



Assessment of Integrated Nutrient Management on Growth and yield of Horegram [*Macrotyloma uniflorum* (Lam.) Verdc.] in Chhattisgarh plains

Nagendra Kumar Verma ^{a*}, Manisha ^a, Rajeshwari Dhurve ^a,
Neha ^a, Dipendra Pankaj Porte ^a and Ramnath ^a

^a Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, 492012 (C.G.), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i224153

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/108934>

Original Research Article

Received: 15/09/2023
Accepted: 21/11/2023
Published: 25/11/2023

ABSTRACT

A field experiment was carried out during at Barrister Thakur Chhedilal Collage of Agriculture and Research station, Bilaspur, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during post *kharif* season 2020-21 entitled with "Assessment of Integrated Nutrient Management on Growth and yield of Horegram [*Macrotyloma uniflorum* (Lam.) Verdc.] in Chhattisgarh plains." including organic and inorganic nutrients source with recommended dose of fertilizers (RDF) 20:40:20 NPK kg ha⁻¹, taking variety of horsegram "Bilasa Kulthi ". Result revealed that between the different organic and inorganic treatments T₆ (100% RDF + *Rhizobium culture* + PSB) result indicated that the highest seed yield (865.24 kg ha⁻¹) was observed which was significantly superior over other treatments but it was at par with T₄ (100% RDF + *Rhizobium culture*) with seed yield (819.40 kg ha⁻¹) closely followed by the treatments of T₅ (75% RDF + 25% N through FYM + *Rhizobium culture*) with (743.24 kg ha⁻¹), plant population (40.46 plants m²) and plant height is (75.11) cm of

*Corresponding author: E-mail: nagendraigkv@gmail.com;

horsegram. The higher growth attributes characters under the T₆ has been affiliated with significantly superior is number of primary branch plant⁻¹ (5.98), Crop growth rate (0.081) g plant⁻¹ day⁻¹. Relative growth rate (0.015g g⁻¹ day⁻¹) Net assimilation rate (0.029 g dm⁻² day⁻¹).

Keywords: Horsegram; growth attributes; organic and inorganic inputs.

1. INTRODUCTION

Pulses play important role in agriculture next to cereals. These are the major source of dietary protein, along with minerals and vitamins. It is the second rich source of dietary protein in vegetarian diet in our country and also in other developing countries [1-6]. Among the pulses, horsegram is an important post season *kharif* crop of the country commonly known as “Kulthi” belongs to the family fabaceae. It has diploid chromosome numbers of 2n = 20 [7]. Horsegram is grown with mixed crop,. The crop duration of horsegram is 100 – 110 days. The average yield is about 350-800 kg ha⁻¹. It is known for its medicinal use and nutritional quality [8-14]. It is consumed as a whole seed and as sprouts in India. Horsegram used traditionally as a medicinal crop famous for its medicinal uses because different parts of the plant are used for the treatment of asthma, bronchitis, urinary disorder, lowering cholesterol levels and kidney stones [15-22]. In India, horsegram occupies an area of 460.40 (000 ha) with a production of 181.29 (000 tonnes) with an average national productivity of 394 kg ha⁻¹ [23]. Horsegram is important pulse crop mostly grown in Karnataka, Odisha, Chhattisgarh, Andhra Pradesh, Tamil Nadu and Maharashtra which together contributes about 89.23 per cent area and 86.10 per cent production [24-32]. Higher productivity of horsegram is obtained in Bihar (1000 kg ha⁻¹). In Chhattisgarh, horsegram occupies an area of 40.15 (000 ha) with a production of 15.20 (000 tonnes) and average productivity of 379 kg ha⁻¹ [23]. Horsegram is an important pulse crop of the state and mostly grown in Sarguja, Jagdalpur, Kanker, Korba and Jashpur which together contributes about 69.74 per cent area and 76.61 per cent production [33-36]. However, the productivity of horsegram is highest in Janjgir (388 kg ha⁻¹)

