The Pharma Innovation Journal 2023; 12(6): 2721-2725

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 2721-2725

www.thepharmajournal.com
Received: 01-03-2023
Accepted: 07-04-2023

Sandeep Sahu
Ph.D. Research Scholar, Department of Agronomy, Banda Agriculture University & Technology, Banda, Uttar Pradesh, India

Abhishek Raj Ranjan
Ph.D. Research Scholar, Department of Agronomy, Banda Agriculture University & Technology, Banda, Uttar Pradesh, India

Shweta Gupta
Ph.D. Research Scholar, Department of Agronomy, Banda Agriculture University & Technology, Banda, Uttar Pradesh, India

Anchal Singh
Ph.D. Research Scholar, Department of Agronomy, Banda Agriculture University & Technology, Banda, Uttar Pradesh, India

Amar Singh Gaur
Ph.D. Research Scholar, Department of Soil Science, Banda Agriculture University & Technology, Banda, Uttar Pradesh, India

Deepak Prajapati
Ph.D. Research scholar, Department of Soil Science, Banda Agriculture University & Technology, Banda, Uttar Pradesh, India

Rajeev Ranjan Patel
Ph.D. Research scholar, Department of Agricultural Extension, Banda Agriculture University & Technology, Banda, Uttar Pradesh, India

Corresponding Author:
Sandeep Sahu
Ph.D. Research Scholar, Department of Agronomy, Banda Agriculture University & Technology, Banda, Uttar Pradesh, India

Effect of integrated nutrient management on green gram (*Vigna radiata*) growth and productivity, soil health and It's economics: An overview

Sandeep Sahu, Abhishek Raj Ranjan, Shweta Gupta, Anchal Singh, Amar Singh Gaur, Deepak Prajapati and Rajeev Ranjan Patel

Abstract
The combination of organic manures and inorganic Fertilizers has been demonstrated to be effective not only in sustaining consistently greater crop yield and for ensuring crop production stability, but also increase the soil microorganisms and improve physic-chemical properties of soil. INM serves as a source of energy, organic carbon, and accessible nitrogen. It also has a significant long-term impact of soil and succeeding crops. The main objective of INM is therefore to achieve eco-friendly or sustainability of soil health and its practices by combining the complementary qualities of both sources, thereby reducing the massive use of chemical Fertilizers and accumulating a balance between fertilizer inputs and crop nutrient requirements, maintaining soil fertility, optimizing the level of yield, maximizing profitability, and subsequently reducing environmental pollution.

Keywords: INM, eco-friendly, biofertilizers, FYM and inorganic fertilizers

Introduction
Indian population is predominantly vegetarian and protein requirement for the growth and development of the human being is mostly met with pulses. As per recommendation of WHO minimum requirement of pulses is 80 g capita^{-1} day^{-1}. India is the largest producer of pulses and cultivated over 29 million hectares of area and recorded the highest ever production of 25. 23 Millon tones during 2017–2018 (MoA&FW, India 2018) [27]. Green gram is a leguminous crop that stores atmospheric nitrogen in root nodules, thereby considerably reducing the usage of chemical fertilizers in farm applications. Green gram is an excellent source of protein (24.5%) with high quality of lysine (460 mg/g N) and tryptophan (60 mg/g N). It contains also Remarkable quantity of ascorbic acid and riboflavin (0.21 mg /100 g) (Azadi *et al*. 2013) [6]. The presence of antinutritional factors such as tannins (366.6 mg/100 mg), phytic acid (441.5 mg/100 g), hemagglutinin, trypsin inhibitors, proteinase inhibitors, and polyphenols (462.5 mg/100 g) were reported in mung bean, which affect the digestion and bioavailability of full nutrition (Mubarak 2005) [29]. Mung bean is an annual crop that is highly branched and is about 60–76 cm tall (Oplinger *et al*. 1990) [31]. A regular depletion of nutrient is a threat to the area of sustainable agriculture. Moreover, at the present context, a proper combined use of organic and inorganic nutrient source is essential to keep stable soil health (Tan, Lal, and Wiebe 2005) [46]. The increased demand of food grain production up to 2050 about 400 Mt. India's annual consumption of chemical fertilizers in nutrient terms (NPK), has increased from 0.7 lakh MT in 1951-52 to 265.9 lakh MT 2017-2018, while per hectare consumption of chemical fertilizers, which was less than 1 kg ha^{-1} in 1951-52 has risen to a level of 145.0 kg/ha in 2017-2018 and Consumption ratio of NPK fertilizers in India is about (6.1:2.5:1) in 2017-2018 for crop production (Anonymous, 2017-18) [4]. A single source of fertilizer is not sufficient to satisfy the requirement of a crop and also single fertilizer does not assist as a substitute for another nutrient, but they counterpart each other (Hazra 2016) [17]. Strong and convincing evidence indicates that INM practice could be an innovative and environment friendly practice for sustainable agriculture worldwide **(**Jat *et al*. 2015) [18]. Although, chemical fertilizer is playing a crucial role to meet the nutrients need of the crop, the imbalance and continuous use of chemical fertilizers has adverse effect on soil physical, chemical and biological properties thus affecting the sustainability of crop production, besides causing environmental pollution (Virmani, 1994) [53].

