Impact of different organic sources on nutrient content, availability and economics of *kharif* cowpea

ABSTRACT

Present study is reported at Agronomy Instructional Farm of SDAU, Sardarkrushinagar during *kharif* season of 2020-2021. The experiment consisting nine treatments *viz.*, T_1-Absolute control, T_2-100% RDF (20 kg N + 40 kg P_2O_5 /ha), T_3- FYM @ 5.0 t/ha, T_4-FYM @ 2.5 t/ha + *Rhizobium* + PSB, T_5-vermicompost @ 2.0 t/ha, T_6-vermicompost @ 1.0 t/ha + *Rhizobium* + PSB, T_7-castor cake @ 2.0 t/ha, T_8-castor cake @ 1.0 t/ha + *Rhizobium* + PSB, T_9-*Ghan Jeevamrut* @ 250 kg/ha at sowing time + Seed treatment with *Beejamrut* @ 200 ml/kg seed+ *Jeevamrut* @ 500 lit/ha with irrigation at sowing and 30 DAS were tested in randomized block design with four replications. The result revealed that the application of T_8-castor cake @ 1.0 t/ha + *Rhizobium* + PSB showed significant improvement. Application of castor cake @ 1.0 t/ha + *Rhizobium* + PSB (T_8) resulted significantly higher nitrogen, phosphorus content, uptake and microbial population in seed and Stover. While significantly higher available nitrogen, phosphorus, status in soil after harvest of cowpea crop was obtained under the treatment of FYM @ 5.0 t/ha (T_3) which was at par with FYM @ 2.5 t/ha + *Rhizobium* + PSB (T_4). Research shows that the application of castor cake @ 1.0 t/ha + *Rhizobium* + PSB (T_8) can significantly enhance nutrients content, its availability and economic returns.

Keywords: Rhizobium, nitrogen, microbial population and irrigation

1. INTRODUCTION

Pulses are the edible seeds of leguminous plants; therefore, it also known as legumes and use for food purpose. Cowpea (*Vigna unguiculata* L.) is used in different parts of the world for its high-protein seeds, but also for its nutrient-rich edible leaves, fodder and soil enrichment. In Indian agriculture, cowpea is grown as a major pulse mainly in Kerala, Madhya Pradesh, Punjab, West Bengal Andhra Pradesh Gujarat and Utter Pradesh (Chauhan *et al.,*2016). It also contains carbohydrates (56.8%), protein (24.0 %), fibre (3.9%), ash (3.20%) and fat

(1.3%). Peas are the most commonly known and consumed types of pulses. The staples dishes and cuisines from across the world feature pulses, from hummus in the Mediterranean to a traditional full English breakfast (baked navy beans) to Indian dal (peas or lentils). Major nutrients play important role in various metabolic process of the plant growth and development (Kalegore *et al.*, 2018). Nitrogen is most important constituent of protein and chlorophyll. The net availability of the food grains per capita per day increased from 144.1 kg year^{-1} in 1951 to 179.6 kg year^{-1} in 2019 whereas, in pulses, the net availability per capita per day decreased from 25 kg year^{-1} in 1961 to 17.5 kg year^{-1} in 2019 (Singh *et al*., 2020). The increased production through organic nutrient sources involved the use of vermicompost, Neem seed kernel, farm Yard Manure and biofertilizers resulting in increased the quality and quantity but also reduce the soil degradation, environmental pollution and living health. Considering the stakes, an alternative to conventional farming was inevitable and led to the emergence of a new agricultural production system. Under this system, the chemicals were replaced by farmyard manure, vermicompost, vermiwash, green manuring, etc. These help to increase the soil biological, physical and chemical properties (Alabadan *et al.*, 2009). Soils with a high concentration of organic matter have been proven to improve the growth and yield of various plants as well as soil infiltration, soil compaction, and increase water retention capacity for seed germination and plant root development (Thapa, 2021). Besides organic farming, Subhash Palekars's Natural Farming is also an alternative to chemical farming wherein on-farm products are used as inputs by converting them into formulations such as Jiwamrita, Bijamrita and Ghanjiwamrita. Apart from supplying nutrients, this method helps increase the microbial population such as phosphorus solubilizing bacteria, plant growth-promoting rhizobacteria, etc. However, frequent use of fertilizers made from soil can end up damaging the chemical, physical, and organic matter of the soil. On the other hand, organic fertilizers provide beneficial effects to the soil and increase nutrient uptake, which helps maintain the quality and yield of plants and is less expensive than inorganic fertilizers (Moretti *et al.*, 2002).

