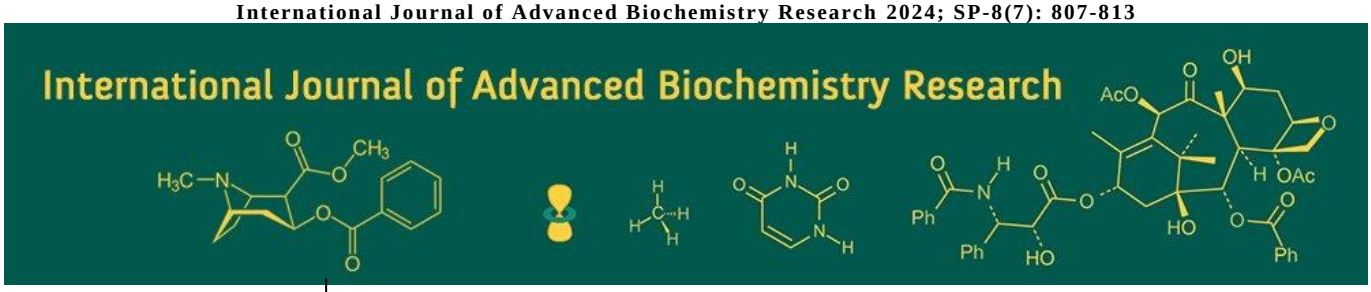

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Organic nutrient management in colour cotton

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Abstract
A field experiment was conducted at Agriculture Research Station, Achalpur, Dist. Amravati under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the season *kharif* 2022-23. The topography of the field was fairly uniform and levelled. The soil was medium black cotton belonging to order Vertisol. The number of picked bolls plant^{-1}, boll weight (g), and seed cotton yield plant^{-1} (g), and lint yield plant^{-1} (g) along with seed cotton, lint and stalk yield of colour cotton hectare^{-1} of colour cotton was observed significantly higher with treatment T_3 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS over all other treatments. The seed cotton equivalent yield of colour cotton was observed significantly higher with treatment T_6 - Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS (1775 kg ha^{-1})**.** The available NPK status and bacterial, fungal and *Actinomycetes* population in soil at flowering stage of colour cotton was significant with treatment T_3 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of Sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS over all other treatments**.**

Keywords: Organic, nutrients, colour cotton

Introduction
Organic farming is one of the several approaches found to meet the objectives of sustainable agriculture. Many techniques used in organic farming like intercropping, mulching and integration of crops and livestock are not alien to various agriculture systems including the traditional agriculture practiced in old countries like India. Organic farming is one of the widely used methods, which are thought of as the best alternative to avoid the ill effects of chemical farming. In organic farming system nutrient management is one of the most important challenges as per the nutrient requirement of crop for those different organic sources including farmyard manure, vermicompost, jeevamrut and green manuring with legume crops are use in organic farming. Each organic source has its own importance for soil health and crop health.

Jeevamrut is low-cost liquid organic manure which is an excellent source of natural carbon, beneficial micro-organism such as nitrogen fixing and phosphate solubilizing bacteria, macro and micro-nutrients. Jeevamrut is made from pure desi cow dung, desi cow urine, jaggery, pulse flour, and fertile soil. Thus, the use of Jeevamrut is the best alternative organic source of nutrients instead of chemical fertilizer and better bio-enhancer to improve the fertility status of soil and increase the sustainable crop productivity, quality, profitability, nutrient use efficiency and resources use efficiency.

The beneficial effects of Jeevamrut reported by Palekar (2006) [14], Vasanthkumar (2006) [28] and Devakumar *et al*., (2008) [3] was attributed to higher microbial load and growth hormones which might have enhanced the soil biomass thereby sustaining the availability and uptake of applied as well as native soil nutrients which ultimately resulted in better growth and yield of crops. Jeevamrut also rich in various microorganisms like *Azospirillium*, PSM, *pseudomonas*, *trichoderma*, *yeast* and mould which promotes immense biological activity in soil and makes the nutrients available to crop (Devakumar *et al*., 2008) [3].

