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Bhoomika SL
PG Scholar, Department of Soil Science, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

AB Age
Associate Professor (CAS), Department of Soil Science, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

SD Jadhao
Professor and Head, Department of Soil Science, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

SM Bhoyar
Associate Dean, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

PS Solunke
Technical Officer, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

Shubhangi J Dhage
Assistant Professor (CAS), Department of Soil Science, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

Corresponding Author:
Bhoomika SL
PG Scholar, Department of Soil Science, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth (PDKV), Akola, Maharashtra, India

Effect of different compost on growth, yield and nutrient uptake by *Bt* cotton in vertisols

Bhoomika SL, AB Age, SD Jadhao, SM Bhoyar, PS Solunke and Shubhangi J Dhage

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Abstract
A field experiment was conducted during the 2024-25 *kharif* season at the Research Farm, Department of Soil Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra),with objective was to evaluate the effect of various composts on the growth, yield, and nutrient uptake by *Bt* cotton in Vertisols. The study included eight treatments: T_1 - Absolute Control, T_2 - 10 t ha^{-1} FYM (University recommended dose), T_3 - 75% RDN through vermicompost, T_4 - 75% RDN through NPS compost, T5 - 75% RDN through phosphocompost, T_6 - 100% RDN through vermicompost, T_7 - 100% RDN through NPS compost, and T_8 - 100% RDN through phosphocompost. The experiment laid out in a Randomized Block Design (RBD) with three replications.

The results reveal that the application of 100% RDN through NPS compost was found significantly highest at 60, 90 DAS and at harvest, and was found statistically at par with 100% RDN through vermicompost, 10 t ha^{-1} FYM, and 100% RDN through phosphocompost. The significantly highest numbers of bolls per plant and boll weight were observed under 100% RDN through NPS compost, comparable with 10 t ha^{-1} FYM and 100% RDN through vermicompost. The seed cotton and stalk yield of cotton were recorded significantly highest with application of 100% RDN through NPS compost (13.54 and 26.23 q ha^{-1}) and was found at par with 10 t ha^{-1} FYM, 100% RDN through vermicompost, and 100% RDN through phosphocompost. N, P, and K uptake was significantly enhanced with 100% RDN through NPS compost, with nitrogen and phosphorus uptake at par with 10 t ha^{-1} FYM and 100% RDN through phosphocompost and in potassium uptake it was found at par with 100% RDN through vermicompost. All parameters were found lowest in the absolute control. It can be concluded that the application of 100% RDN through NPS compost, mutually beneficial with the application of 100% RDN through vermicompost and 100% RDN through phosphocompost increased the growth, yield as well as enhanced the nutrient uptake by cotton.

Keywords: FYM, vermicompost, NPS compost, phosphocompost, seed cotton and stalk yield, nutrient uptake, Vertisols

Introduction

Cotton (*Gossypium* spp.) is one of the most important fibre and commercial crops in India, playing a vital role in the agricultural sector and contributing significantly to the country's industrial economy. Widely recognized as the backbone of the textile industry, cotton is often referred to as the "King of Fibre" and is popularly known as "White Gold" for its immense value in both agriculture and industry.

Globally, cotton is cultivated on about 31.1 million hectares (76.84 million acres), with total world production expected to reach 121 million bales (each weighing 217.72 kg) in 2024-25. India remains a major contributor to global cotton production, accounting for approximately 12.68 million hectares—around 37.5% of the world's total cotton area. However, the country's production is anticipated to decline from 325.22 lakh bales in 2023-24 to 294.25 lakh bales in 2024-25, mainly due to reduced sowing area and adverse weather conditions.

Maharashtra continues to lead in both area and production of cotton within India, with around 42.22 lakh hectares under cultivation and an output of 89.09 lakh bales, followed by Gujarat, which is expected to produce 71.34 lakh bales. Approximately 3 million farmers in Maharashtra are involved in cotton farming, primarily in the underdeveloped regions of Marathwada and Vidarbha (PJTSAU, 2025) [12]. Cotton has been integral to human civilization for over 7,000 years and continues as one of the most widely utilized natural

fibres globally. In India, the textile and apparel industry closely tied to cotton, contributes approximately 2 % of GDP and about 8.21 % of total exports, while providing direct employment to over 45 million people (Ministry of Textiles,2024) [7].

