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Effect of integrated use of molybdenum, vermicompost and combined inoculation of biofertilizers on yield and uptake of nutrients of Mungbean (*Vigna radiata* L. Wilzeck)

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Abstract

A field experiment was conducted for three consecutive years to evaluate the effect of integrated use of molybdenum, vermicompost and inoculation of bio-fertilizers. In order to harness the maximum benefits the mung seeds were subjected to inoculation by rhizobium, PSB & PGPR. Three levels of molybdenum 01 and 2 kg MO ha^{-1} and three levels of vermicompost 0, 2.5 and 5.0 t V.C ha^{-1} were applied as treatments. All eighteen-treatment combinations were applied in Randomized block design with two replications. Three years pooled data revealed that the seed yield of mungbean significantly increased with the application of Mo and vermicompost with inoculation of biofertilizers. The increase in yield was 3.19 q ha^{-1}, 1.21 q ha^{-1} and 2.34 q ha^{-1} due to biofertilizer, molybdenum and vermicompost application, respectively. The interactive effects of biofertilizers and vermicompost were found significant. The application of 2.5 t ha^{-1} vermicompost with biofertilizer was significantly higher than the application of vermicompost without biofertlizers and was at par with higher level of vermicompost application. The B:C ratio due to 2.5 t vc ha^{-1} with inoculation of biofertilizer was 2.61. Application of 1kg Mo ha^{-1} and 2.5 t ha^{-1} vermicompost were statistically superior over control and at par with higher level of nutrients application. The uptake of N, P, K and Mo were found significantly higher over control.

Key words- Biofertilisers, PGPR, PSB, Rhizobium, vermicompost, molybdenum

Introduction

The yield of green gram is greatly influenced by application of molybednum, biofertilizers and vermicompost. Seed inoculation with effective Rhizobium inoculant is recommended to ensure adequate nodulation and nitrogen fixation for maximum growth and yield of pulse crops. Many workers have reported that rhizobacteria belonging to groups of phosphate solublising bacteria (PSB) and plant growth promoting rhizobacteria (PGPR) influenced the symbiosis, (Dashti *et. al* 1998). Many of these rhizobacteria were found to be synergistic with rhizobium and their co-inoculation with rhizobium showed an improvement in nitrogen fixation nutrient uptake and yield of pulse crops (Dube 1997). Inoculation of

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Rhizobium, PSB or mobilizing microorganisms with legume crops has been found to substitute 80 to 20% N and P requirement by N fixation and P solubilization (Singh *et al.* 1998) Beneficial effects of micronutrients on legume crops is well known. It is one of the essential nutrient (Pattanayak *et al*. 2000), Mo is an integral part of nitrogenase and nitrase reductase enzymes system which is responsible for N_2 fixation and nitrate reduction. Molybednum activates the hydrogenase enzyme which is responsible for N reduction in biological N_2 fixation. Indirectly Mo has play role in increasing O_2 content and its availability for root growth (Bergersen and Briggs 1958) and it is known to be essential for microbial assimilation of N_2 participating in biosynthesis of carbohydrates and their translocation to root nodules needed for rhizobia (Mishustin and Shilnikova, 1971). Influence of Mo on N_2 fixation was also reported by (Pattanayak *et al.* 2000) on green gram. Seed treatment with Mo increases effective nodules, nodule weight and nodular N. Molybednum had beneficial effects on nodulation, yield and quality of grains. Higher availability of nutrients contributed to higher grain yield and other yield attributing parameters. Biofertilizers play a pivotal role in increasing the efficiency of nitrogen. The supplementary and complementary use of biofertilizers with chemical fertilizers and vermicompost has shown beneficial effect on crop growth. Depletion of organic carbon is checked and a gap between actual and potential yield was bridged (Singh *et al.* 2001) although combined inoculation of rhizobium and PSB was reported by many scientists (Tiwari *et al.* 1989 and Konde *et al*. 1998) but information about triple inoculation with Rhizobium, PSB, PGPR with vermicompost and molybednum is scanty. The use of organic sources locally available in plenty can be supplemented with minimum chemical fertilizers to serve the dual purpose of (i) maximizing yield and quality with no adverse health hazards and (ii) raising the SOC content for better soil quality and other physical properties. A series of experiments on different agro ecological zones clearly state that application of recommended doses of fertlizers fails to sustain soil health and crop productivity but combined use of fertilizers and organic manures could result in higher yields and sustain soil fertility. Therefore, this paper presents a field assessment of integrated use of vermicompost, Mo, and biofertilizers (Rhizobia, PSB, PGPR) on uptake of nutrients and seed yield of mungbean.

