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# Evaluation of INM on Growth, Yield and Quality of Summer Cowpea Under Doab region of Uttar Pradesh

**OMBIR SINGH[1]*, SANDEEP KUMAR[1], ARUN KUMAR[2] AND MAYA CHOUDHARY[3]**

**ABSTRACT**

A field experiment was conducted at Agriculture Research farm of Chaudhary Chhotu Ram(PG) College Muzaffarnagar during summer season of 2019 and 2020 to evaluate the Integrated Nutrient management on growth, yield and quality of summer cowpea (*Vigna unguiculata* (L) Walp.) under Doab region of Uttar Pradesh. There were sixteen treatments combinations with four fertility levels (Control - $F_0$, 50% RDF - $F_1$, 75% RDF - $F_2$ and 100% RDF - $F_3$) and bio - organics (control - $B_0$, PSB - $B_1$, Vermicompost @2t/ha - $B_2$ and $B_1$+$B_2$ = $B_3$) and tested in a Randomized block Design with three replications. The recommended dose of fertilizer (RDF) was considered as 20 kg N, 40 kg $P_2O_5$ and 40 kg $K_2O$/ha. Results indicated that application of 75% RDF - $F_2$ being at bar with that of 100% RDF ($F_3$) but significantly superior in respect to all the growth as well as yield and yield attributes to other treatments tested in study. Further analysis of data clearly indicates that application of vermicompost @2t/ha being at per with PSB + Vermicompost, but superior to other treatments. Combined application of 75% RDF and Vermicompost @2t/ha ($F_2B_2$) proved to be the best treatment in terms of pod / plant, seed yield and N uptake as well as protein production. Net return work out of different treatment combination in this study is also witness this fact.

**KEYWORDS**

Bioorganics, RDF, Fertility level, Vermicompost

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## INTRODUCTION

Pulses are an important source of dietary protein and have unique property to maintain and restoring soil fertility through biological nitrogen fixation as well as addition of ample amount of residues to the soil (Singh *et al*, 2015). Among the pulses, cowpea is popularly known as 'vegetative-meat' has great importance due to highly nutritious, constitutions with protein (23.4%), fat (1.8%) and carbohydrates (60.3%) and also rich source of Ca and Fe (Singh *et al*, 2012). It has ability to grow as catch crop, inter crop, mixed as well as mulch crop where moisture is scarce (Singh *et al*, 2013b), (Kumar *et al*, 2014a). Green tender pods are used as vegetable containing moisture (84.6%) protein (4.3%) carbohydrate (8.0%) and fat (0.2%), Calcium (72.0 mg), Phosphorus (59.0 mg) Iron (2.5g), Thamine (0.07mg), Riboflavin (0.09mg) and Vit C (24.0mg) per 100g of edible pods (Suryawanshi *et al*, 2017).

Worldwide cowpea was cultivated in 8 m ha and production was estimated about 3.3 MT of dry grain. In India area under this crop was 3.9 m ha with a production of 2.21 MT and the national productivity of 683 kg/ha (Anonymous, 7 18). This poor yield of such important pulse crop is mainly because of grown under neglected land with improper or imbalance fertilizer and other management (Singh *et al*, 2015) although cowpea is highly responsive to fertilizer application. But timely availability of chemical fertilizers at economic prices is another great problem for the farmers. (Singh *et al*, 2013a). Chemical fertilizers play an important role to meet nutrient requirements of the crop but continuous use of these on lands will have deleterious effects on physical, chemical and biological properties of soil, which in turn reflects on yield (Balai *et al*, 2017). In recent year organic farming is becoming great importance for sustainable agriculture to stop deterioration of the agriculture lands and environment, to get yield safer for human beings and animals and to encourage the natural enemies of harmful insects and soil born diseases Anonymous (2013) . Application of vermicompost favourably improves the physical properties of soil due to higher addition of humus through organics (Khan *et al*, 2013), (Kumar *et al*, 2015) . Phosphorus solubilizing Bacteria (PSB) is known to play an important role to improve both fertility and productivity of soil through positive effect on all type of properties of soil and balanced plant nutrition. It also improves the structure and water holding capacity of soil (Kumar *et al*, 2014b) (Sipai *et al*, 2017).

