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Research Paper

Impact of organic fertilization and weed management practices on weed control efficiency and yield of Cotton *(Gossypium hirsutum* L.)

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ABSTRACT

A field experiment was conducted during winter, irrigated, season 2015–16 and 2016–17, to find out the effect of organic manures and weed-management practices on yield and yield attributes of (*Gossypium hirsutum* L.) upland cotton at Coimbatore, Tamil Nadu. The treatments were laid out in a strip-plot design and replicated thrice. Four organic manures, *viz.,* farmyard manure, vermicompost, goat manure, and composted poultry manure, were assigned to main plots and 4 weed-control treatments, *viz.,* hand-weeding, twin wheel hoe weeding, power weeder weeding and weedy check, to subplots. Application of 100% recommended dose of nitrogen (RDN) through composted poultry manure resulted in significantly lower weed density (23.60 No./m^2), higher weed-control efficiency (85.89%), better yield attributes and higher yield (1484 kg/ha) followed by 100% RDN through goat manure. Hand-weeding at 20 and 40 days after sowing (DAS) followed by power-weeder weeding at 20 and 40 DAS enhanced the yield of cotton owing to reduction in weed growth and nutrient depletion by weeds and increased nutrient uptake by the crop. Hence considering the yield and yield attributes of cotton, it could be concluded that 100% RDF through composted poultry manure along with 2 power weeder weeding or hand-weeding at 20 and 40 DAS could reduce the weed density and dry weight and result in higher yield and help in maintaining sustainable soil fertility under irrigated condition in cotton.

Key words : Cotton, Composted poultry manure, Power weeder, Seed cotton yield and Weed control efficiency

INTRODUCTION

Cotton is the most important natural fibre crop; its fibre is used throughout the world and supports 250 million people. It assumes a place of pride in Indian economy, as production, processing and trade of cotton goods provide employment to millions of people. Further, the export of raw cotton, yarn, textile, garments, cotton seed cake, oil and other by-products earn valuable foreign exchange (Ali *et al.,* 2013).

The present farming relying upon synthetic inputs like fertilizers, pesticides and growth regulators for enhancing crop productivity (Walia, *et al.,* 2020). It is a well-documented fact that increased dependence on agro-chemicals has led to the harmful compounds into food chain, death of natural enemies and development of resistance to pesticides. Maintaining good soil health is a pre-requisite for sustaining higher productivity under intensive agricultural production system (Tanwar *et al*., 2010). The organic approach is one of the alternatives to conventional system being advocated. Organic farming helps improve the physical, chemical and biological properties of the soil and maintains the ecological balance as well as productivity of life-supporting systems for the future generations (Meena *et al*., 2013).

Nowadays cotton-production technology relies heavily on the use of fertilizers to supply nutrients and chemical pesticides to control insect-pests, diseases and weeds (Siddagangamma and Channabasavanna, 2018). Cotton occupies only 5% of the total cultivable area, consumes 55% of the total pesticides and in some pockets, the rates are even higher than this, leaving immense ecological and human hazards (Venugopalan *et al.,* 2011). Organic manures like farmyard manure, vermicompost, goat manure

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and composted poultry manure are good source of nutrients and organic matter in soil. It provides strong absorbability and retention of nutrients for a longer period of time.

Crop-weed competition for the first few weeks (4–7) after planting has a great effect on cotton yield. Heavy weed infestations are estimated to reduce cotton seed yields by about 30–40% (Ali *et al.,* 2013). Weed management takes away nearly one-third of total cost of production in field crops. The recent upsurge in environmental awareness of the public, interest in organic food production has led to a range of sustainable techniques being developed for non-chemical weed control. Physical or mechanical methods of weed control like hand-weeding, twin wheel hoe weeder and power-operated weeders (Malarkodi, 2017) are standard practice for organic fields; uproots the weeds between crop rows, keeps the soil surface loose, ensuring better soil aeration and water-intake capacity. Organic cotton fibre is considered extremely important to Indian economy and organic cultivation is a sustainable tool, available today, to revitalize the fast depleting agricultural lands of the country (Venugopalan *et al.,* 2011). The production of organic cotton is rather knowledge-intensive than resource-intensive, thus less dependent on fossil fuels and synthetic inputs. The growing public awareness of the conventional farming methods has led to an increase in both the demand and production of organic cotton growers.