Sunhemp (*Crotalaria juncea*) is a popular as green manure in many tropical and subtropical areas in the world as an organic nitrogen source sunhemp suppresses weeds, slows soil erosion, and reduces root- knot nematode populations.

When ploughed under the early bloom stage, nitrogen recovery is highest. Under optimum growing conditions sunhemp can produce 134 to 147 lb acre^{-1} of nitrogen (N) and 3 tons acre^{-1} organic matter at 60 days of growth at 40 kg seed ha^{-1}. Cutting the crop down to 1 ft 100 days after planting and then letting the plant re-grow for a period of 70 days has been found to increase the N content of the biomass (Abdul-Baki *et al.*, 2001) [1].

Green manuring with sunhemp is most economical and practically applicable method identified for enhancing the soil organic carbon. Addition of organic matter through green manures plays an important role in improving productivity of crop besides improvement in soil physico-chemical properties, which often deteriorate under intensive cropping involving inorganic fertilization (Hiremath and Patel, 1996) [8]. The beneficial effects of the green manuring and intercropping have already been studied in various part of the world in different soils and diverse crops (Hongal, N. 2001; Hayder *et al*., 2003) [9, 7]. Green manure builds up considerable soil organic carbon due to the addition of Phyto-mass and biomass (Selvi and Kalpana, 2009) [22]. It was observed that soil organic carbon content in different soil layer in plots with green manuring increased to the extent of 25 to 50 per cent as compared to no green manuring (Sur *et al*., 1993; Sharma *et al*., 2000) [27, 23]. The use of vermicompost has long been recognized as an effective means of increasing crop yields through improved soil physical, chemical and biological properties (Gopinath *et al*., 2010) [5]. Vermicompost is a nutritive 'organic fertilizer' with 2-3 per cent nitrogen, 1.55-2.25 per cent phosphorus and 1.85-2.25 per cent potassium besides micronutrients. It is reach in bacteria, actinomycetes, fungi and cellulose-degrading bacteria.

Black gram (*Vigna mungo*) is one of the important pulse crop grown in the rainfed farming system throughout India. It has high nutritive value and consist high content of proteins, vitamins and minerals. Grain contains about 24 per cent protein, 60 per cent carbohydrate, 1.3 per cent fats and is the richest among the various pulses in phosphoric acid, being 5 to 10 time richer than others. Black gram is used as green manuring crop and it possesses deep root system which binds soil particles and thus prevents soil erosion. Black gram is used as nutritive fodder especially for milk cattle. Cowpea (*Vigna unguiculata)* is a important pulse crop. The grains contain 25 per cent protein and several vitamins and minerals. The plant tolerates drought, performs well in a wide variety of soils, and being a legume replenishes low fertility soils when the roots are left to decay. It also grows and covers the ground quickly, preventing erosion. Application of biofertilizers result in increased mineral and water uptake, role in development, vegetative growth and 15 to 30 per cent increase in crop yield (Wankhade *et al.*, 2001) [29].

Maharashtra is the leading state in respect of area (39.41 lakh hectare) under cotton cultivation. Which shares 32.82 per cent of the total cotton growing area of the country (120.06 lakh hectare) but ranks second in production (78 lakh bales) which is 21.10 per cent of the production next to Gujarat and 9th in productivity 319 kg ha^{-1} (Anonymous 2021^{c}) [2]. Conventional white cotton is the sought after in the world and most of the countries in the world rely upon cotton for a significant percent of GDP. But the production of white cotton has become increasingly associated with severe negative environmental impacts like reduce soil fertility, salinization etc. Cotton processing also takes another toxic toll, as the use of chlorine bleaching agents, formal-dehydes and phenols is quite dangerous to all lives, fabrics dyes utilizing arsenic, lead, cadmium, cobalt, zinc and chromium are skin irritants and children are especially sensitive to their effects. So, the demand for harmful dyes and pesticides free cotton is increasing in cotton industries. In this context, there is revival of interest in organic and naturally colour cotton without recourse to dyeing using harmful and polluting chemicals.