The role of Integrated Nutrient Management (INM) enhances the crop yields in various cropping systems ensuring long-term sustainability of the system (Aulakh, 2010) [5]. Biofertilizers when added as a component of INM is considered to be cost effective, eco-friendly and renewable source of non-bulky, low cost of plant nutrient supplementing chemical fertilizers in sustainable agriculture system in India (Priya *et al*. 2019) [36]. India is the largest producer and importer of the leguminous crop (Shakya *et al*. 2008) [40]. Legume plants are also capable of adding sufficient amount of plant residues to the soil system (Meena 2014) [25]. INM acts as a source of energy, organic carbon, and available nitrogen for the growth of soil microbes and improvement of physical properties of soil, and also have great residual effect on subsequent crops (Selim 2020) [39]. The important enzymes in the soil are mainly amylase, arylsulfatase, cellulase, chitinase, dehydrogenase, phosphatase, and urease which are released from plants, animals, organic compounds, and microorganisms and soils (Gupta *et al*. 1993) [16]. All these organic acid and enzymes are played a vital role in soil biological processes and improve soil health.

Effect of INM on growth and productivity of Green gram

Integration of organic manure and chemicals fertilizer materials has been found to be promising not only in maintaining higher productivity of crops but also providing stability in crop production, besides improving soil physical conditions (Verma *et al*. 2012) [51]. Abhilasha *et al*. (2022) [2] Observed that application with 50% Vermicompost + 50% Poultry manure significantly resulted in higher values of growth and yield attributes as well as yields in Green gram under Bundelkhand region. Mishra, (2023) [28] Reported that use of Poultry Manure 75% + DAP 25% significantly increase plant height, number of branches plant^{-1}, dry weight, number of nodules plant^{1}, number of grain pod^{-1}, number of pod per plant, grain yield, straw yield of Green gram. The Combined application of 75% RDF from urea+2tFYM ha^{-1} + PSB + Rhizobium was recorded maximum growth and yield of green gam (Patel *et al*. 2016a) [34]. R. A. Singh (2007) [37] results found that the combined application of 20 kg N, 50 kg P_2O_5 and 10 t ha^{-1} FYM results show significantly effect on growth, grain yield and yield attributes of Green gram over control. Integrated application of 100% RDF + Vermicompost @ 1.0 t ha^{-1} + Rhizobium noted that significantly increases all growth and yield parameters its closely followed by 75% RDF + 1tone Vermicompost + Rhizobium treatment (Tyagi and Singh 2019) [48]. A research was conducted by (Kalal, 2020) found that recorded significantly higher growth parameter, yield attributes, yield and economics of summer Green gram due to application of 100% RDF + biocompost @ 2.5 tha^{-1} + PSB. Abbas *et al*. (2011) [1] it was found that application of organic and chemical fertilizers that significantly effect on growth, nodulation, and seed & stover yield of Green gram due to application of RDF (NPK) and Rhizobium inoculation performed better than all other treatments. Application of FYM and inorganic fertilizer increased the grain and biological yield (38.2, 50.6%, 44.1 and 43.2%, respectively) in the two years (Biyan *et al.* 2014) [9]. Combined application of nutrients through 75% RDF + 2.5 t ha^{-1} Vermicompost + Rhizobium + PSB significant improved in plant height at harvest, yield attributes, production, nutrient content (Meena *et al.* 2015) [26]. Dhakal *et al.