E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(1): 255-258
Received: 24-10-2025
Accepted: 27-11-2025

ML Meena
Department of Agronomy, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Gujarat, India

DK Patel
Professor and Head, State Council of Agricultural Universities, Krishibhavan, Gandhinagar, Gujarat, India

JS Desai
Assistant Research Scientists, Regional Research Station, S. D. Agricultural University, Kothara, Kutch, Gujarat, India

Sonam
Department of Agronomy, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Gujarat, India

SV Wadekar
Department of Agronomy, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Gujarat, India

Corresponding Author:
ML Meena
Department of Agronomy, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Gujarat, India

Effect of different organic manures and bio-enhancers on growth and yield of greengram (*Vigna radiata* L.) under organic farming

ML Meena, DK Patel, JS Desai, Sonam and SV Wadekar

DOI: https://www.doi.org/10.33545/2618060X.2026.v9.i1d.4633

Abstract
An experiment entitled "Effect of organic manures and bio-enhancers on growth and yield of greengram (*Vigna radiata* L.) under organic farming" was carried out at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the year 2023. The experiment was laid out in randomized block design with having twelve treatments and three replications. The results of present investigation revealed that different sources of organic manures and bio-enhancers were found non-significant with respect to plant population, plant height, number of branches per plant and fresh weight of root nodules per plant while, significantly highest number of root nodules per plant (24.56) was found with application of FYM @ 5t/ha + *Jivamrut* @ 500 l/ha. While the application of FYM @ 5t/ha + *Panchgavya* @ 4% spray, recorded significantly higher number of pods per plant (28.91), seed yield (961 kg/ha), stover yield (1601 kg/ha), protein content (23.82%) and protein yield (229 kg/ha). The study revealed that higher yield, net return and maintaining soil fertility under organic farming, *kharif* greengram should be fertilized with farm yard manure @ 5 t/ha, along with either foliar spray of *panchgavya* @ 4% spray, at the time of branching and flowering stage, or soil application of *jivamrut* @ 500 l/ha or *amritpani* @ 500 l/ha at the time of sowing and 30 DAS.

Keywords: Amritpani, bioenhancers, FYM, jivamrut, panchgavya.

Introduction
Greengram (*Vigna radiata* L.) is one of the most ancient and extensively grown leguminous crops of India. It is a native of India and Central Asia and commonly known as mung bean. It is the third important pulse crop after chickpea and pigeon pea and cultivated throughout India. Mung bean is also known as greengram, golden gram, moong. Greengram is a self-pollinated pulse crop. The average production of greengram is 721 kg/ha, and there are around 7.3 million hectares planted worldwide. In India during 2022-23, about 15.57 lakh ha area was covered under greengram with 3.74 MT production. The states of Rajasthan, Karnataka, Madhya Pradesh, Haryana and Gujarat are the major producers of greengram in India (Anon., 2023). Greengram output account for about 10 to 12% of total pulses production in the country. In Gujarat, it is cultivated in 1.54 lakh hectare with an annual production of 1.17 lakh metric tonne having average productivity of 758 kg/ha (Anon., 2022). Greengram is cultivated in both *kharif* and summer season in North India where, irrigation water is available whereas in South India in the mild winter season. Greengram seed is high in copper phosphorus, potassium, magnesium and important vitamins, and contains 20-25% protein, 1.3% fat, 15.4% fibre and 3.7% ash (FAO, 2019). Its seeds are high in lysine (4600 mg/g N) and tryptophan (60 mg/g N) and may be consumed as whole grain or as 'dal' in variety of purposes. Organic manures provide a good substrate for the growth of micro-organisms and maintain a favourable nutritional balance and soil physical properties. It is recognized that proper use of organic matter and bio-enhancers play a key role in increasing the productivity of soil. The use of organics in crop production is nothing new to our agriculture and many organics like farmyard manure, compost, vermicompost, poultry manure, *ghanjivamrit*, *panchagavya*, cow urine, *jivamrit*, *amritpani* etc. are used as a substitute for chemical fertilizers to supply plant nutrients in traditional farming which also helps to sustain soil organic carbon and maintain favourable soil condition for crop

growth. Organic manures contain both macro and micro nutrients and enhance soil fertility, and lead to increasing availability of plant nutrients through mineralization (Khan *et al*., 2009, Shweta *et al*., 2021) [10, 16]. In recent years fermented, liquid organic fertilizers, bio enhancers and effective microorganisms (EM) as foliar fertilizers have been introduced to modern agriculture to produce food with good quality and safety. The use of organic manures and bio-enhancers as a low-cost supplement instead of artificial fertilizers may help decreasing the cost of production (Aslam *et al*., 2010) [3].

