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Effect of Integrated Nutrient Management on Production Potential and Quality of Summer Mungbean (*Vigna radiata L.*)

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ABSTRACT

An experiment was conducted during summer seasons of 2014 and 2015 to find out the effect of integrated nutrient management on crop growth, yield attributes, yield and quality of summer mungbean. Increasing the fertility level significantly increased the growth, yield attributes, yield, protein content and nutrient uptake by mungbean. 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 (1060.6 kg/ha) over RDF (978.1kg/ha), and RDF+VC 2.5 t/ha (1009.6 kg/ha), respectively. Fertility level RDF+VC5 t/ha similarly registered highest protein content (22.3%), protein yield (238.4 kg/ha) and nutrient uptake (85.65:9.47:75.33::N:P:Kkg/ha). Mungbean produced maximum response with biofertilizer + Mo 1.0 +Co 1.0 kg/ha in respect to growth, yield attributes, nodule number, nodule weight and 41.2 per cent higher grain yield over control (841.3kg/ha). Protein content (24.21%), protein yield (287.8kg/ha) and nutrient uptake (100.47:11.34:87.62::N:P:K kg/ha) were also recorded maximum with biofertilizer + Mo 1.0 + Co 1.0 kg/ha.

Key Words: *Cobalt, Molybdenum, Mungbean, Phosphorus, Quality, Yield*

INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) is one of the protein rich pulse crop grown in India. The lack of productivity has contributed to food insecurity throughout the region and widespread malnutrition. Being a short duration crop, it fits well in many intensive crop rotations, prevents soil erosion, fixes atmospheric nitrogen through Rhizobial symbiosis and helps in improving soil fertility (Bansal, 2009).

Pulses like mungbean are generally grown in soils with low fertility status or with application of low quantities of organic and inorganic sources of plant nutrients, which has resulted in deterioration of soil health and productivity (Kumpawat, 2010). Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties (Chaudhary *et al*, 2004). The organic acids produced during decomposition of organic waste can exchange with adsorbed P and increase its availability to plants. Application of FYM increased the activity of acid and alkaline phosphatase, phosphodiesterase, inorganic pycophosphatase and dehydrogenase leading to faster hydrolysis of easter-bond P to plant available P (Dinesh *et al*, 2003).

Micronutrients play an important role in increasing legume yield through their effect on the plant itself, nitrogen fixing symbiotic process and effective use of major and secondary nutrients. Among micronutrients, cobalt and molybdenum are essential for the growth of *Rhizobium* and nitrogen fixation. Molybdenum is directly related to nitrogen fixation by legume. Molybdenum application plays a vital role in increasing the nitrogen fixation process by *Rhizobium* and, is responsible for the formation of nodule tissue and increase in N fixation (Roy *et al*, 2006). Cobalt is important in the plant world and constituent of cobalamine coenzyme and required for formation of leghaemoglobin

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in nitrogen fixation. Cobalt also promotes many developmental processes including stem and coleoptiles elongation, opening of hypocotyls hooks, leaf disc expansion and development (Kandil, 2007). Keeping these facts, a field experiment was conducted to investigate the effect of integrated nutrient management on production potential and quality of spring mungbean.