In recent years organic colour cottons are receiving increasing importance in view of their eco- friendly character. The awareness about the toxicity and pollution caused by synthetic dyes have revived the interest in cultivation of organic cotton. The urge for eco-friendly cotton can only be fulfilled preferably by organically grown colour cotton, dispensing harmful chemicals in dying and processing. Naturally colour cotton totally eliminates the process of colouration as this cotton has a colour gene present in the lumen of the fibre that imparts natural colour to cotton as it grows and matures. The fabric has inherent anti-microbial, UV protective and better comfort properties farm to fabric conversion without chemical processing. The dyeing process adds to the cost of production of fabric. The dyeing process is omitted when naturally colour lint is used for manufacturing of the fabric. Thus, the cost of production of fabric can be reduced to some extent through the use of naturally colour cotton.

In organic farming system nutrient management is one of the most important challenges as per the nutrient requirement of crop for those different organic sources including farmyard manure, vermicompost, jeevamrut and green manuring with legume crops are use in organic farming. Each organic source has its own importance for soil health and crop health.

Materials and Methods

A field experiment was conducted at Agriculture Research Station, Achalpur, Dist. Amravati under Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the season *kharif* 2022-23. The topography of the field was fairly uniform and levelled. The soil was medium black cotton belonging to order Vertisol. The soil of experimental plot was clayey in texture (Piper, 1966) [16]. Soil was slightly alkaline in reaction (pH-7.9). Among nutrient status it ranged medium in organic carbon, low in available nitrogen174.3 kg ha^{-1} (Subbiah and Asija, 1956) [26], very low in available phosphorus 12.21 kg ha^{-1} (Olsen *et al*., 1954) and very high in available potassium412.74 kg ha^{-1} (Jackson, 1967) [11].

Achalpur is situated in the subtropical region at 21^{0}15'26'' North latitude and 77^{0}30'31'' East longitude and at an altitude of 375 m above mean sea level. Total rainfall received at Agriculture Research Station, Achalpur, Dist. Amravati was 994.2 mm rainfall in 54 rainy days as against normal rainfall (677.17 mm) during crop growing period. The treatment details as below

T_1: Control.

T_2: Vermicompost @ 2.5 t ha^{-1} + Jeevamrut 10% at 50 DAS.

T_3: Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS.

T_4: Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS).

T_5: Vermicompost @ 2.5 t ha^{-1} + Cowpea in 2:1 proportion at 60 cm spacing (Green manuring of cowpea at 40 DAS) + Jeevamrut 10% at 50 DAS.
T_6: Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS.

Note
1) Seed treatment with Beejamrut, Azotobactor and PSB along with Biological Pest control will be followed in all treatments.
2) Five rows of sunhemp and one row of ambadi were sown at border of experimental plot.

