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Effect of solid and liquid organic nutrient source on growth and yield of cowpea (*Vigna unguiculalta* L.)

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Abstract
The field experiment was conducted during *kharif* season of 2023 at Crop Research Farm, Department of Agronomy. The experiment was laid out in a Randomized Block Design with ten treatments which have replicated thrice. The treatments details are as fallows T_1: Farm yard manure 5 t/ha + Panchagavya 3%, T_2: Farm yard manure 5 t/ha + Jeevamrut 5%, T_3: Farm yard manure 5 t/ha + Cow urine 2%, T_4: Poultry manure 1 t/ha + Panchagavya 3%, T_5: Poultry manure 1 t/ha + Jeevamrut 5%, T_6: Poultry manure 1 t/ha + Cow urine 2%, T_7: Vermicompost 2 t/ha + Panchagavya 3%, T_8: Vermicompost 2 t/ha + Jeevamrut 5%, T_9: Vermicompost 2 t/ha + Cow urine 2%. Application of Vermicompost 2 t/ha + Panchagavya 3% (Treatment 7) recorded highest plant height (82.26 cm), no. of nodules (6.33 per plant), maximum plant dry weight (20.96 g/plant), crop growth rate (10.30 g/*m*2/day), relative growth rate (0.0269 g/g/day), pods per plant (21.67), pods per plant (5.07), seed per pod (8.11), seed index (21.67), seed yield (1.79 t/ha) stover yield (3.42 t/ha), and harvest index (34.21)%. The same treatment also recorded maximum gross return (84130 INR/ha), net return (47930 INR/ha), and benefit cost ratio (1.32).

Keywords: Cowpea, FYM, Poultry manure, vermicompost, Panchagavya, Jeevamrut, cow urine, growth, yield and economics

Introduction
Cowpea (*Vigna unguiculata* (L.) Walp) is an important grain legume crop and belong to family Fabaceae. India is the largest producer of pulses and accounts for about 25 percent of the global share. In India, pulse crops are grown over an area of 26.28 million ha with an annual production of 18.09 million tonnes and productivity of 689 kg ha. In Gujarat, it is cultivated in 2.09 lakh hectares with an annual production of 1.14 lakh metric tonnes leading to average productivity of 546 kg/ha. (2023, IIPR). Cowpea (*Vigna unguiculata* L.), a versatile legume native to West Africa, plays a critical role in global food security. Its ability to fix atmospheric nitrogen, tolerate drought, and have a short growth cycle makes it a valuable crop, particularly in developing nations. Cowpea provides a vital source of protein for millions and enriches soil fertility through nitrogen fixation by root nodule bacteria (*Rhizobium*). However, low soil fertility, especially nitrogen deficiency, hinders cowpea production. Sustainable agricultural practices emphasize exploring alternatives to synthetic fertilizers. Organic nutrient sources, offered in solid and liquid forms, provide a promising solution. Solid amendments like compost and manure offer a slow-release source of nutrients, while liquid organic fertilizers provide readily available nutrients for plant uptake.
The average productivity of this crop is quite poor as compared to other pulses which is now to the tune of 350 kg/ha. The cowpea market is US$ 7.21 billion in 2023 and has been forecasted to be US$ 9.43 billion by 2028 with the CAGR of 5.50%. In recent years cowpea has been included in food security program of different countries. The demand of cowpea is increasing since it is rich in antioxidants, polyphenols, polyunsaturated fatty acids and dietary fibre. In addition, cowpea plays an imperative role in improving soil fertility through biological nitrogen fixation. Farm yard Manure (FYM) is prepared basically using cow dung, cow urine, waste straw and other dairy wastes. It is highly useful and some of its properties is rich in nutrients. A small portion of N is directly available to the plants while a larger portion is made available as and when the FYM decomposes. When cow dung and urine are mixed, a balanced nutrition is made available to the plants.

Availability of Potassium and Phosphorus from FYM is similar to that from inorganic sources. Application of FYM improves soil fertility.

Liquid formulations used in organic agriculture like Panchgavya, beejamrut and jeevamrut are the fermented products which are used as plant growth enhancing substances prepared with the materials available with farmers. They are rich sources of beneficial micro-flora who stimulate the plant growth and help in getting better vegetative growth and good quality yield. Formulations prepared from agricultural by- products *viz*., bran of grains, oil cakes, farmyard manure etc., are excellent growth carriers and storage media.

