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Nitrogen management through organic sources and biofertilizers in summer groundnut (*Arachis hypogaea* L.)

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Abstract
A field experiment was carried out at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during the summer season 2021. The soil of the experimental unit was loamy sand in texture (locally called as "*Goradu*" soil) with low in available nitrogen (203 kg/ha), medium in available phosphorus (30.68 kg/ha) and high in available potash (274 kg/ha) with pH 8.05. The experiment was laid out in Randomized Block Design with four replications and ten treatments. The treatments which are T_1: RDF @ 25-50-00 NPK kg/ha (Control), T_2: *Rhizobium* @ 5.0 ml/kg seed treatment and 1.0 L/ha soil application at first and fourth irrigation, T_3:100% N through FYM, T_4:100% N through vermicompost, T_5:100% N through castor cake, T_6: 100% N through poultry manure, T_7: 50% N through FYM + Seed treatment of *Rhizobium*), T_8: 50% N through vermicompost + Seed treatment of *Rhizobium*, T_9: 50% N through castor cake + Seed treatment of *Rhizobium* and T_{10}: 50% N through poultry manure + Seed treatment of *Rhizobium* used. The results of the experiments revealed that different organic sources treatments failed to create a significant difference in plant population per meter row length at 15 DAS and at harvest as well as plant height at 30 and 60 DAS of groundnut. The results showed that application of 50% N through poultry manure + Seed treatment of *Rhizobium* was recorded significantly higher plant height (55.48 cm) at harvest, number of pods per plant (28.13), pod yield (2986 kg/ha) and haulm yield (4636 kg/ha) whereas higher dry weight of nodules (80.91 mg/plant) at 50 DAS was recorded with 50% N through vermicompost + Seed treatment of *Rhizobium*. Significantly higher protein content of kernel (24.33%) and nitrogen content in kernel (3.89%) and haulm (2.09%) observed under application of 50% N through castor cake + Seed treatment of *Rhizobium*. However, higher net realization (₹ 107918/ha) and benefit cost ratio (3.61) were obtained with application of 50% N through poultry manure + Seed treatment of *Rhizobium* (T_{10}) as compared to other treatments.

Keywords: Castor cake, FYM, groundnut, net realization, organic sources, pod yield, poultry manure, protein content, rhizobium, vermicompost

Introduction
After cereals, oilseeds are India's second most important agricultural commodity. Groundnut plays an important role in the oil economy of the world as well as in India. Groundnut (*Arachis hypogaea* L.) is one of the most important edible oil seed crop in the world. It was belongs to the *Leguminosae* family. Groundnut is also known as "peanut," "monkey nut," "manila nut," "pinda" and "gobber nut." (Bhutadiya *et al.*, 2019) [3]. Groundnut kernels contain 44-51% oil, 25-28% protein and 10-20% carbohydrate. Its kernel is rich source of calcium, iron, dietary fiber and nutritional vitamins *viz.*, A, E, K and B complex except B_{12} (Biswas and Bhattacharjee, 2019) [4].

Groundnut cultivation in India is mainly confined to the states of Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Madhya Pradesh, Uttar Pradesh, Rajasthan, Punjab and Odisha. Gujarat is the largest producer contributing 25% of the total production of groundnut followed by Andhra Pradesh, Tamil Nadu and Karnataka. In Gujarat Rajkot, Junagadh, Devbhoomi Dwarka, Jamnagar, Amreli, Bhavnagar, Gir Somnath and Porbandar main growing district. In Gujarat Groundnut is grown in about 22 lakh hectares area with total production of about 41 lakh tones in 2020-21. The highest productivity of groundnut (2502 kg/ha) is in Tamil Nadu, while in Gujarat the productivity is 1911 kg/ha (Anon., 2021) [1]. The productivity of summer groundnut is considerably higher than the kharif groundnut due to favourable condition such as high temperature, more sunshine hours, assured irrigation under control condition and comparatively low incidence of disease and pests (Sabale and Khuspe, 1986) [15].