2. MATERIALS AND METHODS

The present research entitled “Effect of Integrated nutrient management on growth and yield of horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.] in Chhattisgarh plain” was carried out during post *kharif* season 2020 at

Instructional Farm, BTC College of Agriculture and Research Station, Bilaspur (C.G.), which was situated in dry moist, sub-humid region at an altitude of 292 m above mean sea level on 22.09°N latitude and 82.12°E longitude. The soil of the experimental site was sandy-clay in texture. The Horsegram (var. Bilasa kulthi) was grown and treatments were replicated three times in RBD. The experiment consists of nine treatments *viz.*, T₁ :- 100% RDF, T₂ :- 75%RDF + 25% N through FYM, T₃ :- 50% RDF + 50% N through FYM, T₄ :- 100% RDF + *Rhizobium* culture, T₅ :- 75% RDF + 25% N through FYM + *Rhizobium* culture, T₆ :- 100% RDF + *Rhizobium* culture + PSB, T₇ : 50% RDF + 50% N through FYM + *Rhizobium* culture, T₈ : 50% RDF + 50% N through FYM + *Rhizobium* culture + PSB, T₉ :- Control plot The crop was sown on 11th September, 2020 and harvesting was done on 18th December, 2020.

The weekly maximum and minimum temperature recorded during growing period of crop was 28.7°C in 37th standard week of September and 8.0°C 51th standard week of December and the average maximum and minimum relative humidity was 83.05% and 43.4% on 49th and 45th standard week of (December and November) respectively, the highest sunshine hours during crop growing period was recorded 7.8 hours and the total mean weekly rainfall of 52.8mm was on 40th standard week of September respectively obtained during crop growth period from September to December, 2020.

The experimental area was prepared by ploughing once and harrow twice for obtain good tilth. The field was finally levelled to ensure uniform irrigation and proper drainage. Then the experimental field was laid out as per the plan of layout. The urea, single super phosphate and muriate of potash are used to supply plant nutrients i.e. nitrogen, phosphorus and potash respectively. The required quantities of all fertilizers were mix well together and there after fertilizer are applied in furrow as a basal dose. After the preparation of field, the seed was taken up at a seed rate of 20 kg ha⁻¹. Before sowing the healthy seeds were selected and treated with

carbendazim (12 % WP) @ 2 g kg⁻¹ of seed. Followed by *Rhizobium* @ 10 g and PSB culture @ 10 g kg⁻¹ of seed to avoid damage caused by seed borne disease of crop. The furrows were opened with the help of kudali and seed were sown in the depth of 3-4 cm, there after covering the furrow with soil and maintain row to row spacing at 30 cm.

Harvesting was done manually when the maturity symptoms were observed. The border row were firstly harvested, kept separately and treated as bulk. Then, plants from net plots were harvested. The tagged plants were removed from each plot separately. Threshing was done separately of net plot and border row by beating with sticks. Then grain were separated, winnowed, weighted and net plot yield was recorded treatment wise.

3. RESULT AND DISCUSSION

Effect of INM on growth attributes and yields of horsegram: Plant population (m⁻²) was recorded at 25 days after sowing and harvesting stage of the crop 25 DAS was observed that highest number of plant population recorded in T₆ (100% RDF + *Rhizobium* culture + PSB), is (40.46 plant m⁻²). The lowest number of plant population recorded (38.53 plants m⁻²) was recorded in treatment T₉ (Control). At harvest was observed that highest number of plant population recorded in T₆ (100% RDF + *Rhizobium* culture + PSB), is (38.43 plant m⁻²). The lowest number of plant population recorded (36.29 plants m⁻²) was recorded in treatment T₉ (Control) in Table 1.