Under there circumstances, one should not depend on single source of plant nutrients like chemical fertilizers. So, there is a need to enhance the production potential of this crop by use of organic manure, biofertilizers and others nutrients in combination. There fore, it is time to evolve an integrated plant

[1] Associate Professor, Deptt. of Agronomy, Chaudhary Chhotu Ram Post Graduate College, Muzaffarnagar, Uttar Pradesh, India
[2] Associate Professor, Deptt. of Plant Pathology, Chaudhary Chhotu Ram Post - Graduate College, Muzaffarnagar, Uttar Pradesh, India
[3] PG Student, Deptt. of Agronomy. Chaudhary Chhotu Ram Post - Graduate College, Muzaffarnagar, Uttar Pradesh, India
*Corresponding author email: singhombirccr@gmail.com

nutrients system comprising balanced use of chemical fertilizers, organic manures and biofertilizers. Keeping in view above facts, the present study entitled Evaluation of INM on Growth, Yield and Quality of Summer Cowpea [*Vigna unguiculatal* (L) Walp.] Under Doab region of Uttar - Pradesh was carried out.

## MATERIALS AND METHODS

The experiments were conducted at Agriculture Research Farm of Chaudhary Chhotu Ram Post Graduate College, Muzaffarnagar (U.P.) during summer season of two consecutive years of 2019 and 2020. The experimental site is situated at $28^0$N latitude and $77^0$ E Longitude and at an altitude of 245.82 meters above the mean sea level and lies in doab region of Uttar - Pradesh (India). The soil of experimental field was sandy loam in texture, well drained conditions having alkaline in reaction (pH 7.78), poor in organic carbon (0.13%) with low available nitrogen (128.3 kg/ha) and medium in available phosphorus (16.1 kg $P_2O_5$/ha) and potassium (154.3 kg $K_2O$/ha). The climate of this region is typically sub tropical with high temperature during summer dry hot and winter are cold. Average annual rainfall of this tract is about 1002 mm, most of which is contributed by south-west monsoon during month of June – September. The crop was sown on 1st and $6^{th}$ of March during 2019 and 2020 respectively by manually hand method at 30 cm apart in rows using seed rate of 20 kg per hectare with depth of 5-6 cm. The field experiments was consisted of 16 treatments combinations imposed to cowpea variety Pusa Phalguni comprising four fertility levels (Control - $F_0$, 50% RDF - $F_1$, 75% RDF - $F_2$ and 100% RDF - $F_3$) and four bio-organics (Control - $B_0$, PSB - $B_1$, vermicomposs@2t/ha-$B_2$ and PSB + vermicomposs@2t/ha-$B_3$) replicated thrice in a Randomized Block Design. The recommended dose of fertilizer (RDF) was considered as 20kg N, 40 Kg $P_2O_5$ and 40 kg $K_2O$ /ha. An early cowpea variety Pusa Phalguni having 10-20 cm size of pod with dark green colour, recommended for both summer and rainy season of north states in India is selected for experimentation. Data on various aspects of growth and yield attributes, grain and straw yield and economic return were calculated as per the standard procedure by using local prevailing market price. The nutrient 'N' uptake was estimated from both seed and stover separately during both the years and its uptake were calculated with the help of total seed and stover yield multiply with respective nutrient content. The percent crude protein content in seed was calculated by multiplying percent nitrogen of seed with a factor 6.25 (AOAC, 1996). The experimental data were analysed statistically by applying technique of analysis of variance (ANOVA) prescribed for the design to test and conclusions were drawn at 5% probability levels.