Reduction in the use of chemical fertilizer and increased used of organic manures like FYM, vermicompost, castor cake and poultry manure advisable as, the global environment pollution can be controlled considerably. The use of organic sources such as farmyard manure and vermicompost generally helpful for improving soil aggregation, structure and fertility improving the moisture holding capacity and increasing crop yield (Marinari *et al.*, 2000) [9]. The application of organic manure helps in mitigating multiple nutrient deficiencies and at same time provides better environment for growth and development by improving in physical, chemical and biological properties of soil (Avitoli *et al.*, 2012) [2].

Castor cake has good manurial value which favoured to modify the growth and yield attributes resulted into significant positive correlation with yield of crop (Sujathamma *et al.*, 2003) [18]. Castor cake also supply micronutrients, improve physical properties of soil, immobilize toxic elements like Al and promote Mo activity (Lima *et al.*, 2011) [8]. In India, poultry farming is increasing. The poultry manure is relatively a cheap source of both macronutrients (N, P, K, Ca, Mg & S) and micronutrients (Cu, Fe, Mn & B) and can increases oil and N content, soil porosity and enhances oil microbial activity. As poultry waste contains a high concentration of nutrients, addition of small quantity of it in an integrated nutrient management system could meet the shortage of FYM to some extent (Veeramani *et al.*, 2012) [20]. In this context use of organic manure such as farmyard manure, vermicompost, castor cake and poultry manure may supply sufficient number of micronutrients in available form to crops and improve the quality of the agricultural produces (Maynard, 1993) [12].

Bio-fertilizers play a significant role in fixing atmospheric nitrogen, production of growth promoting substances and make phosphorous available to the plants. Inoculation of seed with *Rhizobium* increase yield due to more nitrogen fixation and better utilization by plants. The PSB like *Pseudomonas* and *Bacillus* also enhance the availability of phosphorous to plant by converting inherent insoluble phosphorous into soluble form. Organic manures in conjunction with bio-fertilizers will sustain and maintained the productivity of soil (Zalate and Padmani, 2009) [22]. Considering the facts and views highlighted above, the present study was undertaken to assess nitrogen management through organic sources and biofertilizers in summer groundnut (*Arachis hypogaea* L.).

2. Materials and Method

In order to achieve the pre-set objectives of the proposed research, a field experiment was carried out during the summer season of the year 2021 on plot no. A-6 at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat). The experimental site had an even topography with moderate slope and decent drainage and the soil is typical of the region's soils, commonly referred to as "*Goradu*" soil. It is alluvial in origin. The soils are very deep and retain a lot of moisture. Soils were ideal for a variety of crops of tropical and sub-tropical regions. Data on soil analysis indicated that the soil of experimental plot was low in available nitrogen (203 kg/ha), medium in available phosphorus (30.68 kg/ha) and high in available potash (274 kg/ha). In the present investigation, groundnut variety Gujarat Groundnut (GG 34) was used.

The experiment was laid out in Randomized Block Design (RBD) encompassing of ten treatments and four replications. Ten treatments comprising different organic sources like FYM, vermicompost, castor cake and poultry manure and biofertilizers like *Rhizobium* (Strain – *Rhizobium* GNR-2) seed treatment with 5 ml/kg seed to respective treatments were used in experimentation. Application of PSB was given to all treatment as soil application (1.0 L/ha) except control treatment. Nitrogen content in different organic manures was taken in to consideration against quantities applied in different treatments (Table 1). For the better mineralization and ready to available of nutrients all the organic sources were applied 15 days before the sowing. The details of treatments are as follows, T_1 (RDF @ 25-50-00 NPK kg/ha) (Control), T_2 (*Rhizobium* @ 5.0 ml/kg seed treatment and 1.0 L/ha soil application at first and fourth irrigation), T_3 (100% N through FYM), T_4 (100% N through vermicompost), T_5 (100% N through castor cake), T_6 (100% N through poultry manure), T_7 (50% N through FYM + Seed treatment of *Rhizobium*), T_8 (50% N through vermicompost + Seed treatment of *Rhizobium*), T_9 (50% N through castor cake + Seed treatment of *Rhizobium*) and T_{10} (50% N through poultry manure + Seed treatment of *Rhizobium*). RDF (25-50-00 kg NPK/ha) was supplied through Urea and SSP in T_1 (Control). Groundnut was sown at 45 cm row spacing with the seed rate of 120 kg/ha. All the agronomic practices were carried as per recommendation of organic farming.

