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Tenzin Dorjee
M.Sc. Agronomy, Dolphin (PG) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand, India

Jitendra Kumar Meena
Assistant Professor, Department of Agriculture, Dolphin (PG) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand, India

CS Pandey
Associate Professor, Department of Agriculture (HOD), Dolphin (PG) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand, India

Corresponding Author:
Jitendra Kumar Meena
Assistant Professor, Department of Agriculture, Dolphin (PG) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand, India

Effect of various concentrations of organic and inorganic nutrients on growth of cowpea [*Vigna unguculata* (L.)] under valley conditions of Dehradun

Tenzin Dorjee, Jitendra Kumar Meena and CS Pandey

Abstract
An agronomic investigation was conducted during 2020 at Agriculture Research Farm, Dolphin (P.G) Institute of Biomedical and Natural Sciences, Dehradun. The aim of study was to study the effect of organic and inorganic nutrients on growth of cowpea. The experimental plot was laid out in a randomized block design with 7 treatments and 3 replications. It was of 3.0 m x 2.0 m2 size with spacing of 30 cm x 20 cm per bed. The experiment was conducted using treatments T1 (Control), T2 (75% RDF + 25% Vermicompost), T3 (75% RDF + 25% vermicompost + 25% Neem cake), T4 (75% RDF + 25% Neem cake), T5 (75% RDF + 25% FYM), T6 (50% RDF + 25% Neem cake) and T7 (100% RDF). The experimental data revealed that the observations taken during 30, 45, 60, and 90 DAS among all the treatments (T3) i.e. 75% RDF + 25% vermicompost + 25% Neem cake showed maximum plant growth among most of the treatments at different growth intervals i.e. plant height, number of leaves, number of branches, number of plants per bed and dry mater accumulation per plant, whereas minimum plant growth was recorded under treatment (T1) control.

Keywords: RDF, vermicompost, FYM, neem cake, N:P:K, growth attributes of cowpea

1. Introduction
Cowpea (*Vigna unguiculata* L.) also known as lobia is an important food legume and grown throughout India for its long green vegetable pod, seeds, and foliage for fodder. Cowpea is an annual herbaceous legume crop from genus Vigna, family "Fabaceae" chromosome no 2n = 22. It is used both for human consumption and for cattle feed. Due to its tolerance for sandy soil and low rainfall, it is an important crop in the semiarid regions across Africa and Asia. It requires very few inputs, as the plant's root nodules are able to fix atmospheric nitrogen, making it a valuable crop for poor farmers and well suited to intercropping with other crops. Cowpea being a legume crop does not require much nitrogen except in small quantities at the beginning of its life cycle. Nitrogen is an essential element for proper plant growth and development. Nitrogen is an essential constituent of compounds like amino acid, protein, nucleic acid, enzymes, and alkaloids (Anuja *et al*. 2014). Phosphorus is an important plant nutrient. It is associated with several vital functions like seed germination, flowering cell division, synthesis of fat, starch, and in almost every biochemical activity).Potassium is the third macronutrient required for plant growth, after nitrogen and phosphorus. In drought, Potassium plays an active role in the maintenance of turgidity in plant cell and regulates stomata function. The productivity of cowpea is very low, due to poor crop management practices and its cultivation in poor and marginal lands. In recent years, crop cultivation requires the use of chemical fertilizers, but it is expensive for people who do not have capacity to buy fertilizer. Therefore, the current trend is to explore the possibilities of supplementing organic fertilizer like FYM, Vermicompost, and neem cake, etc. along with the use of inorganic fertilizers to reduce the cost and increase the soil fertility and productivity. FYM seems to act directly for increasing cell permeability and hormonal growth action by combination of all these processes. It supplies nitrogen, phosphorous, potassium, and micronutrients like Fe, S, and Zn, etc. in available form to the plants through biological decomposition, improve physical, chemical properties, and health of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase cation exchange capacity. FYM contains 0.50% N, 0.17%P2O5 and 0.55% K2o. (Gaur *et al* .1992). Vermicompost is a potential source due to the presence of readily available plant nutrients, growth-enhancing substances and many beneficial microorganisms like nitrogen-fixing, P solubilizing, and cellulose decomposing organisms. Vermicompost is a rich mixture of major

