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Response of Green gram (*Vigna radiata* L.) to different nutrient management practices in *Tarai* region of Uttarakhand

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Abstract
Green gram (*Vigna radiata* L.) commonly known as mungbean, is one of the most important pulse crop which has high nutritive value, ability of biological nitrogen (N_2) fixation and ability of addition of organic carbon to soil. The basic concept behind the appropriate nutrient management from different sources is to maintain the balance between need and supply of nutrients while reducing the adverse impact of imbalanced fertilization simultaneously. Considering these facts the field experiment was carried out to boost the production of mungbean. The experiment was conducted, during *Kharif* season of 2019 at N. E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar. The experiment comprised of 18 treatment combinations with three inorganic levels *viz.*, 75% (15:30:15), 100% (20:40:20) and 125% (25:50:25) of N: P_2O5: K_2O, and two farm yard manure levels (control and application of FYM @ 5 t/ha) and three biofertilizers treatments (*Rhizobium,* LNM-16 and *Rhizobium* + LNM-16) was laid out in factorial randomized block design with three replications. In present investigation the inorganic fertilizer level of RDF 125% is found better in terms of plant height, yield attributes and yields of mungbean followed by RDF 100% and RDF 75%. The application of 5t/ha FYM is found superior over control in terms of plant height, dry matter accumulation, growth rates, yield attributes and yields. The combine inoculation of *Rhizobium* culture (*Rhizobium* + LNM-16) is found comparatively better from solo application of *Rhizobium* and LNM-16.

Keywords: Mungbean, fertilizer, organic, *rhizobium*, FYM, nutrient management

Introduction
Among the pulses, green gram (*Vigna radiata* L.), commonly known as mungbean, is one of the most important and extensively cultivated pulse crop. It has an edge over other pulses because of its high nutritive value (protein 21-24 g, fat 1.31 g, minerals 3.48 g, fibre 4.11 g, carbohydrates 56.72 g, phosphorous 326 mg, calcium 124 mg, energy 334 Kcal and iron 4.42 mg) (Gopalan *et al*., 2002; Dhakal *et al*., 2015) [7, 5]. In India, Mung bean is cultivated in about 20.35 lakh ha with production and productivity of 2.01 million tones and 467 kg ha^{-1}, respectively and contributing 9.41% to total production (DAC&FW 2019). Pulses are known to improve soil quality through their unique ability of biological nitrogen (N_2) fixation, addition of organic carbon and deep root system. The rhizo-deposition of N constitutes a significant pool of the below-ground nitrogen in grain legumes ranges from 47 to 80%, and constitutes between 35 and 45% of total residue N (Mayer *et al*., 2003) [10]. Being a pulse crop, mungbean can fix atmospheric nitrogen about 35 kg ha^{-1} atmospheric nitrogen through *Rhizobium* bacteria and requires less amount of fertilizer inputs. Nitrogen Fixation is done in pulse crops after nodulation; therefore these crops need nutrient supply in initial stage of growth by the fertilizers for quick start and healthy establishment of seedlings. Fertilizer is important source of nutrient supply but imbalanced and continuous use of chemical fertilizers reduces in crop yield along with several adverse impacts on soil health as well as environment. Therefore the integration of all possible nutrient management sources should follow to minimize such adverse impacts of chemical fertilizers. Organic manures are one of such important sources which supply micronutrients, minerals vitamins and organic matter along with major nutrients. Organic manures like farm yard manures (FYM) and compost have been traditionally used as input for improving soil physical, chemical and biological properties as well as to maintain soil fertility which has resulted in yield stability (Ranpariya *et al.,* 2017) [18]. The use of FYM along with inorganic fertilizer increases the nutrient use efficiency and also improves the physical and biological properties of soil (Shete *et al.*, 2010; Sharif *et al.*, 2003)

[23, 21]. Apart from organic manures, biofertilizers (microbial fertilizers) are also aid in nutrient management in eco-friendly manner (Mia, 2010) [13]. These facilitate better root growth of legume crops and enhance nitrogen fixation ability of plant along with several other benefits. FYM in conjunction with bio-fertilizers play an important role in improving the organic matter content of the soil and thereby improving soil productivity and yield along with partial replacement of mineral fertilizers (Sutaria *et al.*, 2010) [25]. Considering these aspects, a field experiment was conducted to find out the production level of mungbean as influenced by different fertilizer levels, organic manure and *Rhizobium* cultures.

