity of cotton depends on local climatic conditions (Mohansundaram, 2015) and management practices (Gopalkrishnan *et al*. 2007). The famous black cotton soil in MP stretches to16.21m ha. (Anon. 2010), yet cotton is limited to few (Khargone, Khandwa, Harda and Nimar) districts (Anon, 2016). The performance of cotton under Jawahar model technology was evaluated by growing the crop in substrate filled used polypropylene bags. The attempt was focused on promoting cotton among small and marginal farmers with limited resources even in non-traditional areas.

MATERIALS AND METHODS

Planting method

Cotton (Rashi Bollguard-2) was sown in 65kg substrate filled polypropylene bag (PPB) of size (24x36 inches). The substrate consisted of a mixture of 40kg *kapu* (riverbed basin soil) or light soil, 25kg well rotten FYM and a consortia of biofertilizers (Patent application no. 201921005340A dated 01.03.2019). The trial with four treatments and seven replicates was conducted in the Jawahar model field of JNKVV, Jabalpur. Agro climatically, Jabalpur lies in Zone-VII, Kymore plateau and Satpura hill zone of Madhya Pradesh. The mean maximum and minimum temperature is 40-43^{o}C (in May) and 8-10^{o}C (in January) respectively, while the mean annual rainfall is 1358mm. The zone is known for Rice-Wheat cropping system and has a good share fields with deep black soil. This soil is well suited for cotton crop, though it is not cultivated.

Treatments

Cotton seed sown on 30th July 2020 in substrate filled PPBs germinated on 4th August 2020. The substrate filled PPB with cotton plants were kept at a spacing of 3feet (plant to plant and row to row). Drip irrigation system was installed with one dripper (2lph) per PPB. The plants were irrigated six times during the cropping period from the November 1st to December 30th at an interval of 10 days. The four treatments consisted foliar application of NPK (T_1), Micronutrients (T_2), NPK + Micronutrients (T_3) and

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Control (T_4). There was one foliar spray at flowering stage. The control treatment consisted of water spray.

Plant growth indicator

Plant growth indicators- plant height, stem thickness and number of sympoidal branches were recorded. The plant growth was recorded by measuring plant height at 55, 85, 130 and 180DAS. Number of sympoidal branches per plant was counted on 29th October 2020 (91st DAS), while the stem thickness was measured on 25th October 2020 (87th DAS).

Yield indicators

The production indicators were number of bolls per picking, size of bolls (mm) and yield per plant (g). At the end of the cropping period on 28th January 2021 (180DAS), the biomass per plant was also recorded.

RESULTS

Mean plant height (MPH)

The mean plant height (MPH) increased during all the four observation period. On 55th DAS, the MPH varied from 62.29cm (T_4- Control) to 67.57cm (T_2- Micronutrients). There was no significant difference in the MPH among the treatments, since there was no foliar spray of the treatments during this period of observation. Though, T_2 (Micronutrients) had 8.48 percent more MPH in comparison to the control (no spray).

Foliar application of nutrients (treatments) was on 68th DAS. On 85th DAS *i.e.*, 17 days after the foliar spray of treatments, the MPH varied from 100.43cm (T_4- Control) to 113.71cm (T_1- NPK). The MPH of T_1 (113.71cm) and T_2 (106.71cm) was significantly higher than the rest of the treatments. It also differed significantly among T_1 and T_2. In comparison to the control (T_4), the MPH of T_1 (NPK) was 13.22 percent more. On 130th DAS *i.e.*, 62 days after the foliar spray of treatments, the MPH varied from 103.57cm (T_3- NPK + micronutrients) to 132.43cm (T_1- NPK). The latter was significantly higher over all the remaining three treatments, which were at par among themselves. In comparison to T_3 (NPK + micronutrients), the MPH in T_1 (NPK) was 27.87 percent more.

On 180th DAS *i.e.*, 112 days after the foliar spray of treatments, the MPH varied from 110.86cm (T_4- Control) to 137.57cm (T_1- NPK). The latter was significantly higher than the rest of the three. In comparison to T_4 (Control), the MPH of T_1 (NPK) was more by 24.09 percent. Between 55th DAS and 180th DAS, the percent increase in MPH of T_1 (NPK) was 107.53 percent, while that of T_2 (Micronutrients), T_3 (NPK + micronutrients) and T_4 (Control) was 70.19, 72.95 and 77.97 percent respectively.

