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A review on response of Integrated Nutrient Management (INM) practices on growth and productivity of Greengram

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Abstract
Integrated Nutrient Management is one of the most important practices which goal is to achieve high performance through the utilization of organic resources in crop management. This leads to development of concept of sustainable agriculture. There is an increasing awareness about INM in view of the energy shortage, food quality, safety and environmental concerns arising out of conventional crop production. An INM practice involves harnessing of soil organism to process to animal and crop residues and to produce slow release of nutrients as needed by the crops. Earthworms can be is a most important biological indicators of soil fertility for billions of years before these silent machines have been performing excellent function of soils plugging and fertilizing. The number of scientists reported significant effects of Vermicompost on germination efficacy, growth, yields and quality of Greengram.

Keywords: INM, RDF, vermicompost, FYM, yield, productivity

Introduction
Greengram has been cultivated in India since prehistoric times and is believed to be a native crop of India. The food value of Greengram lies in its high and easily digestible protein. Its seed contain around 25-28% protein, 1.0-1.5% oil, 3.5-4.5% fibre, 4.5-5.5% ash and 62-65% carbohydrates on dry weight basis. In India food grains occupy 65% of total gross cropped area comprising cereals in 50% and pulses in about 15%. Within pulses, chickpea occupies 5% area followed by urdbean 3%, mungbean 2%, pigeonpea 2% and the other pulses cover about 3% of gross cropped area under pulses in India. Pulses are cultivated on an area of 29.99 million hectares with total production of 25.23 million tonnes and average yield of 841 kg/ha during 2017-18 (Agricultural Statistics at a Glance, 2018) [2]. In India, mungbean is mainly grown in Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Bihar, Gujarat, Odisha, Uttar Pradesh and Madhya Pradesh. There are 17 major pulses producing states in India. Out of these, Uttar Pradesh has contributed to about 8.5% in area and 9.5% in production, thus occupies fifth and fourth ranks in India, respectively. mungbean is cultivated on an area of 4.23 million hectares with total grain production of 2.01 million tonnes and average yield of 472 kg/ha during 2017-18 (4th Adv. Estimates) which contributed 14.19% in area and 7.96% in production of total pulses in India (Anonymous, 2018) [6]. In Uttar Pradesh state, pulses are grown an area of 2255 thousand hectares with a production of 1184 thousand metric tonnes and productivity of 533 kg/ha during 2017-18. Out of this, Uttar Pradesh Bundelkhand alone occupies 54.3% in area and 45.3% in total production. In mungbean, Uttar Pradesh occupies 89.9 thousand hectares of area with a production of 44.7 thousand metric tonnes and a productivity of 477 kg/ha during 2017-18.
Intensive agriculture in India involving the use of chemical fertilizers/pesticides in large amount has, no doubt, resulted in manifold increase in the productivity of farm commodities, but the adverse effects of these chemicals are clearly visible on soil physical, chemical and biological properties. Integrated nutrient management practice envisages the comprehensive management approach to improve the soil health, eco-system of the region and the quality of produce. However, a living soil can be maintained by continuous incorporation of crop and weed biomass, use of animal dung, urine-based manures *viz*., FYM, compost, vermicompost etc. besides achieving higher growth, yield and quality of crops. In this context, the literature pertaining to the INM on various organics, inorganic and biological protocols in greengram.

Effect of INM on Growth, Yield Attributes and Yield of Greengram

Sadeghipour *et al.* (2010) [69] reported that application of N and P fertilizers significantly increased the seed yield (224.2 g/m^2) was obtained when 90 kg N /ha and 120 kg P_2O_5 /ha was applied. Mukherji *et al.* (2013) [54] reported highest dry matter accumulation was obtained in NPK + Mo followed by organic + Zn and NPK with no significant difference among them. Plant height was found highest in NPK followed by NPK + Mo and organic + B without any significant difference. Rathod and Gawande (2014) [68] reported that application of 30:60:00 kg NPK / ha recorded significantly higher growth and yield contributing characters of green gram followed by application of 25:50:00 and 20:40:00 kg NPK/ha. Green gram variety BM-2003-02 recorded significantly higher growth contributing characters followed by BPMR-145 and BM-2002-01. They also reported that variety BM-2003-02 recorded significantly higher yield attributes, followed by BM-2002-01. Kumar *et al.* (2015) [38] observed that application of 50% RDF + 50% RDN + PSB produced significantly higher yield and yield attributes, and N, P, K uptake by mungbean. Imran *et al.* (2016) [33] reported the highest thousand seed weight, seed yield, biological yield, and harvest index were produced by P at the rate of 60 kg/ ha, while maximum plant height, number of pods/ plant, number of seeds/ pod, and protein content were given by P at the rate of 40 kg/ ha at par with P at the rate of 60 kg/ ha. Saha and Patra (2017) [70] reported that 25 kg nitrogen/ha in the form of urea, at constant level of phosphorus and potassium recorded highest growth attributes, which leads to more grain yield of greengram (914.54 and 926.83 kg/ha during 2016 and 2017, respectively) followed by 30 kg N/ha and 35 kg N/ha. Verma *et al.* (2017) [87] reported the highest grain yield (12.35 q/ha) and biological yield (37.42 q/ha) was obtained under Rhizobium + PSB + 60 P_2O_5/ha enhancing by 68.03 and 30.38 per cent higher over control. Kumar *et al.* (2018) [39] reported different potassium level of soils is significantly affected the mungbean plants yield and yield contribution parameters. Maximum mungbean yield was 689 kg/ha was obtained with the application of 85 kg potash per hectare. Muniswam *et al.* (2018) [55] reported that the application of 25 kg N/ha + 40 kg S/ha + 0.1% zinc at pre flowering and pod initiation significantly increased yield and quality parameters of greengram *viz*, maximum number of pods/ plant (30.33), test weight (41.68 g), seed yield (8.89 q/ha) and stover yield (27.10 q/ha) as well as maximum harvest index (24.73%) and protein content (24.83%). Akter *et al.* (2019) [3] reported phosphorus @ 40 kg/ha showed the highest performance in respect of plant height, leaves/plant, branches/plant, root length, leaves area, dry weight of shoot, dry weight of root, yield contributing attributes *viz.* number of pod per plant, pod length, number of seed/pod, thousand seed weight and seed yield/ha of mungbean. Muindi *et al.* (2019) [29] reported that the plots treated with zinc + manure recorded 32% higher plant height and 46% higher grain yield compared to NP applied plots.

