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PK Singh
Directorate of Extension, SVPUA&T, Meerut, Uttar Pradesh, India

Mohd. Anees
Directorate of Extension, SVPUA&T, Meerut, Uttar Pradesh, India

Mukesh Kumar
Directorate of Extension, SVPUA&T, Meerut, Uttar Pradesh, India

KG Yadav
Directorate of Extension, SVPUA&T, Meerut, Uttar Pradesh, India

Ashok Kumar
Directorate of Research, SVPUA&T, Meerut, Uttar Pradesh, India

Mukesh Kumar
Directorate of Research, SVPUA&T, Meerut, Uttar Pradesh, India

Ritesh Sharma
BEDF, Modipuram Meerut, Uttar Pradesh, India

RB Singh
R. B. S. College, Bichpuri, Agra, Uttar Pradesh, India

Shiv Kumar
Department of Genetics & plant breeding, SVPUA&T, Meerut, Uttar Pradesh, India

Correspondence
PK Singh
Directorate of Extension, SVPUA&T, Meerut, Uttar Pradesh, India

Effect of integrated nutrient management on growth, yield and quality of moongbean (*Vigna radiata* L.)

PK Singh, Mohd. Anees, Mukesh Kumar, KG Yadav, Ashok Kumar, Mukesh Kumar, Ritesh Sharma, RB Singh and Shiv Kumar

Abstract
A field experiment was conducted at Basmati Export Development Foundation, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, U.P. during summer season of 2017. The eleven treatments viz. control, *Rhizobium* (20g/kg seed), PSB (20g/kg seed), 100% RDF(20:40:20 kg NPK/ha),75% RDF, 75% RDF + PSB, 75% RDF + Vermicompost (2.5 t/ha), 75% RDF + *Rhizobium*, 75% RDF + PSB,+Vermicompost (2.5 t/ha), 75% RDF + PSB+*Rhizobium*, 75% RDF + PSB + Vermicompost + *Rhizobium* were tested in randomized block design with three replications. The soil of the experimental field was with (pH 7.9) and sandy loam in texture. It was moderately fertile, being low in available organic carbon (0.47%), available nitrogen (182.3 kg/ha), and medium in available phosphorus (12.7 kg/ha) and medium in available potassium (180.1 kg/ha). The 20 kg/ha seed of moongbean (varieties SML-668) was sown in rows 30 x10 cm apart. Among all the treatments application of 75% RDF + PSB + 2.5 t/ha Vermicompost + *Rhizobium* gave maximum growth viz (Plant height, No. of branches/ plant, No. of nodules/plant, Leaf area index and Plant dry weight) and yield attributes viz (No. of pods/plant, No. of grains/pod, Test weight and Grain and straw yield) as well as maximum gross returns and net returns from moongbean. This treatment also gave the maximum Nitrogen, Phosphorus and Potassium content and uptake by moongbean and available N, P and K in soil. The combined use of inorganic and organic fertilizer along with bio-fertilizer had a positive effect on available in Nitrogen, phosphorus and potassium content in the soil after harvest of moongbean.

Keywords: *Rhizobium*, PSB, moongbean

Introduction
Pulse crops play an important role in Indian agriculture and India is the largest producer and consumer of pulse in the world. Pulses contain a high percentage of quality protein nearly three times as much as cereals. Thus, they are cheaper source to overcome protein malnutrition among human beings. For vegetarian diet, pulses form the major source of protein. Pulses can also be referred to as mini fertilizer factory, as they fix atmospheric nitrogen through symbiosis to improve the physical characteristics of soil through tap root system which opens the soil into the deeper strata and their ability to use atmospheric nitrogen through biological nitrogen fixation which is economically sound and environmentally acceptable. Globally pulses are grown in an area of 76 m ha with a production of about 68 mt. the average productivity at the global level is about 800 kg ha^{-1}. India is the largest producer, consumer, importer and processor of pulses in the world which account for 33% of the world area and 22% of the world production of pulses. In India total pulses area is about 25 m ha with production about 18 mt with average productivity of 750 kg ha^{-1}. The area of pulse crop has not increased much during the past 60-65 year except in 2011 and 2012, whereas showed an increase of 1.5 to 2.0 m ha. In order to ensure self-sufficiency, the pulses requirement in the country is projected at 27.7 mt by the year 2025. Moongbean one of important pulse crop of summer season which contain about 25% protein, 60% carbohydrate and 1.3% fat. It is grown in India on an area of 3.55 m ha with production about 1.82 mt and productivity 512 kg ha^{-1} and in U.P on an area of 78,000 ha, production of 45,000 ton and with productivity of 577 kg ha^{-1}.

