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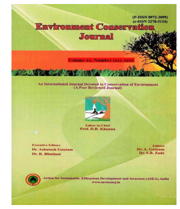

Influence of integrated nutrient management on growth and yield of cowpea (*Vigna unguiculata* L.) in Prayagraj region

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ABSTRACT

A field study was conducted at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, during the zaid season of 2021. (U.P.). This study was carried out with the objective to study the interaction effect of different levels of NPK, FYM, Vermicompost and Panchagavya on growth and yield of cowpea. The experiment used a randomized block design (RBD) with nine treatments which were replicated three times. The soil texture of the experimental plot was sandy loam, with a pH of 7.2, low organic carbon (0.48 percent), available N (171.48 kg/ha), available P (13.6 kg/ha), and available K (215.4 kg/ha). The results showed significantly increase in growth parameters *i.e.* plant height (69.48 cm), number of nodules/plant (24.37), plant dry weight (22.22 g/plant), crop growth rate (3.0 g/m^2/plant) and yield attributing parameters i.e. number of pods/plant (15.45), length of pods (27.02cm), number of seeds/pod (13.57), test weight (85.6 g), seed yield (2.68 t/ha), stover yield (6.09 t/ha). The harvest index (30.56) was recorded with vermicompost 1.5t/ha + RDF 100% kg/ha.

Introduction

Cowpea is a major leguminous crop among the pulse crops. It is a drought tolerant and hardy crop which can survive in most of the stressful environments. It also improves soil fertility by fixing atmospheric nitrogen, especially in small-holder agricultural farming systems where almost no or little fertilizer is applied and requires low input for its production. The green pods and leaves of cowpea are consumed as vegetable while the grainsare used for culinary purposes.Cowpea is a cheap and major source of quality protein since its leaves have a protein content ranging from 27 to 43 percent, while the dry grain has a protein content ranging from 21 to 33 percent (Ahenkora *et al.,* 1998; Ddamulira *et al.,* 2015).Cowpea is also used as fodder for livestock and as a green manure crop. Worldwide, Cowpea is grown in an area of 12.5 million ha with a total grain production of 3 million tonnes. Nigeria is the leading producer of the crop followed by Brazil. Other African countries like Senegal, Ghana, Mali and Burkina Faso are its significant producers. In Asia, only India and Myanmar are significant producers. In India, Cowpea is grown in an area of 3.9 million hectares in India, with a yield of 2.21 million tones and a productivity of 567 kg/ha (Singh *et al.,* 2012). With these and other crop-related challenges in mind, a growing focus is needed on the integrated nutrient management (INM) system, which is necessary for maintaining soil health and crop yield. The basic tenet of integrated nutrient management (INM) is to maintain or modify soil fertility and provide nutrients to plants to an optimum level in order to maintain desirable crop yield by maximizing benefits from all potential sources of plant nutrient in an integrated manner (Tondon, 1992). Uses of

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Organic manure becomes an unavoidable practice in the foreseeable future to meet crop nutrient requirements for sustainable agriculture, as these manures enhance the physical, chemical, and biological properties of the soil while retaining and enhancing the soil water content and nutrient holding capacity, leading to higher crop productivity as well as maintaining the crop produce quality (Jangir *et al.,* 2021).
Inorganic fertilizer to use for pulses crops such as Nitrogen plays an important role in plant metabolism.It promotes the growth and development of all living tissues while also increasing the crop's protein content and yield. The phosphorous helps in root proliferation and development. So, there is efficient biological nitrogen fixation by the roots. It is also essential for meristematic growth, seed development and protein synthesis (Malhotra *et al.,* 2018). Further, potassium plays an important role in photosynthesis and respiration. It plays an important role in osmoregulation, stomatal movement and disease resistance(Prajapati andModi, 2012).
Therefore, it is to know about the integrated nutrient management, because with this technique, soil fertility can be managed and regulated besides the maintained of the organic matter in the soil for further generation. It also gets more production or yields with low input or cost.

Material and Methods

Location of Experimental Site

The experiment was conducted at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P.), which is located at 25º39"42" N latitude, 81º67"56" E longitude, and 98 m altitude above mean sea level (MSL) during the *zaid* season of 2021. This area is around 12 kilometres from the city, on the right bank of the Yamuna river, along the Prayagraj-Rewa route.