and minor plant nutrients containing 1.2-1.6%N, 1.8-2.0% P2O5 and 0.50 -0.75% K2o growth- enhancing substance such as auxins and cytokines (Karmegan *et al*. (2000). Neem cake contains the alkaloids-Nimbin which effectively inhibits the nitrification process. It also controlled some insects and pests effectively. The neem cake has been considered as a rich source of plant nutrients, it has been reported that the neem cake contains 5.2% N, 1.0% P2O5, and 1.4% K2O. (Jain *et.al* 1986).Therefore, continuous use of inorganic fertilizer leads to degradation in soil fertility. Hence, to maintain the soil fertility and supply plant nutrients in the balance portion for optimum growth, yield and quality of crop with the integrated approach is to be practiced through the combined use of an organic and inorganic source of nutrients.

2. Materials and Methods

The field experiment was conducted at Agriculture research farm, Dolphin (P.G.) Institute of Biomedical & Natural Sciences, Dehradun, Uttarakhand (India) during *Zaid* season 2020. Crop variety selected was Pusa Komal. The experiment was laid out in Randomized Block Design with three replications and 7 treatment combinations using different recommended dose of organic and inorganic fertilizers. The sowing was done in the month of March on flat bed by dibbling two seeds at each hill. The spacing adopted was 30 cm between two rows and 20 cm between two plants. The depth of sowing was 5 cm by keeping seed rate 25 kg ha-1. Gap filling was undertaken 10 days after sowing to maintain optimum plant stand. Five plants from each plot were selected to record the data for growth attributes.

Table 1: The experiment comprises of following treatments

Sl. No.	Treatments	RDF (%)
1	T1	Control
2	T2	75% RDF + 25% Vermicompost
3	T3	75% RDF + 25% Vermicompost + 25% Neem cake
4	T4	75% RDF + 25% Neem cake
5	T5	75% RDF + 25% FYM
6	T6	50% RDF + 25% Neem cake
7	T7	100% RDF

3. Results

3.1. Days to 50% germination

Table 2: Effect of various concentrations of organic and inorganic nutrients on days to 50% germination in cowpea

S. No.		Treatments	Days to 50% germination
T1	Control		13.45
T2	75% RDF + 25%Vermicompost		12.12
T3	75% RDF + 25% vermicompost + 25%Neem cake		10.50
T4	75% RDF + 25% Neem cake		12.15
T5	75% RDF + 25% FYM		12.16
T6	50% RDF + 25% Neem cake		12.51
T7	100% RDF		12.16
	S.E(m)		0.61
		CD	NS
		Range	10.50 - 13.45

The data on days to 50% germination of seed as influenced by varying levels of the recommended dose of fertilizers, FYM, vermicompost, Neem cake have been presented in Table 2 and Fig 1.The data indicates that there is no significant difference between the treatments.

Neither the individual treatment nor their interactions had an influence on germination which reveals that treatment did not show any adverse effect on the germination of plants. However minimum days of germination was observed in treatment T3 (10.50 days) i.e. 75% RDF + 25% vermicompost + 25% Neem cake which was followed by T2 (12.12 days) i.e. 75% RDF + 25% vermicompost, T4 (12.15 days) i.e. 75% RDF + 25% Neem cake, T5 (12.16 days) i.e. 75% RDF + 25% FYM, and T7 (12.16 days) i.e. 100% RDF respectively. The maximum days for germination were observed in treatment T6 (12.51days) i.e. 50% RDF + 25% Neem cake and T1 (13.45 days)
i.e. control.

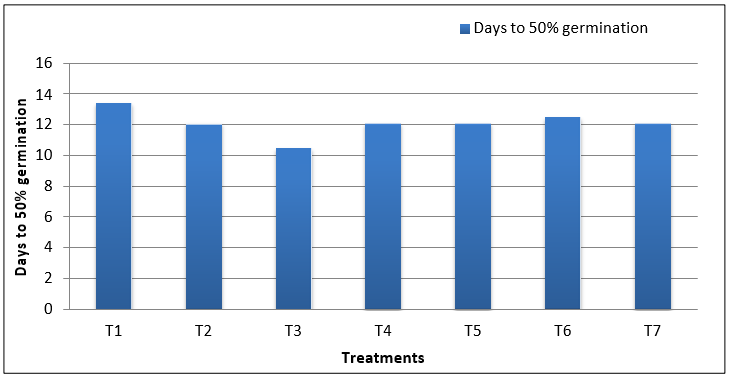

Fig 1: Effect of various concentrations of organic and inorganic nutrients on days to 50% germination in cowpea