MATERIALS AND METHODS

A field experiment was conducted during seasons of 2015–16 and 2016–17 at the Tamil Nadu Agricultural University, Coimbatore, geographically situated in the Western agro-climatic zone of Tamil Nadu at 11° N and 77° E and at an altitude of 426.7 m above mean sea-level. The experimental soil was sandy clay loam and nutrient status of soil at the beginning of experiment was low in available nitrogen (192 kg /ha), medium in available phosphorus (17.2 kg/ha) and high in available potassium (520 kg /ha). Soil samples were collected from each plot, immediately after harvesting of each crop to assess soil fertility dynamics.

The experiment was laid out in a strip-plot design, replicated thrice. Organic manures (farmyard manure, vermicompost, goat manure and composted poultry manure) were allotted to main plot and weed-management practices (hand-weeding, twin-hoe weeder, power operated weeder and weedy check) were assigned to supplot at random using random number tables in each replication. The organic manures on equal nitrogen basis (80 kg/ha) were applied to respective plots as per treatmental schedule (Table 1). Weeding operations were carried out at 20 and 40 days after sowing (DAS) and the weeds present within the rows were removed manually.

Seeds of the test variety 'Suraj' were treated with cowdung slurry at 1%, a day before sowing and dried in shade. Then, the seeds were treated with biocontrol agent *Bacillus subtilis* @ 10 g/kg seed. Two seeds/hill were dibbled in flat beds using the seed rate of 15 kg/ha at a spacing 75 cm × 30 cm and at a depth of 2–3 cm.

First irrigation was given at the time of sowing and subsequent irrigations were scheduled at 9–10 days interval depending on the rainfall. Adequate care was taken to maintain optimum plant population. Gap-filling was done 10 days after sowing (DAS) and thinning at 20 DAS by retaining 1 healthy seedling/hill. After earthing-up at 45 DAS, *panchakavya* spray at 3% spray was given at 45, 60 and 75 DAS as foliar growth-regulator. Three rounds of neem oil sprays @ 3% and fish oil resin soap sprays @ 1% were given at 15 days interval, starting from 30 DAS against sucking pests at initial growth stages depending on extent of pest incidence. Then *Bt* formulation spray was given once in 15 days at boll-development stage to protect from various pests that attack bolls.

Five random plants from each net plot area were chosen. These plants were used for recording all biometric observations at different stages of cotton crop. First seed cotton was picked from the 2 border rows on all sides of the plots and then it was picked from the net plots separately. The harvesting of seed cotton was done in 3 pickings at 10 days interval. Care was taken to avoid bracts and trash adherence while removing the seed cotton from the bolls. The *kapas* was dried in shade, cleaned and weighed.

Table 1. Nutrient content of organic manures and quantity applied during both seasons

Source of organic manures	Nutrient (%) (2015–16)			Supply RDN (80 kg/ha)	Nutrient (%) (2016–17)			Supply RDN (80 kg/ha)
	N	P	K		N	P	K	
Farmyard manure	0.5	0.2	0.5	16.0	0.6	0.2	0.5	13.11
Vermicompost	1.5	1.0	1.5	5.33	1.5	1.0	1.5	5.33
Goat manure	1.3	1.0	2.0	6.15	1.4	1.0	2.0	5.71
Composted poultry manure	2.0	2.60	1.4	4.00	2.2	2.63	1.4	3.63

RDN, Recommended dose of nitrogen

Weed density

The weed count was done before imposing weeding treatments, species-wise, using 0.25 m^2 quadrat from 4 randomly fixed places in each plot and expressed as number of weeds/m^2. The weeds were classified as broad-leaf weeds, grasses, sedges and expressed as number/m^2.