## RESULTS AND DISCUSSION

### Growth and Development

Application of fertility as well as bio-organic treatments had significantly effect on almost all the growth & development characters except plant stands during both the year of experimentation. All the growth parameter viz. Plant height, number of branches per plant dry matter accumulation per meter row length, number and weight of nodules per plant increased linearly with corresponding increase up to levels of 75% RDF ($F_2$). This increment was by and large, statistically superior over control ($F_0$) and 50% RDF ($F_1$), but at par with 100% RDF ($F_3$). The increase in these components seems to have been brought about by increase in amount of growth substances. Probably the increase in auxin supply with higher level of nitrogen brought about increase in dry matter and branches per plant. It might be also due to an early and plentiful availability of nutrients (NPK) leads to better nutritional environment in the root zone for better growth and development. As we know that nitrogen accelerates photosynthetic rate henceforth increase the supply of carbohydrate to plant which ultimate increase the dry matter production in plant. Similarly increase supply of available phosphorus has long been recognised and almost every metabolic reaction of any significance proceeds via phosphate derivatives. Increased availability of phosphorus owing to its application in the soil which was otherwise poor in its content improved its greater uptake which ultimately increased the root and shoot development. The above findings of improvement in overall vegetative growth and development of crop with NPK in the investigation is in close conformity of Upadhyay and Anita (2016) and Balai *et al* (2017).

Result pertaining in Table 1 clearly indicate that application of vermicompost @2t/ha. ($B_2$) significantly increased plant height, number of branches per plant, dry matter accumulation, total and effective number of nodules and their weight over control ($B_0$) and PSB (B1). This might be due to an important role played by vermicompost in the development of root and their superior proliferation results better nodule formation and nitrogen fixation which supplying assimilates to the root. This superiority of Vermicompost may cause rapid mineralization on account of narrow C:N ratio (12:1) which enhanced the release of nutrients early in the crop period. Increase in number of nodules and their weight indicate the improved fertility with vermicompost. Similar findings have also been reported by Yadav *et al* (2019) in cowpea.

**Yield and yield attributes**

Data pertaining to seed yield and yield attributes (Table 2 ) clearly showed that summer Cowpea responded statistically significant in terms of seed yield with increasing fertility level upto 75% RDF ($F_2$) during both the year of study. This treatment of 75% RDF ($F_2$) increased the seed yield by 70.3 and 12.04 percent during 2019 whereas, 54.4 and 9.4 percent during 2020 over control ($F_0$) and 50% RDF ($F_1$) respectively. However, the seed yield increased with 50% RDF ($F_1$) over control ($F_0$) were 51.4 and 38.3 percent during 2019 and 2021 respectively. Further increase of fertilizer level upto 100% RDF ($F_3$) could not bring any significant improvement over 75% RDF ($F_2$) during both the year of experimentation. Hence, fertilizer dose of 75%

**Table 1: rowth and Growth attributing character at harvest of cowpea (*Vigna unguiculate* (L) Walp.) as influence by INM.**

| Treatements | Plant Stand per m (row length) | | Plant height (cm) | | Number of branches per plant | | Dry matter production (g)m. row length | | Root Studies per plant at 40 DAS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Total Nodule | | Effective Nodules | | Fresh weight (g) | |
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| **Fertility Levels** | | | | | | | | | | | | | | |
| $F_0$ - (Control) | 11.9 | 13.4 | 40.6 | 42.5 | 9.5 | 10.1 | 93.63 | 99.72 | 29.57 | 33.63 | 27.9 | 30.3 | 100.1 | 103.2 |
| $F_1$ - (50% (RDF) | 12.1 | 13.8 | 43.0 | 45.4 | 12.4 | 12.9 | 106.29 | 112.48 | 31.28 | 36.66 | 29.4 | 32.6 | 105.2 | 107.8 |
| $F_2$ - (75% RDF) | 12.3 | 13.9 | 45.2 | 47.7 | 13.9 | 14.4 | 113.99 | 120.54 | 32.31 | 37.36 | 30.5 | 33.3 | 107.2 | 110.3 |
| $F_3$ - (100% RDF) | 12.4 | 14.2 | 45.8 | 47.9 | 14.2 | 16.1 | 115.19 | 121.62 | 32.63 | 37.36 | 31.1 | 34.6 | 108.1 | 111.3 |
| SEM + | 0.2 | 0.3 | 1.0 | 1.1 | 0.3 | 0.4 | 2.63 | 2.83 | 0.50 | 0.60 | 0.51 | 0.57 | 1.7 | 1.8 |
| CD (P = 0.05) | NS | NS | 2.8 | 2.9 | 0.8 | 1.1 | 7.59 | 8.16 | 1.44 | 1.45 | 1.51 | 1.53 | 50 | 5.2 |
| **Bio - Organics** | | | | | | | | | | | | | | |
| $B_0$ - Control | 12.0 | 13.6 | 41.2 | 42.6 | 9.8 | 10.3 | 96.93 | 102.76 | 29.37 | 33.73 | 27.8 | 30.6 | 101.9 | 103.2 |
| $B_1$ - PSB | 12.1 | 13.7 | 42.9 | 46.3 | 11.9 | 12.7 | 04.59 | 109.56 | 30.65 | 35.63 | 28.8 | 31.9 | 103.7 | 106.7 |
| $B_2$ - Vermi. @2t/ha | 12.3 | 13.9 | 44.8 | 48.1 | 14.0 | 15.8 | 112.35 | 118.53 | 32.52 | 37.69 | 30.6 | 33.6 | 106.8 | 109.8 |
| $B_3$ - ($B_1$ + $B_2$) | 12.3 | 13.9 | 45.7 | 48.3 | 14.3 | 16.5 | 115.22 | 121.32 | 33.25 | 38.63 | 31.7 | 34.6 | 108.1 | 112.4 |
| SEM + | 0.2 | 0.3 | 1.0 | 1.1 | 0.3 | 0.4 | 2.63 | 2.83 | 0.50 | 0.60 | 0.51 | 0.51 | 1.7 | 1.8 |
| CD (P = 0.05) | NS | NS | 2.8 | 2.9 | 0.8 | 1.1 | 7.59 | 8.16 | 1.44 | 1.45 | 1.51 | 1.53 | 5.0 | 5.2 |