Organic agriculture continues to expand globally, with practices now adopted in 188 countries. By the end of 2023, approximately 98.9 million hectares of agricultural land were managed organically, marking a 2.6% increase from the previous year. This growth is supported by around 4.3 million organic producers worldwide. The global market for organic food and beverages reached approximately 136.4 billion euros in 2023.In India, the total area under organic cultivation during the fiscal year 2023-24 was 7.3 million hectares, comprising 4.5 million hectares of farmed land and 2.8 million hectares of wild collection areas. This accounts for about 7.4% of the global organic agricultural area. India continues to lead globally in the number of organic producers, with approximately 2.5 million farmers engaged in organic agriculture (FiBL & IFOAM, 2024) [4]. Organic cotton farming offers premium prices to growers who can manage cultivation without synthetic pesticides or chemical fertilizers. It emphasizes sustainable nutrient management using organic manures, oil cakes, and green manures. Pest and disease control is achieved through crop rotation, biopesticides, botanical extracts, and encouraging beneficial organisms like predators and parasitoids. These eco-friendly practices minimize reliance on synthetic inputs and non-renewable resources.

Composting is a fundamental component of organic farming, effectively addressing nutrient deficiencies and the decline in soil fertility resulting from prolonged chemical use. Different compost types offer specific agronomic benefits, NPS compost provides a balanced supply of nitrogen, phosphorus, and sulphur, promoting nutrient uptake and boll development, farmyard manure (FYM) enhances soil structure and supports microbial activity, vermicompost supplies readily available nutrients along with plant growth-promoting compounds and phosphocompost, fortified with rock phosphate significantly improves phosphorus availability especially in phosphorus (Dsouza *et al.*, 2020) [3].

Materials and Methods

The present investigation on "Effect of different compost on the growth, yield, and nutrient uptake of *Bt* Cotton in Vertisols" was conducted at the Research Farm, Department of Soil Science, Dr. PDKV, Akola, during the 2024-25 *kharif* season. The experiment was laid out in a randomized block design (RBD) with eight treatments, each replicated three times. The eight treatments are T_1 - Absolute Control, T_2 - 10 t ha^{-1} FYM (University recommended dose), T_3 - 75% RDN through vermicompost, T_4 - 75% RDN through NPS compost, T_5 - 75% RDN through phosphocompost, T_6 - 100% RDN through vermicompost, T_7 - 100% RDN through NPS compost, and T_8 - 100% RDN through phosphocompost. The Ajeet-155 variety of *Bt* cotton was used for study. The spacing adopted was 90cm × 45 cm, the method of sowing followed was dibbling and the recommended dose of fertilizer was 90:45:45 N P K kg ha^{-1} (supplied through organic sources based on nitrogen equivalence).

The plant samples were collected randomly from each treatment at harvest of the crop. After cleansing on they are shade-dried, and oven-dried at 60-65°C to constant weight. The dried samples were ground to fine powder, labelled, and stored in polythene bags for further chemical analysis. Total nitrogen was estimated using the Kjeldahl method with H_2SO_4 digestion and automatic distillation. Phosphorus was determined by the vanado-molybdate yellow color method using a spectrophotometer, while potassium was measured by flame photometry from diacid extracts. Nutrient uptake was calculated based on nutrient concentration and dry weight of plant parts, expressed on a per hectare basis (Piper, 1966) [11].Cotton was picked from the net plots in all the replications and yield per hectare was calculated. Plant height was measured from ground level to the growing point of five randomly selected plants per plot at several stages and the average was recorded.

The number of bolls per plant was counted from five randomly selected plants and averaged.

For boll weight, five bolls were collected from five plants per plot, weighed, and the average weight was recorded. The data was the subjected to statistical analysis.The composts used for the experiment were analysed for their N, P, K and S content and are presented in Table 1.

Table 1: Nutrient content of organic sources used in the experimentation

Sr. No.	Name of organic source	Nutrient content (%)			
		N	P	K	S
1.	FYM	0.52	0.23	0.47	0.20
2.	Phosphocompost	0.80	1.85	0.72	0.72
3.	NPS Compost	1.76	1.92	0.92	0.92
4.	Vermicompost	1.23	0.80	0.96	0.96

Results and discussion

Growth parameters of cotton

a) Plant height.

The data on the effect of different compost on the plant height of cotton is presented in Table 3, revealed that at 30DAS the numerically higher plant height was recorded with 100% RDN through vermicompost (8.39 cm), followed by 10t ha^{-1} FYM (8.37 cm). The significant differences in plant height asinfluenced by different compost as was found at 60, 90DAS and at harvest of cotton. The significantly highest plant height was observed in 100% RDN through NPS compost (T_7), recording 32.67 cm, 63.87 cm, and 84.50 cm at 60, 90 DAS, and at harvest, respectively and was found statistically at par with 100% RDN through vermicompost (T_6), 10 t ha^{-1} FYM (T_2), and 100% RDN through phosphocompost (T8). The lowest height was noted in the absolute control (T1) during 30, 60, 90DAS and at harvest. The results highlight the positive effect of organic composts on plant growth due to sustained nutrient release and improved soil properties, aligning with findings by Tamak *et al.* (1998) [16] and Singh *et al.* (2020) [14].