Effect of Vermicompost Protocols on Growth, Yield Attributes and Yield of Green gram

Mathur (2000) [46] observed that the application of 20 kg N/ha through vermicompost significantly increased the growth of summer green gram in terms of plant height, dry matter, LAI, number and dry weight of nodules per plant than rest of the treatments and observed that application of 70 kg N/ha through vermicompost significantly increased pods per plant, seed yield, stover yield and total biomass yield of green gram over rest of the treatments. Rajkhowa *et al.* (2000) [66] found that application of recommended dose of nitrogen through vermicompost significantly increased seed yield of green gram over control and recommended dose of nitrogen through FYM. Das *et al.* (2002) [19] reported that application of 100 per cent recommended dose of fertilizers to green gram through vermicompost significantly produced taller plants, more leaf area, root volume, nodule number, fresh nodule weight and dry matter yield better influence on dry matter yield, number of pods and pod yield of green gram as compared to the control and 100 per cent RDF through FYM. Rajkhowa *et al.* (2002) [65] reported that application of vermicompost at 2.5 t/ha + 100% RDF significantly increased the plant height, dry matter accumulation, root weight and yield of green gram over the control. Thiyageshwari and Perumal (2002) [82] reported that application of vermicompost @ 2 t/ ha + SSP (100%) + PSB recorded significantly higher grain yield (986 kg/ ha), haulm yield (1337 kg/ ha), number of pods/ plant (21.8), 1000 grain weight (41.00 g) and crude protein content (25.84%) of the blackgram over other nutrient management treatments. Kumar *et al.* (2003) [41] reported that plant height and dry matter accumulation per plant and produced 16.5 and 9.5 per cent higher seed yield of mungbean compared to FYM at 5 t/ ha and vermicompost at 2.5 t/ ha, respectively over the control. Meena (2005) [48] observed significant increase in total uptake of NPK in greengram with application of 5 t FYM/ha along with 75% NPK of RDF and 2.5 t vermicompost/ha over control and other levels**.** Dahama and Poonia *et al.* (2007) [18] while investigating the effect of N (20 kg/ha), P_2O_5 (30 kg/ha), potash (20 kg/ha), Zn (25 kg/ha), Fe (5 kg/ha), FYM (10 t/ha) and vermicompost (5 t/ha), applied singly or in combination, on the performance of green gram cv. RMG-62 at Bikaner (Rajasthan) reported that plant height at harvest was highest with NPK + vermicompost (43.8 cm). Chandramohan and Chandaragiri (2007) reported in blackgram that growth parameters like plant height, LAI, DMP, CGR and RGR and seed yield 502 and 484 kg/ha significantly influenced by application of 50% of N through sunhemp + 50% of N through vermicompost and were comparable with recommended NPK through inorganic source of nutrient respectively. Salah *et al.* (2009) [84] reported that most of the growth and yield component of mungbean *viz*. plant height, branch plant, number of nodules/plant, total dry matter/plant, pods/plant, seeds/plant, seeds/pod, weight of 1000-seeds, seed yield and straw yield were significantly influence by the bio-fertilizer (Bradyrhyzobium inoculums) treatment except number of leaves and dry weight of nodule. Niranjan *et al.* (2010) [58] reported application of vermicompost had significant positive effects on growth performances and yield of plant as compare to the control. Kumwat *et al.* (2010) reported that significantly influenced the yield attributes i.e. pods/plant, seeds/pod and test weight of mungbean. However, seed yield (8.09 q/ha), straw yield (16.24 q/ha) and biological yield (24.33 q/ha) were also significantly higher with the application of organic manures, PSB and phosphorus fertilizatization. Sutaria *et al.* (2010) [79] reported that the application of vermicompost produced significantly higher grain yield (1029 kg/ha) and straw yield (1207 kg/ha) as compared to enriched compost (988 kg/ha) in blackgram. Bhatt *et al.* (2012) [11] reported that the application