Climate and Weather

Prayagraj has a subtropical and semi-arid climate, whereas the south-eastern section of Uttar Pradesh experiences both winter and summer temperatures. This sub-tropical climate has a humid sub-tropical climate. In the winter, temperatures can drop as low as 3°C in December and January, while the weather turns extremely hot in the summer, with temperatures reaching above 48°C in May and June. Cold waves in the winter and hot desiccating winds in the summer are both typical in the region. The average rainfall in this area is over 90.0 cm, with the majority of it falling between July and September during monsoon season with a few showers thrown in throughout the winter months.
The field experiment to assess the effect of integrated nutrient management on growth and yield of cowpea. The soil of experimental plot was sandy loam in texture, nearly natural in soil reaction (pH 7.2), low in organic carbon (0.48 %), available nitrogen (171.48 kg/ha), available phosphorus (13.6 kg/ha) and available potassium (215.4 kg/ha). The experiment was conducted in Randomized Block Design consisting of nine treatment combinations with three replications and was laid out with the different treatments allocated randomly in each replication. The treatment combinations are T_1 – vermicompost 1.5t/ha + RDF 100%, T_2 - vermicompost 1.5t/ha + RDF 75%, T_3 - vermicompost 1.5t/ha + RDF 50%, T_4 – FYM 5 t/ha + RDF 100%, T_5 – FYM 5 t/ha + RDF 75%, T_6 - FYM 5 t/ha + RDF 50%, T_7 – Panchagavya 6% + RDF 100%, T_8 - Panchagavya 6% + RDF 75%, T_9 - Panchagavya 6% + RDF 50%. Kashikanchan is the dwarf variety of cowpea which was sown @ 25 kg/ha with the spacing of 45 cm x 15 cm in net plot area of 3m x 3m was carried on 12 April 2021 for seed production. Full dose of nitrogen was applied through Urea, phosphorus was applied through SSP and potash through MOP. Cowpea seeds were treated with 2 g/kg of seed with thiram before sowing. An observation of growth parameters, such as plant height (cm), number of nodules/plant, plant dry weight (g), crop growth rate and relative growth rate of data were collected from five randomly selected tagged plants. At the time of harvesting, yield-attributing parameters such as the number of pods/plant, number of seeds/pod, length of pods, test weight, seed yield was recorded from each treatment. The data was analysed statistically by ANOVA technique (Gomez and Gomez, 1984). There was a significant difference between the mean of treatments when compared to the critical value at five percent level of significance.

Results and Discussion

A. Growth Attributes:

Plant height (cm)

The result at 75 DAS shows that the effect of T_1 *i.e.*, Vermicompost at 1.5 t/ha along with RDF 100% over plant height was found to be highest (69.48 cm) and significantly superior over other treatment combinations except with T_2 *i.e.,*Vermicompost at 1.5 t/ha along with RDF 75% which was found statistically (69.22 cm) at par with treatment T_1 (69.48 cm). However, effect of T_6 *i.e.,* Farm Yard Manure at 5 t/ha along with RDF 50% over plant height was found to be significantly lowest (55.74 cm) at 5% level of significant.

Vermicompost and NPK application may have regulated oxidation- reduction enzyme reaction of the metabolism in plants which have resulted in cell elongation and multiplication. Organic and inorganic source of nutrients which play major role in cell devision and cell elongation. Then it leads plant height Sabarad *et al.* (2004).

Plant dry weight (g)

The data pertaining to 75 DAS shows that the effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over plant dry weight per plant was found to be highest (22.22 g/plant) and significantly superior over other treatment combinations except with T_2 i.e., Vermicompost at 1.5 t/ha along with RDF 75% Treatment T_2 (21.95g) was shown to be statistically equivalent to treatment T_1 (22.22g). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over plant dry weight per plant was found to be significantly lowest (15.92 g/plant) at 5% level of significant.

Higher dry matter due to the availability of widely accessible nitrogen for rapid growth stage and cumulative improved performance in most growth characters as a result of prolonged availability of macro and micronutrients and improved soil physical conditions throughout the season from vermicompost. Prakash *et al.* (2018).

Numbers of nodules per plant

The data pertaining to 60 DAS shows that the effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over number of nodules per plant was discovered to be the highest (39.2) and significantly superior over other treatment combinations except with T_2 (38.54) i.e., Vermicompost at 1.5 t/ha along with RDF 75% it was discovered to be statistically equivalent to the treatment T_1 (39.2). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over Number of nodules per plant was found to be significantly lowest (25.76) at 5% level of significant.