3.2 Plant height

The data on periodical plant height (cm) recorded at 30, 45, 60, and 90 DAS as influenced by different treatments furnished in Table 3 and Fig 2. The observation was recorded on plant height at 30 DAS where no significant difference was observed in plant height. However, the maximum plant height was recorded in the application of treatment T3 (13.79 cm) i.e. 75% RDF + 25% vermicompost + 25% Neem cake followed by the application of T2 (13.18 cm) i.e. 75% RDF + 25% vermicompost and T5 (12.83 cm) i.e. 75% RDF + 25% FYM and T4 (12.82 cm) i.e. 75%
RDF + 25% Neem cake and T7 (12.45 cm) i.e. 100% RDF respectively, whereas the minimum plant height was recorded in treatment T6 (12.35cm) i.e. 50% RDF + 25% Neem cake and T1 control (11.40)

Table 3: Effect of various concentrations of organic and inorganic nutrients on plant height (cm) in cowpea

S. No.	Treatments		Plant height (cm)		
	30 DAS		45 DAS	60 DAS	90 DAS
T1	Control	11.40	19.09	22.00	23.87
T2	75% RDF + 25% vermicompost	13.18	24.23	28.75	31.88
T3	75% RDF + 25% vermicompost + 25% Neem cake	13.79	24.70	29.39	32.15
T4	75% RDF + 25% Neem cake	12.82	23.16	27.09	28.96
T5	75% RDF + 25% FYM	12.83	24.08	28.58	31.44
T6	100% RDF	12.35	22.04	25.70	26.99
T7	50% RDF + 25% Neem cake	12.45	22.11	26.00	28.20
	S.Em±	0.82	0.31	0.58	0.23
	CD (5%)	NS	0.97	1.82	0.73
	Range	11.40- 13.79	19.09- 24.70	22.00- 29.39	23.87- 32.15

At 45, 60, and 90 DAS significant difference were recorded in plan height. The maximum plant height was recorded in the application of treatment T3 (24.70, 29.39 and 32.15) i.e. 75% RDF + 25% vermicompost + 25% Neem cake which was statistically at par with treatment T2 (24.23, 28.75 and 31.88cm) i.e 75% RDF + 25% vermicompost and T5 (24.08, 28.58 and 31.44 cm) i.e. 75% RDF + 25% FYM respectively. The minimum plant height was recorded under treatment T1 control (19.09, 22.00 and 23.87cm). Similar results are reported by Mahaveer *et al*. 2012.

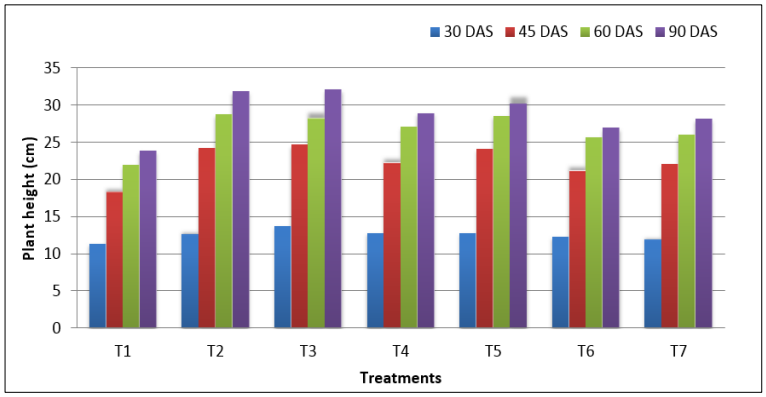

Fig 2: Effect of various concentrations of organic and inorganic nutrients on plant height (cm) of cowpea

3.3 Number of leaves per plant

Data on the number of leaves per plant was recorded at various stages of the crop growth and are presented in Table 4 and presented in Fig 3. The number of functional leaves per plant was gradually increased up to 60DAS and then decreased at 90 DAS due to leaf senescence. At 30, 45 and 60 DAS, significant difference were observed in number of leaves per plant. The maximum number of leaves per plant was recorded with the application of treatment T3 (6.05, 10.61 and 13.89) i.e.75% RDF + 25% vermicompost + 25% Neem cake, which was statistically at par with T2 (5.81, 10.25 and 13.56) i.e. 75% RDF + 25% vermicompost and T5 (5.79, 9.96 and 13.26) i.e.75% RDF + 25% FYM respectively found significantly superior to rest of the other treatment. The minimum number of leaves was recorded under T1 control (4.51, 7.65, and 9.96).