Table 1: Chemical composition of organic manures used in experiment

Parameters	FYM	Vermi compost	Castor cake	Poultry manure
Nitroge (%)	0.63	1.95	3.58	3.12
Phosphorus (%)	0.45	1.67	1.79	2.11
Potassium (%)	0.68	2.31	2.13	1.90

3. Result and Discussion

3.1 Effect on growth attributes

The data clearly showed that different organic sources of nitrogen remained akin to plant population (Table 2) and they had no any significant influence on plant population recorded at 20 DAS as well as at harvest. Consequently, the plant population in all the experimental plots was uniform throughout the plant growth period. This shows that the results obtained in the present investigation was the outcome of treatment effect in the experiment rather than other treatment factors.

The results (Table 2) showed that plant height of groundnut at 30 and 60 DAS was not significantly influenced by various organic treatments. 50% N through poultry manure + Seed treatment of *Rhizobium* (T_{10}) recorded significantly higher plant (55.48 cm) at harvest as compared to other treatments. However, it was remained at par with 100% N through poultry manure (T_6) and 50% N through castor cake + Seed treatment of *Rhizobium* (T_9) (53.01 and 51.96 cm, respectively.) at harvest. While, Lower plant height (44.43 cm) was recorded in *Rhizobium* @ 5.0 ml/kg seed treatment and 1.0 L/ha soil application at first and fourth irrigation (T_2). The application of Poultry manure might have favoured better root proliferation, stimulated the cellular activity, useful for the process of cell division, more solubility of phosphorous which consequently favoured higher biological nitrogen fixation and uptake of nutrients and availability of all plant nutrients during the crop growth period which resulted in the higher plant height. These results are in close in close conformity with the findings of Mobhe *et al.* (2015) [13], Santhosh kumar

et al. (2021) [16] and Verma *et al.* (2022) [21].

Data presented in Table 2 indicated that 50% N through vermicompost + Seed treatment of *Rhizobium* (T_8) noted a significantly dry weight of nodules (80.91 mg/plant) at 50 DAS followed by 50% N through castor cake + Seed treatment of *Rhizobium* (76.02 mg/plant) (T_8) and 50% N through poultry manure + Seed treatment of *Rhizobium* (75.24 mg/plant) (T_{10}). Lower dry weight of nodules (61.83 mg/plant) was recorded under RDF @ 25:50:00 NPK kg/ha (Control) (T_1). Increase in dry weight of nodules per plant of groundnut might be due to combination of organic manure and biofertilizers inoculation resulted in greater nodulation. The additional supply of nitrogen and phosphorus helped in formation of new cell and thus, proliferation of growth. Phosphorus is an important constituent of co-enzymes involved in photosynthesis which might have been increased accumulation of photosynthesis. The findings closely followed the results of Dkhar *et al*. (2019) and Zalate *et al.* (2006) [6, 22].