The above result might be due to the effect of Vermicompost which might have enhanced increased plant growth and yield through lowering pH and particle density while boosting porosity, water holding capacity, cation exchange capacity, and macronutrients in the soil. The presence of humic chemicals in the vermicompost might be the reason of the pH reduction, according to many previous observations (Mahaly *et al.,* 2018). The humic acid concentration of the vermi-compost is high, which aids root development by increasing the effectiveness of the root system and so stimulating plant growth and production. It was done by enhancing food absorption by increasing the permeability of the cell membrane. Humic acid also assisted the development of soil microbial characteristics, leading in higher synthesis of organic aids and, as a consequence, an improvement in soil quality. The bacteria in the vermicompost may create auxin, cytokinins, gibberellins, and other plant growth regulators, as well as a variety of metabolites that the plants can use (Gholami *et al.,* 2018).

Crop growth rate

The result at 45-60 DAS shows that the effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over CGR was found to be highest (4.11 $g/m^2/day$) and significantly superior over other treatment combinations except with T_2 (4.05 $g/m^2/day$) i.e., Vermicompost at 1.5 t/ha along with RDF 75% which, statistically, was determined to be comparable to treatment T_1 (4.11 $g/m^2/day$). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over CGR was found to be significantly lowest (2.21 $g/m^2/day$) at 5% level of significant.

Relative Growth Rate (RGR) (g/g/day)

Shows the mean data for germination percentage recorded at 15-30 DAS, 30-45 DAS, 45-60 DAS, and 60-75 DAS, as well as a graphic representation of the data. The data pertaining to Relative Growth Rate and Integrated Nutrient Management (RGR) (g/g/day) of Cowpea (*Vignaunguiculata* L.) shows that the relative growth rate was found to be non-

Table 1: Effect of integrated nutrient management on growth parameters of Cowpea

Treatment symbols	Treatments	At Harvest		At 60 DAS	During 60 – 75 DAS	
		Plant height (cm)	Dry weight (g)	Nodules/ Plant (No.)	CGR ($g/m^2/day$)	RGR (g/g/day)s
T_1	Vermicompost at 1.5 t/ha + RDF 100%	69.48	22.22	39.2	3.01	0.0213
T_2	Vermicompost at 1.5 t/ha + RDF 75%	69.22	21.95	38.54	2.97	0.0213
T_3	Vermicompost at 1.5 t/ha + RDF 50%	58.61	16.59	28.86	2.19	0.0207
T_4	Farm Yard Manure at 5 t/ha + RDF 100%	62.2	18.46	32.52	2.37	0.0201
T_5	Farm Yard Manure at 5 t/ha + RDF 75%	60.68	17.57	30.62	2.29	0.0205
T_6	Farm Yard Manure at 5 t/ha + RDF 50%	55.74	14.95	25.76	2.15	0.0229
T_7	Panchagavya at 6% + RDF 100%	66.53	20.36	35.5	2.58	0.0198
T_8	Panchagavya at 6% + RDF 75%	64.63	19.36	33.98	2.44	0.0197
T_9	Panchagavya at 6% + RDF 50%	57.07	15.92	27.19	2.16	0.0215
SE(m)±		0.12	0.12	0.25	0.01	0.0002
CD (P=0.05)		0.36	0.36	0.75	0.04	NS

Table 2: Effect of integrated nutrient management on yield attributes and yield of Cowpea

Treatment symbols	Treatment combinations	Pods/ plant (No)	Length of pod/ plant	Seeds/ pod (No)	Test Weight (g)	Seed yield (t/ha)	Stover Yield (t/ha)	Harvest Index (%)
T_1	Vermicompost at 1.5 t/ha + RDF 100%	15.45	27.02	13.57	85.6	2.68	6.09	30.56
T_2	Vermicompost at 1.5 t/ha + RDF 75%	15.13	26.87	13.35	85.19	2.54	6.07	29.5
T_3	Vermicompost at 1.5 t/ha + RDF 50%	12.15	23.22	11.14	81.38	1.64	5.74	22.22
T_4	Farm Yard Manure at 5 t/ha + RDF 100%	13.29	24.65	11.93	82.69	1.95	5.87	24.91
T_5	Farm Yard Manure at 5 t/ha + RDF 75%	12.72	23.81	11.64	81.65	1.76	5.80	23.29
T_6	Farm Yard Manure at 5 t/ha + RDF 50%	10.85	21.31	10.44	80.06	1.34	5.55	19.52
T_7	Panchagavya at 6% + RDF 100%	14.45	26.06	12.81	84.86	2.33	5.99	28.02
T_8	Panchagavya at 6% + RDF 75%	13.85	25.43	12.12	84.25	2.08	5.91	26.03
T_9	Panchagavya at 6% + RDF 50%	11.49	22.24	10.56	80.73	1.45	5.63	25.63
S.EM=		0.11	0.11	0.21	0.19	0.50	0.09	0.49
CD (5%) =		0.32	0.32	0.63	0.57	1.49	0.28	1.48