of vermicompost @ 1.5 t/ha significantly increased plant height, total dry matter production and number of nodules of greengram over that of 0.5 and 1.0 t/ha which accounted to the tune of 13.03, 17.54 and 14.08 per cent higher, respectively. Dhakal (2013) [23] reported that the highest seed yield of mungbean was obtained with the application of recommended dose of 75% RDF + 2.5 t/ha vermicompost + Rhizobium + PSB (12.34 q /ha) followed by treatments 100% RDF + 2.5 t/ha vermicompost (12.05 q /ha) and 100% RDF + Rhizobium + PSB (11.95 q /ha). The highest and comparable net returns were obtained with the application of 100% RDF + Rhizobium + PSB (52894.73) followed by 75% RDF + 2.5 t/ha vermicompost + Rhizobium + PSB (61582.60) and 75% RDF + Rhizobium + PSB (50664.74). Kundu *et al.* (2013) [64] reported that plots treated with rhizobium seed inoculation positively and significantly influenced the growth parameters, nodulation, seed and stalk yield of greengram and also bacterial population of soil system. Chhaparwal *et al.* (2013**)** [17] reported that application of vermicompost being at par with PSB+ vermocompost, significantly increased plant height, number of branches per plant, dry matter accumulation per meter row length, chlorophyll content, number and dry weight of root nodules per plant, seeds per pod, test weight and yield parameters of greengrame. Sitaram *et al.* (2013) [80] reported that application of higher levels of vermicompost from 5 to 7.5 t/ha significantly enhanced the plant height at harvest, dry matter accumulation at 30, 45 and 60 DAS, dry weight of root nodules at 30 and 45 DAS, total chlorophyll content in fresh leaves at 30, 45 and 60 DAS, leaf area index at 30, 45, and 60 DAS, CGR during 30-45 and 45-60 DAS, RGR during 45-60 DAS and NAR during 45-60 DAS in mungbean. Chaudhari *et al.* (2013) [16] reported that application of recommended dose of N (20 kg/ha) through vermicompost along with foliar application of panchagavya at 15 and 30 days after sowing to summer greengram which performed better and recorded significantly higher value of all growth attributes *viz*., plant height (41.6 cm), number of branches/plant (7.8), dry matter accumulation/plant (38.7 g), chlorophyll content (100.44) and root nodules/plant (27.3) over rest of the treatments Maryam and Mohammad (2013) [45] reported that biological yield of greengram was significantly affected by vermicompost and plant density. Significant increase in biological yield (7502 kg/ha) was observed by using 10 t vermicompost per ha compare to the control. Saravanan *et al.* (2013) [59] reported that the FYM + 10% NPK whereas number of seeds was maximum in FYM + CCP 2:1 treatment. Integrated approach recorded better availability of nutrients *viz.* calcium, phosphorus, iron, sodium and potassium in fresh and dry seeds of greengram than the individual application. Patel *et al.* (2013) [61] reported that 100% RDF (20-40-00 kg kg/ha NPK) + biocompost (5 t/ha) + management option recorded higher economic seed yield of greengram. Rathod and Gawande (2014) [68] reported that the application of 30:60:00 kg NPK/ha recorded significantly higher growth and yield contributing characters followed by application of 25:50:00 and 20:40:00. Biswas *et al.* (2014) [13] reported that highest plant height, number of branches per plant, average dry weight per plant, number of pods per plant, number of seeds per plant, test weight, seed yield and stover yield with the application of vermicompost 8 t/ha compared to control. Dhakal *et al.* (2015) [21] reported that significant improvement in LAI, number of trifoliate, SPAD value of green leaf chlorophyll, dry matter accumulation, yield, harvest index and nutrient content of mungbean due to application of 75% RDF + 2.5 t/ha vermicompost + Rhizobium + phosphorus solublizing bacteria, followed by 100% RDF + 2.5 t/ha VC and 100% RDF + Rh + PSB. The highest seed yield of mungbean was obtained with the application of 75% RDF + 2.5 t/ha VC + Rh + PSB (12.34 q/ha) followed by 100% RDF + 2.5 t/ha VC (12.05 q/ha) and 100% RDF + Rh + PSB (11.95q/ha). Neelam *et al.* (2015) [56] reported that application of 1/3 N each applied in form of FYM + vermicompost + neemcake + 75% recommended fertilizer dose (RDF) recorded significantly higher yield attributes and yield (1226 and 1359 kg/ ha) of mungbean and wheat (2908 and 2992 kg/ ha) during first and second year, respectively under tall wheat and mungbean cropping system. Meena *et al.* (2015) [21] reported that significant improvement in plant height at harvest, yield attributes, yield, protein per cent, nutrient content and uptake by greengram were recorded with application of nutrients through 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB as compared to other combinations, followed by treatments 100% RDF + 2.5 t/ha vermicompost and 100% RDF + *Rhizobium* + PSB. Sharif *et al.* (2015) [73] reported that significantly enhanced the seed yield and seed quality parameters of greengram and they also reported that the application of FYM (1/3)+ vermicompost (1/3) + glyricidia leaf manure (1/3) equivalent to 100% RDP and foliar spray of panchagavya (3%) at flower initiation and 15 DAF recorded significantly more number of pods per plant (21.27), pod length (10.25 cm), number of seeds per pod (12.10), seed yield (12.89 g/plant) and seed yield (1263.68 kg/ha). compared to other treatment combinations and control. Dhakal *et al.* (2016) [22] reported that significant improvement in number of nodules/plant (80.97), dry weight of nodules (32.89 mg/plant), yield attributes, seed yield (12.34 q/ha), harvest index (28.32%), nutrient content, available NPK and organic carbon after harvest in soil were recorded with application of nutrients through 75% RDF + 2.5 t/ha vermicompost + rhizobium + phosphate solubilizing bacteria (PSB) as compared to other combinations and control, but it was at par with 100% RDF + 2.5 t/ha vermicompost and 100% RDF + rhizobium + PSB. Suman meena *et al.* (2016) [22] observed that growth and yield of greengram in treatment 20 kg N, 40 kg P, 40 kg K and FYM @ 10 tonnes/ha were found to be significant over all other treatment. Arsalan Muhammad *et al.* (2016) [7] observed that the application of vermicompost (2 t/ha) with full dose of phosphorus (75 kg P_2O_5 /ha) treatment (V_1P_2) fertilization markedly influenced the nutrient concentration in grains (2.56% of N, 0.3% of P, 1.23% of K), their uptake (62 kg/ha N, 12 kg/ha P, 39 kg/ha K) and yield (1410 kg/ha) over the control in mungbean. Economically significant nutrient contents in grain (2.44% N, 0.37% P, 1.17% K), nutrient uptake (52 kg/ha N, 8.91 kg/ha P, 31.5 kg/ha K) and yield (1282 kg/ha) was observed from the treatment where half dose of fertilizer (37.5 kg P_2O_5 /ha) with 2 t/ha vermicompost (V_1P_1) over the control. Mishra *et al.* (2016) [50] reported that the growth characters of greengram like plant height (34.7 cm), number of branches (6.5), number of nodules per plant (23.5), dry weight of nodules (67.3 mg/plant), yield attributes *viz.* number of pods per plant (32.3), number of seeds per pod (8.9), test weight (36.91 g), seed yield (11.6 q/ha), stover yields (26.1 q/ha) and harvest index (30.76%) was influenced significantly by integrated use of nutrient sources *viz.*, 50% recommended doses of NPS through chemical fertilizer and 50% N through FYM which