Methods and Material

Field experiment was conducted for three consecutive year's i.e 2005 to 2007 taking mungbean (RMG-492) as test crop in typic torripssamments in semi arid eastern plain zone of Jaipur district. The treatments comprised of three levels of molybednum 0, 1 and 2 kg Mo/ha and three levels of vermicompost 0, 2.5 and 5.0 t/ha with and without biofertilizers. The statistical design of the experiment was randomized block design. All the eighteen treatment combinations were replicated twice vermicompost was applied one day before and thoroughly mixed with the soil while Mo was applied in band placement as sodium molybdate below the seed at the time of sowing. The nutrient contents of vermicompost were N- 1.20%, P_2O_5 0.67% and K_2O 1.44%. All the intercultural practices were performed as and when required. The studies were carried out in molybednum deficient irrigated coarse textured soils, low in available nitrogen and organic carbon, medium in available phosphorus and potash (Table1). The biofertilizers used were PSB (Phosphorus solubilising bacteria), Rhizobium and PGPR (Plant growth promoting rhizobacteria). The seeds of mungbean (RMG- 492) were subjected to inoculation by (PSB, PGPR, *Rhizobia*) by usual procedure. After inoculation, seeds were dried in shade. After harvesting the seed yield were recorded. Initial soil samples were collected and analysed for physic-chemical characteristics (Jackson 1973,

Table-1 Physico- Chemical properties of the experimental soil (Typic torripssamments)

Soil Properties	values	Method
pH (1:2 soil water suspension)	8.2	
EC dSm^{-1}	0.11	
Texture	Loamy sand	
Microfarming situation	Irrigated coarse textured	
Organic carbon (%)	0.16	Walkley and Black (1934)
Calcium Carbonate (%)	< 1	Rapid titration Method piper
Available Nitrogen (Kg/ha)	134.6	Alkaline $KMnO_4$ Method (Subbia & Asisa,1956)
Available P_2O_5 (Kg/ha)	28.5	Olsen's Method (Jackson- 1973)
Available K_2O (Kg/ha)	120	Jackson (1973)
Available Mo (ppm)	0.066	DTPA extractable (Lindsey and Norvell, 1978)

AOAC 1960). Available Molybednum was extracted with DTPA following the method of Lindsay and Norvell (1978) and in the extract it was determined by Atomic absorption spectro photometer. Seed samples were collected finely ground and prepared for chemical analysis of N, P, K (Jackson 1973, AOAC 1960). Mo was determined by AAS. The uptake was calculated by multiplying the nutrient concentration with yield. Economics of the treatment was computed based upon prevailing market prices.

Results and Discussion

Results showed that seed yield of mungbean significantly increased with the levels of applied molybednum @ 2 kg Mo/ha and vermicompost @ 5 t/ha with seed inoculation of biofertilizers. The optimum economic doses for molybednum and vermicompost were 1 kg Mo/ha and 2.5 t V.C/ha. The higher doses were at par with lower doses of application and are non-significant statistically among them. Vermicompost is a potential source due to the presence of redily available plant nutrients, growth enhancing substances and a number of beneficial micro organisms like N-fixing, P-solubilising and cellulose decomposing organisms (Sultan 1997). Nutrition of leguminous crops requires phosphorus for early root growth, nodulation yield and quality of grain (Konde *et al.* 1998). Iron helps in formation of chlorophyll and it is important constituent of the enzyme nitrogenase, which is essential in N-fixation (Yadav *et al.* 2002). The increase in yield due to biofertilizer, molybednum and vermicompost was 3.19 q/ha, 1.21 q/ha and 2.34 q/ha respectively. The increased yield with the integrated supply of nutrients might be due to increased N_2 fixation. Triple inoculations of biofertilizers promote growth, which results in higher values of yield and protein (Table 3). Seed inoculation provides adequate nodulation to fix N_2 and hence ensures maximum growth and yield (Bansal 2009). *Rhizobium* inoculation together with PSB increased the nodulation, N-fixation and increased uptake of N and P. Similar results were reported by (Gupta *et. al* 1998 and Gupta 2006).