significant with 5 % confidence level during the entire cropping period. Also, it was found that relative growth rate was higher during vegetative stage and decreased gradually up to maturity stage. However, the effect of treatments on RGR values was more or less similar throughout the crop growth stages.

Yield attributes and yield

Number of pods/plant

The data regarding to Number of pods/plants depicts that the effect of integrated nutrient management on Number of pods/plant of Cowpea (*Vigna unguiculata* L.) was found to be significant. The effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over Number of pods/plants was found to be highest (15.45) and significantly superior over other treatment combinations except with T_2 (15.13) i.e., Vermicompost at 1.5 t/ha along with RDF 75% which was found to be statistically at par with treatment T_1 (15.45). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over Number of pods/plants was found to be significantly lowest (10.85) at 5% level of significant.

The beneficial response of vermicompost to Number of pods/plant might also be attributed to the availability of sufficient amounts of readily usable form of plant nutrient throughout the growth period and specially at critical growth periods of crop resulting in better uptake, plant vigour and superior yield attributes (Brar and Pasrich, 1998; Bansal *et al.,* 2000 and Surender Rao and Sita Ramayya, 2000). These finding corroborates with the results of several other workers (Ghanshyam *et al.,* 2010; Singh *et al.,* 2010; Singh *et al.,* 2008; Ramawter *et al.,* 2013).

Length of pod/plant (cm)

The data in relation to Length of pod/plant depicts that the effect of Integrated Nutrient Management on Length of pod/plant of Cowpea (*Vigna unguiculata* L.) was found to be significant. The effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over Length of pod/plant was found to be highest (27.02 cm) and significantly superior over other treatment combinations except with T_2 (26.87 cm) i.e., Vermicompost at 1.5 t/ha along with RDF 75% which was found to be statistically at par with treatment T_1 (27.02 cm). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over Length of pod/plant was found to be significantly lowest (21.31 cm) at 5% level of significant. Application of vermicompost significantly increased length of pod. The beneficial effect of vermicompost on yield attribute like length of pod may probably due to enhanced supply of macro as well as micronutrients during entire growing season led to higher assimilation of food and its subsequent partitionary in sink (Mahaly *et al.,* 2018).

Number of seeds/pod

The data on Number of seeds/pod shows how Integrated Nutrient Management affects the number of seeds/pod of Cowpea (*Vignaunguiculata* L.) was found to be significant. The effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over Number of seeds/pod was found to be highest (13.57) and significantly superior over other treatment combinations except with T_2 (13.35) i.e., Vermicompost at 1.5 t/ha along with RDF 75% it was discovered to be statistically equivalent to the treatment T_1 (13.57). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over Number of seeds/pod was found to be significantly lowest (10.44) at 5% level of significant. Vermicompost and NPK could be attributed to improve photosynthetic translocation to the sink, which increased the amount of photosynthetic in the system thus it helps in increased number of seeds/pod. Similar results were also reported by (Jat and Ahlawat, 2004).

Test Weight (g)

The data as it relates to Test Weight depicts that the impact of Integrated Nutrient Management on Test Weight of Cowpea (*Vignaunguiculata* L.) was found to be significant. The effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over Test Weight was found to be highest (85.6 g) and significantly superior over other treatment combinations except with T_2 (85.19 g) i.e., Vermicompost at 1.5 t/ha along with RDF 75% which was observed to be statistically tat par with treatment T_1 (85.6 g). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over Test Weight was found to be significantly lowest (80.73) at 5% level of significant.

The above result might be attributed due to the fact that the vermicompost acts as slow-release source of N which is expected to match more closely with supply of N and other nutrient with crop demand and provides all essential nutrient along with growth promoting substances, like enzymes, hormones, growth regulators etc. Hence, Test weight as affected by different organic sources of nutrient varied significantly, being higher with vermicompost with 100% RDF. These results are in conformity with the findings of Devi and Singh (2006) and Reddy *et al.* (1998).