Table 2: Effect of different compost on plant height of cotton

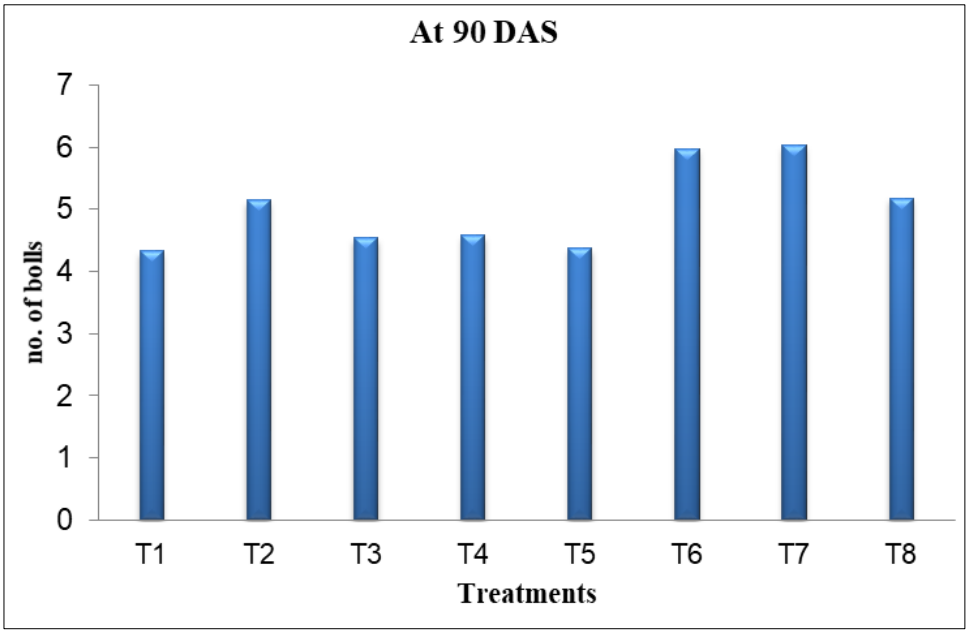
Treatments		Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At Harvest
T_1	Absolute Control	8.19	28.43	57.87	70.33
T_2	10t ha^{-1} FYM (Recommended Dose of FYM)	8.37	32.2	59.67	82.74
T_3	75% RDN through Vermicompost	8.31	30.57	58.40	76.80
T_4	75% RDN through NPS compost	8.33	31.22	58.83	77.38
T_5	75% RDN through Phosphocompost	8.26	30.53	58.22	75.83
T_6	100% RDN through Vermicompost	8.39	32.43	62.7	83.33
T_7	100% RDN through NPS compost	8.34	32.67	63.87	84.50
T_8	100% RDN through Phosphocompost	8.28	31.25	61.10	83.00
SE(m)±		0.11	0.27	0.37	1.03
CD at 5%		NS	0.81	1.11	3.11

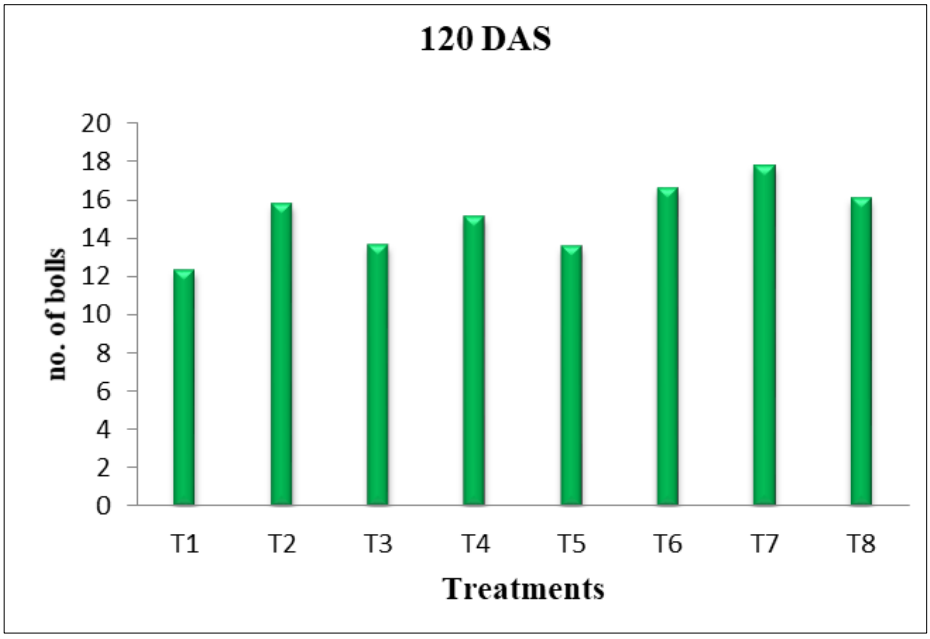
b) No. of bolls per plant and Boll weight of cotton