MATERIALS AND METHODS

A field experiment was carried out in the Instructional Farm of Krishi Vigyna Kendra, Buxar (25˚34'6.33"N, 83˚59'0.18" E and 63 m above sea level). The soil of the experimental farm is clay loam in texture with pH 7.8 and 0.48% organic carbon. The N, P2O5 and K2O, Mo and Co content are 218.8, 17.9 and 145.3 kg/ha, 0.07 mg/kg and 0.10 mg/kg, respectively. The treatments comprised of three levels of fertility viz. F1: RDF (20 N, 40 P2O5 and 30 K2O kg/ha), F2:RDF+VC 2.5 t/ha, F3:RDF+VC 5.0 t/ha and seven levels of biofertilizer + micronutrients viz., M1:Control (No FYM, No fertilizer), M2:Biofertilizer (*Rhizobium* + PSB) M3:Mo 1.0 kg/ha M4:Co 1.0 kg/ha M5:Biofertilizer +Mo 1.0 kg/ha M6:Biofertilizer + Co 1.0 kg/ha M7:Biofertilizer+Mo 1+Co 1 kg/ha. The treatments were replicated thrice and the experiment was laid out in split plot design. Fertilizers were applied as basal through urea, diammonium phosphate and muriate of potash. Molybdenum and cobalt were applied through ammonium molybdate and cobalt chloride, respectively. Vermicompost was applied before one month of sowing as per treatments and seeds were treated with biofertilizer (*Rhizobium* + PSB) except control. Mungbean variety "Samrat" was used as the test crop. Seeds were sown during last week of March and harvested at physiological maturity during both the years. All the cultural practices were followed as per package of practice. The data on various growth and yield attributes, nodule, seed and straws were recorded under various treatments. Before sowing composite soil samples representing the whole field and after harvest plot wise samples were collected. The organic carbon, pH, available N, P and K were analyzed as per the method described by Jackson (1973), DTPA extractable Co was determined following Lindsay and Norvell (1978), available molybdenum by ammonium oxalate extraction method (Jackson, 1973). The representative dry samples of seed and straw were analyzed for ascertaining the nutrient (N, P and K) content. Nitrogen, phosphorus and potassium content in seed and stover were determined by modified Kjeldahl method, vanadomolbedophosphoric yellow colour method, flame photometer and turbidimetric method, respectively. Statistical analyses of all the data were done as per the methodology of Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Crop Growth

Beneficial effect of fertility levels and biofertilizer + micronutrient on growth and development of mungbean has been clearly brought out in this investigation. Perusal of the data (Table 1) revealed that application of RDF+VC 5.0 t/ha recorded maximum plant height, number of branches/plant, dry weight, nodule number and nodule dry weight and significantly superior to RDF. The RDF+VC 2.5 t/ha was next best treatment in these respect. The higher values of these growth parameters with this fertility level might be due to supply of all the essential mineral nutrients in a balanced amount. These results were in conformity with the findings of Choudhary *et al* (2011) and Tiwari *et al* (2011).

The seed inoculation with biofertilizers helped in increasing all the growth characters recorded over control (Table 1), which might be due the beneficial effect of the *Rhizobium* and PSB in enhancing the nutrient supply to the plant. Combined application of micronutrients and biofertilizers was found synergistic in enhancing the growth attributing characters. The significant variations created by the addition of Mo are attributed to higher availability and absorption of nutrients and, Co application improving the nodulation and high population of Rhizobia in the rhizosphere (Jena *et al*, 1994).

Yield and yield attributes

The yield attributing characters namely number of pods/plant, pod length, number of grains/pod and 1000 grain weight increased with addition of VC in RDF and recorded maximum with RDF+VC 5 t/ha. This might be due to combination of organic and inorganic nutrition provides better soil environment for root growth, nodule formation, availability and absorption of nutrient from soil. Seed inoculation resulted in greater number of pods/plant, pod length, number of grains/pod and 1000 grain weight. This may be attributed to increased nodulation and nitrogen fixation, more solublization of native P and production of secondary metabolites by the bacteria. Combined application of biofertilizers along with micronutrients (Mo + Co) resulted in significant improvement in yield attributes (Table 1). Application of these micronutrients along with the inoculations might have a synergistic effect, which enhanced the activity of nitrogenase, in turn supplied more nitrogen by fixation for better growth and yield attributes. Similar results were also reported by Singh *et al* (2010) and Choudhary *et al* (2011).

Grain yield of mungbean crop is a function of cumulative effect of various yield components, which are influenced by genetic make-up of variety, various agronomic practices and environmental conditions. The application of RDF+ VC 5 t/ha produced higher seed and stover yield over RDF and RDF+VC 2.5 t/ha. An enhancement in seed yield is attributed to cumulative effect of number of pods/plant, pod length, number of grain/pod and seed weight. This result is also in close conformity with the findings of Singh *et al* (2010), Tiwari *et al* (2011), Choudhary *et al* (2011) and Meena *et al* (2016).

Seed and stover yield was enhanced by seed inoculation with biofertilizer and micronutrient application. Combined application of micronutrient and seed inoculation resulted higher seed and stover yield over control and alone application of Mo and Co. This might be due to molybdenum have a synergistic effect, which enhances the activity of nitrogenase in turn supplied more nitrogen by fixation for better growth and finally increased yield (Biswas *et al* 2009; Biyan *et al*, 2014) and Co application has been attributed to promotion of many developmental processes such as stem and coleoptiles elongation, opening of hypostyle hooks, leaf disc expansion and bud development (Ibrahim et al, 1989).