In the present investigation, healthy and viable seeds of colour cotton (Vaidehi-95) variety of 160-170 days duration was used. cotton was sown by hand dibbling at 90 and 60 cm spacing between two rows with two seeds $hill^{-1}$ as per treatment. With fertilizer dose 60:30:30 NPK kg ha^{-1}. Jeevamrut was prepared by using 10 kg cow dung (fresh) + 10 litres cow urine + 2 kg jaggery + 2 kg pulse flour (Cowpea) + 1kg live soil in 200 litres water in a container and stirred well, allowed mixture to ferment for 7 days under tree shade. The mixture was stirred twice (morning and evening) every day in a clockwise direction, the container was kept under well ventilated open shade. The mouth of container was tied with thin cotton cloth to enable proper aeration in the container. Sunhemp: It was used as intercrop and grown line of cotton. It was then incorporated in soil at 40 days after sowing as green manuring. Cowpea is used as a green manure crop and it was sown along with cotton in 2:1 row proportion and black gram was sown along with cotton in 2:1 row proportion. It was grown till the plucking of pods and then stalks and straw was incorporated in to the soil as source of nitrogen through biological nitrogen fixation.
The microbial population was determined by serial dilution plate technique using respective media for each group as per Dhingra and Sinclair (1993) [4]. Soil samples were procured from the rhizospheric soil of turmeric grown with treatments under the field conditions. Bacteria count (cfu 10^{-6} g^{-1}) - The serially diluted supernatant (1ml) of 10^{-4} was taken with pipette and spread over into petriplates filled with potato – dextrose agar media. Fungi count (cfu 10^{-4} g^{-1}) - The serially diluted supernatant (1ml) of 10^{-6} was taken with pipette and spread over into petriplates filled with potato – dextrose agar media. Actinomycetes count (cfu 10^{-4} g^{-1}) - The serially diluted supernatant (1ml) of 10^{-3} was taken with pipette and spread over into petriplates filled with potato – dextrose agar media. The statistical design was Randomized Block Design (RBD) with four replications and data was analyzed by "Analysis of Variance" method (Panse and Sukhtame, 1967) [15] and F test of significance was used for testing. Study the effect of organic sources of manures on soil health in organic colour cotton with objectives to study the effect of organic nutrients on yield and quality of colour cotton and soil fertility.

Results and Discussion
The Different organic treatments show significant influence on the number of picked bolls $plant^{-1}$, boll weight (g), and seed cotton yield $plant^{-1}$ (g), lint yield $plant^{-1}$ (g) except seed index (g) under various treatments.

Table 1: Number of picked bolls $plant^{-1}$, boll weight, seed cotton yield $plant^{-1}$, lint yield $plant^{-1}$ and seed index of colour cotton as influenced by various organic treatments.

	Treatments	No. of picked bolls $plant^{-1}$	Boll weight (g)	Seed cotton yield $plant^{-1}$ (g)	Lint yield $plant^{-1}$ (g)	Seed Index (g)
T_1	Control	19.83	2.20	13.62	4.35	7.10
T_2	Vermicompost @ 2.5 t ha^{-1} + Jeevamrut 10% at 50 DAS.	23.73	2.40	23.27	7.57	7.10
T_3	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS.	34.14	2.80	32.93	10.93	7.14
T_4	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS).	33.56	2.75	32.41	10.78	7.13
T_5	Vermicompost @ 2.5 t ha^{-1} + Cowpea in 2:1 proportion at 60 cm spacing (Green manuring of cowpea at 40 DAS) + Jeevamrut 10% at 50 DAS.	28.16	2.55	27.27	9.00	7.13
T_6	Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS.	26.81	2.50	26.19	8.53	7.11
	SE (m) ±	1.39	0.11	1.08	0.39	0.03
	CD at 5%	4.18	0.34	3.26	1.18	NS

The number of picked bolls $plant^{-1}$, boll weight (g), and seed cotton yield $plant^{-1}$ (g), and lint yield $plant^{-1}$ (g) of colour cotton was observed significantly higher with treatment T_3 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS (34.14, 2.80, 32.93, 10.93 and 7.14) over all other treatments. However, this treatment remained at par with treatment T_4 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS). Improvement in different growth and development credits expanded photosynthetic productivity of colour cotton which leads to higher assimilate production and their efficient partitioning to the economic sink. Increase in number of bolls might likewise be because of better environment that promoted number of bolls. Similar type of results was reported by Ramprakash and Mangal Prasad (2000) [18] and Nawlakhe *et al*. (2010) [13]. Organic sources provided balanced nutrients to plant for advancing growth and yield contributing characters. Further, impact of organic manures on physical properties of soil was also a significant factor which might support the reproductive development. The similar results were confirmed in response of vermicompost and *in-situ* green manuring by Rajput (1999) [17], Hulhali and Patil (2005) [10], Nawlakhe *et al*. (2010) [13] and Solunke *et al*. (2011) [25]. Increased lint yield of colour cotton might be due to balanced nutrient supply to plant with organic sources for promoting plant growth and yield contributing characters as

the trend in lint yield was the same as in case of seed cotton yield. Similar result was reported by Hulhali and Patil (2005) [10] and Nawlakhe *et al.* (2010) [13]. The mean seed index of colour cotton was 7.12 g. The different organic treatments did not show significant influence on seed index of colour cotton, it was found nearly identical in all the organic treatments.