* (2015) [11] also observed that Significant improvement in LAI, number of trifoliate, SPAD value of green leaf chlorophyll, dry matter accumulation, yield, HI and nutrient content of Green gram were recorded highest due to application of 75% RDF + 2.5 t ha^{-1}Vermicompost + Rhizobium + phosphorus solubilizing bacteria. Doifode *et al.* (2012) [12] reported that growth and yield were significantly improved due to combine seed treatment with Rhizobium and PSB along with R.D.F. (20:40 N: P kg ha^{-1}) and 2.5 t ha^{-1} FYM. The combined applications of 100 kg DAP + 2 t ha^{-1} Vermicompost + Rhizobium was significantly maximum grain yield of Green gram (Jat *et al.* 2012) [19]. Bhatt *et al.* (2013) [8] result was found that application of 1t ha^{-1} Vermicompost, producing maximum seed yield (11.5 q ha^{-1}) and 23.7 q ha^{-1} Straw yield. Combined application of 50% RDF + 2.5 t FYM + Rhizobium + PSB, results are show significantly maximum seed yield (987.12kg ha^{-1}) and straw yield (3212.87kg ha^{-1}) more nutrient uptake in grain and straw of Green gram (Tripathi *et al.* 2014) [47]. Pandey *et al.* (2019) [31] was found that produced maximum Plant height, no. of leaves & pod, no. of branches, root nodules yield of grain and straw yields Green gram under application of 75% NPK + 5t FYM ha^{-1} + PSB+ Rhizobium. The growth, yield attributes parameters of Green gram was recorded significantly maximum under the combined application P_2O_5 80kg ha^{-1} and PSB(Singh *et al.* 2018) [44]. Kavita *et al.* (2018) [22] results revealed that yield attributes and yields were significantly influenced by the application of different organic nutrient management, 25% nitrogen through FYM + 25% nitrogen through vermicompost+ *Rhizobium*+ PSB @5ml/l produced significantly higher pods plant^{-1} and seeds pod^{-1} as well as seed yield in Green gram. Application of 10:40:20 NPK kg ha^{-1} + 10 kg ha^{-1} N through poultry manure + GA-3 75 + 75 PPM was observed significantly maximum yield and yield attributes of Green gram (Gadi *et al.* 2017) [13]. Combined application of 75% RDF from urea + 2t FYM ha^{-1} + Rhizobium + PSB regularly improve the growth and yield of Green gram (Patel *et al.* 2016) [33].

Effect of INM on soil health

INM improve the Organic Carbon and available NPK and S content in the soil (Singh *et al*. 2011) [42]. Ali *et al*. (2009) [3] reported that the application of OM significantly increased the rhizospheric microbial population (Bacteria, Fungi and Actinomycetes) and available soil N, P and K in Green gram. Barkha, (2020) [7] observed that combined application 50% RDF + biocompost @ 2.5 t/ha + PSB @ 2.5 l/ha recorded significantly higher nutrient uptake (NPK) and available nutrient status in soil. Application of 100% RDN from Vermicompost significantly better response increased root nodules over control (Naveen *et al.* 2012) [30]. Gorade *et al.* (2014) [15] it was found that for obtaining higher yields by sustaining soil fertility in terms of available N and P_2O_5, in Green gram with application of RDF (25: 50: 00 N: P_2O_5: K_2O kg ha^{-1}) along with seed treatment of Rhizobium and PSB bio-fertilizers @ 25 g each kg^{-1} seeds. Application 20kg P_2O_5 ha^{-1} from SSP + PSB inoculation @5ml kg^{-1} seed the highest nodule dry weight (35mg plant^{-1}), followed by 40kg P_2O_5 ha^{-1} from SSP (Rathour *et al.* 2015) [38]. Dhakal *et al.* (2016) [10] results was showed that application of 100% RDF + 2.5 t ha^{-1} vermi-compost and 100% RDF + rhizobium + PSB in Green gram, was recorded significant higher in number of nodules plant^{-1} (80.97), dry weight of nodules (32.89 mg plant^{-1}) and also improve the nutrient content, available NPK and organic carbon in soil. Gohain *et al.* (2017) [14] reported