At 90 DAS significant difference were observed. The maximum number of leaves per plant was recorded with the application of treatment T3 (9.48) i.e. 75% RDF + 25% vermicompost + 25% Neem cake, which was statistically at par with the application of treatment T2 (9.11) i.e. 75% RDF + 25% vermicompost, and T5 (8.82) i.e. 75% RDF + 25% FYM found significantly superior to rest of the other treatments. The minimum number of leaves was recorded under the treatment T1 control (5.86). Similar results were reported by Bapi Das *et al*. 2011.

Table 4: Effect of various concentration organic and inorganic nutrients on number of leaves per plant in cowpea

S. No.	Treatments		Number of leaves plant-1		
	30 DAS		45 DAS	60 DAS	90 DAS
T1	Control	4.51	7.65	9.96	5.86
T2	75% RDF + 25% vermicompost	5.81	10.25	13.56	9.11
T3	75% RDF + 25% vermicompost + 25% Neem cake	6.05	10.61	13.89	9.48
T4	75% RDF + 25% Neem cake	5.26	9.35	12.96	7.28

T5	75% RDF + 25% FYM	5.79	9.96	13.26	8.82
T6	50% RDF + 25% Neem cake	4.91	8.74	11.67	6.97
T7	100% RDF	5.22	8.92	12.54	7.24
	S.Em±	0.09	0.20	0.20	0.29
	CD (5%)	0.28	0.65	0.63	0.93
	Range	4.51- 6.05	7.65- 10.61	9.96- 13.89	5.86- 9.48

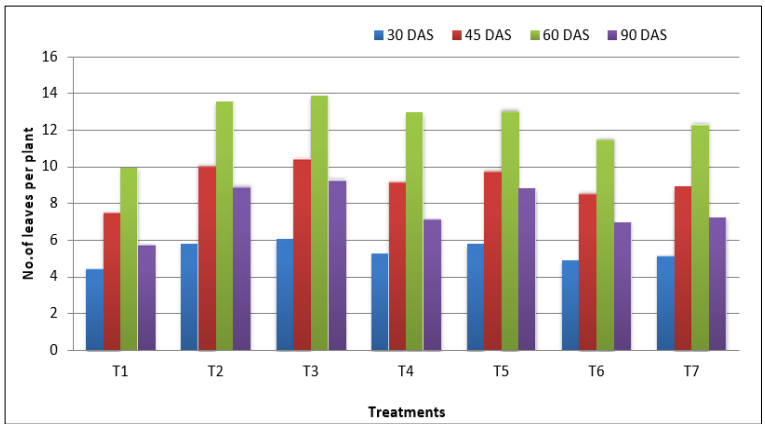

Fig 3: Effect of various concentrations of organic and inorganic nutrients on number of leaves per plant in cowpea

3.4 Number of branches plant-1

The data on the number of branches plant-1 as influenced by different treatments are presented in Table 5 and presented in Fig 4. The maximum increase in branches was observed between 30 to 60 DAS and there after the rate was gradually decreased and became almost constant at harvest.

Table 5: Effect of various concentrations of organic and inorganic nutrients on number of branches per plant in cowpea

S. No.	Treatments		Number of branches plant-1		
	30 DAS		45 DAS	60 DAS	90 DAS
T1	Control	1.91	3.62	3.82	3.82
T2	75% RDF + 25% vermicompost	2.85	5.20	5.85	5.85
T3	75% RDF + 25% vermicompost + 25% Neem cake	3.07	5.26	5.93	5.93
T4	75% RDF + 25% Neem cake	2.55	4.78	5.29	4.63
T5	75% RDF + 25% FYM	2.64	5.02	5.68	5.68
T6	50% RDF + 25% Neem cake	2.32	4.09	4.38	4.38
T7	100% RDF	2.36	4.56	4.96	4.63
	S.Em±	0.03	0.07	0.08	0.21
	CD (5%)	0.12	0.24	0.26	0.66
	Range	1.91- 3.07	3.62- 5.26	3.82- 5.93	3.82 - 5.93