2. MATERIALS AND METHODS

The field experiment was conducted from July to October 2020. at the research farm of Sardar krushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujrat, India. The soil of experimental site is loamy sand in texture, low in organic carbon, slightly alkaline with low available nitrogen (N), medium phosphorous (P) and high potassium (K) contents. The experiment consisting nine treatments *viz.*, T_1-Absolute control, T_2-100% RDF (20 kg N + 40 kg P_2O_5 /ha), T_3- FYM @ 5.0 t/ha, T_4-FYM @ 2.5 t/ha + *Rhizobium* + PSB, T_5-vermicompost @ 2.0 t/ha, T_6-vermicompost @ 1.0 t/ha + *Rhizobium* + PSB, T_7-castor cake @ 2.0 t/ha, T_8-castor cake @ 1.0 t/ha + *Rhizobium* + PSB, T_9-*Ghan Jeevamrut* @ 250 kg/ha at sowing time + Seed treatment with *Beejamrut* @ 200 ml/kg seed+ *Jeevamrut* @ 500 lit/ha with irrigation at sowing and 30 DAS were tested in randomized block design with four replications. The crop cultivar GC-4 of Cowpea [*Vigna unguiculata* (L.)] was grown with recommended dose of fertilizers. In treatments nutrients were applied as FYM, Vermicompost, castor cake etc. To control weed by hand weeding at 20 and 35 days after sowing (DAS) of cowpea. crop was sown at a spacing of 45 × 10 cm in the first week of July and harvested in the second week of October. Soil samples were collected at harvest (October 2020) from soil 0-15 cm from two spots in each plot. Soil was composited for each replicate, air dried, and ground to pass a 8 mesh sieve prior to analysis. Organic carbon was determined by the Walkley and Black (1934). Available nitrogen in soil samples were determined by adapting the alkaline permanganate method of Subbiah and Asija (1956). Available P_2O_5 was determined calorimetrically after the extraction of 1 g soil with 20 ml 0.5 N sodium bicarbonate ($NaHCO_3$) for a half hour (Olsen *et al.,* 1954). Available potassium was determined using a flame photometer following soil extraction with 1N ammonium acetate (CH_3OONH_4) (Hanway and Heidel, 1952). The data was analysed statistically and treatment means were compared using LSD techniques at 5% probability appropriate for RBD (Gomez and Gomez, 1984).

Meteorological observations: the mean maximum temperature was ranged between 32.1 to 38.5^0C, while mean minimum temperature was ranged between 15.8 to 27.4^0C during the period of experimentation in *kharif* 2020. The total rainfall received during July to October 2020 was 1173.5 mm. As well as pan evaporation (mm/day) was ranged between 3.1 to 7.3 mm/day during crop period July 2020 to October 2020. The weekly mean bright sunshine duration varied from 0.0 to 10.2 hr during July to October 2020.

Plant analysis and nutrient uptake: The plant and grain samples collected at harvest of cowpea crop were cleaned with double distilled water and tipped with butter paper and air dried first. Then samples were dried in oven at 62.5°C. These samples were powdered in grinder and used for determining concentration of major nutrients. Nutrient uptake was calculated by multiplying the nutrient concentration of crop (seed and stover) with their respective yield. The total nutrient uptake was obtained by summation of the nutrient uptake of seed and stover.