Pulse cultivation enriches soil by adding nitrogen and improves the physical, chemical and biological soil properties. Pulses are grown since age in different part of the world. They are well suited to diverse environment and fit in various cropping system –sowing to their wide adoptability, low input requirement, fast growth, nitrogen fixing and weed smothering ability. Pulses are mainly grown in low fertile land therefore productivity is poor. Generally in pulses farmer mainly apply Nitrogen/phosphorus through Urea/DAP resulting declining the soil fertility. Apart from primary macro nutrient deficiency, the deficiency of secondary macro

nutrient, micro nutrient particularly of zinc and iron are also emerging and it is being a limiting factor. Biofertilizers play an important role in increasing availability of nitrogen and phosphorus besides increase in biological fixation of atmospheric nitrogen and enhance phosphorus availability to crop. Therefore, introduction of efficient strain of *Rhizobium* in soil enhances the quality of soil by providing more nitrogen fixation and which may be helpful in boosting up production. Inoculation of seeds with *Rhizobium* culture is a very low cost method of nitrogen fertilization in legume and has been found beneficial (Pathak *et al.*, 2001) [5]. In recent year, several strains of phosphate solubilizing bacteria and fungi are isolated. The mechanism actions of these microorganisms involve secretion of organic acids which lower the pH and increase the availability of sparingly soluble phosphorus sources. Inoculation of seed with PSB culture may increase the production and productivity of moongbean crops as reported by (Balachandran *et al*., 2005) [1]. Keeping all the above points in view the present investigation entitled "Effect of integrated nutrient management on growth, yield and quality of moongbean (*Vigna radiata* L.)" was conducted during summer season of 2017.

Methodology

A field experiment was conducted at Basmati Export Development Foundation, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, U.P. during summer season of 2017. The eleven treatments viz control, *Rhizobium* (20g/kg seed), PSB (20g/kg seed), 100% RDF(20:40:20 kg NPK/ha), 75% RDF, 75% RDF + PSB, 75% RDF + Vermicompost (2.5 t/ha), 75% RDF + *Rhizobium*, 75% RDF + PSB,+Vermicompost (2.5 t/ha), 75% RDF + PSB+*Rhizobium*, 75% RDF + PSB + Vermicompost + *Rhizobium* were tested in randomized block design with three replications. The soil of the experimental field was with (pH 7.9) and sandy loam in texture. It was moderately fertile, being low in available organic carbon (0.47%), available nitrogen (182.3 kg/ha), and medium in available phosphorus (12.7 kg/ha) and medium in available potassium (180.1 kg/ha). The 20 kg/ha seed of moongbean (varieties SML-668) was sown in rows 30 x10 cm apart.

Result and discussion

The significant increase in all the growth parameters *viz.*, plant height, branches/plant and dry matter per plant were observed with the use of integrated nutrient management and found maximum with the application of 75% RDF+ PSB+ 2.5 t/ha VC + *Rhizobium* as compared to other treatments (Table 1). Significant increases in growth attributes were observed with the use of inorganic sources of nutrient in combination with vermicompost and biofertilizer over control. The overall improvement in crop growth under the influence of NPK application could be attributed to better environment for growth and development that might be due to increased availability of nitrogen to the growing plants. Further, addition of phosphatic fertilizers in the soil increases the concentration of readily available H_2PO_4 ions in the rhizosphere. The increased availability of phosphorus to plant might have enhanced early root growth and cell multiplication leading to more absorption of other nutrients from deeper layers of soil ultimately resulting in increased plant growth in terms of plant height, branhes/plant and dry matter accumulation. The combined application of NPK to the moongbean increased availability of major nutrients to plant as it might has enhance dearly root growth and cell multiplication leading to more absorption of other nutrients from deeper layers of soil ultimately resulting in increased plant growth in terms of plant height, branches/plant and dry matter accumulation. Similar findings were also reported by Rathore *et al*. (2007) [8] and Sheoran *et al*. (2008) [10].