Yield and yield parameters

The data pertaining to seed cotton, lint and seed cotton equivalent yield (kg ha^{-1}) of colour cotton as influenced by various organic treatments were presented in Table 2.

The seed cotton and lint yield of colour cotton was recorded significantly higher with treatment T_3 -Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS (1707 kg ha^{-1}) over all other treatments. However, this treatment remained at par with treatment T_4 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS). Improvement in growth attributes resulted in more no. of bolls $plant^{-1}$ and also the dry matter production was more in the treatment T_3 which consecutively resulted in higher seed cotton yield in the present investigation. The results are in conformity with the findings of Hongal, N. (2001) [9], Hulhali and Patil (2005) [10], Nawlakhe *et al.* (2010) [13] and Rudragouda *et al.* (2013) [20]. Many workers have reported the increased lint yield of cotton since organic sources supplied balance nutrition to plant for promoting growth and yield contributing characters. Similar result was reported by Hulhali and Patil (2005) [10].

The seed cotton equivalent yield of colour cotton was observed significantly higher with treatment T_6 - Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS (1775 kg ha^{-1})**.** Cotton intercropped with black gram found higher seed equivalent yield similar result was found by Kote *et al.* (2005) [12] and Sankarnarayanan *et al.* (2007) [21].

Table 2: Seed cotton yield, lint yield, intercrop yield and seed cotton equivalent yield as influenced by various organic treatments.

	Treatments	Seed Cotton Yield (kg ha^{-1})	Lint yield (kg ha^{-1})	Intercrop yield (kg ha^{-1})	Seed cotton equivalent Yield (kg ha^{-1})
T_1	Control	692	221	-	692
T_2	Vermicompost @ 2.5 t ha^{-1} + Jeevamrut 10% at 50 DAS.	1186	386	-	1186
T_3	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS.	1707	567	-	1707
T_4	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS).	1678	558	-	1678
T_5	Vermicompost @ 2.5 t ha^{-1} + Cowpea in 2:1 proportion at 60 cm spacing (Green manuring of cowpea at 40 DAS) + Jeevamrut 10% at 50 DAS.	1408	465	-	1408
T_6	Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS.	1341	437	400	1775
	SE (m) ±	60.19	18.95	-	59.74
	CD at 5%	181.39	57.10	-	180.04

1. MSP of cotton: Rs. 6080 q^{-1} 2. MSP of black gram: Rs. 6600 q^{-1}

The significantly higher colour cotton stalk and biological yield was recorded with treatment T_3 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS (3244 & 4951kg ha^{-1}) which was at par with treatment T_4 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS) (3189 & 4867kg ha^{-1})**.**

Table 3: Stalk yield, biological yield and harvest index of colour cotton influenced by various organic treatments.

	Treatments	Stalk yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
T_1	Control	1325	2017	34.22
T_2	Vermicompost @ 2.5 t ha^{-1} + Jeevamrut 10% at 50 DAS.	2254	3440	34.46
T_3	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS.	3244	4951	34.43
T_4	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS).	3189	4867	34.45
T_5	Vermicompost @ 2.5 t ha^{-1} + Cowpea in 2:1 proportion at 60 cm spacing (Green manuring of cowpea at 40 DAS) + Jeevamrut 10% at 50 DAS.	2676	4084	34.46
T_6	Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS.	2547	3888	34.51
	SE (m) ±	51.55	88.26	0.98
	CD at 5%	155.35	265.99	NS

The increase with addition of organic sources through organic treatments resulted significant increase in stalk yield over no organics might be due to better utilization of well decomposed organic nutrient sources supplied through balance nutrient to plant for boosting up growth and yield attributing characters which were responsible for maximum allocation of dry matter to vegetative parts. Similar results were quoted by Nawlakhe *et al.* (2010) [13].