Microbial bacterial counts: The soil adhering or adjoining to the root surface was collected which represented the samples. The viable microbial population of *Rhizobium spp.* and phosphate solubilizing bacteria (PSB) after harvest of crop was determined

Economics: To evaluate the most effective and remunerative treatment, the relative economics of each treatment was worked out in terms of gross, net realization and benefit: cost ratio.

Gross realization: The gross realization in term of rupees per hectare was calculated from the income received from pod and haulm yield of each treatment with the prevailing, market price. The cost of cultivation was worked out considering the cost of all the operations right from the preparation of land to the harvesting of the crop and the cost of all the inputs involved.

Net realization: The net realization was worked out by deducting the total cost of cultivation from the gross realization per hectare for each treatment and recorded accordingly.

Benefit: Cost ratio: The benefit: cost ratio was calculated by using the formula given below.

$$Benefit : Cost\ Ratio\ (BCR) = \frac{Gross\ realization\ (₹//\text{ha})}{\text{Cost of cultivation}\ (₹//\text{ha})}$$

3. RESULTS AND DISCUSSION

3.1 Effect on nutrients content and their uptake

3.1.1 Nitrogen content in seed and stover (%)

Data pertaining to the nitrogen content by seed and stover is furnished in **Table 1** which showed that the different treatments significantly influenced the Nitrogen content by the seed and stover. Treatment T_8 (castor cake @ 1.0 t/ha + *Rhizobium* + PSB) resulted significantly higher content of Nitrogen (3.57%) in seed which was at par with treatment100% RDF (T_2), FYM @ 5.0 t/ha (T_3), FYM @ 2.5 t/ha + *Rhizobium* + PSB (T_4) vermicompost @ 1.0 t/ha + *Rhizobium* + PSB (T_6)and *Ghan Jeevamrut* @ 250 kg/ha at sowing time + Seed treatment with *Beejamrut* @ 200 ml/kg seed + *Jeevamrut* @ 500 lit/ha with irrigation at sowing and 30 DAS (T_9).Treatment T_8 (castor cake @ 1.0 t/ha + *Rhizobium* + PSB) resulted significantly higher content of nitrogen(0.84 %) in stover which was at par with treatment100% RDF (T_2), FYM @ 5.0 t/ha (T_3), FYM @ 2.5 t/ha + *Rhizobium* + PSB (T_4), vermicompost @ 2.0 t/ha (T_5),vermicompost @ 1.0 t/ha + *Rhizobium* + PSB (T_6), castor cake @ 2.0 t/ha (T_7)and *Ghan Jeevamrut* @ 250 kg/ha at sowing time + Seed treatment with *Beejamrut* @ 200 ml/kg seed + *Jeevamrut* @ 500 lit/ha with irrigation at sowing and 30 DAS (T_9).The lowest content of nitrogen in seed (2.95 %) and stover(0.66 %) was registered with treatment T_1(Absolute control). This might be due to application of N fixing bio fertilizers *Rhizobium* which enhanced the seed yield, nitrogenase activity and soil nitrogen status which helped in absorbing more nitrogen. Moreover, PSB was also responsible for P availability which, helped in nitrogen fixing through increasing activity of Rhizobium. The results are in agreement with those reported by Dekhane *et al*. (2011), Khandelwal *et al*. (2012) and Khan *et al*. (2017).

3.1.2 Phosphorus content in seed and stover (%)

The mean data related to phosphorus content in seed and stover as influenced by different treatments are presented in Table 1. Different treatments imparted their significant influence on P content in seed and stover of cowpea. Significantly higher P content in seed and stover (0.66 and 0.25%, respectively) were found with T_8(Castor cake @ 1.0 t/ha + *Rhizobium* + PSB). However, it remained statistically at par with treatment T_2 (100% RDF) and T_4 (FYM @ 2.5 t/ha + *Rhizobium* + PSB) in case of P content in seedandT_4 (FYM @ 2.5 t/ha + *Rhizobium* + PSB) in case of P content in Stover. Significantly minimum P content in seed (0.51 %) and stover (0.20 %) was recorded under absolute control (T_1). This might be due to ample availability of all three major nutrients from organic manure and Bio-fertilizer which leading to more assimilation of phosphorus by the cowpea crop resulting in increased content of phosphorus. Similar conclusion was drawn by Dekhane *et al*. (2011) and Pargi *et al*. (2018).