DAS -Days after sowing

RDF ($F_2$) remained the most effective treatment. It might be interaction of all the yield attributing factors viz. number of pods/ plants, seed / pod and more weight of seed which have similar trend to seed yield in respect to fertility treatments. At later stage in reproductive phase when the current photosynthesis is not able to furnish the increased assimilate demand of plant sinks, the storage compounds probably remobilize and move to active sinks (Pods and Seeds) which ultimately increased pods and seeds per pod. During leaf senescence also, carbohydrate, nitrogenous compounds, phosphorus and other mobile nutrients are remobilized and translocated to current plant sinks i.e. seed which are very close to the source resulting into higher seed weight due to bold grain formation. Data presented (Table 2) further reveal that seed and all the yield attributes except harvest index were statistically influenced by different bio-organics over control too. The application of vermicompost @2t/ha ($B_2$) produced significantly higher seed yield over preceding treatments and the quantum of increase in seed yield due to this treatment ($B_2$) over control ($B_0$) and PSB ($B_1$) was 4.53 (2019), 4.55 (2020) and 2.94 (2014), 3.05 (2020) q/ha respectively. Increase in seed yield due to PSB + Vermicompost ($B_3$) was not significant over vermicompost ($B_2$) alone but at per. Hence, sole application of vermicompost proved to be the best treatment. In successive treatment i.e. PSB + vermicompost ($B_3$) the marginal increment in seed yield and yield attributes was recorded over vermicompost ($B_2$) alone. Obviously, phosphate solubilizing bacteria (PSB) solubilize native and sparingly soluble phosphate ultimate enhanced the availability of P rather its fixation in the soil. Therefore, combined positive effect of PSB + Vermicompost ($B_3$) might have increased the yield attributes and ultimately the seed yield but the variation in yield was so small that could not reach the level of significance over Vermicompost ($B_2$) alone. Yadav *et al* (2019) also obtained similar results in cowpea.

Combined effect between different fertility level and bio-organics was found to be significant with regards to seed yield. The highest seed yield (average of both year) 15.28 q/ha was recorded with 100 RDF with PSB + Vermicompost ($F_3B_3$) but at per with 75% RDF + Vermicompost @2t/ha ($F_2B_2$) remained the most superior treatment. It may be due to enhanced vegetative growth in terms of number of branches per plant provided more sites for the translocation of photosynthates and ultimately resulted in increased number of yield attributes. Such combined beneficial effect of fertility and bio-organics (INM) on yield & yield attributes probably due to enhances supply of macro and micronutrients during entire growing season which led to higher assimilation of food and its subsequent partitioning in sink, which ultimately increased the pods / plant, seeds / pod and test - weight . Similar results were also reported by Lyngdoh *et al* (2017).