was at par to the 100% chemical fertilizer (NPS) treatment. The organic treatments received 100% recommended N combindly through FYM + neem cake + vermicompost (1/ 3 from each source) along with weed and pest control measures provided comparable yields to fertilizer treatment. Verma *et al.* (2017) [87] reported that application of Rhizobium + PSB + 20 kg N/ha gave significantly higher number of nodules (25.10/plant) and dry weight of nodules (24.10 mg/plant) of green gram which was statistically at par with Rhizobium + PSB + 60 kg P_2O_5/ha. Similarly, maximum yield attributes of greengram *viz*., number of pods (70.48), pod length (5.78), number of seeds (8.68) and test weight (40.05 g) were recorded with the application of Rhizobium + PSB + 60 kg P_2O_5/ha. Further results showed that highest grain yield (1235 kg/ha), straw yield (2507 kg/ha), harvest index (33.0%) and production efficiency (17.39 kg/ha/day) were also recorded under Rhizobium + PSB + 60 kg P_2O_5/ha. Singh *et al*. (2017) reported that application of RDF + VC 5 t/ha registered maximum growth attributes, number of nodules, nodules dry weight, yield attributes and produced 8.42 and 5.1 per cent higher seed yield of mungbean (1060.6 kg/ha) over RDF (978.1 kg/ha), and RDF + VC 2.5 t/ha (1009.6 kg/ha), respectively. Chaudhari *et al*. (2017) reported that soil conditioner and INM significantly influenced the yield and yield attributes of mungbean. Application of gypsum @ 2 t/ha was found significantly superior over control (G_1: No gypsum) by recording higher values of number of pods per plant (33.1), number of seeds per pod (10.15), seed yield (1130 kg/ha) and stover yield (3829 kg/ha) as compared to rest of the INM levels. Chandel *et al.* (2017) [14] reported that the use of FYM followed by gliricidia green leaf manuring in conjunction with chemical fertilizers recorded higher cotton and greengram yields with maximum monetary returns with improvement in soil fertility. Hence, it is concluded that long term application of 50% N through FYM/ gliricidia + 50% N through inorganics + 100% P_2O_5 /ha to cotton + greengram (1:1) intercropping system resulted in sustaining crop productivity and build up fertility status of Vertisols under rainfed condition. Mangesh *et al*. (2018) [18] reported that the maximum yield of greengram crop was produced by the vermicompost treatment after 60 day compared to remaining fertilizers treatment. Vermicompost is best organic fertilizer which is best treatment for production of greengram crop. Bhavya *et al*. (2018) [12] reported that application of higher dose of phosphorus along with PSB and vermicompost (100% RDP + vermicompost + phosphate solubilizing bacteria) proved to be the best in improving the seed yield (1033.33 kg/ ha). Application of inorganic P fertilizers, organic manures and PSB markedly influenced the nutrient concentration and their uptake. Results showed that application of vermicompost at 5 t/ha, seed inoculation with PSB and 100% RDP significantly increased the N, P, K and S concentration in grain, haulm and their uptake by greengram. Krishnaprabu (2018) [37] reported that integrated nutrient management not only increased the yield of greengram 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. Tiwari *et al.,* (2021) reported that the better effect of INM practices on growth, yield parameters such as number of pods/plant, number of seeds/pod, seed weight/plant and 1000-seed weight, seed yield and economics as compared to sole application of inorganic fertilizers and vermicompost treatments. However, 100% RDF + 100% Vermicompost had highest seed yield (822 kg/ha), closely followed by 75% RDF + 50% vermicompost (791 kg/ha) compared to rest of treatments.

Effect of INM on Economics of Greengram

Mukherji *et al.* (2013) [54] reported Kalyani, Nadia that economic analysis depicted that higher gross return, net return and net production value of greengram were obtained in NPK + Mo followed by organic + Mo and NPK + Zn. Hence, nutrient management with NPK + Mo at recommended doses for greengram may be suitable for higher yield and profitability. Neelam *et al.* (2015) [56] reported that net returns were higher with 100% RDF (₹ 60272 and ₹ 66948/ha), respectively, during both the years under mungbean-wheat system. The benefit: cost was also found higher with the application of 100% RDF among different nutrient levels with the value of 2.81 and 2.80 during 2010-11 and 2011-12, respectively. Meena *et al.* (2015) [21] reported that The highest and comparable net returns of greengram were obtained with the application of 100% RDF + *Rhizobium* + PSB (INR 52894.73) followed by 75% RDF + 2.5 t/ha vermicompost + *Rhizobium* + PSB (INR 51582.60) and 75% RDF + + *Rhizobium* + PSB (INR 50664.74). Patel *et al*. (2016) [13] conducted an experiment with two greengram varieties *viz*. Meha and GM-4 and seven treatment of INM *viz*. 100% RDF, 75% RDF + 2t FYM/ ha, 75% RDF + Rhizobium + PSB, 75% RDF + 2t FYM/ ha + Rhizobium + PSB, 50% RDF +4 t FYM/ ha, 50% RDF + Rhizobium + PSB and 50% RDF + 4 t FYM/ ha+ Rhizobium + PSB and they reported that maximum net relization along with higher BCR value were recorded with variety 'Meha' and combination application of 75% RDF from urea + 2t FYM/ ha+ Rhizobium + PSB. Dubey *et al*. (2017) reported that higher net realization of ₹ 102274.8/ha was obtained with combined application of $V_1 L_5$ followed by ₹ 100958.9/ha with $V_1 L_2$ treatment combination. Among liquid fertilizer and variety treatment, L_2 (₹ 84122.8/ha) and V_1 (₹ 93299.8/ha) secured maximum net profit. It was lowest (₹ 20099.3/ha) with treatment combination $V_2 L_4$. Muniswam *et al*. (2018) [55] reported that the application of 25 kg N/ha + 40 kg S/ha + 0.1% zinc (pre flowering and pod initiation) recorded maximum, gross return (₹ 44092.0/ha), net return (₹ 24739.0/ha) and B:C ratio (2.30) of greengram while lowest gross return (₹ 29083.0/ha), net return (₹ 11109.0/ha) and B:C ratio (1.61) was obtained in treatment T_1 (control), respectively. INM treatments recorded 169.2, 14.5 and 64.5% higher net returns as well as 43.0, 2.3 and 26.3% more benefit: cost ratio over the control, 100% RDF and 100% vermicompost, respectively. Arsalan *et al.* (2016) [7].

