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Effect of Organic Nutrient Management Practices on Growth, Biomass Accumulation and Physiological Attributes of Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

Background: Cotton (*Gossypium hirsutum* L.) productivity is declining due to continuous use of chemical fertilizers and deterioration of soil health. Integrated organic nutrient management is considered a sustainable approach to enhance crop growth and maintain soil fertility.

Methods: A field experiment was conducted during *Kharif* 2021-22 at Raichur using a randomized complete block design with eleven treatments and three replications. Different combinations of compost, vermicompost and poultry manure were applied as basal and top dressing along with foliar sprays of panchagavya and vermiwash to evaluate their effect on growth, biomass and physiological parameters of cotton.

Result: Treatment T_{10} recorded the highest plant height (99.5 cm), total dry matter production (408.6 g plant^{-1}), leaf area (85.2 dm^2 plant^{-1}), leaf area index (3.15) and SPAD value (45.6). Integrated organic nutrient management significantly improved growth and physiological attributes compared to sole compost application.

Key words: Biomass accumulation, Cotton, Leaf area index, Organic nutrient management, Panchagavya, Vermicompost.

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is a major commercial fibre crop cultivated across diverse agro-climatic regions and serves as an important source of raw material for the textile industry while supporting the livelihoods of millions of farmers (Vitale *et al*., 2024). In India, cotton contributes substantially to agricultural GDP, employment generation and export earnings (Selvakumar *et al.*, 2025). However, intensive reliance on chemical fertilizers has led to declining soil fertility, depletion of soil organic matter, nutrient imbalances and reduced soil biological activity, adversely affecting crop productivity and sustainability (Shi *et al*., 2024). These challenges have increased interest in environmentally sustainable nutrient management approaches.

Organic inputs improve soil organic carbon, soil structure, nutrient availability, microbial activity and enzymatic functions, thereby enhancing soil fertility and crop growth (Lori *et al*., 2017; Selim, 2018; Bhattacharyya *et al*., 2021). Liquid organic formulations such as panchagavya and vermiwash further promote nutrient uptake, physiological activity and plant growth (Ramya *et al*., 2022). Organic production systems have also been shown to improve energy-use efficiency and sustainability in cotton cultivation (Iswarya *et al*., 2024). However, information on the integrated use of solid and liquid organic inputs for improving physiological traits of cotton under semi-arid conditions remains limited, warranting further investigation.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* 2021-22 at the organic block of the Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur, Karnataka, located in the north-eastern dry zone (Zone II) at 16°12′N latitude, 77°20′E longitude and 389 m above mean sea level. The experimental site was characterized by deep black, slightly alkaline soil. During the crop season, the area received 216.1 mm rainfall with mean temperature ranging from 25-35°C and relative humidity of 60-70%.

The experiment was laid out in a randomized complete block design (RCBD) with eleven treatments and three replications. Treatments consisted of different combinations of compost, vermicompost, poultry manure, panchagavya and vermiwash applied as basal, top-dressing and foliar treatments (Table 1). The nutrient composition of compost,

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Table 1: Plant height at different growth stages of cotton as influenced by nutrient management practices under organic cultivation.

Treatment	Plant height (cm)				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T_1: Compost equivalent to 100% RDN as a basal dose	15.0	60.7	65.9	78.2	81.3
T_2: Compost (50%) + Vermicompost (50%) equivalent to 100% RDN as basal dose	16.5	63.1	70.2	81.6	91.3
T_3: Compost (50%) + Poultry manure (50%) equivalent to 100% RDN as basal dose	15.6	60.9	68.4	79.3	84.4
T_4: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + poultry manure (50%) as top dress*	16.6	63.2	71.7	82.0	93.2
T_5: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN + Poultry manure (50%) as top dress*	15.9	62.4	69.0	79.5	86.3
T_6: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*	18.0	66.3	75.1	84.7	95.3
T_7: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN as basal dose + Vermicompost (50%) as top dress*	16.8	64.1	72.7	82.5	94.3
T_8: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50% N equivalent) as top dress*(T_4) + Foliar spray of panchagavya alternated with vermiwash**	18.5	66.5	75.3	85.6	96.8
T_9: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN + Poultry manure (50%) as top dress*(T_5) + Foliar spray of panchagavya alternated with vermiwash**	17.6	64.9	73.5	83.3	94.3
T_{10}: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*(T_6) + Foliar spray of panchagavya alternated with vermiwash**	20.7	71.0	78.9	88.3	99.5
T_{11}: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*(T_7) + Foliar spray of panchagavya alternated with vermiwash**	18.9	67.3	77.8	87.3	98.1
S.Em. (±)	0.32	1.2	1.4	1.6	1.7
C.D. (P=0.05)	0.95	3.6	4.0	4.6	5.1

*Top dressing in equal splits at 30 and 60 DAS, **Foliar spray of 3% panchagavya and 10% vermiwash alternatively at 45, 60, 75 and 90 DAS.

