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Effect of Organic Manures, Organic Supplements and Biofertilizers on Growth and Yield of Cowpea [*Vigna unguiculata* (L.) Walp]

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A B S T R A C T

A field experiment was conducted at Horticulture farm, Department of Horticulture, SHUATS, Allahabad. The experiment consisted of two Bulky organic manures (FYM and Vermicompost), two liquid organic supplements (Fish Amino Acid (FAA) and Panchagavya) and Biofertilizers [*Rhizobium* and Phosphate Solubilizing Bacteria (PSB)]. The result revealed that treatment T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizers) was found to be best in terms of plant height (56.17 cm), number of leaves (57.07), number of branches (28.93), number of root nodules (21.73), length of pods (36.84 cm), width of pods (0.69 cm), days of germination (3.3), number of pods per plant (37.70), number of seeds per pod (14.10), pod weight (17.63), pod yield (254.03 q/ha) (4.7) followed by T_{13} (Vermicompost + Panchagavya + Biofertilizers) with plant height (56.04 cm), number of leaves (56.93), number of branches (27.67), number of root nodules (20.37), length of pods (36.19 cm), width of pods (0.66 cm), days of germination (3.7), number of pods per plant (37.17), number of seeds per pod (13.93), pod weight (17.10), pod yield (240 q/ha).

Introduction

Cowpea is a warm season crop, annual and herbaceous legume cultivated throughout India like Kerala, Tamil Nadu, Andhra Pradesh, West Bengal, Punjab, Gujarat etc. It is also used as a green manuring crop.

The mature cowpea seeds contain around 25% protein, 63.6% carbohydrates, 1.9% fat, 6.3% fiber, 0.00074% Thiamine, 0.00042% Riboflavin and 0.0028% Niacin (Davis *et al.*, 2000). Its grain is nutritious and is a cheap source of protein for both rural and urban consumers. Plant can tolerate drought and it also fixes atmospheric nitrogen. Land resources are degrading due to intensive cultivation and use of chemical fertilizers, pesticide and weedicide. This has caused environmental imbalance and it is causing problem to all living being on the Earth. The soil is becoming low and deficient in organic content (Baloch *et al.*, 2014). Persistent nutrient depletion is posing a greater threat to the sustainable agriculture. Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase the usage of organic manures and organic

fertilizers which are needed to improve the yield and quality of the produce.

Farm yard manure supplies nitrogen, phosphorus, potassium and micronutrients like Fe, S, Mo and Zn etc. It improves physical and chemical properties and health of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase in cation exchange capacity, stimulation of soil flora and fauna etc. On an average, it contains 0.50, 0.17 and 0.55 per cent of N, P and K, respectively (Gaur, 1991). Vermicompost is an aerobically degraded organic matter produced with the help of worms. It contains 0.80 to 1.10% N, 0.40 to 0.80% P_2O_5 and 0.80 to 0.98% K_2O, 10 to 52 ppm Cu, 186.60 ppm Zn, 930.00 ppm Fe and plant growth promoting substances such as NAA, cytokinins, gibberellins, etc. (Giraddi 2001). It improves physico-chemical properties of the soil and enhances the microbial, crop growth and yield (Vansanthi and Kumaraswamy, 1999).

Use of panchagavya and fish amino acid improves the soil and plants health also providing protective measures against plant diseases. Panchagavya and fish amino acid enhances the biological efficiency of the crop plants and disease resistance (Sarkar *et al.*, 2014).

Biofertilizers play a significant role in fixing atmospheric nitrogen, production of growth promoting substances and making phosphorous available to the plants hence the application of biofertilizers is very essential to the plant (Upadhayay *et al.*, 1999).

Materials and Methods

A field experiment was conducted to study the effect of organic manures, organic supplements and biofertilizers on growth and yield of cowpea at Horticulture farm, Department of Horticulture, SHUATS during 2016-2017. The treatments consisted of T_0- Control, T_1- Farm Yard Manure alone, T_2- Farm Yard Manure + Fish Amino Acid, T_3- Farm Yard Manure + +Panchagavya, T_4- Farm Yard Manure + Fish Amino Acid + Panchagavya, T_5- Farm Yard Manure + Fish Amino Acid + Biofertilizer, T_6- Farm Yard Manure + Panchagavya + Biofertilizer, T_7- Farm Yard Manure + Fish Amino Acid + Panchagavya +Biofertilizer, T_8- Vermicompost alone, T_9- Vermicompost + Fish Amino Acid, T_{10}- Vermicompost + Panchagavya, T_{11}- Vermicompost + Fish Amino Acid + Panchagavya, T_{12}- Vermicompost + Fish Amino acid + Biofertilizers, T_{13}- Vermicompost + Panchagavya + Biofertilizers, T_{14}- Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizers. The experiment was conducted following randomized block design replicated thrice. Sowing was done by keeping row to row distance of 60 cm and plant to plant of 30 cm on a plot measuring 1.7 m x 2.1 m. Different growth (days of 100% germination, plant height, number of branches, number of leaves, leaf area, number of nodules, days to first flower appearance), yield [pod yield per plant and pod yield (q/ha)] parameters were studied during the field investigation.