Weed control efficiency (%)

Weed-control efficiency was worked out on the basis of weed density recorded in each treatment at 40 DAS as:

$$\text{WCE (\%)} = \frac{\text{WDWc} - \text{WDWt}}{\text{WDWc}} \times 100$$

Where, WCE, weed control efficiency (%); WDWc, weed density (No./m^2) in weedy check plots; WDWt, weed density in weed control treatment plots

Data on weed density showed high variation and hence they were subjected to square-root transformation (“X + 0.5) and various growth and yield parameters during the cropping period which were statistically analysed following the analysis of variance as suggested by Gomez and Gomez (2010). Wherever the treatmental differences were found significant (`F`test), critical difference was worked out at 0.05 probability level.

RESULTS AND DISCUSSION

Weed flora

General weed flora of the experimental field was recorded in weedy check plots at 40 DAS during both the years 2015–16 and 2016–17 and are presented in Table 2. The predominant among grassy weeds were *Echinochloa frumentacea* and *Cynodon dactylon*. Among the broad-leaf weeds, *Trianthema portulacastrum, Boerhaavia diffusa* and *Digeria arvensis* were dominant weeds and *Cyperus rotundus* was the only sedge species. Comparing the weed species during both the years of study, grassy weed species, especially *Echinochloa frumentacea* found dominant in the first year compared to second crop. Controversially, *T. portulacastrum* highly took over into second crop than first crop in terms of densities due to higher availability of weed seed bank in soil ecosystem as well as applied organic manures also. Similar incidences of predominantly occurred weed species associated with cotton crop (Ayyadurai *et al.*, 2013; Nalayini and Suveetha, 2016; Malarkodi, 2017).

Total weed density

Different organic manures showed significant difference with respect to total weed density at 20, 40 and 60 DAS (Tables 3 and 4). During both the years, among organic manures, lesser total weed density was observed at 40 DAS under 100% RDN through composted poultry manure (N_4), followed by goat manure (N_3). This might be attributed to reduced level of competition for nutrients enabled the plants to vigorously extract high amount of nitrogen compared to the other plots (Malarkodi, 2017). Moreover, composting (recommended under organic standards) could have greatly reduced the number of viable weed seeds, as the temperature during composting was maintained more than 60°C for more than 3 days. Further, compost limits weed growth by releasing phytotoxic substances in immediate environment of weed seeds (Amanullah *et al*., 2006), as well reduces weed seed bank and competitive ability.

With respect to weed-management practices, hand-weeding at 20 and 40 DAS (W_1) recorded lower total weed density, followed by power-weeder weeding at 20 and 40

Table 2. Weed flora of the experimental fields

Botanical Name	Common name	Habit	Family
Grasses			
Echinochloa frumentacea Link.	Indian barnyard millet	Annual	Poaceae
Brachiaria reptans (L.) Gardner Hubb.	Para grass	Annual	Poaceae
Chloris barbata Swasts	Swollen finger grass	Annual	Poaceae
Cynodon dactylon (L). Pers.*	Bermuda grass	Perennial	Poaceae
Sedges			
Cyperus rotundus L.*	Purple nutsedge	Perennial	Cyperaceae
Broad leaf weeds			
Trianthema portulacastrum L.*	Giant pigweed	Annual	Aizaceae
Amaranthus viridis L.	Slender amaranth	Annual	Amaranthaceae
Boerhaavia diffusa L.*	Spreading hog weed	Annual	Nyctaginaceae
Digeria arvensis L.*	False amaranth	Annual	Amaranthaceae
Parthenium hysterophorus L.	Carrot weed	Annual	Asteraceae
Cleome viscosa L.	Tick weed	Annual	Cleomaceae
Corchorus trilocularis L.	Wild jute	Annual	Tiliaceae

* Predominant weeds in experimental plots

Table 3. Effect of organic manures and weed-management practices on density of total weeds (No./m²) in cotton (2015-16)