RDN: Recommended dose of nitrogen.

Table 2: Effect of organic nutrient management on monopodial and sympodial branches (plant^{-1}) of cotton at different growth stages.

Treatment	Monopodial branches plant^{-1}					Sympodial branches plant^{-1}				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T_1: Compost equivalent to 100% RDN as a basal dose	0.27	0.53	0.73	1.60	2.20	1.93	11.13	13.40	17.40	18.90
T_2: Compost (50%) + Vermicompost (50%) equivalent to 100% RDN as basal dose	0.47	0.73	0.93	1.80	2.40	2.33	11.87	14.07	18.30	19.70
T_3: Compost (50%) + Poultry manure (50%) equivalent to 100% RDN as basal dose	0.33	0.60	0.80	1.67	2.27	2.07	11.60	13.80	17.90	19.50
T_4: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50% RDN) as top dress*	0.53	0.80	1.00	1.87	2.47	2.47	11.93	14.13	18.40	19.80
T_5: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN + Poultry manure (50%) as top dress*	0.40	0.67	0.87	1.73	2.33	2.27	11.67	14.00	18.20	19.60
T_6: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50% RDN) as top dress*	0.73	1.00	1.20	2.07	2.67	2.73	12.53	14.80	18.80	20.30
T_7: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN as basal dose + Vermicompost (50% RDN) as top dress*	0.60	0.87	1.07	1.93	2.53	2.60	12.20	14.47	18.50	19.90
T_8: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50% RDN) as top dress* (T_4) + Foliar spray of panchagavya alternated with vermiwash**	0.80	1.07	1.27	2.13	2.80	2.80	13.00	14.93	19.30	20.50
T_9: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN + Poultry manure (50% RDN) as top dress* (T_5) + Foliar spray of panchagavya alternated with vermiwash**	0.67	0.96	1.13	2.00	2.60	2.67	12.47	14.53	18.60	20.00
T_{10}: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50% RDN) as top dress* (T_6) + Foliar spray of panchagavya alternated with vermiwash**	0.93	1.27	1.53	2.27	2.93	3.00	13.13	15.20	20.20	21.60
T_{11}: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN as basal dose + Vermicompost (50% RDN) as top dress* (T_7) + Foliar spray of panchagavya alternated with vermiwash**	0.87	1.20	1.40	2.20	2.87	2.60	13.07	15.07	19.90	21.00
S.Em. (±)	0.02	0.03	0.04	0.05	0.06	0.14	0.22	0.26	0.53	0.55
C.D. (P=0.05)	0.08	0.09	0.13	0.16	0.18	0.42	0.67	0.79	1.58	1.64

*Top dressing in equal splits at 30 and 60 DAS, ** Foliar spray of 3% panchagavya and 10% vermiwash alternatively at 45, 60, 75 and 90 DAS.

RDN: Recommended dose of nitrogen.

Table 3: Effect of organic nutrient management on dry matter accumulation in leaves, stems and reproductive parts (g plant^{-1}) of cotton at different growth stages.