that application of Rhizobium + PSB, V.C @ 0.7 t ha^{-1} was recording significantly higher Soil available N and K status after harvest as well as seed and straw NPK uptake. Verma *et al.* (2017) [50] observed that application of Rhizobium + PSB + 20 kg N ha^{-1} gave significantly higher number of nodules (25.10 $plant^{-1}$) and dry weight of nodules (24.10 mg $plant^{-1}$). S. Krishnaprabu (2018) [24] reported that RDF along with rhizobium and PSB (seed inoculation) @600 g ha^{-1} with foliar application of DAP @2% and NAA @40 ppm ha^{-1} and combined with salicylic acid @ 100 PPM ha^{-1} at 30 and 45 DAS. Integrated nutrient management not only increased the yield of Green gram but also increased the nutrient uptake besides improving the physico-chemical and biological properties of soil which provide better soil environment for growth. The N, P and K uptake in system was higher when the crop was given under above said treatment combinations. Use of biofertilizer source helped in maintaining soil fertility in terms of available nutrients. Singh *et al.* (2019) [43] Reported that application of 75% RDF + PSB + 2.5t ha^{-1} Vermicompost+ Rhizobium, significantly gave the maximum Nitrogen, Phosphorus and Potassium content and uptake by Green gram and available N, P and K in soil. (Vigneshvarraj, 2020) [52] results of the study clearly indicated that the integrated application of recommended dose of NPK + Zn enriched composted coir pith (ZnECCP) @ 6.25 t ha-1 along with Rhizobium @ 2.0 kg ha-1 through soil and foliar spray of pink pigmented facultative methylotrophs (PPFM) 1.0 percent twice at pre flowering and flowering stage enhanced the growth and yield and nutrient uptake of Green gram. (Kalaiyarasi 2019) [20] observed that Application of 75% RDF and bio-fertilizers with vermicompost and castor cake markedly increased the available nutrient content in soil. Integration of organic either in the form of crop residue, organic manure or amendment has a significant effect on BD of agricultural soils and soil aggregation, soil structure, soil moisture retention capacity and infiltration rate (Sharma *et al.* 2015) [41].

Effect of INM on economies of Green gram

Tripathi *et al.* (2014) [47] was reported that consequently resulted maximum gross return (33500 Rs), net return (19578 Rs) and B: C ratio (2.41) with 100% RDF + Rhizobium + PSB (972.12kg ha^{-1}). Meena *et al.* (2015) [26] observed that the highest and comparable net returns were obtained with the application of 100% RDF + Rhizobium + PSB (INR 52894.73). Keerthi *et al.* (2015) [45] conducted an experiment during 2013 and 2014 at Tamil Nadu Agricultural University. Which recorded highest net return (57,806 Rs ha^{-1}) and B: C ratio (2.43) associated with application of RDF, 12.5 t of FYM and 25 kg $ZnSO_4$ as basal and foliar spraying of 1% KNO_3 at 50 percent flowering. Highest Gross monetary returns, Net monetary returns and B: C ratio were observed with the application of 50kg P_2O_5 ha^{-1} along with foliar application of BOOST-52 (0:52:34) 30 and 45 DAS (Swathi *et al.* 2015) [45]. Tyagi *et al.* (2015) [49] reported that Gross return of (62125Rs ha^{-1}) was the highest with the application of 100% RDF + 1.0 t Vermicompost ha^{-1} + Rhizobium. Highest net return (39741Rs ha^{-1}) was recorded with 100% RDF + 2 t FYM ha^{-1} + Rhizobium, while the maximum B: C of 1.97 with the application of 100% RDF + Rhizobium. Kavita *et al.* (2018) [22] observed that Gross monetary returns, Net monetary returns and B: C in Green gram was maximum (39332Rs ha^{-1}), (15392 Rs ha^{-1}) and 1.64 respectively) appliction 25% nitrogen through FYM + 25% nitrogen through Vermicompost + Rhizobium + PSB @ 5ml/l). Singh *et al.* (2018) [44] observed that Experiment results revealed that maximum gross returns (Rs 72371.00 ha^{-1}), net returns (Rs 50873.00 ha^{-1}) and B: C ratio (2.37) was recorded under treatment (60 kg P_2O_5 ha^{-1}+ PSB) for Green gram crop. Singh *et al.* (2019) [43] reported that combined application of 75% RDF + PSB + 2.5t ha^{-1} vermicompost + Rhizobium found best option for achieving higher net returns (Rs ha^{-1} 28905) and B: C ratio 0.79 from Green gram.