The results presented in Table 3 shows the effect of different compost significantly influenced the number of bolls per plant of cotton at 90, 120, and 150 DAS, as well as the boll weight at harvest. The treatment with the application of 100% RDN through NPS compost (T_7) recorded significantly highest number of bolls 6.03 at 90 DAS, 17.76 bolls $plant^{-1}$ at 120 DAS, and 23.03 bolls $plant^{-1}$ at 150 DAS. This was statistically at par with 100% RDN through vermicompost (T_6) at 90 and 120 DAS, and with 100% RDN through phosphocompost (T_8) and 10 t ha^{-1} FYM (T_2) at 120 and 150 DAS. The lowest number of bolls per plant was recorded in the absolute control (T_1). Whereas significantly highest boll weight of 5.83 g was observed in 100% RDN through NPS compost (T_7), which was statistically at par with 10 t ha^{-1} FYM (5.75 g). The lowest boll weight (3.58 g) occurred in absolute control. The improvement in boll number and weight under compost treatments can be attributed to a consistent nutrient supply, enhanced soil structure and increased microbial activity, all of which contributed to better boll development. These findings are in conformity with Nawlakhe *et al.* (2010) [8]. Singh *et al.* (2020) [14] showed that application of FYM @ 30 t ha^{-1} resulted in significantly higher number of bolls per plant and boll weight of cotton.

Table 3: Effect of different compost on number of bolls per plant and boll weight of cotton.

Treatments		No. of bolls $plant^{-1}$			Boll weight (g)
		90 DAS	120 DAS	150 DAS	
T_1	Absolute Control	4.33	12.30	19.16	3.58
T_2	10t ha^{-1} FYM (Recommended Dose of FYM)	5.15	15.81	22.11	5.75
T_3	75% RDN through Vermicompost	4.54	13.64	21.23	4.68
T_4	75% RDN through NPS compost	4.58	15.13	21.66	5.27
T_5	75% RDN through Phosphocompost	4.37	13.57	20.38	5.35
T_6	100% RDN through Vermicompost	5.97	16.57	22.63	5.57
T_7	100% RDN through NPS compost	6.03	17.76	23.03	5.83
T_8	100% RDN through Phosphocompost	5.18	16.04	22.57	5.56
SE(m)±		0.233	0.549	0.338	0.07
CD at 5%		0.705	1.664	1.026	0.23