3.2 Effect on yield attributes and yield

It was observed from data reported data in Table 2 that the number of pod/plant of groundnut at harvest was significantly influenced by different organic sources treatments and recorded a significantly higher number of pod/plant (28.13) under the treatment T_{10} (50% N through poultry manure + Seed treatment of *Rhizobium*), which failed to exert significant difference on number of pod/plant with respect to T_8 (50% N through vermicompost + Seed treatment of *Rhizobium*) and T_9 (50% N through castor cake + Seed treatment of *Rhizobium*) at harvest. Increased in the number of pod/plant might be due to the availability of nitrogen and phosphorous through bio fertilizer inoculation (*Rhizobium* and PSB) by which more pods are produced due to increased rates of primordial production and the greater photosynthesis production of metabolites and enzymatic activities due to the seed treatment of biofertilizers and poultry manure application might have influenced into increased nodulation and extensive root system and the greater production of metabolites and their translocation to various sinks especially the productive structures could have helped to increase into the number of pods per plant besides increasing the overall growth. Observations of the similar kind have been recorded by Verma *et al.* (2022) [21] and Santosh kumar *et al.* (2021) [16].

A perusal of data presented in Table 2 revealed that pod and haulm yield of groundnut was significantly influenced by different organic treatments and recorded significantly higher pod yield (2986 kg/ha) and haulm yield (4636 kg/ha) under treatment T_{10} (50% N through poultry manure + Seed treatment of *Rhizobium*). However, it was remained statistically at par with treatments T_9 (50% N through castor cake + Seed treatment of *Rhizobium*), T_8 (50% N through vermicompost + Seed treatment of *Rhizobium*) and T_6 (100% N through poultry manure). Increasing pod yield might be due to poultry manure supply of almost all plants essential nutrients by translocation of photosynthates accumulated under the influence of the source of organic nutrients. Further, the translocation and accumulation of photosynthates in the economic sinks thus increased yield attributes, chlorophyll content and nitrate reductase activity resulted in pod yield and also might be biofertilizers supply of more plant hormones (auxin, cytokinin, gibberellin *etc.*) by the microorganisms. Addition of organic matter also functions as source of energy for soil micro flora which brings about the transformation of other nutrients held in soil or applied through other means, in a form that is readily utilized by growing plants which helped in increase of seed yield. The results were in accordance with Verma *et al.* (2022) [21] and Mobhe *et al.* (2015) [13].

The increased haulm yield might be because of better vegetative growth and higher dry matter production due to availability of all plant nutrients and better physical properties of soil these finding confirms Verma *et al.* (2022) [21].

3.3 Effect on quality parameters

Perusal of data presented in Table 3 indicated that effect of organic sources found significant on protein content of groundnut kernel. 50% N through castor cake + Seed treatment of *Rhizobium* (T_9) reported significantly higher protein content in kernel (24.33%). Increased in protein content in kernel might be due to nitrogen applied through castor cake was continuously available to the crop at all the growth stages of the crop due to slow release of nitrogen. The beneficial effect of castor cake with bio-fertilizers observed in the study of investigation could be attributed to the fact that application of organic manures increase availability of nitrogen in soil and thereby increase in nitrogen content in kernel that resulted in increased protein content in kernel as nitrogen is basic constitute of amino acids which are building block of molecules of protein. These findings match with Mathivanan *et al*. (2013), Kamdi *et al*. (2014), Marvarkar *et al.* (2016) and Bhutadiya *et al.* (2019) [10, 7, 11, 3].

The results in respect of oil content of kernel showed non-significant difference due to different organic sources and *Rhizobium* on oil content of groundnut kernel. Oil content was not significantly influenced might be due to nutrient management practices as it is a genetical character.

Table 2: Effect of organic sources and biofertilizers on growth and yield attributes on summer groundnut (*Arachis hypogaea* L.)