**Table 2:** **Yield and yield attributes of Cowpea (*Vigna ungniculata* (L) Walp.) as influenced by INM.**

| Treatments | No. of Pod / Plant | | No. of seeds / pod | | Test weight (g) | | Yield (Q/ha) | | | | Harvest IndexY | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Seed | | Straw | | | |
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| **Fertility Levels** | | | | | | | | | | | | |
| $F_0$ - (Control) | 20.12 | 27.42 | 7.7 | 8.1 | 26.1 | 27.7 | 7.42 | 9.95 | 15.82 | 20.45 | 31.92 | 32.72 |
| $F_1$ - (50% (RDF) | 30.00 | 36.52 | 8.5 | 8.9 | 30.9 | 28.3 | 11.24 | 13.77 | 21.32 | 25.98 | 34.52 | 34.64 |
| $F_2$ - (75% RDF) | 32.05 | 38.34 | 8.9 | 9.2 | 32.2 | 28.6 | 12.64 | 15.07 | 24.10 | 28.33 | 34.71 | 34.72 |
| $F_3$ - (100% RDF) | 32.10 | 39.31 | 9.1 | 9.5 | 33.1 | 30.3 | 12.90 | 15.41 | 24.41 | 28.09 | 34.88 | 35.42 |
| SEM + | 0.18 | 0.9 | 0.2 | 0.2 | 0.6 | 0.6 | 0.16 | 0.27 | 0.39 | 0.43 | 0.68 | 0.71 |
| CD (P = 0.05) | 2.3 | 2.4 | 0.5 | 0.5 | 1.9 | NS | 0.47 | 0.76 | 1.12 | 1.23 | 1.96 | NS |
| **Bio - Organics** | | | | | | | | | | | | |
| $B_0$ - Control | 21.15 | 27.15 | 7.6 | 7.9 | 28.3 | 28.2 | 8.36 | 10.88 | 16.43 | 22.27 | 33.72 | 32.82 |
| $B_1$ - PSB | 25.95 | 32.42 | 8.2 | 9.1 | 29.4 | 29.6 | 9.95 | 12.38 | 19.26 | 22.57 | 34.06 | 35.42 |
| $B_2$ -Vermi. @2t/ha | 32.75 | 39.54 | 9.1 | 9.5 | 31.8 | 30.2 | 12.89 | 15.43 | 24.85 | 28.09 | 34.15 | 35.36 |
| $B_3$ - ($B_1$ + $B_2$) | 33.87 | 39.64 | 9.3 | 9.8 | 32.8 | 32.4 | 13.00 | 15.54 | 25.11 | 28.16 | 34.11 | 35.56 |
| SEM + | 0.8 | 0.9 | 0.2 | 0.2 | 0.6 | 0.6 | 0.16 | 0.27 | 0.39 | 0.43 | 0.68 | 0.71 |
| CD (P = 0.05) | 2.3 | 2.4 | 0.5 | 0.5 | 1.9 | NS | 0.47 | 0.76 | 1.12 | 1.23 | NS | NS |

**Table 3:** **Total 'N' Uptake (Kg/ha), protein (%) in grain and Net Income of Cowpea (*Vigna ungniculata* (L) Walp.) as influenced by INM.**

| Treatments | Total N Uptake (Kg/ha) | | Protein content is seed (%) | | Economics of various treatments (Rs.) (Avg. of two consecutive year) | | |
|---|---|---|---|---|---|---|---|
| | 2019 | 2020 | 2019 | 2020 | Total Cost | Net Return | B:C Ratio |
| **Fertility Levels** | | | | | | | |
| $F_0$ - (Control) | 41.45 | 62.06 | 19.59 | 20.22 | 11761 | 7873 | 0.670 |
| $F_1$ - (50% (RDF) | 68.88 | 84.18 | 21.49 | 21.68 | 12574 | 18424 | 1.465 |
| $F_2$ - (75% RDF) | 80.85 | 95.77 | 21.86 | 22.39 | 13033 | 22307 | 1.711 |
| $F_3$ - (100% RDF) | 83.36 | 97.91 | 21.91 | 22.47 | 13457 | 22661 | 1.683 |
| SEM + | 1.06 | 1.72 | 0.47 | 0.49 | - | 548 | - |
| CD (P = 0.05) | 3.06 | 4.96 | 1.36 | 1.42 | - | 1582 | - |
| **Bio - Organics** | | | | | | | |
| $B_0$ - Control | 47.73 | 62.73 | 20.08 | 21.59 | 10284 | 11969 | 1.163 |
| $B_1$ - PSB | 59.93 | 71.03 | 20.81 | 21.80 | 10334 | 16785 | 1.624 |
| $B_2$ - Vermicompost @2t/ha | 82.72 | 96.53 | 21.96 | 22.46 | 15084 | 21089 | 1.398 |
| $B_3$ - ($B_1$ + $B_2$) | 84.16 | 97.73 | 22.01 | 22.51 | 15134 | 21386 | 1.413 |
| SEM + | 1.06 | 1.72 | 0.47 | 0.49 | - | 548 | - |
| CD (P = 0.05) | 3.06 | 4.96 | 1.36 | 1.42 | - | 1582 | - |