At 30 DAS, significant differences were observed in number of branches per plant. The maximum number of branches per plant was recorded with the application of T3 (3.07) i.e. 75% RDF + 25% vermicompost + 25% Neem cake followed by the application of treatment T2 (2.85) i.e. 75% RDF + 25% vermicompost and T5 (2.64) i.e. 75% RDF + 25% FYM recorded superior as compared to the other treaments. The minimum number of branches per plant was recorded under treatment T1 control (1.91).

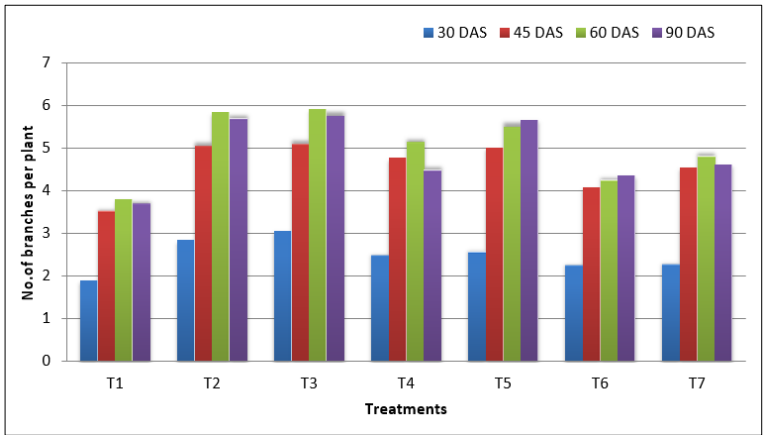

Fig 4: Effect of various concentrations of organic and inorganic nutrients on number of branches per plant in cowpea

At 45, 60 and 90 DAS significantly the maximum number of branches per plant was recorded with the application of T3 (5.26, 5.93 and 5.93) i.e. 75% RDF + 25% vermicompost + 25% Neem cake which was found statistically at par with

treatment T2 (5.20, 5.85 and 5.85) i.e. 75% RDF + 25% vermicompost and T5 (5.02, 5.68 and 5.68) i.e. 75% RDF + 25% FYM found significantly superior over rest of the treatments. The minimum number of branches per plant was recorded under the treatment T1 control (3.62, 3.82 and 3.82). At 90 DAS number of branches remained almost same as 60DAS. Similar results are reported by Choudhary *et al* 2013.

3.5.1 Days to first flowering

The days to first flowering was recorded and have been presented in Table 6 and Fig 5. The Significant difference was not evident in respect to days to first flowering in cowpea due to treatments application. However, the minimum number of days taken for first flowering was recorded under the treatment T3 (36.80 days) i.e. 75% RDF + 25% vermicompost + 25% Neem cake followed by treatment T2 (36.88 days) i.e. 75% RDF + 25% vermicompost, T5 (37.25 days) i.e. 75% RDF + 25% FYM, T4 (37.50 days) i.e. 75% RDF + 25% Neem cake and T7 (37.50) i.e. 100% RDF respectively. The maximum days taken for flowering were recorded under the treatment T6 (39 days) i.e. 50% RDF + 25% Neem cake and T1 (40.50 days) under control. Similar results are reported by Sharma *et al*. 2015.

3.5.2 Days to 50% flowering

Days to 50% flowering was recorded and have been present in Table 6 and Fig 5. There were no significant differences were seen in respect to days to 50% flowering in cowpea due to different treatment application. However, the minimum number of days taken for 50% flowering was recorded under treatment T3 (45.13days) i.e. 75% RDF + 25% vermicompost + 25% Neem cake followed by treatment T2 (45.50 days) i.e. 75% RDF + 25% vermicompost, T5 (46 days) i.e. 75% RDF + 25% FYM, T4 (46.50 days) i.e. 75% RDF + 25% Neem cake and T7 (47 days) i.e. 100% RDF respectively. The maximum days taken for flowering were recorded under the treatment T6 (47.30 days) i.e. 50% RDF + 25% Neem cake and T1 (48 days) under control.