Treatments	Plant population (Per meter row length)		Periodical plant height (cm)			Dry weight of nodules (mg/plant)	No. of pods/plant	Pod yield (kg/ha)	Haulm yield (q/ha)
	At 15 DAS	At harvest	At 20 DAS	At 40 DAS	At Harvest	50 DAS	At Harvest	At Harvest	At Harvest
T_1: RDF (25:50:00 NPK kg/ha) (Control)	10.19	9.50	8.80	22.90	45.63	61.83	21.48	2455	3702
T_2: *Rhizobium* (5.0 ml/kg seed treatment and 1.0 L/ha soil application at first and fourth irrigation)	10.38	9.73	8.74	21.56	44.43	68.37	18.13	2024	3187
T_3: 100% N through FYM	10.46	9.90	9.41	21.78	45.33	67.13	19.18	2287	3376
T_4: 100% N through vermicompost	10.56	9.85	9.90	24.45	44.88	69.86	22.07	2549	3862
T_5: 100% N through castor cake	10.73	10.10	9.54	22.83	47.82	64.73	24.90	2638	4078
T_6: 100% N through poultry manure	10.81	10.25	10.04	25.18	53.01	65.76	24.61	2751	4244
T_7: 50% N through FYM + Seed treatment of *Rhizobium*	10.38	9.75	9.12	22.69	47.02	73.97	20.49	2380	3563
T_8: 50% N through vermicompost + Seed treatment of	10.75	10.80	9.42	24.30	49.68	80.91	25.39	2847	4280

Rhizobium									
T_9: 50% N through castor cake + Seed treatment of *Rhizobium*	10.25	10.95	9.62	24.70	51.96	76.02	26.25	2884	4357
T_{10}: 50% N through poultry manure + Seed treatment of *Rhizobium*	11.44	10.61	10.09	26.23	55.48	75.24	28.13	2986	4636
S.Em±	0.37	0.37	0.32	1.03	1.98	2.38	0.95	119	274
C.D. at 5%	NS	NS	NS	NS	5.76	6.91	2.75	346	433
C.V. (%)	6.91	7.34	6.72	8.67	8.18	6.77	8.21	9.24	7.60