Vermicompost (vermi-compost) is the product of the decomposition process using various species of worms, usually red wigglers, white worms, and other earthworms, to create a mixture of decomposing vegetable or food waste, bedding materials, and Vermicompost. This process is called vermicomposting, while the rearing of worms for this purpose is called vermiculture. Vermicast (also called worm castings, worm humus, worm manure, or worm farces) is the endproduct of the breakdown of organic matter by earthworms.

Poultry manure fertilizer contains all the essential nutrients required for crop production, and its value as an organic fertilizer and a source of plant nutrients has been recognized for centuries. Even with its beneficial effects on plant growth, however, manure constitutes only a small percentage of the nutrients applied to cropland when compared to commercial fertilizer.

Cow urine or Gomutra is a liquid by-product of metabolism in cows. Cow urine is used as medicine in some places of India, Myanmar, and Nigeria. While cow urine and cow dung have benefits as fertilizers, the proponents claim about its curing diseases and cancer have no scientific backing. Cow urine is used for attempted therapeutic purposes in ancient Ayurvedic medicine. Urine of a pregnant cow is considered special. it is claimed to contain special hormones and minerals.

Research on Solid and liquid organic source in cowpea is critical for optimizing nutritional levels, increasing output, improving quality, decreasing the impact on the environment, and balancing costs. These sources are beneficial for plant development, photosynthesis, and protein synthesis. Cowpea can increase biomass and output while increasing nutritional quality by determining an appropriate balance. Understanding these elements can also help farmers develop more sustainable and effective farming practices, which benefit both farmers and the environment.

Material and Methods

During the *Kharif* season of 2023, a field experiment was conducted at the Crop Research Farm of the Department of Agronomy, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh. which is located at 25.24'42'' N latitude, 81.50' 56" E longitude and 98 m altitude above the mean sea level (SL). The soil of experimental plot was sandy loam, having a nearly neutral soil reaction (pH 7.3), electrical conductivity 0.53 ds/m, medium in available nitrogen (225.83 kg/ha) and potassium (36.10 kg/ha), and low in available phosphorous (38 kg/ha). The experiment was conducted in a Randomized Block Design consisting of 9 treatment combinations and three replications. Organic manures were applied as band placement, for which 4-5 cm deep furrows were made along the seed rows with a hand hoe. The treatments comprised of 3 organic manures and 3 spraying frequencies. The plot size of each treatment was 3m x 3m. The cowpea crop was sown on 9 August 2023. Harvesting was done by taking $1m^2$ area from each plot. And from it five plants were randomly selected for recording growth and yield parameters. The observations were recorded for plant height(cm), number of nodules/plant, dry weight(g), Crop growth rate, Relative growth rate, number of pods/plant, number of seeds/pod, seed index(g), seed yield(t/ha), stover yield(t/ha) and Harvest Index(%). The observed data was statistically analysed using analysis of variance (ANOVA) as applicable to randomized block design.

Results and Discussion

Growth parameters

Plant height

At 60 DAS, recorded higher plant height (82.26 cm) in treatment-7 with the application of Vermicompost 2 t/ha along with Panchagavya 3%. However, treatment 3, 1, 9, & 8 (80.89 cm, 77.48 cm, 70.10 cm, & 67.34 cm, respectively) were statistically at par with application of Vermicompost 2 t/ha along with Panchagavya 3%.

It has been demonstrated that vermicompost and panchagavya when applied as foliar spray could have created stimuli in the plant system and increased the production of growth regulators in cell system and the action of growth regulators in plant system ultimately stimulated the necessary growth and development. Similar findings were also reported by Patel *et al.* (2017).

The factors which are responsible for growth plant height was augmented significantly due to increased supply of nutrients from integrated nutrient use of organic manures.

The interaction due to manure with biofertilizers for fresh weight per plant at maturity stage was found more significant. Ramawtar *et al.* (2013) observed that the application of vermicompost increased growth parameters over control treatment. Similar results were observed by Singh *et al.* (2011) [2].

Number of nodules

At 60 DAS, the significantly maximum nodules (6.33 nodules/plant) recorded with application of Vermicompost 2 t/ha along with Panchagavya 3% which was superior over all other treatments.