Materials and Methods

The experiment was conducted at N. E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, (Uttarakhand), during *Kharif* season of 2019. The soil of the experimental field was sandy loam in texture having neutral soil pH (7.2), high in Walkley-Black organic carbon (0.81%), medium in KMnO4 Oxidizable nitrogen (282.4 kg/ha), high in 0.5 M $NaHCO^{3-}$ extractable phosphorus (23.8 kg/ha) and medium in 1 N NH_4OAC extractable potassium (221.3 kg/ha). The experiment comprised of 18 treatment combinations with three fertilizer doses *viz.*, 75% (15:30:15), 100% (20:40:20) and 125% (25:50:25) of N: P_2O5: K_2O, respectively in the form of Urea, DAP and MOP and two farm yard manure levels (control and application of FYM @ 5 t/ha) and three biofertilizer treatments (*Rhizobium*, LNM-16 and *Rhizobium* + LNM-16) was laid out in factorial randomized block design with three replications. The required quantity of seeds (15 kg/ha) was treated with *Rhizobium* culture and LNM-16as per treatment before sowing. Field preparation was done by one ploughing, followed by two cross harrowing and planking to obtain fine tilth for sowing. The seeds of PM-5 variety were sown manually in row maintaining a spacing of 30 × 10 cm. Manual weeding was done at 30 days after sowing (DAS) to control weeds. Overall, weather was congenial for crop growth. Five plants were tagged from each plot and their length from base to top was measured with the help of a centimetre (cm) scale and the average was expressed as plant height at different stages of crop growth. The weight of the total produce per net plot was recorded after sun drying of bundles for each plot before threshing and denoted as biological yield. After threshing and winnowing, total grain production of the net plot was weighed with the help of an electronic weighing balance. The weight of grains was recorded in kilograms to calculate grain yield per plot. Further, it converted into per hectare yield and expressed as grain yield in kg/ha. All the recorded were subjected to analysis of variance technique for factorial randomized block design (FRBD) as per the procedures given by Rangaswamy (2006).

Results and Discussion

Effects on growth attributes

Imposition of different inorganic fertilizer levels, organic manure and *Rhizobium* culture brought significant variation in plant height, (Table 1 and 2). Among inorganic fertilizer levels, 125% RDF recorded markedly taller plants height (36.1, 82.9 and 90.1 cm) and at 30 DAS, 60 DAS and harvest stages, respectively compared to 100 and 75% RDF levels (Table 1).

Application of FYM @ 5 t/ha increased plant height 6.82, 2.08 and 1.85% at 30 DAS, 60 DAS and harvest stages, respectively over control (Table 1). Amid *Rhizobium* culture, seed treatment with *Rhizobium* + LNM- 16 showed significantly the highest plant height (33.78 cm) at 30 DAS (Table 1). The improvement in growth characteristics might be due to extra dose of fertilizer which increases the availability of nutrient to the plants. The major function of nitrogen, being a major structural constituent of cell and metabolically active compounds, helps in stimulating the cell division and cell enlargement, which enhanced the growth of plants. These results are in conformity with the findings of Singh *et al*. (2011) [24]; Azadi *et al*. (2013) [3]; Achakzai *et al*. (2012) [1] and Saha and Patra (2017) [19]. The addition of organics improves the physical, chemical and biological properties of the soil and this leads to uptake of nutrients and water from greater soil volume by improving the root growth and development and resulting in to better plant growth. The results are in close agreement with Tomar *et al*. (2013) [26] and Kokani *et al.* (2014) [8]. The inoculation with *Rhizobium* strains helps the plants to fix atmospheric nitrogen and make available to plant. Along with that, inoculation improves the root growth and proliferation which allow the plants to better absorption, uptake and translocation of the nutrients and water from the soil. The higher availability of nutrients leads to the better growth and devolvement of cells resulting in increased height, leaf area, growth rates and nodulation. The results are also in close conformity with the findings by Sahay *et al*. (2011) [20]; Patel (2012) [16]; Patel *et al.* (2016) [14]; Kumar *et al.* (2002) [9]; Sharma *et al*. (2003) [22] and bhatt *et al*. (2011)

Table 1: Plant height of mungbean as influenced by different inorganic fertilizers, organic manure and biofertilizers