Effect of INM on Soil Health

Kale and Bano (1986) stated that vermiculture can considerably reduce the use of other fertilizers besides improving soil fertility. Edwards and Burrows (1988) [26] Albanell *et al*., (1988) [4] stated that Vermicompost contain nutrients in forms that are readily taken up by plants such as nitrates, exchangeable phosphorous, soluble potassium, calcium and magnesium, and have less soluble salts, greater cation exchange capacity and increased humic acid contents

respectively. Vinceslas-Akpa and Loquet (1997) [88] reported that the Vermicompost product had a lower soil organic carbon and higher nitrogen ratio, which indicates that the Vermicompost products were most suitable for soil amendment use. Atlavinyte and Daciulyte (1969) [8] reported the Vermicompost promote the accumulation of vitamin B12 in the soil. reported a reduction of 50% of the recommended dose of nitrogen was supplemented by the use of Vermicompost. Shi-Wei and Fuzhen (1991) [74] stated that the Vermicompost contain large surface area for retention of nutrients. Orozco *et.al.* (1996) reported the forms are readily taken by the plants. Basker et. al., (1993) [10] pointed out the studies carried out under field conditions indicated that the castings of earthworms contained 2-3 times more available potassium than the surrounding soil. Ellio *et al*. (1990) [28] found that earthworm castings generally have a higher ammonium concentration and water – holding capacity than bulk soil samples and they constitute sites of high denitrification potential. Many authors have reported that Vermicompost enchance the plant growth in field soils and green house media has been attributed to a variety of factors including physicochemical properties. Edwards and Burrows (1988) [26].

Effect of Vermicompost on plant parasite

Vermicompost helps the plant to fight soil – borne plant disease. Choui *et al*., (2002) pointed out the applications of Vermicomposts have been reported to suppress plant fungi such as Phytophthora, Fusarium and Plasmodiophora in tomatoes and cabbage, Pythium,Rhizootonia in cucumber and radish, Verticilli in strawberries. Addabdo (1995) [1] stated that the various forms of organic matter amendments could often suppress plant parasitic nematode populations. Edward and Bohlen (1996) [27] stated that the nursery plants grown in the biologically enhanced Vermicompost may have increased resistance to pests and pathogen.

References

1. Addabdo TD. The nematicideal effect of Organic amendments: a review of literature 1982-1994 Nemendments: a review of the literature 1982-1994 Nematologia Mediterranea. 1995;23:299-305.
2. Agricultural Statistics at a Glance. Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Framers Welfare; c2018.
3. Akter Nadira, Hossain Kamal Md, Uddin Nizam Mohammad, Hoque Fazlul Md, Hossain Billal Md. Effect of phosphorus on growth, yield and yield contributing characters of mungbean. International Journal of Innovative Research. 2019;4(2):39-43.
4. Albanel E, Plaixat J, Cebrero T. Chemical changes during vermicompostiong (*Eisenia foetida*) of sheep manure mixed with cotton industrial wastes, Biology and Fertility of Soils; c1988. p. 266-269.
5. Alhrout H Hussein, Khalifeh Hammad, Aldal'in Hammad, Haddad A Moawiya, Nabeel M, Bani-Hani. The impact of organic and inorganic fertilizer on yield and yield components of common bean (*Phaseolus vulgaris*). Advances in Environmental Biology. 2016;10(9):8-13.
6. Anonymous. Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Directorate of Economics and Statistics, Fourth Advance Estimates of Production of Food grains for; c2017-18.
7. Arsalan Muhamma, Ahmed Shoaib, Chauhdary Nawaz junaid, Sarwar Muhammad. Effect of vermicompost and phosphorus on crop growth and nutrient Uptake in mungbean. Journal of Applied Agriculture and Biotechnology. 2016;1(2):38-46.
8. Atlavtive O, Daciulyte J. the effect of earthworms on the accumulation of vitamin B12 in soil. Pedobiologia. 1969;9:165-170.
9. Bai NR, Thisya K, Christi RM, Kala TC, Yadav RS. Integrated application of organic manures on the growth, yield and nutritional status of *Vigna mungo* L. Plant Archives. 2011;11(2):973-978.
10. Basker A Macgregor. Exchangeable potassium and other cations in non – ingested soil and casts of 2 species of pasture earthworms, Soil. Biol. Biochem. 1993;25:1673-1677.
11. Bhatt PK, Patel PT, Patel BT, Ravel CH, Vyas KG. Effect of vermicompost and phosphorus levels with PSB on growth and yield of summer greengram (*Vigna radiata*) under north Gujarat conditions. Green Farming. 2012;3(6):666-669.
12. Bhavya G, Shaker K Chandra, Jayasree G, Reddy M Malla. Nutrient uptake and yield of greengram (*Vigna radiata* L.) as influenced by phosphorus fertilization, organic manures and biofertilizers. International Journal of Chemical Studies. 2018;6(3):32-35.
13. Biswas Romel M.d, Rahman Wasal M.d, Haque Maksudul M.d, Sharmin Mashuka, and Barua Rajesh. Effect of potassium and vermicompost on the growth, yield and nutrient contents of mungbean. Open Science Journal of Bioscience and Bioengineering. 2014;1(3):33-39.
14. Chandel Ashwini, Gabhane VV, Nagdeve MB, Turkhede AB, Patode RS. Effect of integrated nutrients management on soil fertility,productivity and economics of cotton + greengram intercropping system in vertisols. International Journal of Current Microbiology and Applied Sciences. 2017;6(11):3738-3743.
15. Chandra Mohan S, Chandragiri KK. Effect of organic manures on Growth and yield attributes in cotton + blackgram intercropping system. International Journal of Plant Science. 2007;2(1):156-160.
16. Chaudhari IA, Patel DM Patel, Patel SM. Effect of various organic sources of nutrients on growth and yield of summer greengram (*Vigna radiate* L.). Crop Research, 2013;46(1, 2 &3):70-73.4.
17. Chhaparwal P, Sharma OP, Choudhary HR, Yadav LR. Response of fertility levels and bio-organics on growth, yield and yield attributes of mungbean (*Vigna radiata* L. Wilczek) under semi-arid area. Environment and Ecology. 2013;31(2):506-509.
18. Dahama AK, Poonia BL Suman. Effect of balanced fertilization on growth and yield of greengram. [*Phaseolus radiatus* (L.) Wilczek]. Haryana Journal of Agronomy. 2007;23(1/2):118-119.
19. Das PK, Sarangi D, Jena MK, Mohanty S. Response of greengram [*Vigna rediata* (L.) to integrated application of vermicompost and chemical fertilizers in acid lateritic soil. Indian Agriculturist. 2002;46(1,2):79-87.
20. Dash SR, Rautaray BK. Growth Parameters and yield of