Materials and Methods

A field experiment was conducted during *kharif* season of the year 2023 on Plot no. B-2, organic unit, Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Dist.: Banaskantha (Gujarat). Geographically, Sardarkrushinagar is situated at 24º19' North latitude and 72º19' East longitude with an elevation of 154.52 meter above the mean sea level and situated in the North Gujarat Agro-climatic region. The texture of the soil was loamy sand. It is alluvial in origin, light brown in color, well drained, fairly retentive of moisture, low in organic carbon (0.28%) and available nitrogen (146.20 kg/ha), while medium in available phosphorus (38.62 kg/ha) and potassium (236.56 kg/ha). The present experiment comprising of twelve treatments and three replications. The treatments were comprised of T_1: FYM @ 5 t/ha, T_2: Vermicompost @ 1 t/ha, T_3: *Ghanjivamrut* @ 1 t/ha, T_4: FYM @ 5t/ha + *Jivamrut* @ 500 L/ha, T_5: FYM @ 5t/ha + *Panchgavya* @ 4% spray, T_6: FYM @ 5t/ha + *Amritpani* @ 500 L/ha, T_7: Vermicompost @ 1t/ha + *Jivamrut* @ 500 L/ha, T_8: Vermicompost @ 1t/ha + *Panchgavya* @ 4% spray, T_9: Vermicompost @ 1t/ha + *Amritpani* @ 500 L/ha, T_{10}: *Ghanjivamrut* @ 1t/ha + *Jivamrut* @ 500 L/ha, T_{11}: *Ghanjivamrut* @ 1t/ha + *Panchgavya* @ 4% spray, T_{12}: *Ghanjivamrut* @ 1t/ha + *Amritpani* @ 500 L/ha. *Panchgavya* @ 4% spray at branching and flowering stage. *Jivamrut* and *Amritpani* were applied at the time of sowing and 30 DAS as soil application. The data were statistically analyzed for various characters as described by Panse and Sukhatme (1967) [13].

Results and Discussion

Effect on growth attributes

The data exhibited in Table 1 showed that the plant population per meter row length and plant height at 30 DAS and at harvest were not influenced significantly by the application of different organic manures and bio-enhancers on greengram under organic farming. Which means that the plant population and plant height in all the organic manures and bio-enhancers treated plots were found uniform which indicate that there is no any adverse effect of different organic sources of nutrients on greengram plant.

The data presented in Table 2 indicated that among the different organic manures and bio-enhancers were found not significantly influenced fresh weight of root nodules/plant and number of branches/plant. While in case of number of root nodules/plant (24.56) was significantly influenced by application of (T_4) FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha and it was at par with (T_6) FYM @ 5 t/ha + *Amritpani* @ 500 L/ha (23.11), (T_5) FYM @ 5 t/ha + *Panchgavya* @ 4% spray (22.35), (T_1) FYM @ 5 t/ha (22.33) and (T_7) Vermicompost @ 1 t/ha + *Jivamrut* @ 500 L/ha (22.16). This might be due to application of FYM along with *jivamrut* provided the micronutrients like molybdenum along with all other essential nnutrients which might have acted as co-enzyme for formation of root nodules and bio-enhancers contains favorable growth hormones and microorganism which plays an important role in root development and proliferation resulting in better nodule formation and nitrogen fixation by supplying assimilates to the roots and better environment in rhizosphere for growth and development. These results are in close vicinity with the findings of Das *et al.* (2015) [6], Panchal *et al*. (2017) [12] in chickpea.

Effects on yield attributes

The data exhibited in Table 3 showed that the length of pods, number of seeds/pod and test weight were not significantly influenced by the application of different organic manures and bio-enhancers on greengram under organic farming. While in case of number of pods/plant was significantly higher (28.91) with the treatment T_5 (FYM @ 5 t/ha + *Panchgavya* @ 4% spray) and it was at par with the treatments T_4 (FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha) (26.46). This might be due to increased supply of almost all essential plant nutrients which provides good vegetative growth thus increased the photosynthetic activity and further, the translocation and accumulation of photosynthates in the economic sinks. The findings closely followed the results of Shekh *et al*. (2018) [15] in groundnut, Choudhary *et al*. (2017) [5] in blackgram, Chongre *et al.* (2019) [4] and Rao *et al.* (2021) [14] in greengram.