Treatment	20 DAS					40 DAS					60 DAS				
	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean
N_1	14.28	14.55	14.53	14.75	14.53	8.39	8.92	8.66	15.85	10.45	7.74	8.37	8.03	16.50	10.16
	(203.5)	(211.1)	(210.5)	(217.0)	(210.5)	(69.83)	(79.02)	(74.52)	(250.6)	(118.5)	(59.48)	(69.48)	(63.91)	(271.7)	(116.1)
N_2	13.46	13.55	13.56	13.69	13.57	7.77	8.20	8.00	15.08	9.76	6.85	7.59	7.38	15.85	9.42
	(180.8)	(183.1)	(183.4)	(186.9)	(183.6)	(59.94)	(66.78)	(63.49)	(226.95)	(104.8)	(46.47)	(57.13)	(53.96)	(250.8)	(102.1)
N_3	12.32	12.53	12.76	13.05	12.67	7.10	7.86	7.30	13.85	9.02	6.10	7.08	6.56	14.65	8.60
	(151.8)	(156.6)	(162.4)	(169.8)	(160.1)	(49.93)	(61.2)	(52.73)	(191.19)	(88.76)	(36.76)	(49.65)	(42.50)	(214.1)	(85.8)
N_4	11.53	11.99	11.80	12.28	11.90	6.46	7.54	6.87	13.11	8.50	5.61	6.90	5.77	13.81	8.02
	(132.3)	(143.3)	(138.8)	(150.4)	(141.2)	(41.26)	(56.32)	(46.71)	(171.41)	(78.93)	(30.99)	(47.06)	(32.82)	(190.2)	(75.27)
Mean	12.90	13.15	13.16	13.44		7.43	8.13	7.71	14.47		6.58	7.48	6.93	15.20	
	(167.0)	(173.5)	(173.8)	(181.1)		(55.24)	(65.83)	(59.36)	(210.0)		(43.43)	(55.83)	(48.30)	(231.7)	
	N	W	N at W	W at N		N	W	N at W	W at N		N	W	N at W	W at N	
SEm±	0.32	0.29	0.68	0.67		0.27	0.26	0.55	0.54		0.25	0.24	0.51	0.50	
CD (P=0.05)	0.78	NS	NS	NS		0.63	0.61	1.18	1.15		0.57	0.55	1.17	1.16	

Figures in parentheses are mean of original values; Data subjected to square-root transformation; DAS, days after sowing
N, Organic manures: N_1, 100 % RDN through farmyard manure; N_2, 100 % RDN through vermicompost; N_3, 100 % RDN through goat manure; N_4, 100 % RDN through composted poultry manure
W, Weed-management practices: W_1, hand-weeding at 20 and 40 DAS; W_2, twin wheel-hoe weeding at 20 and 40 DAS; W_3, power weeder weeding at 20 and 40 DAS; W_4, weedy check

Table 4. Effect of organic manures and weed management practices on density of total weeds (No./m²) in cotton (2016–17)

Treatment	20 DAS					40 DAS					60 DAS				
	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean
N_1	12.33	12.55	12.53	12.68	12.52	7.52	8.08	7.83	14.82	9.56	6.92	7.70	7.23	15.63	9.37
	(151.7)	(156.9)	(156.6)	(160.3)	(156.4)	(56.09)	(64.85)	(60.76)	(219.2)	(100.2)	(47.39)	(58.75)	(51.82)	(243.8)	(100.4)
N_2	11.61	11.69	11.71	11.83	11.71	7.21	7.53	7.21	14.09	9.01	6.16	6.91	6.67	14.91	8.66
	(134.2)	(136.2)	(136.5)	(139.4)	(136.6)	(51.45)	(56.25)	(51.47)	(198.0)	(89.3)	(37.41)	(47.29)	(44.01)	(221.7)	(87.60)
N_3	10.75	10.80	11.00	11.24	10.95	6.61	7.30	6.60	12.96	8.37	5.30	6.45	5.86	13.84	7.86
	(114.9)	(116.0)	(120.6)	(125.9)	(119.4)	(43.14)	(52.81)	(43.07)	(167.4)	(76.61)	(27.60)	(41.13)	(33.84)	(191.1)	(73.41)
N_4	10.11	10.30	10.32	10.55	10.32	5.97	6.92	6.38	12.20	7.87	4.91	6.28	4.95	12.95	7.27
	(101.7)	(105.5)	(105.9)	(110.8)	(105.9)	(35.13)	(47.44)	(40.25)	(148.3)	(67.79)	(23.60)	(38.98)	(24.05)	(167.2)	(63.46)
Mean	11.2	11.33	11.39	11.58		6.83	7.46	7.01	13.52		5.82	6.84	6.18	14.33	
	(125.6)	(128.7)	(129.9)	(134.1)		(46.45)	(55.34)	(48.89)	(183.2)		(34.00)	(46.54)	(38.43)	(205.9)	
	N	W	N at W	W at N		N	W	N at W	W at N		N	W	N at W	W at N	
SEm±	0.28	0.25	0.59	0.58		0.25	0.24	0.52	0.50		0.24	0.23	0.50	0.49	
CD(P=0.05)	0.68	NS	NS	NS		0.60	0.58	1.10	1.08		0.59	0.57	1.08	1.08	