3.1.3 Nitrogen uptake by crop (kg ha^{-1})

Significantly higher nitrogen uptake (56.03 kg ha^{-1}) was registered with treatment T_8 (castor cake @ 1.0 kg ha^{-1}+ *Rhizobium* + PSB). However, it remained statistically at par with treatments T_4 (FYM @ 2.5 t/ha + *Rhizobium* + PSB). The lowest nitrogen uptake by crop

(29.71 kg ha^{-1}) was noted with treatment T_1 (absolute control). The reason behind the highest uptake of N (kg ha^{-1}) under treatment T_8 (castor cake @ 1.0 t/ha + *Rhizobium* + PSB) is directly related with the yield and N content in seed and stover. This treatment received maximum yield and N content in seed and stover which would have resulted in overall higher N uptake with this treatment. The findings are in close proximity with the findings of Dekhane *et al*. (2011) and Khandelwal *et al*. (2012).

3.1.4 Phosphorus uptake by cowpea (kg ha^{-1})

Significantly higher phosphorus uptake (12.16 kg ha^{-1}) was registered with treatment T_8 (castor cake @ 1.0 kg ha^{-1}+ *Rhizobium* + PSB). The lowest phosphorus uptake by crop (6.30 kg ha^{-1}) was noted with treatment T_1(absolute control). As the uptake is a product of nutrient content and seed yield, so in accordance with this T_8 (castor cake @ 1.0 kg ha^{-1}+ *Rhizobium* + PSB) having higher phosphorus content and seed yield contributed to higher uptake of phosphorus. Similar results were presented by Dekhane *et al*. (2011) and Khandelwal *et al*. (2012).

3.2 Effect on available nutrients in soil after harvest of crop

3.2.1 Available nitrogen (kg ha^{-1})

The set of data in Table 2 revealed that different treatments exercised their significant influence on available N (kg ha^{-1}) status of soil. Significantly higher available nitrogen (155.52 kg ha^{-1}) status in soil after harvest of cowpea crop was obtained under treatment T_3 (FYM @ 5.0 kg ha^{-1}) which was at par with FYM @ 2.5 kg ha^{-1}+ *Rhizobium* + PSB (T_4), vermicompost @ 2.0 kg ha^{-1} (T_5) and castor cake @ 2.0 t/ha (T_7). However, significantly lower N availability (134.71kg/ha) was observed under treatment T_1 (absolute control). Significantly higher available N contribution by organic manure along with bio fertilizer, the increment was due to slow release of nutrients through organic manure and enriching the available pool of nitrogen. The higher available nitrogen after harvest of cowpea crop might be due to the direct addition of nitrogen through organic manure and greater multiplication of soil microbes, which helps to convert organically bound nitrogen in to inorganic form Bio-fertilizers had improved the nitrogen status of soil due to synergism in *Rhizobium* and PSB might have also resulted in better nodulation with their dual inoculation as against no inoculation. The results are in close conformity with the findings of Dekhane *et al*. (2011), Khan *et al*. (2013) and Joshi *et al*. (2016).

3.2.2 Available phosphorus (kg ha^{-1})

Data furnished in Table 2 indicated that different treatments exerted their significant effect on available phosphorus content in soil after the harvest of the crop. Significantly higher available phosphorus (41.10 kg ha^{-1}) was observed under the treatmentT_7 (castor cake @ 2.0 kg ha^{-1}), which was at par with FYM @ 5.0 kg ha^{-1} (T_3), FYM @ 2.5 kg ha^{-1}+ *Rhizobium* + PSB (T_4), vermicompost @ 2.0 kg ha^{-1} (T_5) and castor cake @ 1.0 kg ha^{-1}+ *Rhizobium* + PSB (T_8), while lower Phosphorus availability (35.40 kg ha^{-1}) was observed under treatment T_1 (absolute control). The reason for significantly higher phosphorus might be due to release of organic acid during microbial decomposition of organic manure might help in increasing solubility of native phosphates, thus increased available phosphorus pool in the soil. Similar results were also reported by Dekhane *et al*. (2011), Khan *et al*. (2013) and Joshi *et al*. (2016).