Harvest index provide the potential of economic yield achieved when compared to the biological yield function of

the specific treatment, the effect of various organic sources and green manuring was also observed in respect of harvest index. Data on harvest index as influenced by various organic treatments are presented in Table 16. Mean harvest index of colour cotton recorded was 34.42%. The values of harvest index were recorded non-significant among all the organic treatments.

Quality parameters

The data pertaining to the ginning percentage, fibre length (mm), Uniformity index (%), micronaire value (µg inch^{-1}) and Tenacity 3.2 mm (g tex^{-1}) and Elongation (%) under different organic treatments presented in Table 4 quality parameter was not influenced by organic treatments significantly; it was nearly identical among the all organic treatments.

Table 4: Quality parameters of colour cotton as influenced by various organic treatments.

Treatments		Ginning Percentage	Fibre Length (mm)	Uniformity Index (%)	Micronaire (µg inch^{-1})	Tenacity 3.2 mm (g tex^{-1})	Elongation (%)
T_1	Control	32.30	23.56	72.65	3.36	27.95	7.80
T_2	Vermicompost @ 2.5 t ha^{-1} + Jeevamrut 10% at 50 DAS.	32.40	24.58	72.75	3.37	28.03	7.83
T_3	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS.	33.16	24.70	72.92	3.40	28.43	7.88
T_4	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS).	33.12	23.65	72.84	3.38	28.38	7.88
T_5	Vermicompost @ 2.5 t ha^{-1} + Cowpea in 2:1 proportion at 60 cm spacing (Green manuring of cowpea at 40 DAS) + Jeevamrut 10% at 50 DAS.	33.10	24.62	72.78	3.38	28.28	7.85
T_6	Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS.	32.56	24.60	72.76	3.38	28.20	7.85
	SE (m) ±	0.42	0.05	0.07	0.006	0.07	0.03
	CD at 5%	NS	NS	NS	NS	NS	NS

Most of the quality parameters are governed genetically to a larger extent rather than the management factors. This might due to ginning out turn (GOT) in colour cotton relates mainly to the genetic character of the variety. However significant variation in the environment may influence it.

However, numerically higher values of all quality parameter was recorded in treatment T_3 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS. All quality parameters were generally influenced by genetical characters of the varieties and species of the crop hence improvement in these was noticed very rarely. Similar observation was revealed by Solunke and Fatak (2010) [24] and Gudadhe *et al.* (2013) [6].

Chemical analysis

NPK uptake by colour cotton plant was significant higher with treatment T_3 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS over all other treatments and the highest value of NPK uptake by crop was 65.30, 13.86 and 55.50 kg ha^{-1}. Green manuring crops are known to fix atmospheric nitrogen, further develop soil structure and recycle the nutrients. The expanded uptake of nitrogen might be because of mineralization of N added by green manure crops and its quick decomposition after incorporation of green manuring crops. Higher dry matter accumulation and yield contribution resulted in increase in nitrogen uptake. These results are conformity with findings of.

The initial available NPK status was (174.3, 12.21 and 412.74kg ha^{-1})**.** The available NPK status was significantly higher with treatment T_3 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of Sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS (210.49, 17.45 and 430.14 kg ha^{-1}) over all other treatments**.** Lowest available NPK status was recorded with control treatment**.**

Table 5: Total and available NPK uptake by colour cotton crop as influenced by various organic treatments.