Figures in parentheses are mean of original values; Data subjected to square-root transformation; DAS, days after sowing
N, Organic manures: N_1, 100 % RDN through farmyard manure; N_2, 100 % RDN through vermicompost; N_3, 100 % RDN through goat manure; N_4, 100 % RDN through composted poultry manure
W, Weed-management practices: W_1, hand-weeding at 20 and 40 DAS; W_2, twin wheel-hoe weeding at 20 and 40 DAS; W_3, power weeder weeding at 20 and 40 DAS; W_4, weedy check

DAS (W_3). Hand-weeding twice or mechanical weeding twice with power weeder were also found significantly superior to the weedy check in reducing the density of the dominant weed species in the earlier crop-growth stages which might have lowered the weed seed return and ultimately the densities of weed species (Nalini and Chinnusamy, 2019).

Invariably weedy check (W_4) registered the highest total weed density at all stages of observation, *viz.,* 20, 40 and 60 DAS. Higher population of grasses, sedges and broad-leaf weeds were associated with weedy check.

Weed-control efficiency

Weed-control efficiency (WCE) which indicates the magnitude of effective reduction of weed density by weed-management practices over weedy check was worked out and presented in Table 5. Comparing the various sources of organic manures on weed-control efficiency, there was no much difference between the organic manures, though composted poultry manure (N_4) registered higher weed-control efficiency. With respect to weed-management practices, hand-weeding at 20 and 40 DAS (W_1) resulted in higher weed-control efficiency, followed by power-weeder weeding (W_3) and both were comparable with each other owing to greater reduction of grasses, sedges and broad-leaf weeds at all the stages of crop growth which in turn increased the vigour and growth of cotton, resulted in better crop growth which in turn smothered the weed growth in comparison to other treatments (Malarkodi, 2017).

Nalini and Chinnusamy (2019) reported higher weed-control efficiency, better cotton crop growth and maximum fibre yield under hand-weeding done at 21 and 42 DAS. Composted poultry manure along with hand-weeding twice at 20 and 40 DAS (N_4W_1) recorded higher weed-control efficiency, followed by the treatment combination of composted poultry manure with power-weeder weeding at 20 and 40 DAS (N_4W_3). The use of chicken manure can be an effective weed-management practice for weed control in cotton (Tewolde *et al.,* 2009). However, at later stages, effective weed control was achieved under 2 hand-weedings or power weeder weedings in terms of reduced biomass of weeds and led to higher weed-control efficiency (Nalini and Chinnusamy, 2019).

Lower weed-control efficiency was recorded under farmyard manure-applied plot with weedy check (N_1W_4) treatment. This might be owing to initial higher weed growth under farmyard manure and subsequent higher emergence of grasses, sedges and broad leaf weeds along with weedy check.

Yield attributes and yield

Yield per plant is the culmination of the interplay of several factors like morphological, physiological and yield parameters. The purpose of all cultural operations is to

Table 5. Effect of organic manures and weed management practices on weed-control efficiency (%) in cotton