Mean thickness of stem (MTS)

The MTS on 87th DAS *i.e.*, 19 days after the foliar spray of treatments varied from 12.92mm (T_3- NPK + micronutrients) to 14.67mm (T_1- NPK) yet there was no significant difference among the treatments.

Mean number of sympoidal branches

The mean number of sympoidal branches on 91st DAS i.e., 23 days after the foliar spray of nutrients varied from 22.71 per plant (T_3- NPK + micronutrients) to 29.71 in T_1 (NPK). The latter was significantly highest over all the treatments.

Yield indicator

Flowering initiated on 5th October 2020 (68th DAS) while boll formation from 23rd October 2020 (85th DAS onwards). The boll size measured on 31st October 2020 (93rd DAS and 25 days after foliar spray), varied from 35.25mm (T_2- Micronutrients) to 36.50mm (T_1- NPK). The latter had significantly biggest boll over all the treatments. There were five pickings. The two pickings were on 3rd and 19th December 2020, while the remaining three pickings were on 3rd, 18th and 27th January 2021 i.e., on 125th, 141st, 156th, 171st and 180th DAS respectively. The mean number of total bolls per plant in these pickings varied from 43.73 (T_3- NPK + micronutrients) to 62.14 (T_1- NPK). The latter was significantly higher over rest of the others. The mean cotton yield per plant in PPB varied from 210g (T_3- NPK + micronutrients) to 270g (T_1- NPK) but there was no significant difference among the treatments. After the last picking on 27th January 2021, the cotton plants were uprooted on 28th January 2021 and weighed to record the biomass. It varied from 388.57g (T_4- Control) to 727.14g (T_1- NPK). In comparison to T_4 (Control), the biomass in the latter (T_1- NPK) was 87.13 percent more.

Table 1. Details of observations recorded on cotton

Treatments	Indicators mean									
	Plant growth							Production		
	Plant height				Stem thickness	Sympoidal branches	Boll width	Bolls	Yield/ PPB	Biomass (g)
	55	85	130	180	mm	No./plant	mm	No./plant	g	
	DAS (cm)							5 picking		
NPK (T_1)	66.3	113.7	132.4	137.6	14.67	29.71	36.50	62.14	270.00	727.14
Micronutrient (T_2)	67.6	106.7	110.1	115.0	14.15	27.43	35.25	46.57	222.86	442.86

NPK + Micronutrient (T_3)	64.4	102.7	103.6	111.4	12.92	22.71	35.68	43.43	210.00	412.86
Control (T_4)	62.3	100.4	106.6	110.9	13.52	26.71	36.00	49.71	217.14	388.57
SeM	1.4	2.92	4.61	5.60	0.92	2.32	0.42	4.25	21.86	93.96
C.D. (0.05%)	4.1	8.54	13.45	16.35	2.69	6.77	1.23	12.41	63.81	274.24
Significance	NS	S	S	S	NS	S	S	S	NS	S

Table 2. Economics of nutrient application (treatments)

Treatment			Change over control			Treatment B:C ratio
Code	Cost	Income	Fibre+seed	Biomass	Income	
	Rs./plant		g/plant		Rs./plant	
NPK (T_1)	0.18	14.58+3.64 (18.22)	+52.86 (24.34%)	+338.57 (87.13%)	+4.55 (33.28%)	1:25.28
Micronutrient (T_2)	0.28	12.03+2.21 (14.24)	+5.72 (2.63%)	+54.29 (13.97%)	+0.57 (4.17%)	1:2.03
NPK + Micronutrient (T_3)	0.35	11.34+2.06 (13.40)	-7.14 (-3.28%)	+24.29 (6.25%)	-0.27 (-1.98%)	1:0.77
Control (T_4)	-	11.73+1.94 (13.67)				
Price of Cotton @ Rs. 54/kg and biomass @ Rs. 5/kg						