At 25 DAS the data varies in plant height were found significant and treatment T₆ (100% RDF + *Rhizobium* culture + PSB), earned significantly larger plant height (20.32 cm) at par with T₄ (100% RDF + *Rhizobium* culture), is (20.26 cm) and T₅ (75% RDF + 25% N through FYM + *Rhizobium* culture), is (18.85 cm). The lowest plant height (14.45 cm) was recorded in treatment T₉ (Control). Almost similar trend was also observed at 50 DAS. At harvest, height of plant was observed declined with respect to 75 DAS. Significantly higher plant height was recorded in T₆ (100% RDF + *Rhizobium* culture + PSB), earned significantly larger plant height (75.11 cm) at par with T₄ (100% RDF + *Rhizobium* culture), is (72.94 cm) and T₅ (75% RDF + 25% N through FYM + *Rhizobium* culture), is (70.40 cm). The lowest plant height

(58.25 cm) was recorded in treatment T₉ (Control) in Table 1.

Treatment T₆ (100% RDF + *Rhizobium* culture + PSB) recorded significantly the higher number of primary branches (2.80) plant⁻¹, however, it was found at par with T₄ (100% RDF + *Rhizobium* culture), is (2.69) plant⁻¹ and T₅ (75% RDF + 25% N through FYM + *Rhizobium* culture), is (2.01) plant⁻¹. Significantly lower number of primary branches plant⁻¹ (1.20) plant⁻¹ was observed under treatment T₉ (control). The same trend followed at the time at 50 DAS and 75 DAS in number of primary branches plant⁻¹. At in number of primary branches plant⁻¹. Treatment T₆ (100% RDF + *Rhizobium* culture + PSB) recorded significantly the higher number of primary branches (5.95) plant⁻¹. It was found at par with T₄ (100% RDF + *Rhizobium* culture), is (5.75) plant⁻¹ and T₅ (75% RDF + 25% N through FYM + *Rhizobium* culture), is (5.70) plant⁻¹. Significantly lower number of primary branches plant⁻¹ (3.79) plant⁻¹ was observed under treatment T₉ (control) in Table 2.

Crop growth rate (g plant⁻¹ day⁻¹): T₆ (100% RDF + *Rhizobium* culture + PSB) recorded higher crop growth rate between 25-50 days after sowing among the treatment in is (0.140 g plant⁻¹ day⁻¹) and lower crop growth rate in T₉ (Control) is (0.116 g plant⁻¹ day⁻¹) At 50-75 days after sowing among the treatment higher crop growth rate in T₆ (100% RDF + *Rhizobium* culture + PSB) is (0.130 g plant⁻¹ day⁻¹) and lower crop growth rate in T₉ (Control) is (0.112 g plant⁻¹ day⁻¹) At 75 DAS- at harvest among the treatment higher crop growth rate in T₆ (100% RDF + *Rhizobium* culture + PSB) is (0.081 g plant⁻¹ day⁻¹) and lower crop growth rate in T₉ (Control) is (0.049 g plant⁻¹ day⁻¹) in Table 2..

Relative growth rate (g g⁻¹ day⁻¹): It was observed that significantly higher relative growth rate between 25-50 days after sowing among the treatment in T₆ (100% RDF + *Rhizobium* culture + PSB) is (0.058 g g⁻¹ day⁻¹) and lower relative growth rate in T₉ (Control) is (0.038 g g⁻¹ day⁻¹) At 50-75 days after sowing among the treatment higher relative growth rate in T₆ (100% RDF + *Rhizobium* culture + PSB) is (0.028 g g⁻¹ day⁻¹) and lower relative growth rate in T₉ (Control) is (0.017 g g⁻¹ day⁻¹) At 75 DAS- at harvest among the treatment higher relative growth rate in T₆ (100% RDF + *Rhizobium* culture + PSB) is (0.015 g g⁻¹ day⁻¹) and lower relative growth rate in T₉ (Control) is (0.006 g g⁻¹ day⁻¹) in Table 3.