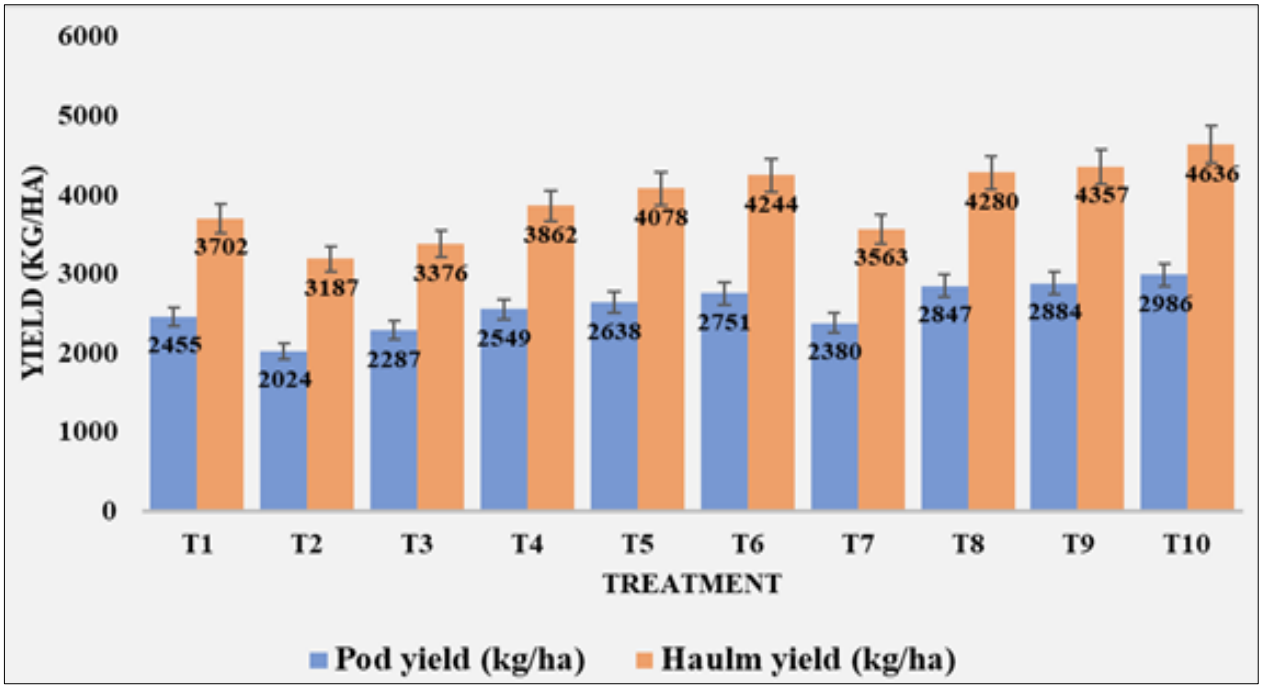

Fig 1: Pod and haulm yield as influenced by different organic sources and biofertilizers

3.4 Effect on Nutrient content

The data tabulated in Table 3 indicated that significantly higher nitrogen content in kernel (3.89%) and haulm (2.09%) of groundnut at harvest were obtained with application of 50% N through castor cake + Seed treatment of *Rhizobium* (T_9) followed by treatment T_5, T_6 and T_{10}, respectively. Increase in nutrient content of kernel and haulm might be due to castor cake having rich in N and P (usually the most influential macronutrients) for its fast mineralization rate and Seed treatment of *Rhizobium* increase in nitrogen availability in soil leads to increase in content of nitrogen and phosphorus application in seed and haulm of groundnut. These are in conformity with the results of Singh *et al.* (2018) [17].

3.5 Effect on soil available nutrient

The data from Table 3 revealed that significantly higher available nitrogen content in soil (232 kg/ha) after harvest of groundnut under application of 100% N through FYM (T_3) which was statistically at par with treatment T_5 (100% N through castor cake), T_4 (100% N through vermicompost) and T_6 (100% N through neem cake). Application of FYM, *Rhizobium* and PSB in groundnut crop increases the available soil nitrogen and phosphorus in soil after harvest through addition of organic manures. Besides this nitrogen through N fixation by symbiosis with *Rhizobium*. Use of FYM might have attributed to the mineralization of nitrogen in soil and due to high enzyme activities in the soil amended with organic manures might have increased the transformation of nutrients into available form. It might also be due to accumulation of residual nitrogen through FYM and increase C: N ratio in the soil. These results are in close agreement with findings of Tagore *et al.* (2013) [19], Chaudhary *et al.* (2015) [5] and Bhutadiya *et al.* (2019) [3].

Available phosphorus contents in soil after harvest of groundnut crop as influenced by different treatments of organic sources are presented in Table 3. Application of 50% N through poultry manure + Seed treatment of *Rhizobium* (T_{10}) recorded significantly higher available phosphorus content in soil (38.70 kg/ha) after harvest of groundnut, however, it was remained at par with treatment T_6, T_5, T_4, T_9 and T_8. Increase in available phosphorus content in soil might be due to application of poultry manure with PSB in groundnut crop increases the available soil phosphorus in soil after harvest. PSB also enhance the availability of phosphorus by converting insoluble phosphorus to soluble phosphorus. These findings match with Tagore *et al.* (2013) [19] and Raja and Thakankhar (2017) [14].

3.6 Effect on Economics

Results revealed that maximum net realization (₹ 107918/ha) was obtained under 50% N through poultry manure + Seed treatment of *Rhizobium* followed by treatment T_9 (50% N through castor cake + Seed treatment of *Rhizobium*) and T_8 (50% N through vermicompost + Seed treatment of *Rhizobium*) with net realization of ₹ 99202/ha and ₹ 97356/ha, respectively (Table 3).

Table 3: Effect of organic sources and biofertilizers on quality parameters, available soil nutrients and economics of summer groundnut (*Arachis hypogaea* L.)