greengram varieties (*Vigna radiata* L.) in East and South East Coastal Plain of Odisha. International Journal of Current Microbiology and Applied Science. 2017;6(10):1517-1523.
21. Dhakal Yubaraj, Meena RS, De Nirmal, Verma SK, Singh Ajeet. Growth, yield and nutrient content of mungbean (*Vigna radiata* L.) in response to INM in eastern Uttar Pradesh, India. Bangladesh Journal of Botany. 2015;44(3):479-482.
22. Dhakal Yubaraj, Meena Ram, Swaroop, Kumar Sushil. Effect of INM on nodulation, yield, quality and available nutrient status in soil after harvest of greengram. Legume Research Agriculture Research Communication centre. 2016;39(4):590-594.
23. Dhakal Y. Effect of integrated nutrient management on growth, yield and quality of mungbean [*Vigna radiata* (L.) Wilczek]., Institute of Agricultural Sciences, Banaras Hindu University Varanasi M.Sc. (Ag) Arornomy (krishikosh); c2013.
24. Dodwadia KS, Sharma AR. Effect of tillage and methods of sowing on performance of greengram varieties during *summer* and *rainy* season. Indian Journal Agriculture Science. 2012;82(5):462-475.
25. Dueby PK, Akhila K, Kaswala Anand, Priyanka. Effect of liquid fertilizers on growth yield and economics of the green gram (*Vigna radiata*) crop under organic farming. International Journal of Chemical Studies. 2017;5(6):809-812.
26. Edwards CA, Burrows 1. The potential of earthworm composts as plant growth media. In: Edwards, C.A Neuhauser, E. (eds) Earthworms in waste and Environmental Management SPB Acadmic Press The Hague, The Netherlands; c1988. p. 21-32.
27. Edwards CA, Bohlen PJ. Biology end Ecology of Earthworms. Third Edition 426 PP. Chapman and Hall London; c1996.
28. Ellio PW, Knight D, Anderson JM. Denitrifiction of earthworm casts and soil from pastures under different fertilizer and draingeregimes. Soil Biol. Biochem. 1990;22(5):601-605.
29. Esther Mwende Muindi, Consalata Mueni Muindi, James Ndiso. The effects of combining farm yard manure, starter nitrogen, phosphorus and zinc on growth and yield of greengrams. Journal of Agriculture and Ecology Research International. 2019;20(4):1-9.
30. Fisher RA, Yates F. Statistical tables for biological, agricultural and medical research, Oliver and Boyd. Edinburgh 6th edition; c1957. p. 98-108.
31. Gadi Parvati, Dawson Joy, Shankar M. Effect of different organic manures, inorganic fertilizer and growth regulator on yield attributes and yield. International Journal of Current Research. 2017;9(06):52385-52389.
32. Gorade VN, Chavan LS, Jagtap DN, Kolekar AB. Response of greengram (*Vigna radiata* L.) varieties to Integrated nutrient management in summer season. Agricultural Science Digest. 2014;34(1):36-40.
33. Imran Asad, Ali Khan, Inam Ullah, Manuel Tejada Moral. Yield and yield attributes of Mungbean (*Vigna radiata* L.) cultivars as affected by phosphorous levels under different tillage systems. Cogent Food and Agriculture. 2016;2(1).
34. Jackson ML. Soil chemical analysis, Indian Edn. Practice Hall of Indian Private Limited New Delhi; c1967. p. 485.
35. Jat RS, Ahlawat IPS. Effect of vermicompost, bio-fertilizer and phosphorus on chickpea and their residual effect on succeeding fodder maize. Extended Summaries of Second. International Agronomy Congress. 2002;28(1):369-370.
36. Jawhara AL, Owied AL. Comparative study of synthetic fertilizers and organic manures on some mungbean (*Vigna radiata* (L.) Wilczek) genotypes 1-Effect on growth parameters and photosynthesis productivity. American-Eurasian Journal Agriculture and Environmental Science. 2016;16(4):666-676.
37. Krishnaprabu S. Integrated approach in nutrient management of greengram on nutrient uptake and economics. International journal of Pure and Applied Bioscience. 2018;6(5):832-834.
38. Kumar Rakesh, Deka Bidyut, Ngachan SV. Response of *summer* mungbean to sowing time, seed rates and integrated nutrient management. Legume Research, 2015;l38(3):348-352.
39. Kumar Saket, Singh JD, Singh Rajesh. Growth and yield response of mung bean (*Vigna radiata* L.) in different levels of potassium. Acta Scientific Agriculture. 2018;2(6):23-25.
40. Kumar Alok, Tripathi AK. Studies on nutrient management practices through organic sources in greengram [*Vigna radiata* (L.) Wilczek] under organic farming. M.Sc. (Ag.) Agronomy thesis submitted to C.S. Azad University of Agriculture and Technology, Kanpur; c2015.
41. Kumar S, Singh RC, Kadian VS. Performance of mungbean as influenced by seed inoculation with Rhizobium and levels of inorganic sources of nutrients. Indian Journal of Pulses Research. 2003;16(1):67-68.
42. Kumari MSS, Kumar KV. Effect of vermicompost enriched with rock phosphate on growth and yield of cowpea. Journal of Indian Society of Soil Science. 2002;50(2):223-224.
43. Kumawat Narendra, Sharma O.P; Kumar Rakesh and Kumar Anupma. yield and yield attributes of mungbean [*Vigna radiata* (L.) Wilczekas] affected by organic manures, PSB and phosphorus fertilization. Environment and Ecology. 2010;28(1A):332-335.
44. Malawadi MN, Palled YB, Basavaraj B, Hiremath SM. Effect of secondary and micronutrients on yield and quality of chilli (*Capsicum annuum* L.). M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad, India; c2003.
45. Maryam S, Mohammad RH. Influence of vermicompost and plant density on some morphological traits and biological yield of mungbean (*Vigna radiata*). International Research Journal of Applied Basic Sciences. 2013;5(3):319-323.
46. Mathur K. Effect of *Rhizobium* inoculation and various sources of nitrogen on growth and yield of summer greengram [*Vigna radiata* (L.) Wilczek]. M.Sc. Thesis, C.C.S. H.A.U., Hisar; c2000.
47. Meena RS, Dhakal Yubaraj, Bohra JS, Singh SP, Singh MK, Sanodiya Pratik, Meena Hemraj. Influence of bioinorganic combinations on yield, quality and economics of mung Bean. American Journal of Experimental Agriculture. 2015;8(3):159-166.
48. Meena RS. Effect of organic and inorganic sources of nutrients on growth, yield and quality of mungbean