Effect on yield and quality parameter

The data presented in Table 4 indicated that treatment T_5 (FYM @ 5 t/ha + *Panchgavya* @ 4% spray) (23.82%) recorded significantly higher protein content which was at par with treatments T_4 (FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha) (23.36%), T_6 (FYM @ 5 t/ha + *Amritpani* @ 500 L/ha) (22.90%), T_8 (Vermicompost @ 1 t/ha + *Panchgavya* @ 4% spray) (22.86%) and T_{11} (*Ghanjivamrut* @ 1 t/ha + *Panchgavya* @ 4% spray) (22.38%). While, significantly higher protein yield (229 kg/ha) was obtained under treatment T_5 (FYM @ 5 t/ha + *Panchgavya* @ 4% spray) which was at par with treatments T_4 (FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha) (214 kg/ha) and T_6 (FYM @ 5 t/ha + *Amritpani* @ 500 L/ha) (202 kg/ha). It might be due to better availability of desired and required nutrients in the crop root zone resulting from its solubilization caused by the organic acid produce from the decaying organic matter and also increased their uptake by greengram roots due to its association with micro-organisms, ultimately reflected into higher seed yield and protein content. These results are in agreement with those reported by Jani *et al*. (2020) [8] in cowpea, Jayachithra and Abirami (2016) [9] in horsegram.

The data presented in Table 4 indicated that among the different organic manures and bio-enhancers, application of T_5 (FYM @ 5 t/ha + *Panchgavya* @ 4% spray) gave significantly higher seed yield which was at par with T_4 (FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha), T_6 (FYM @ 5 t/ha + *Amritpani* @ 500 L/ha). While in case of stover yield, T_5 (FYM @ 5 t/ha + *Panchgavya* @ 4% spray) recorded significantly highest among the different treatments which was at par with T_4 (FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha), T_6 (FYM @ 5 t/ha + *Amritpani* @ 500 L/ha) and T_8 (Vermicompost @ 1 t/ha + *Panchgavya* @ 4% spray). This might be due to application of FYM and *panchgavya* increase the yield attributes like number of pods per plant, number of seeds/pod which reflected in higher yield of greengram. The present findings are in accordance with those reported earlier by Choudhary *et al*. (2017) [5] in blackgram, Chongre *et al.* (2019) [4] and Rao *et al.* (2021) [14] in greengram.

Table 1: Effect of organic manures and bio-enhancers on plant population and plant height of greengram

Treatments	Plant population per meter row length		Plant height (cm)		
	At 30 DAS	At Harvest	At 30 DAS	At 60 DAS	At Harvest
T_1: FYM @ 5 t/ha	8.44	7.31	20.49	43.22	65.11
T_2: Vermicompost @ 1 t/ha	8.19	7.22	20.31	40.61	60.84
T_3: *Ghanjivamrut* @ 1 t/ha	8.07	7.10	18.62	39.19	57.54
T_4: FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha	9.07	7.99	22.28	50.83	67.45
T_5: FYM @ 5 t/ha + *Panchgavya* @ 4% spray	9.50	8.22	23.07	51.16	69.10
T_6: FYM @ 5 t/ha + *Amritpani* @ 500 L/ha	8.73	7.88	22.26	49.80	67.17
T_7: Vermicompost @ 1 t/ha + *Jivamrut* @ 500 L/ha	8.30	7.44	21.42	44.96	65.14
T_8: Vermicompost @ 1 t/ha + *Panchgavya* @ 4% spray	8.60	7.33	22.13	46.07	66.21
T_9: Vermicompost @ 1 t/ha + *Amritpani* @ 500 L/ha	8.30	7.22	20.41	42.05	63.05
T_{10}: *Ghanjivamrut* @ 1 t/ha + *Jivamrut* @ 500 L/ha	8.27	7.33	20.47	40.79	63.93
T_{11}: *Ghanjivamrut* @ 1 t/ha + *Panchgavya* @ 4% spray	8.43	7.44	20.93	46.18	65.47
T_{12}: *Ghanjivamrut* @ 1 t/ha + *Amritpani* @ 500 L/ha	8.15	7.11	19.16	40.13	58.49
S. Em. ±	0.40	0.37	0.90	2.86	3.81
CD (P=0.05)	NS	NS	NS	NS	NS
CV%	8.09	8.48	7.41	11.10	10.30

Table 2: Effect of organic manures and bio-enhancers on number of root nodules, fresh weight of root nodules and number of branches/plant of greengram

Treatments	Number of root nodules/plant at 45 DAS	Fresh weight of root nodules/plant at 45 DAS (mg)	Number of branches/plant at harvest
T_1: FYM @ 5 t/ha	22.33	1524.00	3.96
T_2: Vermicompost @ 1 t/ha	19.89	1422.73	3.79
T_3: *Ghanjivamrut* @ 1 t/ha	19.33	1352.27	3.70
T_4: FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha	24.56	1622.21	4.57
T_5: FYM @ 5 t/ha + *Panchgavya* @ 4% spray	22.35	1544.60	4.77
T_6: FYM @ 5 t/ha + *Amritpani* @ 500 L/ha	23.11	1552.46	4.40
T_7: Vermicompost @ 1 t/ha + *Jivamrut* @ 500 L/ha	22.16	1515.41	4.00
T_8: Vermicompost @ 1 t/ha + *Panchgavya* @ 4% spray	20.56	1458.00	4.36
T_9: Vermicompost @ 1 t/ha + *Amritpani* @ 500 L/ha	21.33	1495.33	3.80
T_{10}: *Ghanjivamrut* @ 1 t/ha + *Jivamrut* @ 500 L/ha	21.12	1468.55	3.87
T_{11}: *Ghanjivamrut* @ 1 t/ha + *Panchgavya* @ 4% spray	20.10	1439.43	4.21
T_{12}: *Ghanjivamrut* @ 1 t/ha + *Amritpani* @ 500 L/ha	20.00	1432.34	3.75
S. Em. ±	0.99	69.26	0.24
CD (P=0.05)	2.91	NS	NS
CV%	8.02	8.07	10.02