Conclusion

Integrated Nutrient Management (INM) increases crop yields as compared with conventional practices, increases water and nutrients use efficiency and the economic returns to farmers, while improving grain quality and soil health and sustainability. INM not only increased the yield of Green gram but also increased the nutrient use efficiency and minimize the loss of nutrient their effect on improving the physico-chemical and biological properties of soil which provide better soil environment for crop growth.

Reference

1. Abbas G, Abbas Z, Aslam M, Malik AU, Ishaque M, Hussain F. Effects of organic and inorganic fertilizers on Green gram (*Vigna radiata* (L.)) yield under arid climate. International Research Journal of Plant Science. 2011;2(4):094-098.
2. Abhilasha D, Pandey S, Prajapati H, Gangwar B. Integrated nutrient management through organic sources in Green gram (*Vigna radiata*) under Bundelkhand region of Jhansi. 2022.
3. Ali ME, Islam MR, Jahiruddin M. Effect of integrated use of organic manures with chemical Fertilizers in the rice-rice cropping system and its impact on soil health. Bangladesh Journal of Agricultural Research. 2009;34:81-90.
4. Anonymous, Annual Report, Government of India, Ministry of Chemicals and Fertilizers, Department of Fertilizers; c2017-18. p. 49-52.
5. Aulakh MS. Integrated nutrient management for sustainable crop production, improving crop quality and soil health, and minimizing environmental pollution. In 19th world congress of soil science, soil solutions for a changing world; c2010. p. 1-6.
6. Azadi P, Inderwildi OR, Farnood R, King DA. Liquid fuels, hydrogen and chemicals from lignin: A critical review. Renewable and Sustainable Energy Reviews. 2013;21:506-523.
7. Barkha MK, Joshi N, Vaghela TD. Effect of integrated nutrient management on growth, yield, nutrient uptake and soil nutrient status of summer Green gram (*Vigna radiata* L.) under south Gujarat conditions. IJCS. 2020;8(5):2675-2678.
8. Bhatt PK, Patel PT, Patel BT, Raval CH, Vyas KG, Ali Shaukat Productivity, quality, nutrient content and soil fertility of summer Green gram (*Vigna radiata*) as influenced by different levels of vermicompost and phosphorus with and without PSB. International Journal Agriculture Science. 2013;9(2):659-662.
9. Biyan SC, Dhuppar P, Rao D Sarveshwara. Integrated nutrient management assessment for increased Green gram crop yield. Indian journal of crop research.