Table 1. Effect of INM on plant population, plant height and seed yield (m²) of horsegram

Treatments	Plant population (m ²)		Plant height (cm)			At harvest	Seed yield (kg ha ⁻¹)
	25 DAS	At harvest	25 DAS	50 DAS	75 DAS		
T ₁ 100% RDF	39.00	36.60	16.26	43.90	68.71	67.09	605.01
T ₂ 75%RDF + 25% N through FYM	39.16	37.17	16.37	44.19	69.30	67.25	630.78
T ₃ 50% RDF + 50% N through FYM	38.40	36.50	15.47	42.72	67.30	65.43	571.76
T ₄ 100% RDF + <i>Rhizobium</i> culture	40.33	38.33	20.26	49.68	74.60	72.94	819.40
T ₅ 75% RDF + 25% N through FYM + <i>Rhizobium</i> culture	40.23	38.23	18.85	48.56	72.31	70.40	743.24
T ₆ 100% RDF + <i>Rhizobium</i> culture + PSB	40.46	38.43	20.32	50.28	76.43	75.11	865.24
T ₇ 50% RDF + 50% N through FYM + <i>Rhizobium</i> culture	39.60	36.42	16.31	46.29	70.13	69.0	645.45
T ₈ 50% RDF + 50% N through FYM + <i>Rhizobium</i> culture + PSB	39.96	37.70	16.39	46.37	70.60	69.20	661.50
T ₉ Control plot	38.53	36.29	14.45	40.76	61.58	58.25	343.34
SEm ±	0.51	0.55	1.22	1.36	1.86	1.47	45.37
CD(0.05)	NS	NS	3.67	4.08	5.58	4.41	136.01

Table 2. Effect of INM Number of primary branch plant⁻¹ and Crop growth rate (g plant⁻¹ day⁻¹) of horsegram

Treatments		Number of primary branch plant ⁻¹				Crop growth rate (g plant ⁻¹ day ⁻¹)		
		25 DAS	50 DAS	75 DAS	At harvest	25-50 DAS	50-75 DAS	75- At harvest
T ₁	100% RDF	1.30	3.20	4.26	4.30	0.123	0.119	0.058
T ₂	75%RDF + 25% N through FYM	1.45	3.25	4.60	4.81	0.128	0.121	0.061
T ₃	50% RDF + 50% N through FYM	1.22	3.02	4.19	4.27	0.120	0.116	0.055
T ₄	100% RDF + <i>Rhizobium</i> culture	2.69	4.79	5.75	5.83	0.136	0.129	0.075
T ₅	75% RDF + 25% N through FYM + <i>Rhizobium</i> culture	2.01	4.65	5.70	5.75	0.134	0.127	0.071
T ₆	100% RDF + <i>Rhizobium</i> culture + PSB	2.80	4.83	5.95	5.98	0.140	0.130	0.081
T ₇	50% RDF + 50% N through FYM + <i>Rhizobium</i> culture	1.70	3.69	4.65	4.73	0.130	0.124	0.063
T ₈	50% RDF + 50% N through FYM + <i>Rhizobium</i> culture + PSB	1.95	3.70	4.85	4.97	0.132	0.125	0.065
T ₉	Control plot	1.20	2.20	3.79	3.85	0.116	0.112	0.049

Table 3. Effect of INM Relative growth rate (g g⁻¹ day⁻¹) and Net assimilation rate (g dm⁻² day⁻¹) of horsegram

Treatments		Relative growth rate (g g ⁻¹ day ⁻¹)			Net assimilation rate (g dm ⁻² day ⁻¹)		
		25-50 DAS	50-75 DAS	75- At harvest	25-50 DAS	50-75 DAS	75- At harvest
T ₁	100% RDF	0.041	0.018	0.008	0.064	0.016	0.019
T ₂	75%RDF + 25% N through FYM	0.046	0.022	0.010	0.062	0.021	0.021
T ₃	50% RDF + 50% N through FYM	0.044	0.021	0.007	0.060	0.017	0.017
T ₄	100% RDF + <i>Rhizobium</i> culture	0.056	0.025	0.013	0.072	0.029	0.027
T ₅	75% RDF + 25% N through FYM + <i>Rhizobium</i> culture	0.053	0.024	0.011	0.070	0.027	0.025
T ₆	100% RDF + <i>Rhizobium</i> culture + PSB	0.058	0.028	0.015	0.075	0.033	0.029
T ₇	50% RDF + 50% N through FYM + <i>Rhizobium</i> culture	0.048	0.020	0.010	0.065	0.023	0.014
T ₈	50% RDF + 50% N through FYM + <i>Rhizobium</i> culture + PSB	0.051	0.022	0.011	0.069	0.025	0.022
T ₉	Control plot	0.038	0.017	0.006	0.058	0.014	0.010