The cost of treatment per plant varied from Rs. 0.18 to Rs. 0.35 per plant depending on the nutrient dose. The total income per PPB of cotton varied from Rs. 13.40 (Rs. 11.34 from fibre and Rs. 2.06 from biomass) in T_3 (NPK + micronutrients) to Rs. 18.22 (Rs. 14.58 from fibre and Rs. 3.64 from biomass) in T_1 (NPK). The relative change in the mean weight of fibre+seed (g/plant), biomass (g/plant) and income (Rs./plant) in treatments over the control was appreciable in the treatments T_1 (NPK) and T_2 (Micronutrients). The relative change in in mean weight of fibre+seed was 52.86g/plant i.e., 24.34 percent in T_1 and 5.72g/plant i.e., 2.63 percent in T_2, while in T_3 the mean weight of fibre+seed was lesser than control by 7.14g/plant i.e., 3.28 percent. The relative change in the mean weight of biomass (fuelwood) was 338.57g/plant i.e., 87.13 percent in T_1, 54.29g/plant i.e., 13.97 percent in T_2 and 24.29g/plant i.e., 6.25 percent in T_3. The relative change in average income per plant was Rs. 4.55/plant i.e., 33.28 percent in T_1 and Rs. 0.57/plant i.e., 4.17 percent in T_2, while it was lesser than control in T_3 by Rs. 0.27/plant i.e., 1.98 percent. The B:C ratio of foliar nutrition (treatments) was highest (1:25.28) in T_1 (NPK) and lowest (1:0.77) in T_3 (NPK+ micronutrients).

DISCUSSION

No significant difference in the MPH of cotton plants prior to the foliar application of nutrients confirms that there was uniform plant growth prior to treatments (during pre-treatment).

The MPH on 180th DAS ranged from 110.86cm in control to 137.57cm in NPK foliar application. The MPH in cotton plants is governed by climate, genomic and also management factors (Staggenborg *et al*. 1992). Kanchana *et al*. (2019) reported MPH of cotton between 94.21cm to 104.3cm which was significantly influenced by fertilizer application. Similar results were reported by Tamilselvam *et al*. (2013). Zarina *et al*. (2011) as well as Udikeri and Shashidhara (2017) also reported that plant height increased linearly with each increment of Nitrogen. Sahito *et al*. (2015) reported maximum plant height of cotton varying from 123.44cm to 138.16cm depending on varieties and irrigation scheduling.

It may be noted that the Sahito *et al*. (2015) grew cotton in field following all agronomic practices of land preparation, fertilizer application, weed management and six irrigations at 21 days interval. The present plant height was achieved by direct sowing of cotton seeds in the substrate filled PPBs thus cost cutting of majority of operations. Throughout the four observations, cotton plants with foliar application of NPK (19:19:19) proved to be best. It means VAM, *Aspergillus*, *Trichoderma* in FYM may have mobilized soil nutrients efficiently. Role of rhizosphere microbial population in the health of both plant and soil is widely reported (Mishra et al. 2017). The stem thickness also grew due to foliar application.

There was a significant increase in number of sympoidal branches. On 91st DAS, it varied from 22.71 to 29.71 per plant. Number of sympoidal branches on cotton plant determines the yield of the crop, as on it bolls are formed. Sahito *et al*. (2015)

recorded a maximum of 24.88 sympoidal branches in variety NIAB-78 against the present observation of 29.71 per plant. Kanchana *et al*. (2019) and Bharati *et al*. (2012) recorded a non-significant difference in the mean number of sympodial branches against various levels of nutrient application.

The foliar application of NPK had the highest bolls (62.14) per plant; while Sahito *et al*. (2015) recorded 44.58 per plant. The number of bolls per plant reported by earlier workers varied from 34.11 to 44.66 (Sahito *et al*., 2015), 16.8 to 26.2 (Karar *et al*., 2017) and 14.68 to 17.83 found that the mean number of bolls per plant varied from 12.2 (75% RDF) to 16.6 (150% RDF) and significantly influenced by fertilizer application. It was highest (16.6) for 150 percent RDF which was at par with 125 percent RDF (16.4) and 100 percent RDF (14.8). The fresh width of boll reported by Ahmad *et al*. (2019) varied from 25.6mm to 36.7mm in 2016 and 31.2mm to 37.8mm in 2017 in the variety Siza-1; while 26.1mm to 38.1mm in 2016 and 31.5mm to 38.7mm in 2017 in the variety Sikang-1 was similar with the present findings. Kanchana *et al*. (2019) observed no significant difference in the mean number of bolls per plant against various genotypes and nutrient levels.

The maximum yield (fibre+seed) was 270g in the treatment of NPK foliar spray. Though there was no significant difference in the yield among the treatments, but, it can be assumed that if the foliar application was earlier than 58 DAS and at least three sprays. The yield would have been better.

The maximum yield on the present findings was comparatively much higher than that of Sahito *et al*. (2015) varying from 134.25g to 151.36g per plant and as 141.39g to 149.98g per plant respectively. Udikeri and Shashidhara (2017) reported that the yield of cotton increases with increase in fertilizer application.