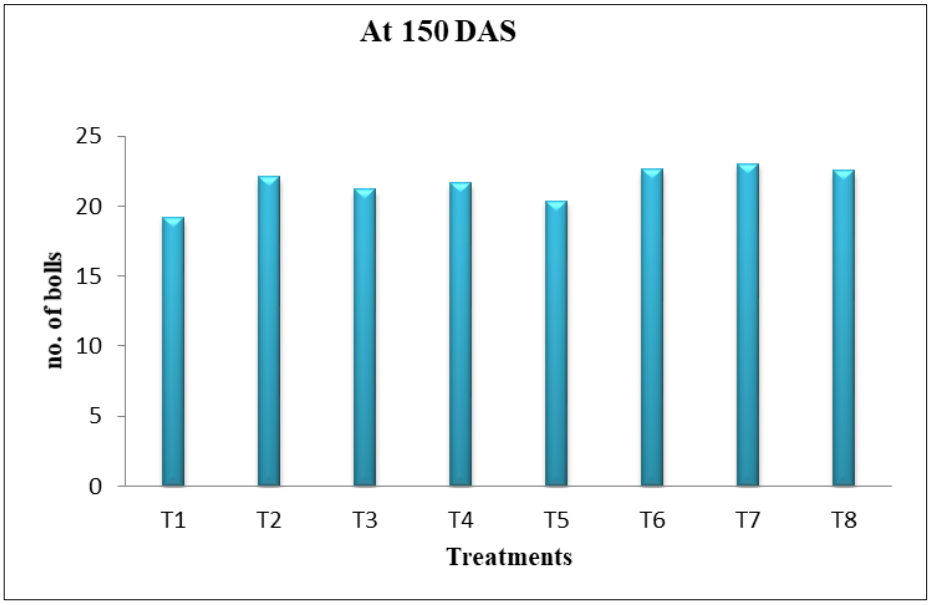


Fig 1: Effect of various compost on number of bolls per plant of cotton

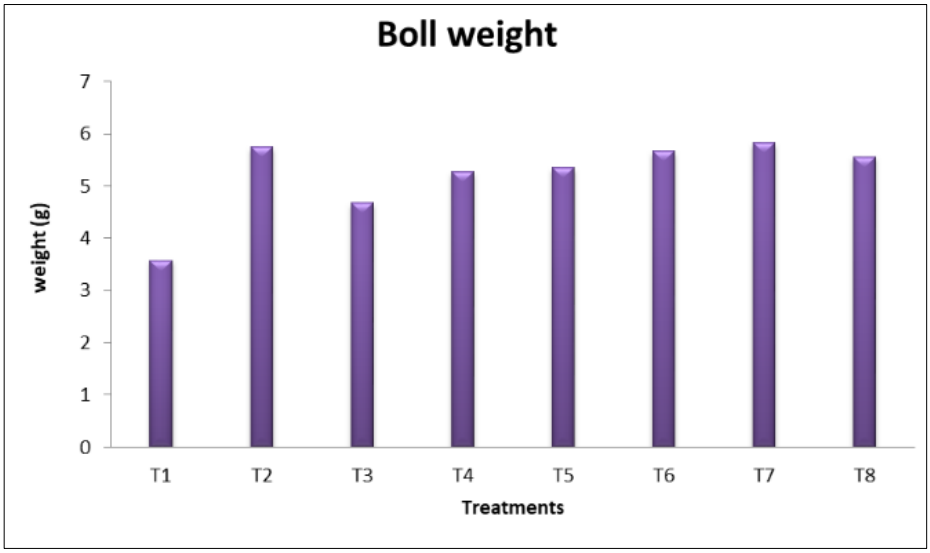


Fig 2: Effect of various compost on boll weight of cotton

Seed cotton and stalk yield of cotton

The results from Table 4 and Fig 3 indicate that seed cotton and stalk yield of cotton were significantly influenced by different compost treatments, ranging from 8.56 to 13.54 q ha^{-1} and 14.22 to 26.23 q ha^{-1}, respectively. The highest seed cotton yield (13.54 q ha^{-1}) was recorded with 100% RDN through NPS compost (T_7), statistically at par with 10 t ha^{-1} FYM (12.91 q ha^{-1}) and 100% RDN through vermicompost (12.63 q ha^{-1}). The lowest yield was observed in the absolute control (8.56 q ha^{-1}). Similarly, the highest stalk yield (26.23 q ha^{-1}) was recorded under NPS compost, statistically at par with 100% RDN through phosphocompost (25.28 q ha^{-1}) and 10t ha^{-1} FYM (23.54 q ha^{-1}), while the control recorded the lowest (14.22 q ha^{-1}).The increase in the yield with the application of NPS compost might be due to enhanced nutrient uptake because of increased nutrient availability from well-decomposed composts, improving soil fertility and plant growth. These results are in close agreement with the findings of Solunke *et al.* (2011) [15] and Bonge *et al.* (2017) [2].

Table 4: Effect of different compost on seed cotton and stalk yield of cotton.

Treatments		Seed cotton yield	Stalk yield
		(qha^{-1})	
T_1	Absolute Control	8.56	14.22
T_2	10t ha^{-1} FYM (Recommended Dose of FYM)	12.91	23.54
T_3	75% RDN through Vermicompost	10.88	19.28
T_4	75% RDN through NPS compost	11.04	19.66
T_5	75% RDN through Phosphocompost	11.19	20.43
T_6	100% RDN through Vermicompost	12.63	23.38
T_7	100% RDN through NPS compost	13.54	26.23
T_8	100% RDN through Phosphocompost	11.67	25.28
SE(m)±		0.74	0.93
CD at 5%		2.25	2.83

