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Effect of inorganic and organic manures on growth, flowering and yield of cowpea (*Vigna unguiculata* L.)

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Abstract
A field experiment was conducted to observe the effect of inorganic and organic manures on growth, flowering and yield of cowpea (*Vigna unguiculata* L.) at Jaunpur, Uttar Pradesh in 2019 year. The experiment was arranged in a Randomized Block Design (RBD) with 10 treatments (T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9 and T_{10}) of three replicates each. The experiment using treatments T_1 (100% RDF), T_2 (75% RDF + 25% FYM), T_3 (75% RDF + 25% VC),T_4 (75% RDF + 25% PM), T_5 (75% RDF + 25 NC), T_6 (50% RDF + 50% FYM), T_7 (50% RDF + 50% VC), T_8 (50% RDF + 50% PM), T_9 (50% RDF +50% NC), T_{10} (Control). Observations of crop data revealed that (T_3) i.e. 75% RDF + 25% vermicompost showed maximum plant growth among all of the treatments at different growth intervals i.e. plant height (113.9 cm), leaf area (604.7 cm^2), branch number (12.3), days of first flowering (49.8), days to 50% flowering (56.3), first pod emergence (55.1), number of pod per plant (36.6), length of pod (36.1 cm), diameter of pod (2.9 cm), weight of per pod (8.8 g), green pod yield (112.9 q/ha), number of seed per pod (12.2), 100-seed weight (18.2), seed yield per plot (4.5 kg), seed yield (22.4 q/ha). Moreover, the maximum net returns (Rs 67845 ha^{-1}) and B:C ratio (2.60) were obtained with the T_3 i.e. T_3 (75% RDF + 25% VC). Whereas, minimum plant growth, yield and net return and B:C ratio were recorded under treatment (T_{10}) control. Above result showed that T_3 (75% RDF + 25% VC) was best in all treatments.

Keywords: Cowpea, inorganic manures, organic manures, vermicompost, growth and yield

Introduction
Cowpea (*Vigna unguiculata* L.) is one of the most important vegetable crops. It is also known as black eye pea, southern pea and Crowder pea. It is grown for green pods, dry seeds and fodders, leguminous crop play an important role in Indian agriculture. It is one of the poor man's protein sources vegetable crop. It is self - pollinated annual herb with a wide range of growth habit and response to photoperiod. Origin place of this crop is Central Africa and mainly cultivated in Asia, Africa Central and South America. Cowpea pods are good source of protein, fiber, minerals, calcium and vitamins particularly vitamin A and vitamin C. It contains 8.0 g carbohydrates, 4.3 g proteins and 0.6 g fat, 2.0 g fiber per 100.0 g of edible portion. Amino acid profile particularly lysine, leucine and phenylalanine contents are relatively high. Tender fruits contain 80.0 mg calcium, 74.0 mg phosphorus and 2.5 mg iron per 100 g fresh pod.

It can be grown in all types of the well-drained soil with pH 5.5 to 6.5. Cowpea fixes atmospheric nitrogen up to 240 kg ha^{-1} and leaves about 60-70 kg residual nitrogen for succeeding crops. It requires good quantity of nutrients throughout the growth periods especially phosphorus for better development of roots, better nodulation and N- Fixation.

Moreover, in early stage, plant requires N for better germination, production of more branches and peduncles' resulting in greater number of pods, seed, and significantly higher yields (Abayomi *et al*., 2008) [1]. Nitrogen plays important role in various metabolic process of the plant growth. Nitrogen is an essential constituent of protein and chlorophyll (Meena *et al.*, 2014) [8]. Phosphorus plays an important role in the plant metabolism and is a constituent of various organic substances. It is play an important role in photosynthesis, respiration and other physiological process of plant. Potassium has a direct and indirect impact on the plant growth. Using potassium directly causes the reduced transpiration, increasing water absorption or creating internal condition in order to endure the dryness.

Organic materials are intrinsic and essential components of all soil. Organic compost is a very important method of providing the plants with their nutritional requirements without having an undesirable impact on the environment (Adeoye *et al.*, 2011) [3]. FYM, vermicompost, poultry manures are organic manures that is formed with organic materials.