Treatments	Protein content (%)	Oil content (%)	Nitrogen content (%)		Available N (kg/ha)	Available P_2O_5 (kg/ha)	Net income (₹ /ha)	BCR
			Kernel	Haulm				
T_1: RDF (25:50:00 NPK kg/ha) (Control)	20.57	49.34	3.29	1.44	205	31.33	79245	2.82
T_2: *Rhizobium* (5.0 ml/kg seed treatment and 1.0 L/ha soil application at first and fourth irrigation)	18.28	47.28	2.93	1.31	198	33.27	60119	2.46
T_3: 100% N through FYM	20.29	49.08	3.25	1.45	232	35.54	69264	2.54
T_4: 100% N through vermicompost	21.26	49.88	3.40	1.57	225	36.75	78366	2.60
T_5: 100% N through castor cake	22.53	51.63	3.61	1.92	230	37.01	82808	2.69
T_6: 100% N through poultry manure	23.26	50.78	3.72	2.04	222	37.21	95690	3.29
T_7: 50% N through FYM + Seed treatment of *Rhizobium*	20.05	47.53	3.21	1.39	211	34.62	76004	2.77
T_8: 50% N through vermicompost + Seed treatment of *Rhizobium*	21.54	50.21	3.45	1.90	209	35.89	97356	3.16
T_9: 50% N through castor cake + Seed treatment of *Rhizobium*	24.33	50.48	3.89	2.09	209	36.42	99202	3.20
T_{10}: 50% N through poultry manure + Seed treatment of *Rhizobium*	22.43	51.34	3.59	1.96	206	38.70	107918	3.61
S.Em±	0.78	1.29	0.12	0.08	6.85	1.05	-	-
C.D. at 5%	2.26	NS	0.36	0.24	19.89	3.05	-	-
C.V. (%)	7.27	5.51	7.27	9.87	6.38	5.89	-	-

In case of benefit cost ratio, the highest benefit cost ratio of 3.61 was recorded under application of 50% N through poultry manure + Seed treatment of *Rhizobium* (T_{10}) which was closely followed by treatment T_6: 100% N through poultry manure (3.29), T_9: 50% N through castor cake + Seed treatment of *Rhizobium* (3.20) and T_8: 50% N through vermicompost + Seed treatment of *Rhizobium* (3.16), respectively. The highest net return (₹ 107918/ha) and benefit cost ratio (3.61) under poultry manure might be attributed to highest yield and lower cost of poultry manure. These results corroborate with the finding of Santosh kumar *et al.* (2021) [16] and Verma *et al.* (2022) [21].

Conclusions

According to the findings of the present investigation, it is concluded that application of either 50% N through poultry manure + Seed treatment of *Rhizobium* or 50% N through castor cake + Seed treatment of *Rhizobium*) or 50% N through vermicompost + Seed treatment of *Rhizobium* secured higher growth and yield attributes, yield, quality and higher net realization with maintaining soil health.