Table 6: Effect of various concentrations of organic and inorganic nutrients on days to flowering in cowpea

S. No.	Treatments	Days to 1st flowering	Days to 50% flowering
T1	Control	40.50	48.00
T2	75% RDF + 25% vermicompost	36.88	45.50
T3	75% RDF + 25% vermicompost + 25% Neem cake	36.80	45.13
T4	75% RDF + 25% Neem cake	37.50	46.50
T5	75% RDF + 25% FYM	37.25	46.00
T6	50% RDF + 25% Neem cake	39.00	47.30
T7	100% RDF	37.50	47.00
	S.Em±	0.94	0.61
	CD (5%)	NS	NS
	Range	36.80 - 40.50	45.13 - 48.00

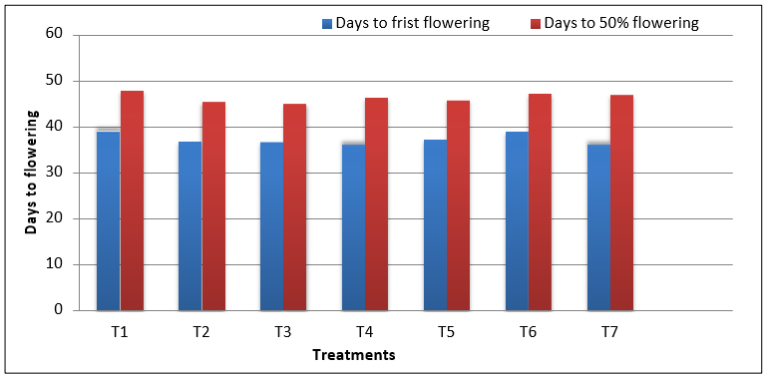

Fig 5: Effect of various concentrations of organic and inorganic nutrients on days to flowering in cowpea

3.6 Number of plants per bed

The number of plants per bed was recorded and has been presented in Table 7 and Fig 6.

Table 7: Effect of various concentration of organic and inorganic nutrients on number of plants per bed in cowpea

S. No.	Treatments	Number of plants bed-1
T1	Control	49.60
T2	75% RDF +25%Vermicompost	64.28
T3	75% RDF + 25% vermicompost + 25%Neem cake	66.15
T4	75% RDF + 25% Neem cake	60.32
T5	75% RDF + 25% FYM	62.60
T6	50% RDF + 25% Neem cake	53.69
T7	100% RDF	57.50
S.E(m)		0.62
CD (5%)		1.93
Range		46.60-66.15

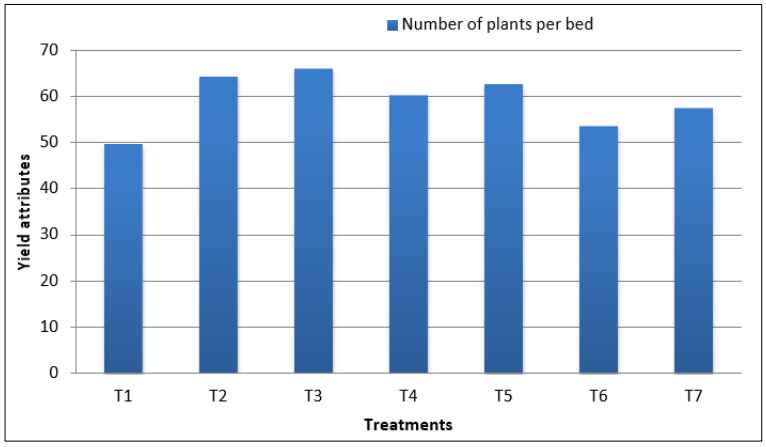

Fig 6: Effect of various concentrations of organic and inorganic nutrients on number of plants per bed in cowpea

The number of plants per bed was significantly influenced by the application of different treatments. The maximum number of the plants were recorded in treatment T3 (66.15) i.e.75% RDF + 25% vermicompost + 25% Neem cake which was statistically at par with the application of treatment T2 (64.28) i.e. 75% RDF + 25% vermicompost. The minimum number of plants per bed was observed under the treatment T1 control (49.60).