It is soil's storehouse for nitrogen, phosphorus and sulphur and thereby contributes significantly to the supply of these nutrients to higher plants. It improves various other chemical properties of soil. Plant growth and development are benefited by the physiological action of some organic materials that is directly taken up by plant. It is the product of the composting process using various species of worms, red wigglers, and other earthworms, to create a mixture of decomposing vegetable or food waste, bedding materials and vermicast, benefits soil, plant growth, enhance germination, plant growth, and crop yield, improves root growth and structure, enriches soil with micro-organisms. Poultry manure one of that available and it is used in highly production of vegetable crops. Cowpea is a most important crop for healthy diet so it's needed to be available in high quality (Radices *et al.,* 2002).

Materials and Methods

The present investigation was carried out at Experimental Unit, Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh, India during *Zaid* season of 2019. The cowpea cultivar Kashi Nidhi procured from Indian Institute of Vegetable Research (IIVR), Varanasi, Uttar Pradesh. The climatic condition of Jaunpur district is subtropical with distinct three season i.e. winter, summer and rainy. During winter season (December – January) temperature fall 5 °C or even low, while in summer season (May – June) it reaches as high as 45 °C. Occasional spell of frost and precipitation may occur during winter. The mean temperature is minimum 15 - 20 °C and maximum 18-32 °C, maximum relative humidity 95% and minimum 55% with annual rainfall of 850-1100 mm (Singh *et al.,* 2012) [13]. The seed of cowpea sowing on the ridges were first week of March. NPK, Farm yard manure, vermicompost, neem cake, poultry manure, were applied at the time of field preparation in the concerned plots as per the treatment. Other cultural practices like weeding, hoeing, irrigation, insect pest and disease management done as and when required. The observations were recorded from each treatment to assess the effect of inorganic and organic manures on growth, flowering and yield of cowpea. The observed data were analyzed by analysis of variance (ANOVA) using the statistical program and the significance differences between the mean were tested against the critical difference at 5% probability level.

Results and Discussion

The experimental field was treated with organic and inorganic manures. Organic manure play a crucial role for providing the plants nutrient requirements without having an undesirable impact on the environment Adeoye *et al*., (2011) [3]. There has been much discussion on the effect of organic fertilizer and waste compost from farmyard manure (FYM), crop residues and ashes on soil properties and crop quality Abdel-Rahma *et al*., (2009) [2].

Crop Growth

The results indicated that growth parameters such as plant height, leaf area (cm^2) and branch number of cowpea crop were significantly influenced by integrated approach of organic and inorganic manures on. The data (Table 1) showed that maximum plant height (113.9 cm), leaf area (604.7 cm^2) and branch number (12.3) were recorded with applied nitrogen (75% by urea + 25% by vermicompost), phosphorus (75% by single superphosphate + 25% by vermicompost) and potassium (75% by Murate of potash +25% by vermicompost). This treatment was closely followed by the treatment, T_5, T_4 and T_2. The reason for higher values of growth parameter can be discussed in the light of fact that crop under these treatments had comparatively better rhizosphere for root growth and development and proliferation resulting in better nodule formation and nitrogen fixation. Thus, which helped to draw more water and nutrients from larger area and deeper layers and thus owing to higher availability of nutrients, synthesis of more carbohydrates and their translocation to different plant parts resulted in increased vegetative growth including the reproductive structures. These results corroborate with the finding of Das *et al*., (2000). Kumar *et al*., (2003) [7], More *et al*., (2008) [9], Sammauria *et al*., (2009) [11] and Choudhary and Yadav (2011) [4].