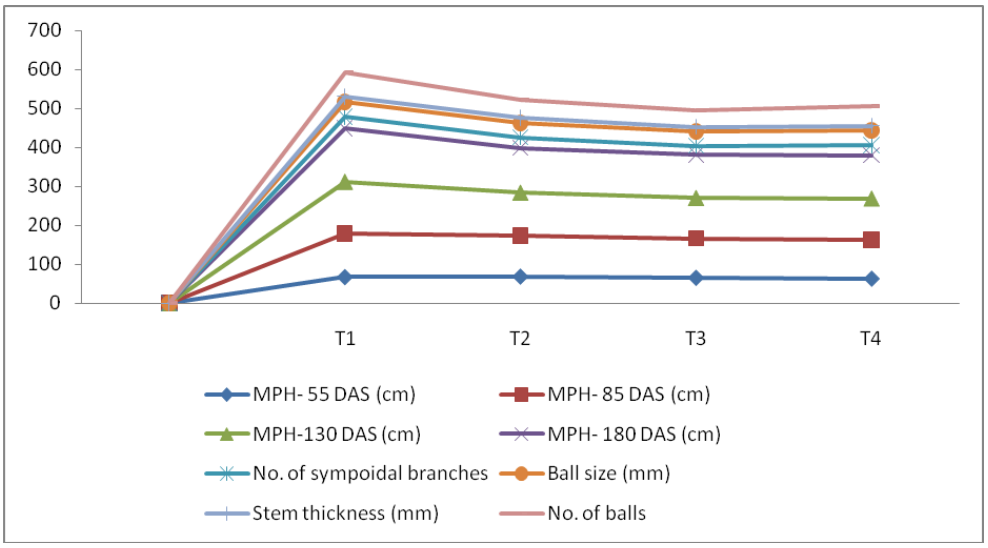

Figure 1. Growth indicators of cotton

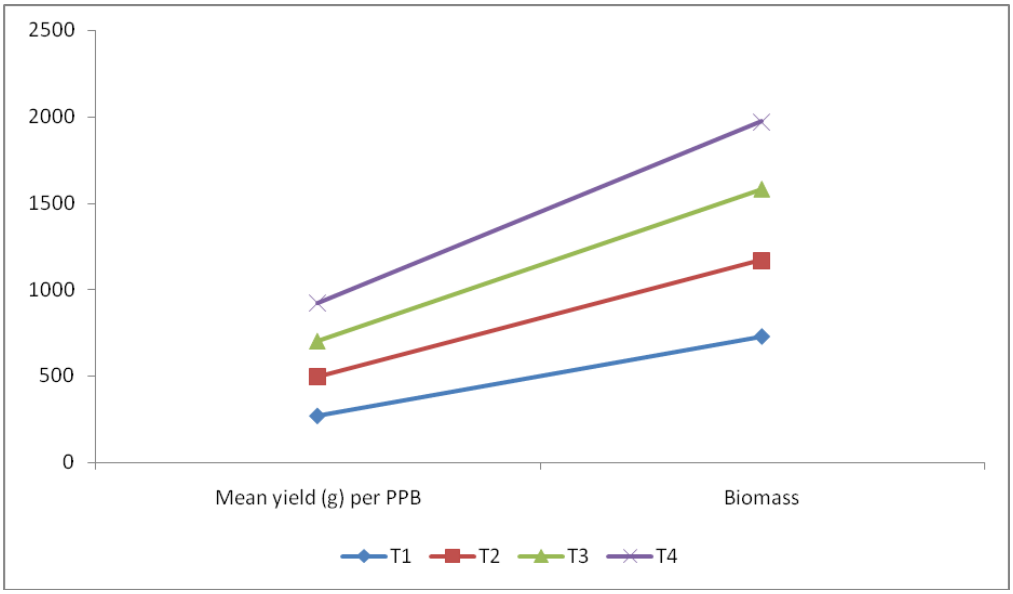

Figure 2. Productive indicators of cotton

CONCLUSION

The present finding reveals another possibility of growing cotton profitably in substrate filled PPBs. This method will reduce the cost of land preparation, soil fertilizer application, timely sowing without waiting for the monsoon showers and organically. In the present method, the plant growth and yield is comparatively better than the traditional practices of cotton cultivation.

ACKNOWLEDGEMENT

The administrative support extended by the Director Research Services, JNKVV, Jabalpur is gratefully acknowledged by the authors.

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