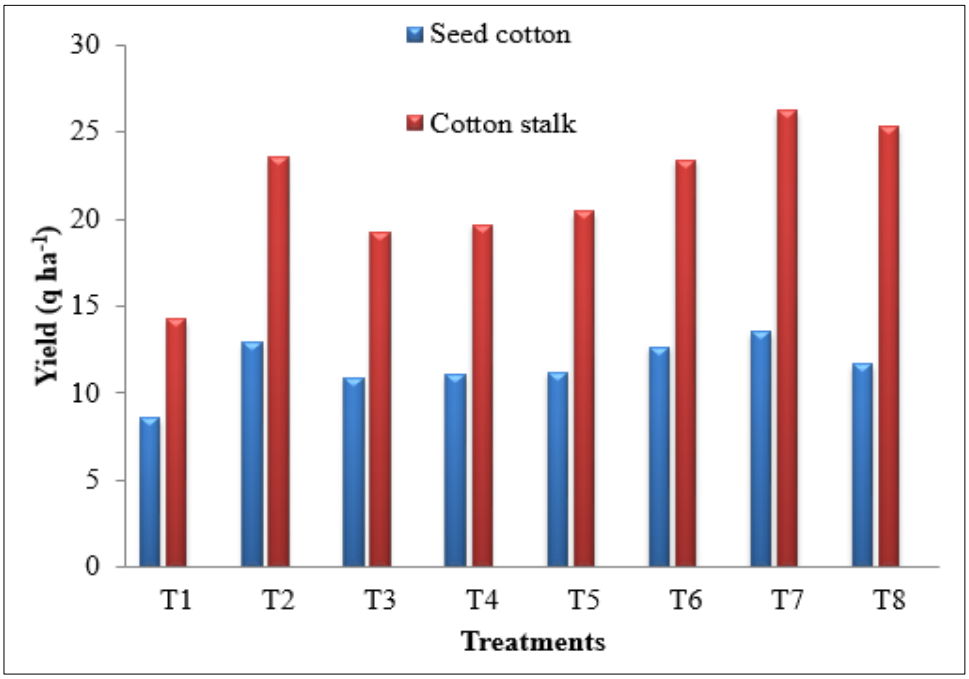


Fig 3: Effect of various compost on the yield of cotton

Nutrient uptake by cotton

a) Nitrogen uptake

Nitrogen uptake by seed cotton, stalk, and total plant, as presented in Table 5 and depicted in Fig 4, was significantly influenced by the application of different compost treatments. The highest nitrogen uptake was recorded in 100% RDN through NPS compost, with 25.83 kg ha^{-1} in seed cotton and 30.20 kg ha^{-1} in stalk. This was statistically at par with 100% RDN through vermicompost, 10 t ha^{-1} FYM and 100% RDN through phosphocompost, which recorded 24.00 and 26.49 kg ha^{-1}, 23.87 and 26.73 kg ha^{-1}, and 22.10 and 28.77 kg ha^{-1} in seed cotton and stalk, respectively. The lowest nitrogen uptake was observed in the absolute control, with 15.35 kg ha^{-1} in seed cotton and 15.50 kg ha^{-1} in stalk. Across all treatments, nitrogen uptake was generally higher in the stalk than in the seed cotton. However total nitrogen uptake, the significantly highest value (56.04 kg ha^{-1}) was observed in 100% RDN through NPS compost, which was statistically at par with 100% RDN through phosphocompost (50.88 kg ha^{-1}) and 10 t ha^{-1} FYM (50.60 kg ha^{-1}). The absolute control recorded the lowest total nitrogen uptake (30.85 kg ha^{-1}). The higher nitrogen uptake observed with NPS compost, phosphocompost, vermicompost, and FYM can be attributed to their balanced and sustained nutrient release, which supports improved root development, microbial activity, and enzymatic processes such as nitrate reductase activity, thereby enhancing nitrogen absorption and assimilation in cotton. The results are in confirmity with the findings of Age *et al.* (2019) [1].

Table 5: Effect of different compost on the nitrogen uptake by cotton.

Treatments		N uptake (kg ha^{-1})		
		Seed cotton	Cotton stalk	Total N
T_1	Absolute Control	15.35	15.50	30.85
T_2	10t ha^{-1} FYM (Recommended Dose of FYM)	23.87	26.73	50.60
T_3	75% RDN through Vermicompost	20.31	21.77	42.08
T_4	75% RDN through NPS compost	20.67	21.88	42.55
T_5	75% RDN through Phosphocompost	21.23	22.39	43.62
T_6	100% RDN through Vermicompost	24.00	26.49	50.50
T_7	100% RDN through NPS compost	25.83	30.20	56.04
T_8	100% RDN through Phosphocompost	22.10	28.77	50.88
SE(m)±		1.33	1.40	1.56
CD at 5%		4.05	4.24	5.54