**Total 'N' uptake and protein content in grain**

It is evident from data (Table 3) that nitrogen uptake significantly increased with increasing fertility level up to 75% RDF ($F_2$) during both the year of experimentation. On an average, magnitude of increase in N uptake due to 75% RDF ($F_2$) over its proceeding level i.e. control ($F_0$) and 5% RDF ($F_1$) were 92 and 18 percent, respectively. Further, data present in Table 3 revealed that all the bio-organic treatment also significantly enhances this character and application of vermicompost@2t/ha ($B_2$) resulted significantly higher nitrogen uptake and represented on an average increase of 70.3 and 38.5 percent respectively, over control ($B_0$) and PSB ($B_1$). This might be due to improved nutritional environment in the rhizosphere as well as in the plant system leading to enhanced translocation especially major nutrients to reproductive structure like pod, seed and other plant part.

Significant increase in protein content from control $F_0$ (19.5% and 20.2% percent) to 75% RDF - $F_2$ (21.8% and 23.3%) has been observed in the present investigation during 2019 and 2020. Higher content of nitrogen at higher level might be due to increase activity of nitrate reductable enzyme. Higher 'N' content in seed is directly responsible of higher protein because it is a primary component of amino acid, which constitutes the basis of protein. These results are in close conformity with findings of Yakadri *et al* (2004).

**Interaction**

Instead of individual factor, it is desirable to looks for combined effect of different factors to derive maximum advantage of input. Application of 75% RDF combined with vermicompost ($F_2B_2$) proved the most superior in enhancing the pods / plant, seed yield and total nitrogen uptake. Result revealed that treatment combination $F_3B_3$ (100% RDF with PSB + Vermicompost@2t/ha) though recorded highest all these parameters but it was found at per with $F_2$ $B_2$ (75% RDF + Vermicompost). The significant increase in yield under the combined application of inorganic fertilizer and bio-organics was largely a function of improved growth and subsequent increase in number of pods / plant and other yield attributes as described here. Therefore, the interactive effect of combining inorganic fertilizer and bio-organics proved more advantageous than the use of each component separately. Similar results regarding these parameters were also noticed by Dutta *et al* (2019).

**Economics**

Average data of two consecutive years on total cost of cultivation, net return and B: C ratio revealed that application of 75% RDF ($F_2$) gave of Rs. 22307 which was significantly higher over 50% RDF ($F_1$) and control ($F_0$). Whereas, application of Vermicompost @ 2t/ha ($B_2$) Rs. 21089 being at per with PSB + Vermicompost @t/ha $B_3$ Rs. 21386 recorded significantly higher net return over other treatment in this investigation. Benefit: cost ratio also witnessed this fact.

## CONCLUSION

Based on finding of these two-consecutive years of experimentation, it may be inferred that combined application of 75% RDF and Vermicompost - @2t/ha ($F_2B_2$) proved to be the most superior treatment to seed yield of summer cowpea. Application of 75% RDF (Rs. 25908/ha) and Vermicompost @2t/ha (Rs. 24690/ha) also fetched significantly higher net return as compared to other treatments. Hence the treatment combination 75% RDF with vermicompost @2t/ha is a viable option for enhancing the growth, yield and quality as well as net monetary income of summer cow pea under Doab region of Uttar Pradesh.

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