[*Vigna radiata* (L.) Wilczek]. M.Sc. Thesis, Rajasthan Agricultural University; c2005.
49. Bikaner Meena Suman, Swaroop Narendra, Dawson Joy. Effect of integrated nutrient management on growth and yield of greengram. Agricultural Science Digest. 2016;36(1):63-65.
50. Mishra Ravindra, Patel Avinash, singh Kumar Rakesh, Kumar Alok, Sharma Alekhk. Effect of nutrient management practices on growth and yield of greengram (*Vigna radiata* L.). Advances in Life Sciences. 2016;5(24):11139-11143.
51. Mishra AC, Pandey VK. Performance of cowpea [*Vigna unguiculata* (L.) Walp.] cultivars as influenced by organic manures in rainfed plateaus of Jharkhand. Asian Journal of Horticulture. 2013;8(1):143-145.
52. Mohbe Sandeep, Dotaniya CK, Dharwe DS, Doutaniya RK, Chandel Devendra. Effect of different organic manure on primary branches and straw yield attributes of greengram [*Phaseolus radiata* (L.)] under rainfed condition in Chitrakoot Region India. International Journal of Current Microbiology and Applied Sciences. 2018;7(2):2805-2811.
53. Muhammad Naeem, Muhammad Ahmad, Alias Haji, Javaid Iqbal. Comparative study of inorganic fertilizers and organic manures on yield and yield components of mungbean (*Vigna radiata* L.). Journal of Agriculture and Social Science. 2006;2(4):227-229.
54. Mukherji S, Mandal AK, Bandopadhyay PK, Pramanik M. Studies on growth, yield and economics of greengram under both organic and inorganic fertilizer management along with Mo, Zn and B. Indian Biologist. 2013;45(2):83-87.
55. Muniswamy RS, Singh Vikram, Prasad Mithare. Response of nitrogen, sulphur and foliar application of zinc on yield and quality of greengram (*Vigna radiata* L.). Journal of Pharmacognosy and Phytochemistry. 2018;7(3):517-522.
56. Neelam Nanwal RK, Kumar Pawan. Effect of organic and inorganic sources of nutrients on productivity and profitability of mungbean -wheat cropping system. Legume Research and International Journal. 2015;38(4):509-512.
57. Netwal LC. Effect of FYM and vermicompost on nutrient uptake and quality of cowpea [*Vigna unguiculata* (L.) Walp.] grown under saline condition. M.Sc. (Ag.) Thesis, RAU, Bikaner; c2003.
58. Niranjan K Rajeev, Pal Amit, Gupta HK, Verma K Manish, Gond Prasad Dadhibal. Performance of different vermicomposts on yield and yield components of mung bean in major soils of Bundelkhand region. India Journal Ecophysiology and Occupational Health. 2010;10(1):61-70.
59. Saravanan P, Sathish KS Ignesh. A Effect of organic manures and chemical fertilizers on the yield and macronutrient concentrations of greengram. International Journal of Pharmaceutical Science Invention. 2013;2(1):18-20.
60. Krishna PS. Integrated approach in nutrient management of greengram on nutrient uptake and economics. International. Journal. Pure and Applied. Bioscience, 2018;6(5):832-834.
61. Patel AR, Patel DD, Patel TU, Patel HM. Nutrient management in summer greengram (*Vigna radiata* L.). International Journal of Applied and Pure Science and agriculture. 2013;2(2):133-142.
62. Patel Swetha A, Chaudhari PP, Desai NH. Yield and economics of greengram cultivars as influenced by integrated nutrient management. Journal of crop research 2016;51(1):1-3.
63. Patil MB, Mohammed RG, Ghadge PM. Effect of organic and inorganic fertilizers on growth, yield and quality of tomato. Journal of Maharashtra Agriculture University. 2004;29(2):124-127.
64. Rajib Kundu, Jajati Mandal, Aparjita Majumder. Growth and production potential of greengram influenced by rhizobium inoculation with different nutrient source. International journal of Agriculture. Environment and Biotechnology. 2013;6(3): 344-350.
65. Rajkhowa DJ, Saikia M, Rajkhowa KM. Effect of vermicompost with and without fertilization of greengram. Legume Research. An International journal. 2002;25(4):295-296.
66. Rajkhowa DJ, Gogoi AK, Kandali R, Rajkhowa KM. Effect of Vermicompost on greengram nutrition. Journal of Indian Society of Soil Science. 2000;48(1):207-208.
67. Ranjan JK, Ahmed N, Das B, Ranjan P and Mishra BK, Green technology for production of baby corn (*Zea mays* L.) under North-West Himalayan conditions. International Journal of Chemical Technology Research. 2013;5(2):880-885.
68. Rathod SL, Gawande MB. Response of greengram varieties to different fertilizer grades. International Journal of Science and Research. 2014;3(7):1313-1315.
69. Sadeghipour O, Monem R, Tajali AA. Production of mungbean (*Vigna radiata* L.) as affected by nitrogen and phosphorus fertilizer application. Journal of Applied Science. 2010;10(10):843-847.
70. Saha Rajesh, Sarathi PP. Energetics and economics of greengram [*Vigna radiata* (L.) Wilczek] as influenced by varying level of nitrogen. Advance Research Journal of Crop Improvement. 2017;8(2):145-149.
71. Saravanan P, Sathish SK, Ignesh A. Effect of organic manures and chemical fertilizers on the yield and macronutrient concentrations of greengram. International Journal of Pharmaceutical Science Invention. 2013;2(1):18-20.
72. Selvaraj N. Report on organic farming at horticultural research station, Tamil Nadu Agricultural University, Ooty. 2003-04, p.2-5
73. Shariff Fazulla A, Ashok S, Sajjan HB, Babalad LB Nagaraj, Palanka Gireshr S. Effect of organics on seed yield and quality of greengram (*Vigna radiata* L.), International Journal. 2015;40(2):388-392.
74. Shi Wei Z, Fu Zhen H. The nitrogen uptake effciency from 15 N labeled chemical fertilizer in the presence kof earthworm manure (cast) In: Veeresh, G.K Rajagopal, D. Viraktmat C.A. (Eds) Advances in management and conservation of Sill fauna oxford and IBH publishing Co., New Delhi, Bombay; c1991. p. 539-542.
75. Shwetha BN, Babalad HB. Studies on nutrient management through organics in soybean–wheat cropping system. M.Sc. (Ag.) thesis submitted to the University of Agricultural Sciences, Dharwad; c2007.
76. Singh Kumar Ritesh, Dawson Joy, Srivastava Nishant Effect of sources of nutrient on growth and yield of blackgram (*Vigna mungo* L.) varieties in NEPZ of India.