2014;48(3):38-41.
10. Dhakal Y, Meena RS, Kumar S. Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of Green gram. Legume Research-An International Journal. 2016;39(4):590-594.
11. Dhakal Y, Meena RS, De N, Verma SK, Singh A. Growth, yield and nutrient content of Green gram (*Vigna radiata* L.) in response to INM in eastern Uttar Pradesh, India. Bangladesh journal of Botany. 2015;44(3):479-482.
12. Doifode GS, Sethi HN, Zadode RS, Goud VV. Effect of Integrated Nutrient Management on growth and yield of black gram. Annals of Plant Physiology. 2012;26(1/2):29-31.
13. Gadi Parvati, Dawson Joy, Shankar M. Effect of different organic manures, inorganic fertilizers and growth regulator on yield attributes and yield of Green gram (*Vigna radiata* L.). Agriculture Update. 2017;12(6):1567-1572.
14. Gohain T, Kikon N. Optimization of organic nutrient sources for Green gram (*Vigna radiata* L.) under rain fed conditions. Indian Journal of Agricultural Research. 2017;51(5):443-447.
15. Gorade VN, Chavan LS, Jagtap DN, Kolekar AB. Response of Green gram (*Vigna radiata* L.) varieties to integrated nutrient management in summer season. Agricultural Science Digest-A Research Journal. 2014;34(1):36-40.
16. Gupta VVSR, Farrell RE, Germida JJ. The activity of arylsuphatases in Saskatchewan soils. Can J Soil Science. 1993;73:341–347.
17. Hazra G. Different types of eco-friendly fertilizers: an overview sustainability in environment. Sustainability in Environment. 2016;1(1):1. doi:10.22158/se.v1n1p54.
18. Jat LK, Singh YV, Meena SK, Meena SK, Parihar M, Jatav HS, *et al*. Does integrated nutrient management enhance agricultural productivity. Journal Pure Applied Microbiol. 2015;9(2):1211-1221.
19. Jat SL, Prasad K, Parihar CM. Effect of organic manuring on productivity and economics of summer Green gram (*Vigna radiata* var. radiata). Annals of Agricultural Research, 2012, 33(1&2).
20. Kalaiyarasi S, Avudaithai S, Somasundaram S, Sundar M. Effect of INM on chemical properties of soil nutrient uptake and yield of Green gram in sodic soil. International Journal of Chemical Studies. 2019;7(3):2053-2055.
21. Kalal PH. Effect of Integrated nutrient management on growth, yield and economics of summer Green gram (*Vigna radiata* L.) Under south Gujarat condition. Economics, 2020, 3.
22. Kavita B, Agrawal KK, Rakesh C. Yield and Economics Performance of Green gram as Influenced by Nutrient Management under Organic Farming. International Journal of Current Microbiology and Applied Sciences. 2018;7(3):3565-3572.
23. Keerthi MM, Babu R, Joseph M, Amutha R. Optimizing plant geometry and nutrient management for grain yield and economics in irrigated Green gram. American Journal of Plant Sciences. 2015;6(08):1144.
24. Krishnaprabu S. Integrated Approach in Nutrient Management of Green gram on Nutrient Uptake and Economics. International journal of Pure and Applied Bioscience. 2018;6(5):832-834.
25. Meena JS. Effect of integrated nutrient management on soil fertility, yield and quality of cowpea [*Vigna unguiculata* (L.) wilczek].M.Sc. Ag, SRI KARAN narendra agriculture, university, Jobner; c2014.
26. Meena RS, Dhakal Y, Bohra JS, Singh SP, Singh MK, Sanodiya P, *et al*. Influence of bioinorganic combinations on yield, quality and economics of Mung Bean. International Journal of Experimental Agriculture; c2015. p. 159-166.
27. Ministry of Agriculture and Farmers Welfare (2018). Pulses revolution from food to nutritional security-success report. Retrieved May 23, 2019 from https://www.farmer.gov.in/ SucessReport2018-19.pdf.
28. Mishra SK, Chaturvedi PK. Effect of integrated nutrient management on growth and yield of Green gram (*Vigna radiation* L.); c2023.
29. Mubarak AE. Nutritional composition and antinutritional factors of Mung bean seeds (Phaseolus aureus) as affected by some home traditional processes. Food Chemistry. 2005;89(4):489-495.
30. Naveen KH, Mevada KD. Performance of different composts and biofertilizer on yield and quality of Green gram (*Vigna radiata* L.), Advances Research Journal of Crop Improvement. 2012;3(1):17-20.
31. Oplinger ES, Hardman LL, Kaminski AR, *et al*. Mungbean. In Alternative feed crop manual. Madison, WI: University of Wisconsin; c1990.
32. Pandey OP, Shahi SK, Dubey AN, Maurya SK. Effect of integrated nutrient management of growth and yield attributes of Green gram (*Vigna radiata* L.). Journal of Pharmacognosy and Phytochemistry. 2019;8(3):2347-2352
33. Patel AR. Integrated nutrient management in summer Green gram (*Vigna radiata* L.) Under south Gujarat condition (Doctoral dissertation, Agronomy Dept., NM College of Agriculture, Navsari Agricultural University, Navsari), 2016.
34. Patel SA, Chaudhari PP, Desai NH. Yield and economics of Green gram (*Vigna radiata* (L.) Wilczek) Cultivars as Influenced by Integrated Nutrient Management. Crop Res. 2016a;51(1):2454-1761.
35. Pattanayak SK, Rao DLN, Mishra KN. Effect of biofertilizers on yield, nutrient uptake and nitrogen economy of rice-peanut cropping sequence. Journal of the Indian Society of Soil Science. 2007;55(2):184-189.
36. Priya C, Divya J, Anand K, Debasis M. Biofertilizers: A sustainable approach for plant and soil health. In Mitra *et al*., eds. Research advancements and beneficial effects of plant growth promoting microorganism in agriculture, 106–109. Maldova: Lambert Academic Publishing. 2019.
37. Singh RA. Integrated nutrient management in Green gram (*Phaseolus radiatus*)– Indian mustard (*Brassica juncea*) summer groundnut (*Arachis hypogaea*) cropping system. International Journal of Agriculture Science. 2007;3(2):263-268
38. Rathour DK, Gupta AK, Choudhary RR, Sadhu AC. Effect of integrated phosphorus management on growth, yield attributes and yields of summer Green gram (*Vigna radiata* L.). The Bioscan. 2015;10(1):05-07.
39. Selim MM. Introduction to the integrated nutrient management strategies and their contribution to yield and soil properties. International Journal of Agronomy;