3.2.3 Available potassium (kg ha^{-1})

The data presented in Table 2 disclosed that available potassium (kg ha^{-1}) was not significantly varied due to different treatments. However, marginally higheravailable potassium (kg ha^{-1}) was observed in treatment T_7 castor cake @ 2.0 t/ha (203.62 kg ha^{-1}) than rest of treatments.

3.3 Effect on soil microbial population

An appraisal of results presented in Table 2 showed that significantly a greater number of *rhizobium* (21 × 10^5 g/soil) count was recorded withT_4 (FYM @ 2.5 t/ha + *Rhizobium* + PSB), T_6 (vermicompost @ 1.0 t ha^{-1}+ *Rhizobium* + PSB) and T_8 (castor cake @ 1.0 t ha^{-1} + *Rhizobium* + PSB). While a greater number of PSB (27 × 10^4 g/soil) count was recorded withT_8 (castor cake @ 1.0 t/ha + *Rhizobium* + PSB). However, it remained statistically at par with treatment T_4 (FYM @ 2.5 t/ha + *Rhizobium* + PSB) in case of PSB. Minimum population of *rhizobium* (9 × 10^5 g/soil) and PSB (4 × 10^4 g/soil) were noted in absolute control treatment. Moreover, seed inoculation of bio-fertilizers (*Rhizobium* + PSB) facilitated robust growth of plants and soil health and thereby increased nodulation (Table 3). Increase in nodulation is directly related to increase in microbial count in soil. Similar findings have been reported by Lyngdoh *et al*. (2017) and Pargi *et al*. (2018).

3.4 Economics

The details of gross realization, net realization as well as total cost of cultivation and benefit: cost Ratio (BCR) of cowpea as influenced by various integrated nutrient management treatments are outlined in Table 3.

3.4.1 Net realization (₹/ha)

A perusal of data on net return as influenced by various integrated nutrient management treatments are presented in Table 3 revealed that higher net realization of ₹56,353/ha was recorded by fertilizing the crop with castor cake @ 1.0 t/ha + *Rhizobium* + PSB (T_8) followed by treatment of FYM @ 2.5 t/ha + *Rhizobium* + PSB (T_4) and100% RDF(T_2). The lowest net realization(₹32,343/ha) was fetched under treatment absolute control (T_1).

3.4.2 Benefit: Cost Ratio (BCR)

The data on benefit: cost Ratio (BCR) as influenced by various integrated nutrient management treatments are furnished in Table 3 indicated that higher benefit: cost Ratio (BCR) of 3.15 was obtained with treatment 100% RDF (T_2) followed by treatment FYM @ 2.5 t/ha + *Rhizobium* + PSB (T_4) (3.12). The lowest benefit: cost Ratio (BCR) of 1.99 was noted with treatment of vermicompost @ 2.0 t/ha (T_5).

4. CONCLUSION

The present study shows Application of castor cake @ 1.0 t/ha + *Rhizobium* + PSB (T_8) resulted significantly higher nitrogen, phosphorus content, uptake and microbial population in seed and Stover. While significantly higher available nitrogen, phosphorus, status in soil after harvest of cowpea crop was obtained under the treatment of FYM @ 5.0 t/ha which was at par with FYM @ 2.5 t/ha + *Rhizobium* + PSB. and Available potassium in soil after harvest of crop did not very due to different treatments.