Net assimilation rate ($\text{g dm}^{-2} \text{ day}^{-1}$) Significantly higher net assimilation rate: Between 25-50 days after sowing among the treatment higher net assimilation rate ($\text{g dm}^{-2} \text{ day}^{-1}$) in T_6 (100% RDF + *Rhizobium* culture + PSB) is ($0.075 \text{ g dm}^{-2} \text{ day}^{-1}$) and lower net assimilation rate ($\text{g dm}^{-2} \text{ day}^{-1}$) in T_9 (Control) is ($0.058 \text{ g dm}^{-2} \text{ day}^{-1}$) At 50-75 days after sowing among the treatment higher net assimilation rate ($\text{g dm}^{-2} \text{ day}^{-1}$) in T_6 (100% RDF + *Rhizobium* culture + PSB) is ($0.033 \text{ g dm}^{-2} \text{ day}^{-1}$) and lower net assimilation rate ($\text{g dm}^{-2} \text{ day}^{-1}$) in T_9 (Control) is ($0.112 \text{ g dm}^{-2} \text{ day}^{-1}$) At 75 DAS- at harvest among the treatment higher net assimilation rate ($\text{g dm}^{-2} \text{ day}^{-1}$) in T_6 (100% RDF + *Rhizobium* culture + PSB) is ($0.029 \text{ g dm}^{-2} \text{ day}^{-1}$) and lower net assimilation rate ($\text{g dm}^{-2} \text{ day}^{-1}$) in T_9 (Control) is ($0.010 \text{ g plant}^{-1} \text{ day}^{-1}$) in Table 3.