Crop development

The results revealed that development of crop parameters such as appearance of first flowering, 50% flowering and first pod emergence were significantly influenced by integrated approach of organic and inorganic manures. Minimum days taken to appearance of first flowering (47.00 DAS), 50% flowering (52.9 DAS) and first pod emergence (52.1 DAS) were recorded with applied nitrogen (100% by urea), phosphorus (100% by single superphosphate) and potassium (100% by muriate of potash) followed by the treatment, T_6, T_8 and T_7 (Table 2). The reason for higher values of growth parameter due to comparatively better rhizosphere for root growth. Thus, owing to higher availability of nutrients, synthesis of more carbohydrates and their translocation to different plant parts resulted in increased vegetative growth including the reproductive structures. Therefore, increased growth length to appearance of physiology development. These results validated with the finding of More *et al*., (2008) [9], Sammauria *et al*., (2009) [11] and Choudhary and Yadav (2011) [4].

Yields and yield attributes

The results of the present study indicated that yield parameters of cowpea such as number of pods/plant (36.6), length of pod (36.1cm), diameter of pod (2.9 cm), weight of pod (8.8 g), green pod yield (112.9 q/ha), number of seed/pod(12.2), 100 seed weight (18.2 g) and seed yield (22.4 q/ha) of cowpea crop were significantly influenced by integrated approach of organic and inorganic manures treatments (Table 3). An increase in number of pods per plant, length of pod, diameter of pod, weight of per pod, green pod yield, number of seed per pod, 100 seed weight and seed yield of cowpea was obtained under T_3 i.e. nitrogen (75% by urea + 25% by vermicompost), phosphorus (75% by single superphosphate + 25% by vermicompost) and potassium (75% by muriate of potash +25% by vermicompost) over control plot. The reason for higher values of growth parameter can be discussed in the light of fact that crop under these treatments had comparatively better rhizosphere for root growth and development and proliferation resulting in better nodule formation and nitrogen fixation. Thus, which helped to draw more water and nutrients from larger area and deeper layers and thus owing to higher availability of nutrients, synthesis of more carbohydrates and their translocation to different plant parts resulted in increased vegetative growth including the reproductive structures. This treatment was statistically at par with the T_5 i.e. nitrogen (75% N by urea + 25% N by neemcake) + phosphorus (75% single superphasphate +25% by neemcake) + Potash (75% by murate of potash + 25% by

neemcake) plots. Whereas, The number of pods/plant, length of pod (cm), diameter of pod (cm), weight of pod (g), green pod yield (q/ha), number of seed/pod, 100 seed weight (g) and seed yield (q/ ha) were observed in control plots. These results corroborate with the finding of Das *et al*., (2000). Kumar *et al*., (2003) [7], More *et al*., (2008) [9], Sammauria *et al*., (2009) [11] and Choudhary and Yadav (2011) [4].

Economics of cowpea cultivation

A critical examination of data (Table 4) revealed that treatment of organic and inorganic manures was a significant increase in grass return, net returns and benefit cost ratio in comparison to control treatment. Further, the increase in cost of cultivation with vermicompost amount, however, the increase in net returns in cowpea with application of vermicompost, Mostly treatments were at par with that of vermicompost application. The maximum net returns (Rs 67845 ha^{-1}) and B:C ratio (2.60) were obtained under the T_3 i.e. nitrogen (75% by urea + 25% by vermicompost), phosphorus (75% by single superphosphate + 25% by vermicompost) and potassium (75% by muriate of potash +25% by vermicompost). Whereas, minimum net return (Rs 22618 ha^{-1}) and B:C ratio (1.08) were under T_{10} (control treatment).