Treatment	Leaves (g plant^{-1})					Stem (g plant^{-1})					Reproductive parts (g plant^{-1})			
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	60 DAS	90 DAS	120 DAS	At harvest
T_1: Compost equivalent to 100% RDN as a basal dose	4.2	33.7	55.6	83.6	75.3	2.0	22.1	49.0	90.1	105.1	13.7	51.8	90.9	120.8
T_2: Compost (50%) + Vermicompost (50%) equivalent to 100% RDN as basal dose	4.7	40.9	64.1	89.1	84.3	2.3	30.5	56.1	101.7	116.3	15.5	57.6	102.1	131.0
T_3: Compost (50%) + Poultry manure (50%) equivalent to 100% RDN as basal dose	4.5	38.1	58.4	84.6	79.6	2.1	29.5	54.6	96.7	108.4	13.9	53.9	98.8	125.7
T_4: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50%) as top dress*	5.0	42.0	64.8	91.2	83.7	2.4	32.5	64.7	103.1	117.8	15.7	59.7	106.0	132.2
T_5: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN + Poultry manure (50%) as top dress*	4.6	40.1	62.7	81.2	80.6	2.2	29.9	56.1	100.9	111.1	14.5	57.1	100.7	128.9
T_6: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*	7.9	44.5	67.9	99.7	94.7	3.7	35.9	66.8	114.6	128.5	19.5	67.1	117.8	145.3
T_7: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*	6.9	42.6	64.9	92.7	89.3	3.2	33.4	65.3	105.3	120.7	17.6	65.1	108.3	136.4
T_8: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50% N equivalent) as top dress* (T_4) + Foliar spray of panchagavya alternated with vermiwash**	8.1	55.3	68.7	102.1	100.9	4.0	40.0	67.0	116.0	130.7	22.6	72.2	118.7	148.2
T_9: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN + Poultry manure (50%) as top dress* (T_5) + Foliar spray of panchagavya alternated with vermiwash**	7.6	44.1	65.0	94.0	72.8	3.4	33.5	65.4	109.9	124.7	18.6	65.6	112.0	141.6
T_{10}: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress* (T_6) + Foliar spray of panchagavya alternated with vermiwash**	9.7	59.7	77.2	117.6	108.5	5.0	46.1	87.1	125.7	140.3	28.7	76.9	127.0	159.8
T_{11}: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress* (T_7) + Foliar spray of panchagavya alternated with vermiwash**	8.7	55.4	74.1	105.8	103.2	4.3	41.9	68.5	118.5	135.1	25.7	75.4	120.5	150.3
S.Em. (±)	0.6	2.1	3.2	5.5	2.9	0.4	2.1	6.5	6.6	3.7	1.2	1.6	3.2	4.2
C.D. (P=0.05)	1.7	6.2	9.3	16.3	8.7	1.2	6.1	19.2	19.5	11.1	3.5	4.8	9.5	12.4

*Top dressing in equal splits at 30 and 60 DAS, ** Foliar spray of 3% panchagavya and 10% vermiwash alternatively at 45, 60, 75 and 90 DAS.

RDN: Recommended dose of nitrogen.

Table 4: Effect of organic nutrient management on dry matter production and its rate in cotton.

Treatment	Total dry matter (g plant^{-1})					Rate of dry matter production (g plant^{-1} day^{-1})			
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30-60 DAS	61-90 DAS	91-120 DAS	121-DAS At harvest
T_1: Compost equivalent to 100% RDN as a basal dose	6.2	69.5	156.5	264.6	301.2	2.13	2.90	3.61	2.44
T_2: Compost (50%) + Vermicompost (50%) equivalent to 100% RDN as basal dose	7.0	87.2	177.8	292.9	331.6	2.67	3.03	3.84	2.58
T_3: Compost (50%) + Poultry manure (50%) equivalent to 100% RDN as basal dose	6.6	81.5	168.4	280.1	313.7	2.50	2.89	3.73	2.24
T_4: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50%) as top dress*	7.5	90.3	189.2	300.4	333.7	2.73	3.29	3.71	2.22
T_5: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN + Poultry manure (50%) as top dress*	6.8	84.5	174.5	288.9	320.6	2.60	3.00	3.81	2.12
T_6: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*	11.5	99.9	201.8	332.1	368.5	2.97	3.40	4.34	2.43
T_7: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN as basal dose + Vermicompost (50%) as top dress*	10.1	93.9	195.3	306.3	346.5	2.77	3.39	3.70	2.68
T_8: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50% N equivalent) as top dress* (T_4) + Foliar spray of panchagavya alternated with vermiwash**	12.2	118.0	207.9	336.8	379.8	3.53	3.02	4.30	2.87
T_9: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN + Poultry manure (50%) as top dress* (T_5) + Foliar spray of panchagavya alternated with vermiwash**	11.0	96.2	196.0	315.9	339.1	2.83	3.32	4.00	2.88
T_{10}: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress* (T_6) + Foliar spray of panchagavya alternated with vermiwash**	14.7	134.5	241.2	370.4	408.6	4.00	3.55	4.31	2.55
T_{11}: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress* (T_7) + Foliar spray of panchagavya alternated with vermiwash**	13.0	123.0	218.0	344.8	388.7	3.67	3.16	4.23	2.92
S.Em. (±)	0.6	3.9	9.9	9.8	7.2	0.13	0.06	0.07	0.05
C.D. (P=0.05)	1.7	11.5	29.2	29.0	21.2	0.39	0.19	0.21	0.14

*Top dressing in equal splits at 30 and 60 DAS, ** Foliar spray of 3% panchagavya and 10% vermiwash alternatively at 45, 60, 75 and 90 DAS.
RDN: Recommended dose of nitrogen.