Quality

Protein content and protein yield was significantly influenced by different fertility levels (Table 3). Maximum protein content (25.2%) and protein yield (107.6 kg/ha) was recorded under RDF+VC 5 t/ha. This was mainly due to higher biological production under these treatments which increase the nutrient uptake. Application of Mo + Co along with biofertilizer recorded maximum protein content and protein yield. The minimum protein content and protein yield was recorded under control. Similar result was observed by Khan *et al* (2002) and Jain *et al* (2007).

Nitrogen, phosphorus, potassium uptake by crop was also relatively higher with RDF+ VC 5 t/ha (Table 3). This was mainly due to higher biological production under these fertility levels. Nutrient uptake increased significantly with biofertilizer + Mo + Co treatment. The increased uptake with the application of biofertilizers and micronutrients might be due to enhanced effect of Rhizobium in nitrogen supply (Bhattacharyya and Pal, 2001). The increased uptake of P by phosphobacteria (Bacillus) could be attributed to its greater P-solubilization potentiality in the presence of organic matter. Organic fertilizer provides significant cation exchange capacity to hold cations such as K+. The change in cation exchange capacity of organics by acidification might have enhanced K availability (Kumar *et al*, 2009 and Jat *et al*, 2011).

Table1. Effect of phosphorus, molybdenum and boron on growth, yield attributes and yield of mungbean

Treatment	Plant height (cm)	No branches/ plant	Dry weight (g/row length)	No of nodules/ plant	Nodule dry weight (mg)	No of pods/ plant	Pod length (cm)	No of grains/pod	Test weight (g)
Fertility level									
F1:RDF	39.53	6.76	39.33	26.43	55.50	18.86	6.64	8.83	28.11
F2:RDF+ VC 2.5 t/ha	40.94	6.94	40.49	28.29	67.89	19.57	6.69	9.07	28.80
F3:RDF+ VC 5.0 t/ha	43.16	7.31	42.36	30.14	75.36	20.50	6.80	9.67	30.48
CD (P=0.05)	2.97	0.50	2.95	1.94	4.32	1.41	NS	0.65	2.08
Biofertilizer+Micronutrient									
M1:Control	35.23	5.80	39.28	19.67	46.10	16.7	6.00	8.67	26.90
M2:Biofertilizer	37.17	6.43	40.27	29.67	69.43	18.3	6.60	9.00	29.10
M3:Mo 1.0 kg/ha	38.90	6.53	38.23	23.33	54.63	18.0	6.40	8.33	26.89
M4:Co 1.0 kg/ha	41.67	6.63	40.07	23.00	53.80	18.7	6.50	8.33	27.03
M5:Biofertilizer +Mo 1.0 kg/ ha	42.27	7.23	41.33	33.67	78.90	20.0	6.87	9.17	29.64
M6:Biofertilizer + Co 1.0 kg/ ha	45.10	7.80	41.63	32.33	75.77	20.8	7.00	9.67	30.93
M7:Biofertilizer+Mo 1+Co 1 kg/ha	48.13	8.13	44.25	36.33	85.10	25.0	7.60	11.17	33.43
CD (P=0.05)	1.51	0.26	1.49	1.07	2.51	0.7	0.25	0.32	1.06

Table 2. Interaction effect of phosphorus, molybdenum and cobalt on dry matter accumulation, number of nodules, grain and protein yield of mungbean