c2020.
40. Shakya MS, Patel MM, Singh VB. Knowledge level of chickpea grower about chick pea production technology. Indian Research Journal of Extension Education. 2008;8:65-68.
41. Sharma VK, Pandey RN, Sharma BM. Studies on long term impact of STCR based integrated fertilizer use on pearl millet (*Pennisetum glaucum*) -wheat (*Triticum aestivum*) cropping system in semi arid condition of India. J Environ. Bio. 2015;36:241-247.
42. Singh SR, Zargar MY, Najar GR, Peer FA, Ishaq MI. Integrated use of Organic and Inorganic Fertilizers with Bio-inoculants on yield, soil fertility and Quality of Apple (*Malus domestica*). Indian Society of Soil Science. 2011;59(4):362-367.
43. Singh PK, Anees M, Kumar M, Yadav KG, Kumar A, Sharma R, *et al*. Effect of integrated nutrient management on growth, yield and quality of Moongbean (*Vigna radiata* L.). Journal of Pharmacognosy and Phytochemistry, 2019. p. 1003-1006.
44. Singh R, Singh P, Singh P, Yadav RA. Effect of phosphorus and PSB on yield attributes, quality and economics of summer Green gram (*Vigna radiata* L.). Journal of Pharmacognosy and Phyto-chemistry. 2018;7(2):404-408.
45. Swathi K, Sunanda M, Shinde VS, Kote GM. Nutrient uptake, quality and economics of Green gram (*Vigna radiata* L.) As influenced by phosphorus management. Annals of Plant and Soil Research. 2015;17:241-244
46. Tan ZX, Lal R, Wiebe KD. Global soil nutrient depletion and yield reduction. Journal of Sustainable Agriculture. 2005;26(1):123–46. DOI:10.1300/J064v26n01_10.
47. Tripathi ANM, Tripathi SK, Mishra P, Singh ON. Effect of INM on growth, yield and uptake of N,P and K of Green gram (*Vigna radiata* L.) In custard apple based Agri-horti system under rainfed condition. Biosciences. 2014;7(1):980-982
48. Tyagi PK, Singh VK. Effect of integrated nutrient management on growth, yield and nutrients uptake of summer black gram (*Vigna mungo*). Annals of Plant and Soil Research. 2019;21(1):30-35.
49. Tyagi PK, Upadhay AK. Effect of integrated nutrient management on yield, quality, nutrients uptake and economics of summer Green gram. Annals of Plant and Soil Research. 2015;17(3):242-247.
50. Verma NK, Pandey BK, Mahan RD, Kumar A. Response of Mode of Application with Integrated Nutrient Management on Growth and Yield of Chick Pea (*Cicer arietinum* L.). International Journal of Agriculture Innovations and Research. 2017;6(1):2319-1473.
51. Verma S, Saxena R, Singh HV. Integrated nutrient management in sesame (*Sesamum indicum* L.). Bioinfolet-a Quarterly Journal of Life Sciences. 2012;9(4):576-579.
52. Vigneshvarraj A, Elayaraja D, Arivukkarasu K, Jawahar S. Effect of integrated nutrient management on growth, yield and Nutreint uptake by Green gram (*Vigna radiata* l.) In coastal saline soil. Plant Archives. 2020;20(2):4601-4607.
53. Virmani SM. The twenty first- Dr. R. V. Tamhane Memorial Lecture: UNCEED Agenda 21: The new challenge for protein research. Journal of Indian Society of Soil Science. 1994;42:516-523.