Treatment	Weed control efficiency (%) 2015–16			Weed control efficiency (%) 2016–17		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
N_1W_1	6.21	72.13	78.10	5.40	74.41	80.55
N_1W_2	2.72	68.47	74.43	2.06	70.41	75.90
N_1W_3	3.00	70.26	76.47	2.32	72.27	78.74
N_1W_4	0.00	0.00	0.00	0.00	0.00	0.00
N_2W_1	3.22	73.59	81.47	3.71	74.02	83.12
N_2W_2	1.99	70.57	77.22	2.29	71.59	78.67
N_2W_3	1.83	72.02	78.48	2.06	74.01	80.15
N_2W_4	0.00	0.00	0.00	0.00	0.00	0.00
N_3W_1	10.92	73.88	82.83	8.68	74.23	85.56
N_3W_2	7.81	67.99	76.81	7.84	68.46	78.47
N_3W_3	4.35	72.42	80.15	4.23	74.27	82.29
N_3W_4	0.00	0.00	0.00	0.00	0.00	0.00
N_4W_1	12.01	75.93	83.71	8.18	76.32	85.89
N_4W_2	4.75	67.14	75.26	4.76	68.02	76.69
N_4W_3	7.72	72.75	82.75	4.42	72.87	85.62
N_4W_4	0.00	0.00	0.00	0.00	0.00	0.00

Data not statistically analysed; DAS, days after sowing

N, Organic manures: N_1, 100 % RDN through farmyard manure; N_2, 100 % RDN through vermicompost; N_3, 100 % RDN through goat manure; N_4, 100 % RDN through composted poultry manure

W, Weed-management practices: W_1, hand-weeding at 20 and 40 DAS; W_2, twin wheel-hoe weeding at 20 and 40 DAS; W_3, power weeder weeding at 20 and 40 DAS; W_4, weedy check manipulate these parameters thereby to attain maximum yield.

All the yield attributes, *viz.,* sympodial branches/plant, number of fruiting points and bolls/plant were positively influenced by 100% RDN through composted poultry manure (N_4), followed by goat-manure (N_3) application during 2015–16 and 2016–17 (Tables 6 and 7). Higher availability of nutrients from organic manures for plant development and boll formation, gradual transformation and mineralization of organics, solubilization of water insoluble P compounds by organic acids released during decomposition of organics, resulting in greater P availability to crop coupled with higher native K availability might have played a key role in ensuring superior yield attributes (Reddy *et al.*, 2007).

Organic sources play a key role in enhancing efficient utilization of the native as well as applied nutrients through matching nutrient availability with crop requirement to exhibit crop's productive capability. These organic sources also supply some micronutrients and growth- promoting substances, which might have enhanced photosynthesis, accumulation of carbohydrates, that led to favourable effect on vegetative growth, retention of flowers and boll formation (Tewolde *et al.,* 2009).

Among the weed-management techniques, hand-weeding at 20 and 40 DAS (W_1) improved the yield characters of cotton, followed by 2 power-weeder weedings (W_3). This might be owing to reduction in crop-weed competition which favoured the growth of crop that encouraged flowering, formation of more bolls/plant and higher boll weight. The competition of weeds for light, water and minerals reflected on metabolic process of the plant and finally caused reduction in yield (Modak *et al.,* 2019). The reduced yield under control was due to reduction in yield-attributing parameters due to higher weed population causing severe intra-row weed-crop competition during the reproductive phase of cotton crop (Ahmed *et al.,* (2019).

Seed-cotton yield

Among the organic manures, application of composted poultry manure (N_4) resulted in the highest seed cotton yield. Composted poultry manure supplies the nutrients in soluble form for a quiet longer period by not allowing the entire soluble form into solution, to come in contact with soil and plant roots can absorb more nutrients leading to better yield. Increased yield in response to organics especially application of poultry manure (Ahmed *et al*., 2019).

Among the weed-management practices, hand-weeding twice at 20 and 40 DAS (W_1) recorded higher seed-cotton yield, but remained comparable with power-weeder weed-

Table 6. Effect of organic manures and weed-management practices on yield attributes of cotton (2015–16)