4. CONCLUSIONS

From the experimental result, it could be enlightened that T_6 (100% RDF + *Rhizobium* culture + PSB) found highest plant height (75.11cm), number of primary branches plant^{-1} (5.95), crop growth rate ($0.081 \text{ g plant}^{-1} \text{ day}^{-1}$), Relative growth rate ($0.015 \text{ g g}^{-1} \text{ day}^{-1}$) Net assimilation rate ($0.029 \text{ g dm}^{-2} \text{ day}^{-1}$) and yield was observed to be significantly higher under treatment T_6 (100% RDF + *Rhizobium* culture + PSB), in horsegram crop cultivated under Chhattisgarh plains conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. More SR, Mendhe SN, Kolte HS, Yenprediwar MD, Choudhary RL. Growth and yield attributes of soybean as influenced by nutrient management. Journal of Soils and Crops. 2008;18(1): 154-157.
2. Nadeem MA, Ahmad R, Ahmad MS. Effect of seed inoculation and different fertilizer levels on the growth and yield of mungbean (*Vigna radiata* L.), J. agron., 2004;3(1):40-42.
3. Neenu S, Ramesh K, Ramana S, Biswas AK, Rao S. Growth and yield of different varieties of chickpea (*Cicer arietinum* L.) as influenced by the phosphorus nutrition under rainfed conditions on vertisols. International J. of bio-resource and stress management. 2014;5(1):053-057.
4. Netwal LC. Effect of FYM and vermicompost on nutrient uptake and quality of cowpea [*Vigna unguiculata* (L.) Walp.] grown under saline conditions. M.Sc. (Ag.) Thesis, Rajasthan Agricultural University, Bikaner; 2003.
5. Patel JJ, Mevada KD, Chotaliya RL. Response of summer mungbean to data of sowing and level of fertilizer, Indian Journal of Pulses Research. 2004;17(2): 143-144.
6. Patel HB, Shah KA, Barvaliya MM, Patel SA. Response of Green gram (*Vigna radiata* L.) to different level of phosphorus and organic liquid fertilizer. International J. Current Microbiology and Applied Science. 2017;6(10):3443-3451.
7. Cook BG, Pengelly BC, Brown SD, Donnelly JL, Eagles DA, Franco MA, Hanson J, Mullen BF, Partridge IJ, Peters M, Schultze-Kraft R. Tropical Forages: an interactive selection tool. [CD-ROM], CSIRO, DPI&F(Qld). CIAT and ILRI, Brisbane; 2005.
8. Khan SK, Khan ZI, Ansar M, Shah H. Response of mungbean genotypes to *Rhizobium* inoculation and varying levels of nitrogen fertilizer, Pak. J. Agri. Res. 2008;21:1-4.
9. Khattak SG, Khan DF, Shah SH, Madani MS, Khan T. Role of *rhizobial* inoculation in the production of chickpea crop, Soil and Environ. 2006;25:143-145.
10. Kala TC, Christi RM, Bai NR. Effect of *rhizobium* inoculation on the growth and yield of Horsegram (*Dolichos biflorus* Linn), Plant archives. 2011;11(1):97-99.
11. Kakar AA, Saleem M, Shah R, Shah SAQ. Growth and marketable green pod yield performance of pea (*Pisum sativum* L.) under varying levels of NPK fertilizers, Asian J. Plant Sci. 2002;1(5):532-534.
12. Keshava BS, Halepyati AS, Pujari BT, Desai BK. Yield and economics of horse gram (*Macrotyloma uniflorum* Lam. Verdc.) as influenced by genotypes, plant densities and phosphorus levels, Karnataka Journal of Agricultural Sciences. 2007;20:589-591.
13. Krishnaprabu S. Integrated Approach in Nutrient Management of Greengram on Nutrient Uptake and Economics Department of Agronomy, Faculty of Agriculture, Annamalai University, International journal of pure and applied bioscience. 2018:2320–7051.