Treatment	Plant height (cm)		
	30 DAS	60 DAS	Harvest
75% RDF	29.2	76.8	83.6
100% RDF	32.0	77.7	84.8
125% RDF	36.1	82.9	90.1
S.Em±	0.3	0.4	0.6
CD at 5%	0.9	1.3	1.7
Control	31.8	78.3	85.4
FYM 5 t/ha	33.0	79.9	86.9
S.Em±	0.2	0.4	0.5
CD at 5%	0.7	1.0	1.4
Rhizobium	32.6	78.7	82.0
LNM-16	31.8	79.2	82.2
Rhizobium + LNM-16	32.9	80.6	84.3
S.Em±	0.3	0.4	0.6
CD at 5%	0.9	1.3	1.7

Effects on yield attributes and yield

Yield attributes *i.e.*, pods/plant and grains/pod as well as yield (grain, straw and biological) of mungbean significantly varied by different inorganic fertilizer levels, organic manure and *Rhizobium* culture (Table 2). Among inorganic fertilizer levels, application of 125% RDF expressed the highest numbers of pods/plant (40.2) and grains/pod (10.1). Application of FYM @ 5 t/ha had 13.95 and 18.61% more pods/plant and grains/pod, respectively over control. Amid *Rhizobium* treatments, the combination of *Rhizobium* + LNM-16 corroborated markedly the highest pods/plant (39.1) and grains/pod (9.7). 125% RDF (1019 kg/ha) had significantly higher grain yield over 100% RDF (985 kg/ha) and 75% RDF (928 kg/ha). Alike, 125% RDF recorded noticeably higher straw and biological yields (2838 and 3688 kg/ha, respectively) over rest of RDF levels.

Application of FYM @ 5 t/ha was significantly increased straw (13.16%) and biological yield (13.88%) over control. The combined application of *Rhizobium* + LNM -16 had 1.11 and 1.14 times higher grain yield as compared to individual application of *Rhizobium* and LNM- 16, respectively. Similarly, *Rhizobium* + LNM-16 showed 9.74 and 9.80% higher straw yield over individual application of *Rhizobium* and LNM- 16 treatments. The extent of enhancement in biological yield through combined application of *Rhizobium* + LNM-16 was 10.01 and 10.81% as compared to sole application of *Rhizobium* and LNM- 16, respectively.

The achievement of present findings might be due to the better growth and development which achieved by better absorption, uptake and translocation and nutrients. The better photosynthesis and chlorophyll formation leads to higher production, translocation and partitioning of photosynthates. The increase of yield attributing characteristics reflects to achieve higher grain yield and biological yield. The results of present experiment are in agreement with findings of Sahay *et al*. (2011) [20]; Patel (2013) [15]; Patel *et al.* (2016) [14]; Yadav *et al.* (2007) [27]; Meena and Sharma 2012 [11] and Dhakal *et al*. (2015) [5].

Table 2: Yield attributes and yield of mungbean as influenced by different inorganic fertilizers, organic manure and biofertilizers

Treatment	Yield attributes and yield				
	Pods plant^{-1}	Grains pod^{-1}	Grain Yield (kg ha^{-1})	Straw Yield (Kg ha^{-1})	Biological Yield (Kg ha^{-1})
Inorganic Fertilizers					
75% RDF	35.2	8.2	928	2,560	3,288
100% RDF	37.8	8.9	985	2,624	3,409
125%RDF	40.2	10.1	1019	2,868	3,688
S.Em ±	0.4	0.1	10	39	47
CD (P=0.05)	1.2	0.4	28	113	136
Organic Manure					
Control	35.2	8.3	913	2,525	3,238
FYM 5t/ha	40.2	9.8	1042	2,844	3,685
S.Em ±	0.3	0.1	8	32	39
CD (P=0.05)	1.0	0.3	23	92	111
Biofertilizers					
Rhizobium	37.3	8.7	956	2,605	3,360
LNM -16	36.8	8.6	933	2,615	3,350
Rhizobium+ LNM-16	39.1	9.7	1042	2,833	3,675
S.Em ±	0.4	0.1	10	39	47
CD (P=0.05)	1.2	0.4	28	113	136

Conclusion

On the basis of present experiment it can conclude that the application of fertilizer level as RDF 125% is gives better result in terms of plant height, dry matter accumulation, growth rates which ultimately reflect to provide better yield attributes and yields of mungbean. The application of 5t/ha FYM is found superior over control in terms of plant height, yield attributes and yields. The combine inoculation of *Rhizobium* culture (*Rhizobium* + LNM-16) is comparatively better from single application of *Rhizobium* and LNM-16.

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