REFERENCES

1. Alabadan, B. A., Adeoye, P. A., & Folorunso, E. A. (2009). Effects of different poultry wastes on physical, chemical and biological properties of soil. *Caspian Journal of Environmental Sciences*, 7, 31-35.
2. Chauhan, J., Paithankar D.H, Khichi, P., Ramteke, V., Jogdhande, S., and Manohar, M. Effect of various sources of nutrients including organic, inorganic, bio- fertilizer and its combination on growth and protein content of cowpea (*Vignaunguiculata* L. Walp). *Research Journal of Agricultural Sciences.*2016; **7**(2): 256-259.
3. Dekhane, S.S., Khafi, H.R., Raj, A.D., and Parmar, R.M. Effect of bio fertilizer and fertility levels on yield, protein content and nutrient uptake of cowpea [*Vignaunguiculata* (L.) Walp.]. *Legume Research*,2011; 34(1):51-54.
4. Gomez, K.A. and Gomez, A.A. (1984). Statistical procedure for agricultural research. 2nd ed. Singapore: John Wiley and Sons.
5. Hanway, J.J. and Heidel, H. (1952). Soil analysis methods as used in Iowa State College, *Soil Testing Laboratory, Iowa State College Bulletin*, 57: 1-131.
6. Joshi, D.,Gediya, K.M., Patel, J.S., Birari, M.M., and Gupta, S. Effect of organic manures on growth and yield of summer cowpea [*Vignaunguiculata*(L.) Walp] under middle Gujarat conditions. *Agricultural Science Digest*, 2016; **36**(2): 134-137.
7. Kalegore, N. K., Gavhane, M. A., Bhusari, S. A., Kasle, S. V. and Dhamane, R. S. Response of cowpea [*Vigna unguiculata* (L.) Walp.] to inorganic and biofertilizers. *International Journal of Economic Plants*, 2018; **5**(4):167-169.
8. Khan, V.M., Ahmed, A., Yadav, B.L. and Mohammad, I. (2017). Effect of vermicompost and biofertilizers on yield attributes and nutrient content and it's their uptake of cowpea [*Vigna unguiculata* (L.) Walp.]. *International Journal of Current Microbiology and Applied Sciences*,**6**(6): 1045-1050.
9. Khan, V.M., Manohar, K.S., Kumawat S.K. and Verma H.P. (2013). Effect of vermicompost and biofertilizers on yield and soil nutrient status after harvest of cowpea [*Vigna unguiculata* (L.) Walp]. *Agriculture for Sustainable Development*,**1**(1):79-81.
10. Khandelwal, R., Choudhary, S.K., Khangarot S.S., Jat, M.K. and Singh, P. Effect of inorganic and biofertilizers on productivity and nutrients uptake in cowpea [*Vigna unguiculata* (L.) Walp]. *Legume Research*, 2012; 35(3): 235-238.
11. Lyngdoh, C., Bahadur, V., David, A.A., Prasad, V.M., and Jamir, T. Effect of manures, organic supplements and bio-fertilizers on growth and yield of cow pea (*Vigna unguiculata* L. Walp). *International Journal of Current Microbiology and Applied Sciences*.2017; **6**(8): 1029-1036.
12. Moretti, M.D.L., Sanna-Passino, G., Demontis, S., Bazzoni, E., 2002. Essential oil formulations useful as a new tool for insect pest control. *AAPS Pharm Sci Tech*, https://doi.org/10.1208/pt030213

13. Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). Estimation of available P in soil by extraction with $NaHCO_3$. USDA Circular Nr 939, US Gov. Print. Office, Washington, D.C.
14. Pargi, K. L., Leva, R. L., Vaghasiya, H. Y. and Patel H. A. Integrated nutrient management in summer cowpea [*Vigna unguiculata* (L.) Walp.] under south Gujarat condition. *International Journal of Current Microbiology and Applied Sciences,*2018; **7**(9): 1513-1522.
15. Singh, A., Rana, S. S., & Bala, A. (2020). Weed management strategies in chickpea (Cicer arietinum): A review. *Agricultural Reviews*, 41(2), 153-159.
16. Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for the estimation of available nitrogen in soils. *Current Science, 25: 259-260.*
17. Thapa, R., 2021. A Detail review on Status and Prospect of Maize Production in Nepal. *Food and Agri Economics Review*, 1 (1), Pp. 52–56.
18. Walkley, A. and Black, I.A. (1934). An examination of the digestion method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science,* 37: 29-33.