Table 3: Effect of organic manures and bio-enhancers on yield attributes of greengram

Treatments	Number of pods/plant	Length of pods (cm)	Number of seeds/pod	Test weight (g)
T_1: FYM @ 5 t/ha	21.18	8.30	9.25	42.17
T_2: Vermicompost @ 1 t/ha	16.57	8.26	9.13	41.78
T_3: *Ghanjivamrut* @ 1 t/ha	14.17	8.04	9.05	41.07
T_4: FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha	26.46	9.07	9.80	43.23
T_5: FYM @ 5 t/ha + *Panchgavya* @ 4% spray	28.91	9.16	10.50	43.53
T_6: FYM @ 5 t/ha + *Amritpani* @ 500 L/ha	24.80	8.79	9.77	42.97
T_7: Vermicompost @ 1 t/ha + *Jivamrut* @ 500 L/ha	21.92	8.36	9.30	42.30
T_8: Vermicompost @ 1 t/ha + *Panchgavya* @ 4% spray	22.82	8.50	9.68	42.63
T_9: Vermicompost @ 1 t/ha + *Amritpani* @ 500 L/ha	16.70	8.27	9.18	41.95
T_{10}: *Ghanjivamrut* @ 1 t/ha + *Jivamrut* @ 500 L/ha	17.39	8.32	9.23	42.13
T_{11}: *Ghanjivamrut* @ 1 t/ha + *Panchgavya* @ 4% spray	22.04	8.40	9.43	42.60
T_{12}: *Ghanjivamrut* @ 1 t/ha + *Amritpani* @ 500 L/ha	16.24	8.13	9.11	41.15
S. Em. ±	1.17	0.57	0.41	1.78
CD (P=0.05)	3.42	NS	NS	NS
CV%	9.72	11.70	7.47	7.29

Table 4: Effect of organic manures and bio-enhancers on protein content, protein yield, seed yield, straw yield and harvest index of greengram

Treatments	Protein content (%)	Protein yield (kg/ha)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
T_1: FYM @ 5 t/ha	21.76	170	777	1401	35.70
T_2: Vermicompost @ 1 t/ha	20.80	157	754	1347	35.92
T_3: *Ghanjivamrut* @ 1 t/ha	20.63	140	679	1298	34.37
T_4: FYM @ 5 t/ha + *Jivamrut* @ 500 L/ha	23.36	214	915	1522	37.23
T_5: FYM @ 5 t/ha + *Panchgavya* @ 4% spray	23.82	229	961	1601	37.52
T_6: FYM @ 5 t/ha + *Amritpani* @ 500 L/ha	22.90	202	881	1512	36.82
T_7: Vermicompost @ 1 t/ha + *Jivamrut* @ 500 L/ha	21.90	172	780	1407	35.49
T_8: Vermicompost @ 1 t/ha + *Panchgavya* @ 4% spray	22.86	184	805	1505	34.91
T_9: Vermicompost @ 1 t/ha + *Amritpani* @ 500 L/ha	21.05	161	761	1371	35.74
T_{10}: *Ghanjivamrut* @ 1 t/ha + *Jivamrut* @ 500 L/ha	21.49	166	769	1381	35.85
T_{11}: *Ghanjivamrut* @ 1 t/ha + *Panchgavya* @ 4% spray	22.38	180	803	1410	36.31
T_{12}: *Ghanjivamrut* @ 1 t/ha + *Amritpani* @ 500 L/ha	20.65	142	690	1302	39.92
S. Em. ±	0.56	13.54	51.58	61.62	2.35
CD (P=0.05)	1.63	39.72	151.29	180.71	NS
CV%	4.40	13.31	11.20	7.51	11.23

Conclusion

From the results of one year experimentation, it is concluded that for obtaining higher yield of greengram and maintaining soil fertility under organic farming, *kharif* greengram should be fertilized with farm yard manure @ 5 t/ha, along with either foliar spray of *panchgavya* @ 4% spray, at the time of branching and flowering stage, or soil application of *jivamrut* @ 500 l/ha or *amritpani* @ 500 l/ha at the time of sowing and 30 DAS.

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