Seed yield (t/ha)

The data concerning to Seed yield (t/ha) depicts that the impact of Integrated Nutrient Management (INM) on Seed yield (t/ha) of Cowpea (*Vigna unguiculata* L.) was found to be significant. The effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over Seed yield (t/ha) was found to be highest (2.68 t/ha) and significantly superior over other treatment combinations except with T_2 (2.54 t/ha) i.e., Vermicompost at 1.5 t/ha along with RDF 75% which was found at par with treatment T_1 (2.68 t/ha).

However, effect of T_6 i.e.,Farm Yard Manure at 5 t/ha along with RDF 50% over Seed yield (t/ha) was found to be significantly lowest (1.34 t/ha) at 5% level of significant. The increase in seed output following the application of 1.5 tonnes of vermicompost and 100 percent RDF could be due to higher vegetative growth in the crop, which means more light interception and hence more assimilated production, resulting in higher pod and seed yield. These findings are consistent with those of (Babaji *et al.,* 2011).

Figure 1: General view of experimental site

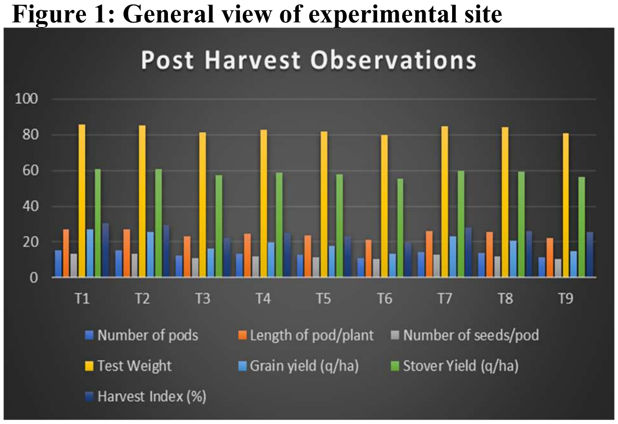

Figure 2: Graphical presentation of post-harvest observation

Stover yield (t/ha)

The data pertaining to Stover yield (t/ha) depicts that the effect of Integrated Nutrient Management on Stover yield (t/ha) of Cowpea (*Vigna unguiculata* L.) was found to be significant. The effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over Stover yield (t/ha) was found to be highest (6.09 t/ha) and significantly superior over other treatment combinations except with T_2 (6.07 t/ha) i.e., Vermicompost at 1.5 t/ha along with RDF 75% which was found at par with treatment T_1 (6.09 t/ha). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over Stover yield (t/ha) was found to be significantly lowest (5.55 t/ha) at 5% level of significant. The application of 1.5 tonnes of vermicompost and 100 percent RDF could be due to higher vegetative growth of the crop i.e plant height, number of branches, leaf area etc. these positively affect biomass production. Which means more light interception and hence more assimilated production, resulting in higher straw yield.

Harvest Index (%)

The data pertaining to Harvest Index (%) depicts that the effect of Integrated Nutrient Managemnt on Harvest Index (%) of Cowpea (*Vigna unguiculata* L.) was found to be significant. The effect of T_1 i.e., Vermicompost at 1.5 t/ha along with RDF 100% over Harvest Index (%) was found to be highest (30.56%) and significantly superior over other treatment combinations except with T_2 (29.5%) i.e., Vermicompost at 1.5 t/ha along with RDF 75% which was found to be statistically at par with treatment T_1 (30.56%). However, effect of T_6 i.e., Farm Yard Manure at 5 t/ha along with RDF 50% over Harvest Index (%) was found to be significantly lowest (19.52%) at 5% level of significant.

Conclusion

The current inquiry has led to the conclusion that Treatment (T_1) with the application of Vermicompost 1.5 tones along with RDF 100% was found to be significant higher at Pre and post-harvest parameters whereas Treatment (T_2) application of Vermicompost at 1.5 t/ha + RDF 75% was found to be statistically at par with Treatment (T_1). It may be concluded that influence of integrated nutrient management will not only reduces the cost of cultivation also enhances the productivity, quality of crop and maintaining the soil fertility for next generation. Continuous usage of organic manure will not only enrich the nutrients in the soil but also increases the soil water holding capacity, porosity, and other physical qualities density and infiltration of soil as well as protects the crop from pest and diseases. Since this is based on one season trail therefore, further evaluation trails are needed to substantiate the findings.

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Conflict of interest

The authors declare that they have no conflict of interest.

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