Results and Discussion

The data presented in table 1 revealed that different treatments had significant influence on pre harvest growth attributes of cowpea such as days to 100% germination, plant height, number of branches, number of leaves, root nodules, days to flowering.

It is clear from table 1 that the earliest germination (3.3 days) was observed in T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizer), T_{12}

(Vermicompost + Fish Amino Acid + Biofertilizers) (3.3 days) and T_7 (FYM + Fish Amino Acid + Panchagavya + Biofertilizers) (3.3 days) followed by T_{13} (Vermicompost + Panchagavya + Biofertilizers) (3.7 days), T_{11} (Vermicompost + Fish Amino Acid + Panchagavya) (4.3 days), T_6 (FYM + Panchagavya + Biofertilizers) (3.7 days) and T_4 (FYM + Fish amino acid + Panchagavya) (4 days) which were found to be at par, whereas the lowest germination percentage was noticed in control (6.67 days). The number of days to germination is an important character which indicates earliness/ lateness of a crop in general. The presence of N-indole-3-acetic acid (IAA), cytokinin, gibberellins, and humic acids in vermicompost could have been responsible for the faster germination of seeds (Aroncon *et al.,* 2012).

At 60 days after sowing significant and highest plant height (56.17 cm) was observed in T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizer) followed by T_{13} (Vermicompost + Panchagavya + Biofertilizer) (56.04 cm), T_{12} (Vermicompost + Fish Amino Acid + Biofertilizer) (55.43 cm), T_{11} (Vermicompost + Fish Amino Acid + Panchagavya) (52.77 cm), T_7 (FYM + Fish Amino Acid + Panchagavya + Biofertilizer) (55.80 cm) and T_6 (FYM + Panchagavya+ Biofertilizer) (54.00 cm) which were on par. The least plant height (46.23 cm) was noted in control. Vermicompost improve the soil physical conditions and promote microbial and soil organic matter, which in turn produces organic acids, which inhibits enzymes, particularly IAA oxidase resulting in enhancing the promotive effect of auxin-IAA which has direct effect on plant growth (Leopold, 1974). In case of Panchagavya and Fish Amino Acid, the easy transfer of nutrients to plant through foliar spray could have created the stimuli in the plant system which in turn increased the production of growth regulators in cell system resulting in higher plant height (Sarkar *et al.,* 2014). Nitrogen and phosphorus play an important role in the synthesis of chlorophyll and amino acids. Rhizobium and PSB ensured the continuous supply of these nutrients during plant growth resulting in taller plants (Pawar and singh, 2003)

At 60 days after sowing T_{14} Vermicompost + Panchagavya + Biofertilizer showed significant and maximum number of branches per plant (28.93) followed by T_{13} Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizer (27.67) which were on par whereas minimum number of branches per plant (17.27) was observed in Control.

Similarly, at 60 days after sowing **s**ignificant and maximum number of leaves per plant (57.07) was registered in T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizer) followed by T_{13} (Vermicompost + Panchagavya + Biofertilizer) (56.93), T_{12} (Vermicompost + Fish Amino Acid + Biofertilizers) (53.33), T_{11} (Vermicompost + Fish Amino Acid + Panchagavya) (53.53), T_{10} (Vermicompost + Panchagavya) (50.47), T_9 (Vermicompost + Fish Amino Acid) (56.33), T_8 (Vermicompost alone) (51.20), T_7 (FYM + Fish Amino Acid + Panchagavya + Biofertilizers) (56.27), and T_6 (FYM + Panchagavya + Biofertilizers) (54.40) which were on par. The least number of leaves per plant (43.87) was noted in control. The number of branches and leaves due to application of organic manure may be attributed the fact that they possess optimum C: N ratio which on decomposition readily release nitrogen in the easily available form of nutrients ions such as ammonium and nitrate (Anuja and Vijayalakshma, 2014).