Treatment	Sympodial branches/plant					Fruiting points/plant					Bolls/plant				
	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean
N_1	16.57	10.53	15.18	9.74	13.00	41.66	35.29	41.57	29.94	37.11	15.01	12.22	14.86	9.79	12.97
N_2	18.32	13.48	17.15	10.29	14.81	52.51	34.91	45.89	33.81	41.78	19.07	12.42	16.60	11.14	14.81
N_3	19.06	16.74	18.80	13.66	17.07	51.87	42.02	43.03	34.42	42.83	19.19	15.41	16.01	11.59	15.55
N_4	19.52	17.11	19.33	15.14	17.77	54.24	48.67	50.06	34.46	46.86	20.65	17.44	18.96	11.83	17.22
Mean	18.37	14.47	17.62	12.21		50.07	40.22	45.14	33.16		18.48	14.37	16.61	11.09	
	N	*W*	*N at W*	*W at N*		*N*	*W*	*N at W*	*W at N*		*N*	*W*	*N at W*	*W at N*	
SEm±	0.63	0.50	0.96	0.88		1.20	1.04	2.15	1.94		0.77	0.72	1.14	1.01	
CD (P=0.05)	0.54	1.22	2.16	1.94		2.94	2.65	4.75	4.27		1.87	1.80	2.57	2.34	

Details of treatments are given under Materials and Methods

Table 7. Effect of organic manures and weed-management practices on yield attributes of cotton (2016-17)

Treatment	Sympodial branches/plant					Fruiting points/plant)					Bolls/plant				
	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean	W_1	W_2	W_3	W_4	Mean
N_1	16.96	10.79	15.53	9.96	13.31	41.31	34.97	41.22	29.66	36.79	15.33	12.48	15.18	10.00	13.25
N_2	18.74	13.80	17.55	10.54	15.16	52.07	34.60	45.51	33.56	41.43	19.49	12.68	16.95	11.39	15.13
N_3	19.52	17.13	19.24	13.99	17.47	51.44	41.69	42.67	34.12	42.48	19.60	15.75	16.36	11.84	15.88
N_4	19.96	17.50	19.77	15.49	18.18	53.77	48.24	49.63	34.16	46.45	21.09	17.80	19.37	12.07	17.58
Mean	18.79	14.80	18.02	12.50		49.65	39.87	44.76	32.88		18.88	14.68	16.96	11.32	
	N	*W*	*N at W*	*W at N*		*N*	*W*	*N at W*	*W at N*		*N*	*W*	*N at W*	*W at N*	
SEm±	0.63	0.51	0.97	0.88		1.19	0.92	2.13	1.92		0.78	0.72	1.17	1.04	
CD (P=0.05)	1.54	1.39	2.18	1.95		2.92	2.76	4.71	4.14		1.92	1.80	2.63	2.30	

Details of treatments are given under Materials and Methods

Table 8. Effect of organic manures and weed-management practices on cotton yield (kg/ha) (pooled data 2015–16 and 2016–17)

Treatment	Cotton yield				
	W_1	W_2	W_3	W_4	Mean
N_1	1424	1035	1272	922	1163
N_2	1439	1164	1316	957	1219
N_3	1472	1417	1517	984	1347
N_4	1602	1430	1506	1026	1391
Mean	1484	1261	1402	972	
	N	*W*	*N at W*	*W at N*	
SEm±	36	24	65	59	
CD (P=0.05)	88	58	143	127	

DAS, days after sowing
N, Organic manures: N_1, 100 % RDN through farmyard manure; N_2, 100 % RDN through vermicompost; N_3, 100 % RDN through goat manure; N_4, 100 % RDN through composted poultry manure
W, Weed-management practices: W_1, hand-weeding at 20 and 40 DAS; W_2, twin wheel-hoe weeding at 20 and 40 DAS; W_3, power weeder weeding at 20 and 40 DAS; W_4, weedy check

ing at 20 and 40 DAS (W_3). It might be owing to the decreased weed competition and minimized nutrient removal by weeds, thereby provided a competition-free environment for the crop for better growth and development (Sandangi and Barik, 2007; Modak *et al.,* 2019). Hand-weeding or manual weeding practices in cotton proved to be most effective in controlling weeds (Malarkodi, 2017; Nalini and Chinnusamy, 2019).

CONCLUSION

Organic manures and weed-management practices had significant influence on growth and yield. Better growth and yield components and higher grain yield were obtained under 100% recommendecd dose of nitrogen RDN through composted poultry manure along with hand-weeding or power-weeder weeding at 20 and 40 days after sowing and this treatment recorded lower weed density and higher WCE higher growth attributes, improved root growth and activity which improved the remobilization of photosynthates from vegetative organs to reproductive parts and ultimately enhanced the yield attributes and yield.

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