Treatment	Dry weight (g/row length)			Protein yield		
	RDF	RDF+ VC 2.5 t/ha	RDF+ VC 5.0 t/ha	RDF	RDF+ VC 2.5 t/ha	RDF+ VC.0 t/ha
Biofertilizer+Micronutrient						
M1:Control	36.85	38.40	42.60	167.57	175.35	184.63
M2:Biofertilizer	38.00	39.50	43.30	193.20	205.52	217.81
M3:Mo 1.0 kg/ha	37.50	38.00	39.20	191.10	198.58	205.67
M4:Co 1.0 kg/ha	39.50	40.20	40.50	192.66	202.47	211.93
M5:Biofertilizer +Mo 1.0 kg/ha	40.80	41.30	41.90	236.74	253.65	266.24
M6:Biofertilizer + Co 1.0 kg/ha	41.20	41.50	42.20	252.45	245.58	276.95
M7:Biofertilizer+Mo 1+Co 1 kg/ha	41.44	44.50	46.82	274.08	283.94	305.35
CD (P=0.05)	Biofertilizer+Micronutrient at same fertility level		2.59	14.46		
	Fertility level at same/different biofertilizer+micronutrient		3.75	20.49		
Biofertilizer+Micronutrient	**Seed yield (kg/ha)**			**Total N uptake (kg/ha)**		
M1:Control	810.0	840.0	874.0	63.10	66.52	69.97
M2:Biofertilizer	920.0	970.0	1025.0	72.33	77.10	82.16
M3:Mo 1.0 kg/ha	910.0	940.0	965.0	72.49	74.84	79.05
M4:Co 1.0 kg/ha	912.0	950.0	980.0	73.12	75.80	80.86
M5:Biofertilizer +Mo 1.0 kg/ha	1070.0	1140.0	1180.0	82.90	86.77	90.19
M6:Biofertilizer + Co 1.0 kg/ha	1080.0	1045.0	1160.0	91.04	87.06	93.10
M7:Biofertilizer+Mo 1+Co 1 kg/ha	1145.0	1180.0	1240.0	97.03	100.18	104.19
CD (P=0.05)	Biofertilizer+Micronutrient at same fertility level		65.11	5.22		
	Fertility level at same/different biofertilizer+micronutrient		92.96	7.44		

Interaction effect

The interaction between fertility levels and micronutrient + biofertilizer was found significant in case of dry weight, grain yield, protein yield and total N uptake (Table 2). Maximum dry weight, protein yield, seed yield and total N uptake by crop were recorded under RDF+VC 5 t/ha along with Mo +Co + biofertilizer. The next best treatment in these respect was RDF+VC 2.5 t/ha. This may be attributed to increased nodulation and nitrogen fixation, more solublization of native P and production of secondary metabolites by the bacteria resulting; these facilitate a greater economic sink capacity as the yield has a highly significant correlation with yield attributes (Patra and Bhattacharya, 2009). The application of molybdenum and cobalt with biofertilizer was found effective in enhancing the dry weight, seed yield, protein yield and total N uptake in all the fertility levels.

CONCLUSION

On the basis of results drawn it may be recommended that application of RDF+VC 5 t/ ha along with biofertilizer+Mo1.0+Co1.0 kg/ha in combination should be superimposed over no application (control and seed must be inoculated with rhizobium for realizing economic optimum yield.

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Table 3. Effect of phosphorus, molybdenum and cobalt on quality of mungbean

Treatment	Protein content (%)	Protein yield (kg/ha)	Seed yield (kg/ha)	Stover yield (kg/ha)	Total nutrient uptake by crop (kg/ha)		
					N uptake	P uptake	K uptake
Fertility level							
F_1:RDF	21.89	215.40	978.14	2665.57	78.86	8.73	70.19
F_2:RDF+ VC 2.5 t/ha	22.04	223.58	1009.29	2712.71	81.18	8.98	72.00
F_3:RDF+ VC 5.0 t/ha	22.34	238.37	1060.57	2822.57	85.65	9.47	75.33
CD (P=0.05)	NS	15.86	72.37	151.78	5.79	0.60	5.10
Biofertilizer+Micronutrient							
M_1:Control	20.90	175.85	841.33	2350.00	66.53	7.05	58.98
M_2:Biofertilizer	21.15	205.51	971.67	2680.00	77.20	8.37	68.55
M_3:Mo 1.0 kg/ha	21.15	198.45	938.33	2643.33	75.46	8.27	67.72
M_4:Co 1.0 kg/ha	21.35	202.35	947.33	2652.67	76.60	8.58	68.39
M_5:Biofertilizer +Mo 1.0 kg/ha	22.31	252.21	1130.00	2759.33	86.62	9.80	76.44
M_6:Biofertilizer + Co 1.0 kg/ha	23.58	258.33	1095.00	2898.33	90.40	10.02	79.87
M_7:Biofertilizer+Mo 1+Co 1 kg/ha	24.21	287.79	1188.33	3151.67	100.47	11.34	87.62
CD (P=0.05)	0.81	8.35	37.59	90.13	3.01	0.34	2.67

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