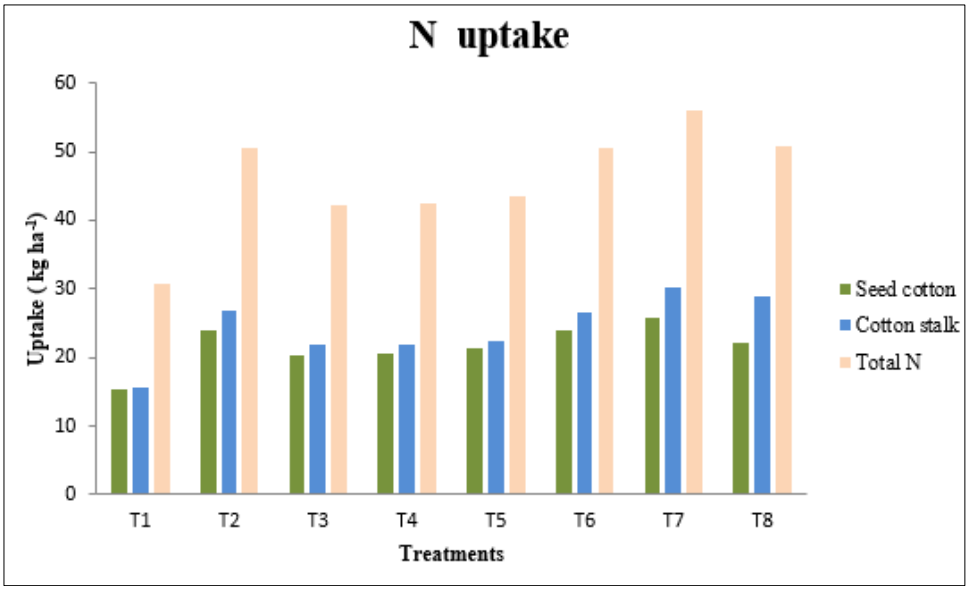


Fig 4: Effect of various compost on Total N uptake by cotton

b) Phosphorous uptake

The data on phosphorus uptake by seed cotton, stalk, and total uptake under different compost treatments are presented in Table 6 and presented graphically in Fig 5. The highest phosphorus uptake by seed was recorded in 100% RDN through NPS compost with 16.48 kg ha^{-1} and was statistically at par with 100% RDN through vermicompost (15.12 kg ha^{-1}) and 10 t ha^{-1} FYM(15.20 kg ha^{-1}), while the lowest was observed in absolute control(9.98 kg ha^{-1}).For phosphorus uptake by stalk, 100% RDN through NPS compost recorded the highest value (5.44 kg ha^{-1}), which was at par with 100% RDN through phosphocompost, (4.97 kg ha^{-1}); the lowest was again in absolute control (2.24 kg ha^{-1}). Across all treatments, phosphorus uptake was consistently higher in seed cotton than in stalk. Whereas total phosphorus uptake was significantly highest in 100% RDN through NPS compost (21.92 kg ha^{-1}), and was found at par with 100% RDN through vermicompost (19.36 kg ha^{-1}) and 10 t ha^{-1} FYM (19.30 kg ha^{-1}), with the lowest in absolute control (12.22 kg ha^{-1}). The improved phosphorus uptake with application of treatments can be attributed to balanced nutrient release. These results align with the findings of Pal *et al.* (2020) [10], Padghan *et al.* (2020) [9], and Gawande M N (2024) [5], who reported enhanced phosphorus uptake with organic nutrient sources such as phosphocompost and FYM.

Table 6: Effect of different compost on the phosphorous uptake by cotton.

Treatments		P uptake (kg ha^{-1})		
		Seed cotton	Cotton stalk	Total P
T_1	Absolute Control	9.98	2.24	12.22
T_2	10t ha^{-1} FYM (Recommended Dose of FYM)	15.20	4.10	19.30
T_3	75% RDN through Vermicompost	13.22	3.54	16.76
T_4	75% RDN through NPS compost	13.48	3.89	17.38
T_5	75% RDN through Phosphocompost	13.62	3.61	17.23
T_6	100% RDN through Vermicompost	15.12	4.24	19.36
T_7	100% RDN through NPS compost	16.48	5.44	21.92
T_8	100% RDN through Phosphocompost	14.07	4.97	19.03
SE(m)±		0.09	0.32	0.90
CD at 5%		2.74	0.97	2.74