Treatments		Total uptake (kg ha^{-1})			Available Nutrients (kg ha^{-1})		
		N	P	K	N	P	K
T_1	Control	24.74	4.76	20.74	169.7	10.71	408.24
T_2	Vermicompost @ 2.5 t ha^{-1} + Jeevamrut 10% at 50 DAS.	43.20	8.60	36.26	179.1	14.58	418.04
T_3	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS.	65.30	13.86	55.50	210.49	17.45	430.14
T_4	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS).	63.40	13.14	53.57	203.74	16.32	426.84
T_5	Vermicompost @ 2.5 t ha^{-1} + Cowpea in 2:1 proportion at 60 cm spacing (Green manuring of cowpea at 40 DAS) + Jeevamrut 10% at 50 DAS.	52.63	10.76	44.13	189.62	15.83	424.44
T_6	Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS.	49.73	10.11	41.62	181.30	15.30	420.54
	SE (m) ±	1.56	0.31	0.88	1.84	1.01	1.43

	CD at 5%	4.72	0.93	2.66	5.54	3.04	4.30
	Initial	49.83	10.21	41.97	174.3	12.21	412.74

The main improvement in availability of nitrogen under the treatment T_3 receiving balance fertilization might be expected due to increasing recommended dose of nutrient through vermicompost, jeevamrut 10% and green manuring of sunhemp as it is source of multiple nutrients. The use of PSB and vermicompost, being direct source of phosphorus and it might have also solubilized the native phosphorus in the soil through release of various organic acids which had chelating effect, that reduced phosphorus fixation. The reduction of potassium fixation and release of more K due to interaction of organic matter with clay, besides the direct K addition in the available K pool to the soil it might have increased the available K in the soils. This confirms the earlier reports of many workers Wankhade *et al*., (2001) [29].

Microbial Population

The data on effect of various organic treatments on bacterial, fungal and *Actinomycetes* population in soil at flowering stage of colour cotton was significant. There was more population growth of bacterial, fungal and *Actinomycetes* colonies in soil found with treatment T_3 - Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS that which was recorded significance over rest of the treatments.

Table 6: Microbial population in soil at flowering stage of colour cotton as influenced by various organic treatments.

Treatments		Bacteria (x 10^{-6}cfu g^{-1})	Fungi (x 10^{-4}cfu g^{-1})	Actinomycetes (x 10^{-4}cfu g^{-1})
T_1	Control	25.19	8.58	9.82
T_2	Vermicompost @ 2.5 t ha^{-1} + Jeevamrut 10% at 50 DAS.	31.39	10.16	12.42
T_3	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp 40 DAS) + Jeevamrut 10% at 50 DAS.	36.53	15.22	17.33
T_4	Vermicompost @ 2.5 t ha^{-1} + Sunhemp in 2:1 proportion at 60 cm spacing (Green manuring of sunhemp at 40 DAS).	34.43	14.84	16.30
T_5	Vermicompost @ 2.5 t ha^{-1} + Cowpea in 2:1 proportion at 60 cm spacing (Green manuring of cowpea at 40 DAS) + Jeevamrut 10% at 50 DAS.	33.27	12.81	14.89
T_6	Vermicompost @ 2.5 t ha^{-1} + Black gram in 2:1 proportion at 60 cm spacing (Mulching of black gram after picking of pods) + Jeevamrut 10% at 50 DAS.	32.31	11.75	13.67
	SE (m) ±	1.20	1.00	0.77
	CD at 5%	3.63	3.02	2.31

Improvement in the bacterial, fungal and *Actinomycetes* colonies in rhizosphere of colour cotton crop at might be due to application of vermicompost and *in-situ* green manuring of sunhemp which serve as food and energy for bacteria was higher than later stage and also microbes attack the food material and increase their colonies and which was decreased as reduction in the quantity of food material. The presence of easily metabolizable compounds at the beginning of the crop was also under active growth phase releasing higher amounts of root exudates, supporting numerous and diverse micro flora. The present results are accordance with those of Wankhade *et al*. (2001) [29].

The application of Vermicompost @ 2.5 t ha^{-1} + Jeevamrut 10% @ 500 L ha^{-1} at 50 DAS along with green manuring of Sunhemp at 40 DAS recorded significantly higher growth and yield attributes, seed cotton, lint and stalk yield of colour cotton $hectare^{-1}$.

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