The application of 75%RDF+ PSB+ 2.5 t/ha VC + *Rhizobium* significantly increased number of pods /plant, number of seeds /pod and test weight of moongbean over control. The increased yield attributes might be due to the increased supply of the major nutrients (NPK) by translocation of the photosynthates accumulated under the influence of the sources of inorganic nutrients. Further, the translocation and accumulation of photosynthates in the economic sinks, resulted in increased number of pods /plant, number of seeds /pod and test weight of moongbean. Similar, results have been reported by Patel *et al.* (2003) [4] and Yadav *et al*. (2004) [12] in different pulses.

Application of 2.5 t/ha vermicompost significantly increased number of pods/plant, number of seeds /pod, grain, straw and biological yields and harvest index of moongbean over control. Vermicompost would not only increase organic carbon status of the soils but also increase the soil water holding capacity. Flocculation of soil and availability of all micro and macronutrients making the soil and crop production sustainable one (Rajkhowa *et al*., 2000) [6]. Vermicompost helps in enhancing the activity of microorganism in soils resulting in enhanced solubility of nutrients and their consequent availability to plants by reducing soil pH at micro sites, chelating action of organic acids produced by them and intraphyl mobility in the fungal filaments (Chhonkar, 2002) [2]. The increased yield attributes and yield might be due the increased supply of almost all plant essential nutrients by translocation of the photosynthates accumulated under the influence of the sources of organic nutrients. Further, the translocation and accumulation of photosynthates in the economic sinks, resulted in increased grain, straw and biological yields. The combined inoculation of *Rhizobium* + PSB significantly enhanced the yield attributes of moongbean over control. The synergistic effect of *Rhizobium* and PSB as discussed above might have increased the growth, yield attributes and ultimately the yield in present investigation due to increased nitrogen activity and available phosphorus status of soil. Similar findings were reported by Kumar and Kushwaha (2006) [3] and Yadav *et al*. (2007) [11].

Available nitrogen, phosphorus and potash in soil after harvest of crop were increased by the application of 75%RDF+ PSB+ 2.5 t/ha VC + *Rhizobium.* Further, bio-fertilizer inoculation significantly improved content of potassium in soil after harvest of crop as compared to control. In case of phosphorus in soil after harvest significantly higher found in inoculation of bio-fertilizer (*Rhizibium* and PSB) as compare to not inoculants treatment and control. The vermicompost contains appreciable amounts major and micronutrients with in the most suitable pH range that might have resulted in making their increased status in soil after the harvest of the moongbean. The application of vermicompost has positive effect of vermicompost on the soil properties and mineralization of nitrogen, phosphorus and potassium in soil. Selvi *et al.* (2004) [9] in a long term experiment has reported positive balance of available N, P_2O_5 and K_2O in the soil after the harvest of the moongbean crop.

Application of 75%RDF+ PSB+ 2.5 t/ha VC + *Rhizobium* increased the net returns and benefit cost ratio of moongbean

over control. The increased net returns could be explained on the basis of increased yield under the influence of sources of inorganic nutrients in the present investigation. This might be due to better yield under this treatment resulted in more net returns. Rajkhowa *et al.* (2003) [7] observed that application of 75%RDF+ PSB+ 2.5 t/ha VC + *Rhizobium* significantly increased economics of moongbean over control. Similar, results have been reported Yakadri *et al*. (2004) [13] and Yadav *et al*. (2004) [12].

Table 1: Growth and yield attributes of moongbean as influenced by integrated nutrient management.