At the last harvest, significant and maximum number of nodules per plant (21.73) was

recorded in T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizer) followed by T_{13} (Vermicompost + Panchagavya+ Biofertilizer) (20.37), and T_7 (Farm Yard Manure + Fish Amino Acid +Panchagavya + Biofertilizer) (19.93), whereas the least number of nodules per plant (9.93) was recorded in Control. Vermicompost not only supply the macro and micronutrients but also act as a store house of beneficial microorganisms hence enhanced the symbiotic relationship with micro- organism in the soil increasing in the number of nodules in the roots (Rajkhowa *et al.*, 2003)

Significantly minimum number of days taken to first flower appearance was observed in T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizern) (27 days), T_{13} (Vermicompost + Panchagavya + Biofertilizer) (27 days) and T_7 (FYM + Fish Amino Acid + Panchagavya + Biofertilizer) (27 days), which were on par, whereas maximum number of days taken to first flower appearance (32 days) was observed in Control.

Days to first flower appearance take less number of days as this might be due to the combined application of the organic manures, organic supplements and biofertilizers and it has resulted more of vegetative growth and early flowering. The above findings are in confirmation with the research findings of Shrikant (2010) and Erdal *et al.*, 2008.

Fig.1 Effect of organic manures, organic supplements and biofertilizers on pod yield per plant (g) in cowpea

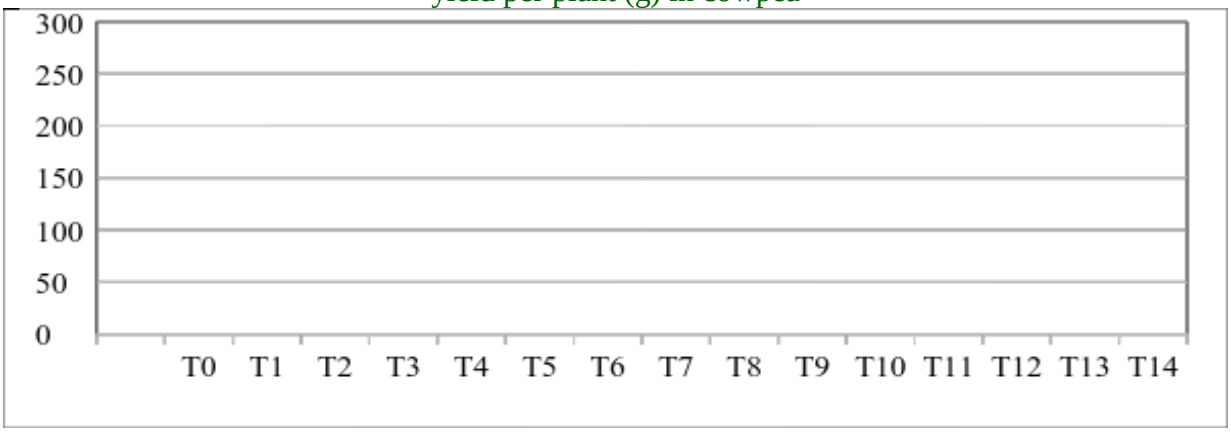

Fig.2 Effect of organic manures, organic supplements and biofertilizers on pod yield (q/ha) in cowpea

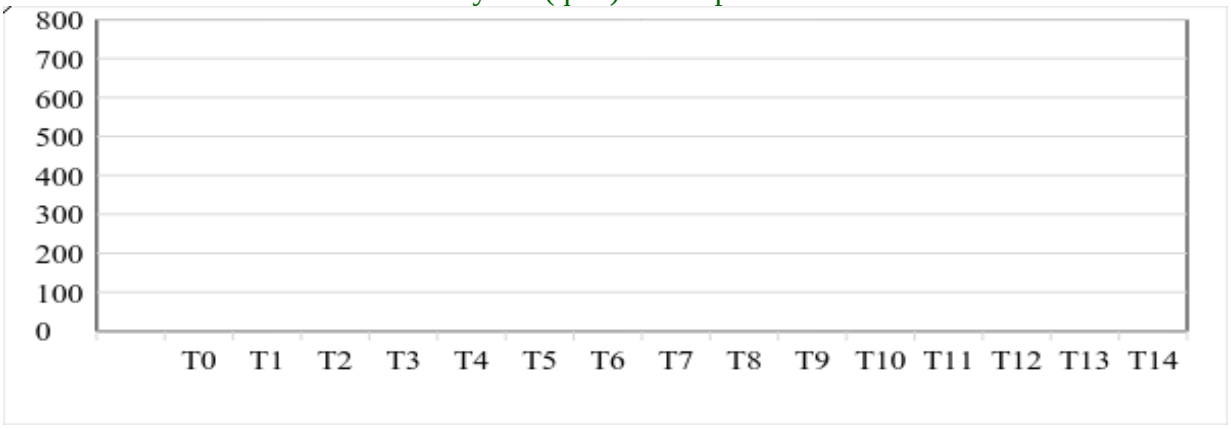

Table.1 Effect of organic manures, organic supplements and biofertilizers on pre-harvest observations of cowpea