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References

1. Anonymous; c2021. Retrieved from: https://www.indiastatagri.com/table/agriculture/selected-state-season-wise-area-production-product/1423706. Retrieved on: 17th May, 2022.
2. Avitoli K, Singh AK, Kanaujia SP, Singh VB. Quality production of *kharif* Onion (*Allium cepa* L.) in response to fertilizers inoculated organic manures. Indian Journal of Agricultural Sciences. 2012;82:236-240.
3. Bhutadiya JP, Chaudhary MG, Damor RP, Patel AJ. Effect of different organic sources on growth, yield, yield attributes and economics of summer groundnut (*Arachis hypogaea* L.) under organic farming. Journal of Pharmacognosy and Phytochemistry. 2019;8(2):846-9.
4. Biswas S, Bhattacharjee S. Groundnut: multifarious utilities of the 'King of Oilseeds' Agriculture & Food: e-Newsletter. 2019;1(7):373-377.
5. Chaudhary VJ, Patel BJ, Patel KM. Response of summer groundnut (*Arachis hypogaea* L.) to irrigation scheduling and sources of nitrogen under North Gujarat conditions. Trends in Biosciences. 2015;8(5):1310-3.
6. Dkhar S, Bordoloi J, Bordooloi LJ, Sharma YK. Soil quality parameters and yield of green gram as affected by the combined application of manures and biofertilisers. International Journal of Current Microbiology and Applied Sciences. 2019;8(4):23-32.
7. Kamdi TS, Joshi S, Sonkamble P. Effect of organic manure and bio-fertilizers on seed quality of groundnut. The Bioscan. 2014;9(3):1011-3.
8. Lima RSL, Severino Liv, Sampaio LR, Sofiatti V. Blends of castor meal and castor husks for optimized use as organic fertilizer. Industrial Crops and Products. 2011;33(2):364-368.
9. Marinari S, Masciandaro G, Grego S. Influence of organic and mineral fertilizers on soil biological and physical properties. Bioresource Technology. 2000;72(1):1317-1320.
10. Mathivanan S, Kalaikandhan R, Chidambaram A, Sundramoorthy P. Effect of vermicompost on the growth and nutrient status in groundnut. Asian Journal of Plant Science and Research. 2013;3(2):15-22.
11. Mavarkar NS, Naik TB, Naik KPS, Sharanappa HG. Effect of organic sources of nutrients on groundnut (*Arachis hypogaea* L.) under Southern Transitional Zone of Karnataka. International Journal of Tropical Agriculture. 2016;34(3):567-71.
12. Maynard AA. Evaluating the suitability of MSW compost as a soil amendment in field-grown tomatoes. Compost Scientific Utilization. 1993;1:34-36.
13. Mohbe S, Mishra U, Pandey RA. Study on organic

manure on green gram (*Phaseolus radiata* L.) under rainfed condition of Chitrakoot area; c2015.
14. Raja D, Takankhar VG. Effect of liquid bio-fertilizers (Bradyrhizobium and PSB) on availability of nutrients and soil chemical properties of soybean (*Glycine max* L.). International Journal of Pure and Applied Bioscience. 2017;5(5):88-96.
15. Sabale RN, Khuspe VS. Effect of moisture, phosphate and anti-transparent on growth, dry matter and yield of summer groundnut. Journal of Maharashtra Agricultural University. 1986;11(1):13-16.
16. Santhosh Kumar SG, Dawson J, Pavithra BV. Effect of spacing and organic manures on growth and yield of greengram (*Vigna radiata* L.). The Pharma Innovation Journal. 2021;10(12):1612-1617.
17. Singh A, Sachan AK, Pathak RK, Srivastava AS. Study on the effects of PSB and Rhizobium with their combinations on nutrient concentration and uptake of chickpea (*Cicer arietinum* L.). Journal of Pharmacognosy and Phytochemistry. 2018;7(1):1591-3.
18. Sujathamma P, Reddy DS, Reddy BS. Direct, residual and cumulative residual effect of nitrogen on yield parameters, yield and nitrogen uptake of sesame in rice groundnut-sesame cropping system. Annals of Agricultural Research. 2003;24(3):587-592.
19. Tagore GS, Namdeo SL, Sharma SK, Kumar N. Effect of rhizobium and phosphate solubilizing bacterial inoculants on symbiotic traits, nodule leghaemoglobin and yield of chickpea genotypes. International Journal of Agronomy. 2013;(5):1-8.
20. Veeramani P, Subrahmaniyan K, Ganesaraja V. Organic manure management on groundnut; A review. Wudpecker Journal of Agricultural Research. 2012;1(7):238-243.
21. Verma R, Singh M, Dawson J, Muddassir P, Khan I. Effect of bio-fertilizers and organic manures on growth and yield of greengram (*Vigna radiata* L.). The Pharma Innovation Journal. 2022;11(4):1599-1602.
22. Zalate PY, Padmani DR. Effect of organic manure and bio-fertilizer on growth and yield attributing characters of kharif groundnut (*Arachis hypogaea*). International Journal of Agricultural Science. 2009;5(2):343-5.