Enhanced growth parameters due to interaction of jeevamrutha and panchagavya might be due to synergistic effect of Rhizobacteria with Panchagavya spray and soil application of jeevamrutha has helped translocation of carbohydrates to developing root nodules" as reported by Sait and Mehmet Kibritei (2014) and Velmurgan and Mahendran.

Plant dry weight

At 60 DAS, the maximum dry matter accumulation (20.96 g/plant) was recorded with application of Vermicompost 2 t/ha along with Panchagavya 3% while treatments 7 found to be statistically at par with highest.

It might be due to the improvement in soil environment of encouraged proliferation of plant roots, 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 increased vegetative growth including the reproductive structures. These results corroborate with the finding of Sharma (2001).
The salicylic acid stimulates the activity of auxins that contributes to cell division and increases the number of lateral roots and number of root hairs that lead to increase the absorption of nutrients necessary for plant growth (Li *et al* 2015) and increase the plant dry weight, our results agreed with also those of Azoz and El-Taher (2018).

Crop Growth Rate
At 45-60 DAS, the significantly maximum Crop Growth Rate (10.30 g/m^2/day) was recorded with application of Vermicompost 2 t/ha along with Panchagavya 3% which was superior over all other treatments.

Relative Growth Rate: At 45-60 DAS, maximum Relative Growth Rate (0.0269 g/g/day) was recorded with application of Vermicompost 2 t/ha along with Panchagavya 3% which was superior over all other treatments.
The combined application of organic and inorganic nitrogen fertilizer to cowpea rather than single application of organic and inorganic nitrogen fertilizer leads to significant increase in plant growth and development. These results are in close conformity with the findings of Olusegun (2014).

Yield Attributes
Number of pods per plant: At harvest, the significantly higher number of pods/plants were observed in the treatment combination of Vermicompost 2 t/ha along with Panchagavya 3% recording 5.07 pods/plant. which was superior over all other treatments.

Number of seeds per pod
At harvest, significantly maximum number of seeds/pod (8.11) was observed in the treatment combination of Vermicompost 2 t/ha along with Panchagavya 3% which was superior over all other treatments.

Seed Index: The maximum test weight (21.67 g) was recorded in the treatment Jeevamrutha (5%) along with Spacing 45 × 10 cm^2. The minimum test weight (20.40 g) was recorded in the treatment combination Panchgavya (5%) along with Spacing 40 × 15 cm. Test weight of seed (28.84 g) were recorded in treatment Vermicompost (6 t/ha) + Rhizobium along with Azospirillum. It might be due to Increase in yield attributes in combination of organic manures and biofertilizer (Vermicompost (6 t/ha).
The highest 1000 seed weight of 18.35 g was obtained from the L2 treatment, while the lowest 1000 seed weight of 17.30 g was obtained from the FM2 and 17.34 g from the V2 treatments. It was determined that leonardite applications had a more positive effect on the 1000 seed weight compared to other organic and chemical fertilizers. Similar results by Uçar, Soysal and Erman *et al.* (2016) have also been reported.

Seed Yield (t/ha)
At harvest, the data showed that significantly maximum seed yield of cowpea (1.79 t/ha) was foud with the application of Vermicompost 2 t/ha along with Panchagavya 3%. However, treatments 8, 9, 1, 2, 3, 4, and 5 (1.73, 1.69, 1.60, 1.53, 1.42, and 1.29 t/ha respectively) which was found to be statistically at par with all treatments
The present results are in collaboration with the findings of Rajkhowa *et al*., (2003) [4, 14] in green gram, Khandelwal *et al.* (2012) [14, 15] and Balachandran *et al*., (2005). In Grain yield (t/ha), treatment with application of Vermicompost (6t/ha) along with Rhizobium along with Azospirillum was recorded maximum grain yield (1.31 t/ha) Which was superior over other treatments, Observed that, it was found that the differences between the fertilizer forms were significantly effective in terms of all the examined characteristics. It was determined that the seed yields varied between 3043.3–4126.7 kg/ha, and according to the results of the two year study, 10,000 kg/ha vermicompost would be sufficient to obtain the highest cowpea yield (4126.7 kg/ha) under Mediterranean climate conditions.