Table 5: Effect of organic nutrient management on leaf area and leaf area index (LAI) of cotton at different growth stages.

Treatment	Leaf area (dm^2 $plant^{-1}$) at different growth stages of crop					Leaf area index (LAI)				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T_1: Compost equivalent to 100% RDN as a basal dose	3.3	26.5	43.6	65.6	59.1	0.13	0.98	1.62	2.43	2.19
T_2: Compost (50%) + Vermicompost (50%) equivalent to 100% RDN as basal dose	3.7	32.1	50.3	68.6	66.2	0.14	1.19	1.87	2.59	2.45
T_3: Compost (50%) + Poultry manure (50%) equivalent to 100% RDN as basal dose	3.6	30.2	45.8	66.4	62.5	0.13	1.11	1.70	2.46	2.31
T_4: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50%) as top dress*	4.0	33.0	50.9	71.0	65.7	0.15	1.22	1.89	2.65	2.43
T_5: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN + Poultry manure (50%) as top dress*	3.6	31.5	49.2	68.5	63.3	0.13	1.17	1.82	2.54	2.34
T_6: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*	6.2	34.9	53.3	78.3	74.3	0.23	1.30	1.97	2.93	2.75
T_7: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN as basal dose + Vermicompost (50%) as top dress*	5.4	33.4	50.9	72.8	70.1	0.20	1.24	1.88	2.69	2.60
T_8: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50% N equivalent) as top dress* (T_4) + Foliar spray of panchagavya alternated with vermiwash**	6.4	43.4	53.9	80.2	79.2	0.24	1.61	2.00	2.97	2.93
T_9: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN + Poultry manure (50%) as top dress* (T_5) + Foliar spray of panchagavya alternated with vermiwash**	5.9	34.6	51.1	73.8	72.9	0.22	1.28	1.89	2.73	2.70
T_{10}: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress* (T_6) + Foliar spray of panchagavya alternated with vermiwash**	7.6	46.9	60.6	92.4	85.2	0.28	1.74	2.24	3.42	3.15
T_{11}: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress* (T_7) + Foliar spray of panchagavya alternated with vermiwash**	6.9	46.5	58.2	83.1	81.0	0.25	1.61	2.13	3.08	3.00
S.Em. (±)	1.3	1.4	1.9	3.4	2.1	0.01	0.05	0.05	0.14	0.07
C.D. (P=0.05)	3.9	4.1	5.5	10.0	6.3	0.03	0.14	0.16	0.41	0.23

*Top dressing in equal splits at 30 and 60 DAS, ** Foliar spray of 3% panchagavya and 10% vermiwash alternatively at 45, 60, 75 and 90 DAS.

RDN: Recommended dose of nitrogen.

Table 6: SPAD value at different growth stages of cotton as influenced by nutrient management practices under organic cultivation.

Treatment	SPAD value			
	60 DAS	90 DAS	120 DAS	At harvest
T_1: Compost equivalent to 100% RDN as a basal dose	34.7	35.5	36.9	34.9
T_2: Compost (50%) + Vermicompost (50%) equivalent to 100% RDN as basal dose	36.4	39.8	40.5	37.1
T_3: Compost (50%) + Poultry manure (50%) equivalent to 100% RDN as basal dose	36.0	37.3	39.1	36.2
T_4: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + poultry manure (50%) as top dress*	36.9	40.9	40.9	37.8
T_5: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN + Poultry manure (50%) as top dress*	36.1	39.3	40.1	36.6
T_6: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*	37.9	41.9	43.0	40.4
T_7: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN as basal dose + Vermicompost (50%) as top dress*	37.5	41.0	41.2	38.3
T_8: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Poultry manure (50% N equivalent) as top dress*(T_4) + Foliar spray of panchagavya alternated with vermiwash**	38.2	42.1	44.0	41.7
T_9: Compost (25%) + Poultry manure (25%) equivalent to 50%RDN + Poultry manure (50%) as top dress*(T_5) + Foliar spray of panchagavya alternated with vermiwash**	37.8	41.8	42.8	39.5
T_{10}: Compost (25%) + Vermicompost (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress* (T_6) + Foliar spray of panchagavya alternated with vermiwash**	39.4	44.2	49.4	45.6
T_{11}: Compost (25%) + Poultry manure (25%) equivalent to 50% RDN as basal dose + Vermicompost (50%) as top dress*(T_7) + Foliar spray of panchagavya alternated with vermiwash**	38.3	42.2	46.6	43.7
S.Em. (±)	0.7	0.8	1.1	0.7
C.D. (P=0.05)	2.1	2.3	3.1	2.1

*Top dressing in equal splits at 30 and 60 DAS, ** Foliar spray of 3% panchagavya and 10% vermiwash alternatively at 45, 60, 75 and 90 DAS.