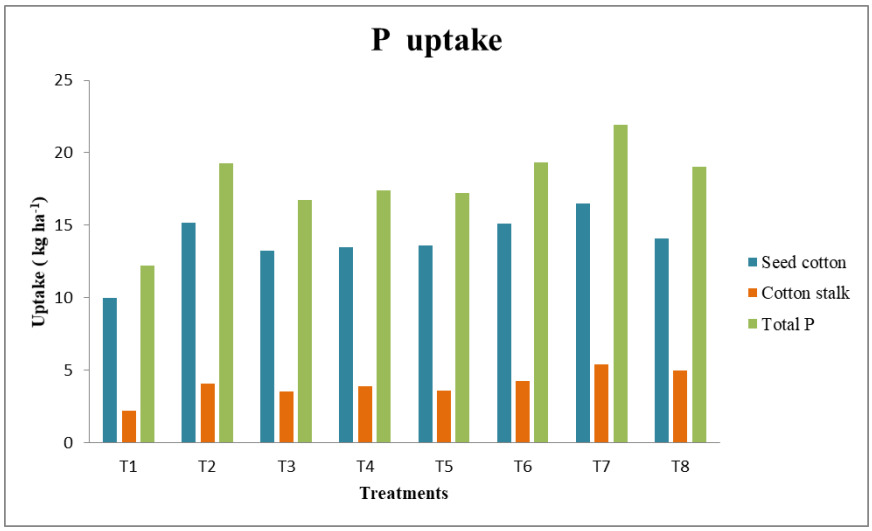


Fig 5: Effect of various compost on Total P uptake by cotton

c) Potassium uptake

The potassium uptake by seed cotton, stalk, and the total uptake under different compost treatments varied significantly across the treatments is presented in Table 7. The significantly highest potassium uptake by cotton seed and stalk was recorded in 100% RDN through NPS compost (T_7) with 21.93 kg ha^{-1} and 20.52 kg ha^{-1}, respectively and was found at par with 100% RDN through vermicompost (19.83 and 18.11 kg ha^{-1}), 10t ha^{-1} FYM (19.67 and 17.42 kg ha^{-1}), and 100% RDN through phosphocompost (18.14 and 19.05 kg ha^{-1}), all of which were statistically at par. The lowest uptake was observed in absolute control, with 12.91 kg ha^{-1} in seed cotton and 10.23 kg ha^{-1} in stalk. Overall, potassium uptake by seed cotton was slightly higher than that by stalk across all treatments. Regarding total potassium uptake was significantly highest in 100% RDN through NPS compost (42.45 kg ha^{-1}), which was statistically at par with 100% RDN through vermicompost (37.93 kg ha^{-1}), while the lowest was in absolute control (23.14 kg ha^{-1}). The increased uptake in compost-treated plots may be attributed to improved soil physical conditions, enhanced microbial activity, and better potassium availability in the root zone. These findings are consistent with Age *et al.* (2019) [1], who reported increased potassium uptake in cotton with organic nutrient sources, and further supported by Thimmareddy *et al.* (2013) [17] and Khambalkar *et al.* (2017) [6].

Table 7: Effect of different compost on the potassium uptake of by cotton.

Treatments		K uptake (kg ha^{-1})		
		Seed cotton	Cotton stalk	Total K
T_1	Absolute Control	12.91	10.23	23.14
T_2	10t ha^{-1} FYM (Recommended Dose of FYM)	19.67	17.42	37.09
T_3	75% RDN through Vermicompost	16.93	14.97	31.90
T_4	75% RDN through NPS compost	16.96	14.47	31.43
T_5	75% RDN through Phosphocompost	17.08	15.04	32.12
T_6	100% RDN through Vermicompost	19.83	18.11	37.93
T_7	100% RDN through NPS compost	21.93	20.52	42.45
T_8	100% RDN through Phosphocompost	18.14	19.05	37.18
SE(m)+		1.18	1.06	1.56
CD at 5%		3.59	3.23	4.75

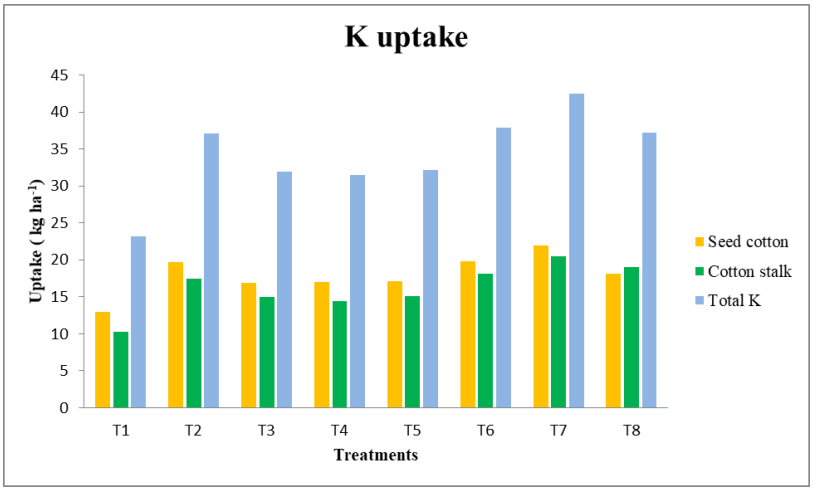


Fig 6: Effect of various compost on Total K uptake by cotton

Conclusion

It can be concluded that the application of 100% RDN through NPS compost significantly enhanced plant height, number of bolls plant^{-1}, boll weight, seed cotton and stalk yield of cotton, as well as the uptake of nitrogen, phosphorus, and potassium by cotton. Similar improvements were also observed with 100% RDN through phosphocompost, 100% RDN through vermicompost, and 10 t ha^{-1} FYM.

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