14. Kumar J, Sharma M. Effect of phosphorus and molybdenum on yield and nutrient uptake by chickpea (*Cicer arietinum* L.), Advances in Plant Sciences. 2005;18(11): 1869-873.
15. Devi NK, Singh TB, Singh H, Singh NB. Diana S. Influence of inorganic, biological and organic manures on nodulation and yield of soybean (*Glycine max* L. Merrill.) and soil properties. Aus. J. Crop Sci. 2013;9(7):1047-1145.
16. Morya J, Tripathi RK, Kumawat N, Singh M, Yadav RK, Tomar IS, Sahu YK. Influence of Organic and Inorganic Fertilizers on Growth, Yields and Nutrient Uptake of Soybean (*Glycine max* Merrill L.) under Jhabua Hills. Int. J. Curr. Microbiol. App. Sci. 2018;7(2): 725-730.
17. Chaudhary M, Singh S, Babu S, Prasad M. Effect of integrated nutrient management on productivity, nutrient acquisition and economics of blackgram (*Phaseolus mungo* L.) in an inceptisol of eastern Uttar Pradesh. Legume Research-An International Journal. 2018;41(5):759-762.
18. Hussain F, Malik AU, Haji MA, Malghani AL. Growth and yield response of two cultivars of mungbean (*Vigna radiata* L.) to different potassium levels, J. Animal and Plant Sci. 2011;21(3):622-625.
19. Karwasara RS, Kumar Y, Yadav AS. Effect of phosphorus and sulphur on green gram (*Phaseolus radiatus*), Haryana Journal of Agronomy. 2006;22(2):164-165.
20. Patel AR, Patel DD, Patel TU, Patel HM. Nutrient management in summer green gram. International Journal Of Applied And Pure Science And Agriculture. 2016;2:134-142.
21. Pandey Vineeta OS, Dahiya, Mor VS, Yadav R, Jitender Ovais, Hamid Peerzada, Archana Brar. Impact of Integrated Nutrient Management on Seed Yield and Its Attributes in Field Pea (*Pisum sativum* L.) Chemical Science Review and Letter; 2017.
22. Poudyal RS, Prasad BN. Effect of Bradyrhizobium japonicum on Chlorophyll Content, Nodulation, and Plant Growth in Soybean, Korean Journal of Crop Science. 2005;50(4):265-267.
23. Anonymous. Ministry of Agricultural and Farmers Welfare, Government of India; 2018-19.
24. Kumar N, Chandra R. *Rhizobium* and VAM inoculation effect on mungbean (*Vigna radiata*) with varying phosphorus levels, Legume Research. 2003;26(4):284-287.
25. Kumar K, Verma AK, Srivastava GP. Yield attributing character and grain yield of urdbean (*Vigna mungo* L. Hepper) as influenced by levels of phosphate application, Journal of Research, Agriculture University. 2000;12(2):233-234.
26. Kumawat N, Sharma OP, Kumar R. Effect of Organic Manures, PSB and Phosphorus Fertilization on Yield and Economics of Mungbean (*Vigna radiata*), Environment & Ecology. 2006;27(1):5-7, 2009.
27. Koushal S, Singh P. Effect of integrated use of fertilizer, FYM and Biofertilizer on growth and yield performance on soybean (*Glycine max*), Research Journal of Agricultural Science. 2007;43(3):2011.
28. Khaliq A. Irrigation and nitrogen management effects on productivity of hybrid sunflower (*Helianthus annuus* L.), Ph.D. thesis, Dept. of Agron, Uni. of Agri. Faisalabad, Pakistan; 2004.
29. Maheshbabu HM, Hunje R, Patil NKB, Babalad HB. Effect of Organic Manures on Plant Growth, Seed Yield and Quality of Soybean, Karnataka J. Agric. Sci. 2008; 21(2):(219-221).
30. Math Ganajaxi, Gurupad Balol, Lalita Jaggal. Integrated nutrient management in lentil University of Agricultural Sciences, Dharwad, Karnataka, International Journal of Chemical Studies, 2018;6(6):201-202 .
31. Meena DD, Thomas T, Rao PS. Effect of different levels of NPK *rhizobium* and FYM on soil properties, growth and yield of cowpea (*Vigna unguiculata* L.) var Pusa Barsati. International J. of Chemical Studies IJCS. 2018;6(3):2117-2119.
32. Mishra N. Growth and yield response of pea (*Pisum sativum* L.) to Integrated Nutrient Management Department of Vegetable Science, OUAT, Bhubaneswar, Odisha Journal of Plant and Pest Science (ISSN: 2204-0021); 2014.
33. Purushotham S, Sharma KMS, Kulkarni KR. Response of horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.] to combinations of nitrogen, 76 phosphorus and potassium on farmers field in Tumur district Bangalore, India. Mysore J. of Agricultural Science. 1988;22(4):444-451.
34. Qureshi MA, Shakir MA, Iqbal A, Akhtar N. Khan A. Co-inoculation of phosphate solubilizing bacteria and rhizobia for

- improving growth and yield of mungbean (*Vigna radiata* L.). The J. Animal and plant Sci., 2011;21(3):491-497.
35. Ram SN, Dixit RS. Growth, yield attributing parameters and quality of summer green gram (*Vigna radiata* L. Wilezek) as influenced by date of sowing and phosphorus, Indian Journal of Agricultural Research. 2001;35:275-277.
36. Rahman MA, Islam N, Hassan MK, Talukder MMR. Yield performance of mungbean (*Vigna radiata* L. Wilczek) cv. Barimung-4 as influenced by Rhizobium inoculation and NPK Fertilizers, Pak. J. Biol. Sci. 2002;5(2):146-148.

© 2023 Verma et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/108934>