Table 1: seed yield, stover yield, nitrogen, phosphorus content and uptake influence by organic nutrient sources.

Treatments	Yield (kg ha^{-1})		Nutrient content (%)				Nutrient Uptake (kg ha^{-1})	
			Nitrogen		Phosphorus			
	Seed	Stover	Seed	Stover	Seed	Stover	Nitrogen	Phosphorus
T_1: Absolute control	707	1367	2.95	0.66	0.51	0.20	29.71	6.30
T_2: 100% RDF	1037	1825	3.32	0.81	0.60	0.22	49.09	10.12
T_3: FYM @ 5.0 t/ha	945	1733	3.22	0.79	0.55	0.22	44.01	8.89
T_4: FYM @ 2.5 t/ha + *Rhizobium* + PSB	1054	1840	3.44	0.83	0.63	0.24	51.23	10.83
T_5: Vermicompost @ 2.0 t/ha	901	1699	3.27	0.78	0.52	0.21	42.70	8.08
T_6: Vermicompost @ 1.0 t/ha + *Rhizobium* + PSB	1033	1813	3.31	0.83	0.56	0.22	49.22	9.61
T_7: Castor cake @ 2.0 t/ha	958	1721	3.25	0.80	0.52	0.20	44.90	8.37
T_8: Castor cake @ 1.0 t/ha +	1109	1986	3.57	0.84	0.66	0.25	56.03	12.16

Rhizobium + PSB								
T_9: *Ghan Jeevamrut* @ 250 kg/ha at sowing time + Seed treatment with *Beejamrut* @ 200 ml/kg seed + *Jeevamrut* @ 500 lit/ha with irrigation at sowing and 30 DAS	891	1596	3.38	0.77	0.53	0.21	42.34	7.94
S.Em. ±	50	88	0.09	0.03	0.02	0.01	2.04	0.36
C.D. at 5 %	146	257	0.26	0.09	0.06	0.02	5.96	1.06
C.V. %	10.41	10.18	5.48	7.50	7.37	7.90	8.98	7.95

Table 2: nitrogen, phosphorus and potassium availability and microbial population influence by different treatments.

Treatments	**Available nutrients in soil (kg ha^{-1})**			**Microbial population**	
	N	**P_2O_5**	**K_2O**	***Rhizobium*** **(CFU × 10^5/g soil)**	**PSB (CFU × 10^4/g soil)**
T_1	134.71	35.40	194.30	9	4
T_2	140.71	37.49	195.80	11	21
T_3	155.52	39.01	201.28	17	11
T_4	150.53	38.70	201.00	21	25
T_5	147.25	39.54	199.50	15	10
T_6	143.83	37.65	199.40	21	22
T_7	147.87	41.10	203.62	15	18
T_8	145.32	39.80	199.49	21	27
T_9	137.47	36.78	196.80	15	9
S.Em. ±	3.27	1.00	4.89	0.87	0.81
C.D. at 5 %	9.55	2.92	NS	2.54	2.37
C.V. %	4.52	5.21	4.92	10.81	9.93

Table 3: Economics of *kharif* cowpea as influenced by different integrated nutrient management treatments.

Treatments	Seed yield (kg/ha)	Stover yield (kg/ha)	Gross realization (₹/ha)	Cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
T_1	707	1367	54,958	22,615	32,343	2.43
T_2	1037	1825	79,890	25,370	54,520	3.15
T_3	945	1733	73,082	28,135	44,947	2.60
T_4	1054	1840	81,140	25,981	55,159	3.12
T_5	901	1699	69,866	35,135	34,731	1.99
T_6	1033	1813	79,562	29,221	50,341	2.72
T_7	958	1721	73,944	35,135	38,809	2.10
T_8	1109	1986	85,574	29,221	56,353	2.93
T_9	891	1596	68,754	25,931	42,823	2.65