Treatments	Growth attributes			Yield attributes		
	Plant height (cm)	Branches /plant	Plant dry weight (g/plant)	Number of pods/plant	Number of grains/pod	Test weight (g)
Control (No fertilizer)	34.7	4.27	13.07	13.07	6.00	28.00
Rhizobium (20g/kg seed)	41.6	4.49	14.78	16.17	6.12	28.66
PSB (20g/kg seed)	43.4	4.68	15.12	16.29	6.42	28.88
75% RDF	44.1	4.84	14.97	18.17	6.94	29.21
100% RDF	45.6	4.94	16.12	20.88	7.01	29.93
75% RDF + PSB	46.5	5.11	16.38	21.26	7.12	30.42
75% RDF + Vermicompost (2.5 t/ha)	47.7	5.26	16.81	22.47	8.00	31.25
75% RDF + Rhizobium	49.6	5.37	17.02	22.87	8.06	31.60
75% RDF + PSB+Vermicompost (2.5 t/ha)	52.9	5.56	17.88	23.24	8.40	31.96
75% RDF +PSB+Rhizobium	50.9	5.73	15.79	24.26	8.64	32.15
75% RDF + PSB + Vermicompost + Rhizobium	53.9	5.83	18.62	26.31	8.77	32.58
SEm±	0.3	0.04	0.2	0.04	0.37	0.57
C.D (P=0.05)	1.1	0.12	0.6	0.12	1.1	1.7

Table 2: Yield and harvest index of moongbean and available nutrient in soil after harvest of crop as influenced by integrated nutrient management.

Treatments	Yield (q ha^{-1})			Harvest index (%)	Available nutrient in soil after harvest (kg/ha)		
	Grain yield	Straw yield	Biological yield		Nitrogen	Phosphorus	Potash
Control (No fertilizer)	4.19	12.35	16.54	25.48	151.53	9.70	175.53
Rhizobium (20g/kg seed)	6.03	17.29	23.32	25.82	174.80	10.52	179.63
PSB (20g/kg seed)	6.42	18.16	24.58	26.11	185.13	12.68	180.53
75% RDF	8.88	25.76	34.64	25.64	189.00	13.01	182.80
100% RDF	10.32	28.97	39.29	26.27	190.83	13.37	183.63
75% RDF + PSB	10.24	30.21	40.45	25.32	192.23	13.62	185.10
75% RDF + Vermicompost (2.5 t/ha)	10.67	30.49	41.16	25.94	192.90	13.73	185.70
75% RDF + Rhizobium	10.91	31.05	41.96	25.98	193.53	14.26	186.66
75% RDF + PSB+Vermicompost (2.5 t/ha)	11.42	32.29	43.71	26.13	195.00	15.07	187.36
75% RDF +PSB+Rhizobium	11.73	33.12	44.85	26.16	193.56	14.63	185.73
75% RDF + PSB + Vermicompost + Rhizobium	12.68	33.19	45.87	27.64	197.40	15.96	187.86
SEm±	0.28	0.77	1.05	0.19	0.42	0.14	0.24
C.D (P=0.05)	0.84	2.28	3.12	0.57	1.2	0.4	0.7
					182.30	12.70	180.00

Table 3: Economics of moongbean as influenced by integrated nutrient management

Treatments	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B: C ratio
Control (No fertilizer)	19162	21567	2405	0.12
Rhizobium (20g/kg seed)	19222	31014	11792	0.61
PSB (20g/kg seed)	19222	33008	13786	0.71
75% RDF	21034	45688	24654	1.17
100% RDF	21502	53048	31546	1.46
75% RDF + PSB	21094	52710	31616	1.49
75% RDF + Vermicompost (2.5 t/ha)	36034	54874	18840	0.52
75% RDF + Rhizobium	21094	56102	35008	1.65
75% RDF + PSB+Vermicompost (2.5 t/ha)	36094	58714	22620	0.62
75% RDF +PSB+Rhizobium	21154	60306	39152	1.85
75% RDF + PSB + Vermicompost + Rhizobium	36154	65059	28905	0.79

Conclusion

From the foregoing discussion it may be concluded that application of 75%RDF+ PSB+ 2.5 t/ha VC + *Rhizobium* gave the maximum seed yield of moongbean followed by treatments 75% RDF +PSB+Rhizobium and 75% RDF + PSB+Vermicompost (2.5 t/ha). The highest and comparable net returns were obtained with the application of 75% RDF + PSB + 2.5 t/ha vermicompost + *Rhizobium* followed by 75% RDF +PSB+Rhizobium and 75% RDF + PSB+Vermicompost (2.5 t/ha). The combine used of inorganic and organic

(fertilizers) along with bio-fertilizer had a positive effect on available nitrogen, phosphorus and potassium content in the soil after harvest of moongbean. Thus, it may be concluded that the application of 75% RDF + PSB + 2.5 t/ha vermicompost + *Rhizobium* seems to be best option for achieving higher yield and net returns from moongbean.

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