Days to first flower appearance	Root nodules per plant (At harvest)	No. of leaves per plant (60 DAS)	No. of branches per plant (60 DAS)	Plant height (cm) (60 DAS)	Days to 100% germination (60 DAS)	TREATMENTS
32	9.93	43.87	17.27	46.23	6.7	T_0
30	10.47	46.87	18.40	47.23	5.3	T_1
30	10.53	48.53	19.40	47.79	5.7	T_2
30	11.57	53.67	22.87	49.47	5.3	T_3
29	13.67	49.00	23.13	51.32	5.7	$T_{4:}$
28	16.40	49.33	23.39	52.03	4.0	T_5
28	17.74	54.40	25.30	54.00	3.7	$T_{6:}$
27	20.20	56.27	26.37	55.80	3.3	$T_{7:}$
29	10.67	51.20	19.87	48.53	5.3	T_8
30	12.20	56.33	23.27	50.50	4.7	T_9
30	14.67	50.47	23.40	51.70	5.0	T_{10}
30	17.53	53.53	24.42	52.77	4.3	T_{11}
28	19.93	53.33	25.81	55.43	3.3	T_{12}
27	20.37	56.93	27.67	56.04	3.7	T_{13}
27	21.73	57.07	28.93	56.17	3.3	T_{14}
S	S	S	S	S	S	F Test
0.38	1.35	3.76	0.73	1.96	0.73	SE d =
0.77	2.77	7.70	1.49	4.02	1.49	CD (P=0.05%)

Table.2 Influence of organic manures, organic supplements and biofertilizers on post- harvest observations of cowpea

Pod yield (q/ha)	Pod yield per plant (g)	No. of seeds per pod	No. of pods per plant	Average pod weight	Width of pods (cm)	Length of pods (cm)	TREATMENTS
157.06	414.64	10.07	29.30	14.17	0.54	29.93	T_0
171.01	452.53	10.27	30.23	15.00	0.57	31.52	T_1
191.93	507.85	11.13	33.73	15.03	0.58	31.57	T_2
195.29	516.76	11.47	33.47	15.53	0.61	32.20	T_3
205.63	544.13	11.50	34.53	15.73	0.61	32.39	$T_{4:}$
226.05	598.17	13.07	36.13	15.57	0.62	34.10	T_5
234.71	620.96	13.53	36.67	16.90	0.63	35.20	$T_{6:}$
238.57	631.67	13.73	36.97	17.07	0.63	35.77	$T_{7:}$
193.61	512.23	12.03	33.07	15.47	0.59	31.87	T_8
207.81	549.97	12.47	34.40	15.70	0.61	32.30	T_9
207.06	548.04	13.13	35.40	16.53	0.62	33.40	T_{10}
226.13	598.27	13.13	36.17	16.63	0.62	34.15	T_{11}
237.98	629.70	13.77	36.93	16.97	0.63	35.47	T_{12}
240.00	635.07	13.93	37.17	17.10	0.66	36.19	T_{13}
254.03	671.97	14.10	37.70	17.63	0.69	36.84	T_{14}
S	S	S	S	S	S	S	F Test
20.89	55.33	0.94	1.50	1.54	0.04	1.86	SE d =
42.80	113.34	1.93	3.06	3.15	0.09	3.82	CD (P=0.05%)

The yield attributes of Cowpea viz., Pod length, pod width, average pod weight, number of pods per plant, number of seeds per pod were significantly influenced by the different treatments presented in table 2.

Significant and maximum pod length (36.84 cm) was observed in T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizers) followed by T_{13} (Vermicompost + Panchagavya + Biofertilizers) (36.19 cm), T_{12} (Vermicompost + Fish Amino Acid + Biofertilizer) (35.47 cm), T_{11} (Vermicompost + Fish Amino Acid + Panchagavya) (34.15 cm), T_{10} (Vermicompost + Panchagavya) (33.40 cm), T_7 (FYM + Fish Amino Acid + Panchagavya+ Biofertilizer) (35.77 cm), T_6 (FYM + Panchagavya + Biofertilizer) (35.20 cm) and T_5 (FYM + Fish Amino Acid + Biofertilizers) (34.10 cm), whereas minimum pod length was observed in Control (26.93 cm). Significantly maximum pod width (0.69 cm) was observed in T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizers) followed by T_{13} (Vermicompost + Panchagavya + Biofertilizers) (0.66 cm) T_{12} (Vermicompost + Fish Amino Acid + Biofertilizer) (0.63 cm), T_{11} (Vermicompost + Fish Amino Acid + Panchagavya) (0.62 cm),T_{10} (Vermicompost + Panchagavya) (0.62 cm), T_9 (Vermicompost + Fish Amino Acid) (0.61 cm), T_7 (FYM + Fish Amino Acid + Panchagavya+ Biofertilizer) (0.63 cm), T_6 (FYM + Panchagavya+ Biofertilizer) (0.63 cm), T_5 (FYM + Fish Amino Acid + Biofertilizers) (0.62 cm) and T_5 (FYM + Fish Amino Acid + Biofertilizers) (0.61 cm), T_4 (FYM + Fish Amino Acid + Panchagavya) (0.61 cm) whereas minimum pod width was observed in Control (0.54 cm).