3.7 Dry matter accumulations per plant

The data on dry matter accumulation at different treatments recorded significant effect and are presented in Table 8 and Fig 7. The dry matter accumulation per plant was found to be increased continuously with the advancement in the age of the crop. The dry matter production was slow at the beginning, fast during 30 to 45 days and gradually increased at 90 days. At 30 and 45 DAS significantly higher dry matter accumulation per plant was recorded under treatment T3 (3.23 and 9.67) i.e 75% RDF + 25% vermicompost + 25% Neem cake which was statistically at par with the application of T2 (3.04 and 9.59) i.e. 75% RDF + 25% vermicompost. Minimum dry matter accumulation per plant was recorded under treatment T1 (2.35 and 7.25) i.e. control.

Table 8: Effect of various concentration of organic and inorganic nutrients on dry matter accumulation per plant in cowpea

S. No.	Treatments		Dry matter accumulation plant-1		
		30 DAS	45 DAS	60 DAS	90 DAS
T1	Control	2.35	7.25	10.06	12.34
T2	75% RDF + 25% vermicompost	3.04	9.59	15.29	17.54
T3	75% RDF + 25% vermicompost + 25% Neem cake	3.23	9.67	15.45	17.87
T4	75% RDF + 25% Neem cake	2.87	8.89	14.71	16.56
T5	75% RDF + 25% FYM	2.96	9.16	15.07	17.25
T6	50% RDF + 25% Neem cake	2.59	8.43	13.56	16.00
T7	100% RDF	2.66	8.77	14.08	16.19
	S.Em±	0.07	0.12	0.18	0.38
	CD (5%)	0.22	0.38	0.56	1.18
	Range	2.35 - 3.23	7.25 - 9.67	10.06 -15.45	12.34-17.87

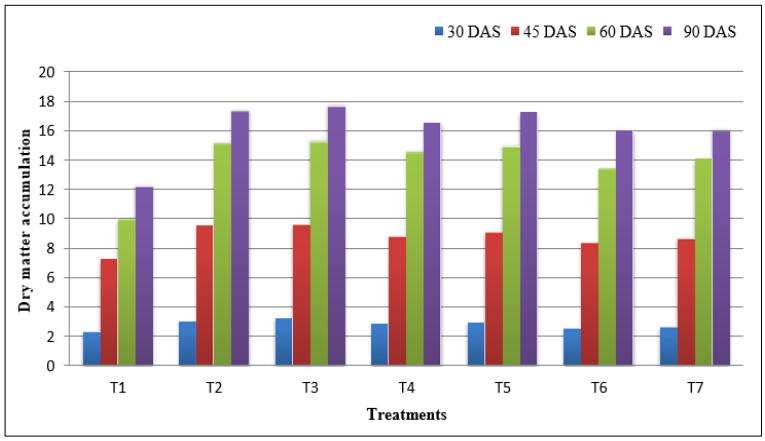

Fig 7: Effect of various concentrations of organic and inorganic nutrients on dry matter accumulation of cowpea

At 60 and 90 DAS significantly higher dry matter accumulation per plant was recorded under treatment T3 (15.45 and 17.87) i.e. 75% RDF + 25% vermicompost + 25% + Neem cake which was statistically at par with the application of T2 (15.29 and 17.54) i.e. 75% RDF + 25% vermicompost and T5 (15.07 and 17.25) i.e. 75% RDF + 25% FYM found significantly superior over the other treatments. Minimum dry matter accumulation per plant was recorded under the treatment T1 (10.06 and 12.34) i.e. control. Similar results are reported by Yadav and malik 2005.

4. Conclusion

The growth parameters of cowpea viz., plant height, number of leaves per plant, number of branches per plant, number of plants per bed, dry matter accumulation per plant, were significantly varied due to different treatments. It was also noted that all the growth parameters significantly increased by the combine use of organic and inorganic sources of nutrients. Among all the treatments T3 i.e. 75% RDF + 25% vermicompost + 25% Neem cake showed maximum plant growth over most of treatments at different growth intervals. However, it was statistically at par with the application of T2 i.e. 75% RDF + 25% vermicompost. While minimum growth parameters were recorded under control T1

Whereas on days to 50% germination, first flowering and days to 50% flowering the data recorded non-significant due to various treatments interaction. The earliest germination and flowering was recorded under T3 i.e. 75% RDF + 25% vermicompost + 25% Neem cake followed by the application of T2 i.e. 75% RDF + 25% vermicompost and the minimum days to 50% germination and flowering were recorded under treatment T1 control.

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