Table 1: Effect of inorganic and organic manures on growth of cowpea

Treatments		Plant height (cm)	Leaf area (cm^2)	Branch numbers
T_1	100% N by urea +100% P_2O_5 by SSP +100% K_2O by MOP	71.2	268.7	8.2
T_2	N (75% N by urea + 25% N by FYM) + P_2O_5 (75% by SSP + 25% by FYM) + K_2O (75% by MOP + 25% by FYM)	98.8	457.7	9.6
T_3	N (75% N by urea+25% N by VC) + P_2O_5 (75% by SSP + 25% by VC) + K_2O (75% by MOP +25% by VC)	113.9	604.7	12.3
T_4	N (75% N by urea + 25% N by PM) + P_2O_5 (75% SSP +25% by PM)+ K_2O (75% by MOP + 25% by PM)	103.1	535.0	10.4
T_5	N (75% N by urea + 25% N by NC) + P_2O_5 (75% SSP +25% by NC)+ K_2O (75% by MOP + 25% by NC)	107.0	563.3	10.8
T_6	N(50% N by urea + 50% N by FYM) + P_2O_5 (50% by SSP + 50% by FYM) + K_2O (50% by MOP + 50% by FYM)	79.2	294.0	8.6
T_7	N (50% N by urea+50% N by VC) + P_2O_5 (50% by SSP + 50% by VC) + K_2O (50% by MOP +50% by VC)	89.6	383.3	9.3
T_8	N (50% N by urea + 50% N by PM) + P_2O_5 (50% SSP +50% by PM)+ K_2O (50% by MOP + 50% by PM)	80.6	294.3	9.0
T_9	N(50% N by urea + 50% N by NC) + P_2O_5 (50% SSP +50% by NC)+ K_2O (50% by MOP + 50% by NC)	81.4	336.0	9.2
T_{10}	0.0 kg (NPK) + 0.0 kg (organic manures)	61.2	205.0	8.0
	S.Em±	3.94	6.75	0.40
	CD (at) 5%	11.71	20.05	1.18

Table 2: Effect of inorganic and organic manures on physiology development of cowpea.

Treatments	First flowering	50% flowering	First pod emergence
T_1	47.0	52.9	52.1
T_2	48.3	54.8	53.7
T_3	49.8	56.3	55.1
T_4	48.7	55.3	54.0
T_5	49.0	55.7	54.8
T_6	47.4	53.6	52.4
T_7	48.1	54.6	53.4
T_8	47.9	54.0	52.9
T_9	48.0	54.2	53.1
T_{10}	47.0	52.9	52.1
S.Em±	0.16	0.34	0.16
CD at 5%	0.47	1.02	0.47

Table 3: Effect of inorganic and organic manures on yield and yield attributes of cowpea.

Treatments	No. of pods/plant	Length of pod (cm)	Diameter of pod (cm)	Weight of /pod (g)	Green pod yield (q/ha)	No. of seed/pod	100 seed weight (g)	Seed yield (q/ ha)
T_1	26.1	31.0	2.2	6.9	73.7	10.1	14.8	14.2
T_2	31.9	34.6	2.6	8.2	94.2	11.2	16.6	18.5
T_3	36.6	36.1	2.9	8.8	112.9	12.7	18.2	22.4
T_4	33.3	34.7	2.6	8.3	98.0	11.6	16.9	19.5
T_5	35.9	35.7	2.8	8.7	109.8	12.3	17.4	21.4
T_6	26.6	32.7	2.2	7.4	76.6	10.1	15.2	15.0
T_7	30.4	34.1	2.4	8.0	93.7	10.4	16.1	17.7
T_8	28.0	32.9	2.3	7.7	84.2	10.2	15.7	16.4
T_9	29.2	33.2	2.4	7.8	88.4	10.3	15.9	17.3
T_{10}	20.8	31.0	2.0	6.9	65.7	7.9	14.8	12.9
S.Em±	0.76	0.46	0.08	0.2	4.36	0.19	0.18	0.91
CD at 5%	2.25	31.00	0.23	0.58	12.95	0.55	0.52	2.71

Table 4: Effect of inorganic and organic manures on economic of cowpea

Treatments	Fixed cost (Rs.)	Variable cost (Rs.)	Total cost (Rs.)	Gross return (Rs.)	Net Return (Rs.)	B:C ratio
T_1	12000	14158	26158	92136.5	65979	2.52
T_2	12000	14136	26136	92263.5	66128	2.53
T_3	12000	14048	26048	93893.5	67845	2.60
T_4	12000	13472	25472	79990.5	54519	2.14
T_5	12000	13364	25364	81304.5	55941	2.21
T_6	12000	13454	25454	85156.5	59703	2.35
T_7	12000	12754	24754	78341.5	53587	2.16
T_8	12000	12765	24765	78739.5	53974	2.18
T_9	12000	13791	25791	79078.5	53288	2.07
T_{10}	12000	8936	20936	43553.5	22618	1.08

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