Significantly maximum average weight per pod (17.63 g) was observed in T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizers) followed by T_{13} Vermicompost + Panchagavya + Biofertilizers (17.10 g), T_{12} (Vermicompost + Fish Amino Acid + Biofertilizer) (16.97 g), T_{11} (Vermicompost + Fish Amino Acid + Panchagavya) (16.63 g),T_{10} (Vermicompost + Panchagavya) (16.53 g) T_9 (Vermicompost + Fish Amino Acid) (15.70 g), T_8 (Vermicompost alone) (15.47 g), T_7 (FYM + Panchagavya+ Fish Amino Acid + Biofertilizer) (17.07 g), T_6 (FYM + Panchagavya + Biofertilizers) (16.90 g), T_5 (FYM + Fish Amino Acid + Biofertilizers) (16.57 g), T_4 (FYM + Fish Amino Acid + Panchagavya) (15.73 g) T_3 (FYM + Panchagavya) (15.53 g), T_2 (FYM + Fish Amino Acid) (15.03 g),T_1 (FYM alone) (15.00 g), whereas minimum average weight per pod was observed in Control (14.17 g). Vermicompost treatments greater root extension under biofertilizers application might have helped in greater uptake of nutrients which ultimately improved the yield attributing characters like pod length, pod yield, pod weight, number of pods per plant and number of seeds per pod (Joshi *et al.*, 2016).

From table 2, T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizers) showed significant and maximum pod yield per plant (671.97 g) followed by T_{13} Vermicompost + Panchagavya + Biofertilizers (635.07 g), T_{12} (Vermicompost + Fish Amino Acid + Biofertilizer) (629.70 g), T_{11} (Vermicompost + Fish Amino Acid + Panchagavya) (598.27 g), T_7 (FYM + Fish Amino Acid + Panchagavya+ Biofertilizer) (631.67 g), T_6 (FYM + Panchagavya+ Biofertilizer) (620.96 g) and T_5 (FYM + Fish Amino Acid + Biofertilizers) (598.17 g), whereas minimum pod yield per plant was observed in Control (414.64 g) (Fig. 1). Similarly treatment T_{14} (Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizers) showed significantly maximum pod yield per

quintal per hectare (254.03 q/ha) followed by T_{13} (Vermicompost + Panchagavya + Biofertilizers) (240.00 q/ha) T_{12} (Vermicompost + Fish Amino Acid + Biofertilizer) (237.98 q/ha), T_{11} (Vermicompost + Fish Amino Acid + Panchagavya) (226.13 q/ha), T_7 (FYM + Fish Amino Acid + Panchagavya + Biofertilizer) (238.57 q/ha), T_6 (FYM + Panchagavya + Biofertilizer) (234.71 q/ha) and T_5 (FYM + Fish Amino Acid + Biofertilizers) (226.05 q/ha), whereas minimum pod yield quintal per hectare was observed in Control (157.06 q/ha) (Fig. 2). One of the factors responsible for pod yield in cowpea might be the different sources of organic manures, organic supplements and biofertilizers which are responsible for variations in the yield components like average pod weight, pod length, pod width, number of pods per plant, number of seeds per pod, pod yield per plant and pod yield per plot. These yield components had direct influence on the yield. Growth attributes viz., days to germination, plant height, number of branches, number of leaves, number of nodules and days to flower initiation have indirect effect on the yield of cowpea. Similar results were also reported by Takankar *et al.,* (1998), Aruna and Narsa Reddy (1999).

In light of results obtained during the investigation, it is concluded that treatment (T_{14}) Vermicompost + Fish Amino Acid + Panchagavya + Biofertilizers emerged as superior over all other treatment and can be used to achieve quantitative, qualitative and sustainable production of cowpea.

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