Stover Yield (t/ha)
The significantly maximum stover yield of cowpea (3.42 t/ha) was observed in the treatment combination of Vermicompost 2 t/ha along with Panchagavya 3%. However, Vermicompost 2 t/ha along with Jeevamrut 5% (3.37 t/ha), Vermicompost 2 t/ha along with Cow urine 2% (3.28 t/ha), and Farm yard manure 5 t/ha along with Panchagavya 3% (3.12) were statistically at par Vermicompost 2 t/ha along with Panchagavya 3%.
Whereas treatment with application of Vermicompost (3t/ha) + Rhizobium + Azospirillum and Vermicompost (6t/ha) along with Azospirillum were at par with highest treatment. In Stover yield (t/ha), The present results are in collaboration with the findings of Rajkhowa *et al.* (2003)

Harvest index (%)
Significantly higher Harvest index of cowpea was observed in the treatment combination of Vermicompost 2 t/ha along with Panchagavya 3%. (34.21%). though there was significant difference among the treatments.

Table 1: Influence of solid and liquid organic nutrient source on growth attributes of cowpea

At 60 DAS						
S. No.	**Treatments**	**Plant Height (cm)**	**No. of Nodules/ plant**	**Plant Dry weight (g/plant)**	**CGR (g/ m^2 /day)**	**RGR (g/ g/day)**
1.	Farm yard manure 5 t/ha + Panchagavya 3%	75.21	6.07	17.49	7.34	0.0222
2.	Farm yard manure 5 t/ha + Jeevamrut 5%	74.24	6.05	16.71	6.86	0.0216
3.	Farm yard manure 5 t/ha + Cow urine 2%	72.09	5.93	16.66	7.43	0.0238
4.	Poultry manure 1 t/ha + Panchagavya 3%	71.57	5.67	16.07	6.63	0.0219
5.	Poultry manure 1 t/ha + Jeevamrut 5%	71.16	5.33	15.62	6.06	0.0205
6.	Poultry manure 1 t/ha + Cow urine 2%	66.45	4.80	13.31	2.80	0.0100
7.	Vermicompost 2 t/ha + Panchagavya 3%	82.26	6.33	20.96	10.30	0.0269
8.	Vermicompost 2 t/ha + Jeevamrut 5%	80.89	6.20	19.50	8.39	0.0230
9.	Vermicompost 2 t/ha + Cow urine 2%	77.48	6.13	17.63	5.89	0.0171
	F-Test	S	S	S	S	NS
	SEm (±)	2.231	0.2963	0.541	0.853	0.00294
	CD (P=0.05)	6.690	0.89	1.62	2.559	0.0088

Table 2: Influence of solid and liquid organic nutrient source on yield attributes of cowpea

Yield attributes							
S. No.	**Treatments**	**Pods/plant (No.)**	**Seeds/pod (No.)**	**Seed Index (g)**	**Seed yield (t/ha)**	**Stover yield (t/ha)**	**Harvest index (%)**
1.	Farm yard manure 5 t/ha + Panchagavya 3%	4.90	7.93	20.18	1.60	3.12	33.36
2.	Farm yard manure 5 t/ha + Jeevamrut 5%	4.87	7.86	19.62	1.53	3.11	32.55
3.	Farm yard manure 5 t/ha + Cow urine 2%	4.85	7.59	19.15	1.42	3.07	31.44
4.	Poultry manure 1 t/ha + Panchagavya 3%	4.76	7.24	18.53	1.29	2.86	30.84
5.	Poultry manure 1 t/ha + Jeevamrut 5%	4.49	6.87	18.41	1.15	2.73	29.37
6.	Poultry manure 1 t/ha + Cow urine 2%	4.47	6.20	17.87	0.99	2.55	28.04
7.	Vermicompost 2 t/ha + Panchagavya 3%	5.07	8.11	21.67	1.79	3.42	34.21
8.	Vermicompost 2 t/ha + Jeevamrut 5%	5.02	8.06	21.33	1.73	3.37	33.76
9.	Vermicompost 2 t/ha + Cow urine 2%	4.96	8.00	21.22	1.69	3.28	33.78
	F-Test	S	S	S	S	S	S
	SEm (±)	0.164	0.308	0.575	0.108	0.086	1.825
	CD (P=0.05)	0.49	0.93	1.72	0.32	0.26	5.47

Conclusion

From the result, it is conducted that the treatment combination of (Treatment no. 7) Vermicompost 2 t/ha along with Panchagavya 3% has recorded highest growth and grain yield.

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