RDN: Recommended dose of nitrogen.

vermicompost and poultry manure was 0.77, 1.57 and 2.10% N; 0.68, 0.79 and 1.80% P; and 1.01, 1.22 and 1.39% K, respectively.

Cotton seeds of pre-release variety SCS-1062 (yield potential: 22-25 q ha^{-1}) were treated with azospirillum and phosphate solubilizing bacteria before sowing. Sowing was done by hand dibbling at a spacing of 90 × 30 cm, followed by thinning at 7 days after germination to maintain one healthy plant per hill. Five plants were randomly tagged in each plot for recording observations on growth, biomass accumulation and physiological parameters at 30, 60, 90, 120 DAS and at harvest. The experimental data were subjected to analysis of variance (ANOVA) and treatment means were compared at the 5% level of significance ($P \leq 0.05$).

RESULTS AND DISCUSSION

Effect of organic nutrient management on plant height

Plant height was significantly influenced by organic nutrient management (Table 1). Treatment T_{10} recorded the highest plant height, followed by T_{11} and T_8, while T_1 showed the lowest. The superior performance of T_{10} may be due to integrated nutrient application, ensuring continuous nutrient supply and improved microbial activity, promoting better growth. Similar findings were reported by (Selvakumar *et al*., 2025; Shi *et al*., 2024; Abisankar *et al*., 2024; Sanjivkumar *et al*., 2025; Marimuthu and Amanullah, 2021).

Number of branches

Branching behaviour (monopodial and sympodial) was significantly influenced by nutrient management (Table 2). Treatment T_{10} recorded maximum branches due to improved nutrient availability and hormonal stimulation from integrated organic inputs. Organic sources are known to improve auxin and cytokinin activity, leading to increased branching. These findings are in agreement with (Channagouda *et al*., 2015; Sanjivkumar *et al*., 2025).

Effect on dry matter accumulation

Dry matter accumulation in leaves, stems and reproductive parts was significantly influenced by organic nutrient management (Table 3). Treatment T_{10} recorded the highest accumulation, followed by T_{11} and T_8, while T_1 was lowest. Increased biomass under integrated treatments may be due to enhanced nutrient mineralization, microbial activity, efficient photosynthesis and improved assimilate production and partitioning (Paramesh *et al.*, 2023). Similar results were reported by (Yu *et al*., 2025; Selim, 2018).

Effect on total dry matter production and its rate

Total dry matter production and its rate varied significantly among treatments (Table 4). Treatment T_{10} recorded the highest values, followed by T_{11} and T_8, while T_1 was lowest. This improvement may be due to sustained nutrient release, efficient uptake and improved source-sink relationship under integrated organic nutrient management. These findings are supported by (Bhattacharyya *et al*., 2021; Selim, 2018).

Effect on leaf area and leaf area index (LAI)

Leaf area and leaf area index were significantly influenced by different treatments (Table 5). Treatment T_{10} recorded the highest leaf area and LAI, followed by T_{11} and T_8, while T_1 recorded the lowest values. Improved canopy development under integrated treatments may be due to enhanced nutrient availability and better physiological efficiency, resulting in increased photosynthetic surface area. Organic inputs also improve soil structure and moisture retention, which further supports leaf expansion. These findings are supported by (Selvakumar *et al*., 2025; Ramya *et al*., 2022; Sanjivkumar *et al*., 2025; Marimuthu and Amanullah, 2021).

Effect on SPAD value (chlorophyll content)

SPAD values were significantly influenced by organic nutrient management (Table 6). Treatment T_{10} recorded the highest values, followed by T_{11} and T_8, while T_1 showed the lowest. Higher chlorophyll content under integrated treatments may be due to sustained nutrient supply and growth-promoting substances, enhancing photosynthetic efficiency and overall plant performance. These findings are supported by (Jiménez-Ríos *et al*., 2024; Meena *et al*., 2014).

CONCLUSION

Integrated organic nutrient management significantly improved growth, biomass accumulation and physiological attributes of cotton. Treatment T_{10} proved superior owing to balanced nutrient supply and improved physiological efficiency under organic cultivation. The study suggests that integrated use of organic inputs is a sustainable approach for improving cotton productivity and maintaining soil health under semi-arid conditions.

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Conflict of interest

The authors declare no conflict of interest. The study involved no human or animal subjects.

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