Journal of Pharmacognosy and Phytochemistry. 2017;6(4):1064-1066.
77. Singh Mandhata, Mishra JS, Bhatt BP. Effect of integrated nutrient management on production potential and quality of summer mungbean (*Vigna radiata* L.). Journal of Krishi Vigyan. 2017;5(2):39-45.
78. Singh P Ramesh, Singh Mohan, Panwar Navraten, Singh AB. Response of pigeonpea (*Cajanus cajan*) varieties to organic manures and their influence on fertility and enzyme activity of soil. Indian Journal of Agricultural Sciences. 2006;76(4):252-254.
79. Sutaria GS, Akbari KN, Vora VD, Hirpara DS, Padmani DR. Response of legume crops to enriched compost and vermicompost on vertic ustochret under rain fed agriculture. Legume Research. 2010;33(2):128-130.
80. Sitaram T, Sharma SK, Reager ML. Growth attributes and nutrient uptake of greengram as influenced by vermicompost and zinc in arid western Rajasthan. Advance Research Journal of Crop Improvement. 2013;4(1):65-69.
81. Thanuathan K, Arumarugan K, kurppsuswam G, Ravichandran M. (. Effect of vermicompost on growth and yield of soybean (*Glycine max)*. Madras Agricultural Journal. 2012;8(9):613-616.
82. Thiyageshwari S, Perumal R. Integrated use of sources of phosphorus with vermicompost and phosphobacteria in urdbean. Indian Journal of Pulses Research. 2002;15(1):81-82.
83. Tyagi PK, Upadhyay AK, Raikwar RS. Integrated approach in nutrient management of summer greengram. The bioscience. 2014;9(4):1529-1533.
84. Uddin Salah Md, Amin Ruhul AKM, Ullah jafar Md. Asaduzzman Md. Interaction Effect of variety and different fertilizers on the growth and yield of summer mung bean. American-Eurasian Journal of Agronomy. 2009;2(3):180-184.
85. Vedpathak M Mangesh, Chavan L Balbhim. Response of greengram crop to different fertilizers. International Journal for Research Trends and Innovation. 2018;3(6):290-294.
86. Verma Ghanshyam, Kumawat Narendra, Morya Jagdeesh. Nutrient management in mungbean for higher production and productivity under semi-arid tract central India. International Journal of Current Microbiology and Applied Sciences. 2017;6(7):488-493.
87. Verma Ghanshyam, Singh Mahipat, Morya Jagdeesh, Kumawat Narendra. Effect of N, P and biofertilizers on growth attributes and yields of mungbean [*Vigna radiata* (L.) Wilczek] under semi-arid tract of central India. International Archive of Applied Sciences and Technology. 2017;8(2):31-34.
88. Vinceslas – Akpa M, Lquet M. Organic matter transformations in lignocellulosic waste products composted or vermicomposed (*Eisenia foetida anderi*) Chemical analysis and 13C CPMAS NMR spectroscopy, Soil Biol and Bichem. 1997;29:751-758.
89. Yadav OS. Effect of nitrogen sources and bio-fertilizer on growth, yield and quality of cowpea. M.Sc. (Ag.) Thesis, RAU, Bikaner; c2001.