Table -2 Interactive effect of biofertilizer and vermicompost on seed yield of Mungbean

Treatments	Seed yield					% increse over control (seed)	Net Return Rs ha-1	Incremental Gross return	B:C
Levels of VC	2005	2006	2007	Pooled	Pooled Mean				
Without BF									
No Application	6.36	3.65	5.46	5.16	12247	0%	5648	Rs.0.00	1.86
2.5 t VC ha^{-1}	7.65	5.05	5.54	6.08	14440	18%	5341	-Rs.307.08	1.59
5.0 t VC ha^{-1}	7.84	5.29	5.39	6.17	14662	20%	3063	-Rs.2,585.42	1.26
With BF									
No Application	8.58	4.50	6.82	6.63	15754	0%	9155	Rs.0.00	2.37
2.5 t VC ha^{-1}	10.40	8.80	11.00	10.07	23916	52%	14817	Rs.5,662.08	2.61
5.0 t VC ha^{-1}	11.01	9.13	10.74	10.30	24463	55%	12864	Rs.3,708.33	2.09
SALE RATE Rs ha^{-1}									
Mung			Grain	2375					
Cost of cultivation ha^{-1}				Cost of Vermicompost					
	Mung	Rs.6,599.00		2.5 t	Rs.2,500.00				
	cost of BF	Rs.50.00		5.0 t	Rs.5,000.00				

Table- 3 Average effect of Molybednum and vermicompost with and without inoculation of biofertilizers on yield and nodules per plants and crude protein in Mungbean seeds

Treatments	Yield (q/ha)	Nodules plant^{-1}	Crude protein %
Levels of Biofertilisers			
Without inoculation of BF	5.81	19.55	20.41
With inoculation BF	9.00**	25.64	22.40*
C.D. at 5%	0.59	2.37	1.12
Levels of Molybednum (Kg/ha)			
0	6.72	18.90	20.38
1	7.57**	21.48	21.48
2	7.93	25.46	22.48**
Levels of vermicompost (t/ha)			
0	5.9	19.92	20.08
2.5	8.07	22.23	21.82
5	8.24	23.68	22.43**
C.D. at 5%	0.73	2.89	1.37
B:C ratio	01:02.6		

Application of fertilizers i.e. Mo @ 1 and 2 kg/ha with and without inoculation significantly influenced nitrogen content in plants inoculation with biofertilizers improved the efficiency of fertilizers applied. The results indicated that use of molybednum with an added source of organic manure as vermicompost as well as incorporation of value added biofertilizers not only improved the quality of pulses, but also recorded a significant increase in uptake of nutrients which is evident from a significant increasd in NPK and Mo content. The uptake of nutrients also increased with increasing application of nutrients. (Table. 4 and 5)

Table-4 Average effect of Mo and vermicompost with and without inoculation of biofertilizers on content of nutrients in mungbean seeds

Treatments	**Content of Nutrients**			
	Nitrogen (%)	**Phosphorus (%)**	**Potash (%)**	**Molybednum (PPM)**
Levels of Biofertilizers (BF)				
Without inoculation of BF	3.26	0.22	0.71	0.12
With inoculation BF	3.60	0.34	0.82	0.15
C.D. at 5%	0.18	0.018	0.031	0.007
Levels of Molybednum (kg/ha)				
0.0	3.26	0.25	0.70	0.13
1.0	3.48	0.27	0.76	0.14
2.0	3.68	0.30	0.83	0.15
Levels of vermicompost (t/ha)				
0.0	3.21	0.24	0.71	0.11
2.5	3.49	0.28	0.77	0.14
5.0	3.59	0.31	0.81	0.15
C.D. at 5%	0.22	0.022	0.038	0.008

Table- 5 Average effect of Mo and vermicompost with and without inoculation of biofertilizers on uptake in Mungbean seeds

Treatments	Uptake of Nutrients			
	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	Mo (g/ha)
Levels of Biofertilizers (BF)				
Without inoculation of BF	15.46	1.17	3.92	0.64
With inoculation BF	33.70	3.32	7.86	1.48
C.D. at 5%	1.66	0.21	0.39	0.059
Levels of Molybednum (Kg/ha)				
0.0	19.86	1.74	4.74	0.88
1.0	25.78	2.38	6.18	1.15
2.0	28.11	2.63	6.74	1.16
Levels of vermicompost (t/ha)				
0.0	18.50	1.51	4.43	0.67
2.5	27.61	2.55	6.54	1.22
5.0	27.64	2.69	6.70	1.29
C.D. at 5%	2.03	0.26	0.48	0.072

Protein content increased significantly with inoculation of biofertilisers by 1.99 %. Application of molybdenum @ 2 kg ha^{-1} along with biofertilizers inoculation increased the protein content significantly when improved to treatment receiving 2 kg Mo ha^{-1} while lowest value (20.38%) was estimated in the treatment with no application of molybdenum (Table 3). The data in Table-5 revealed that uptake of nitrogen, phosphorus and potassium were increased with the application of biofertilizer, Mo and vermicompost significantly improved over the control although the application of molybdenum and V.C. at higher levels was at par and found statistically non- significant. This reduction in yield at higher levels of applied nutrients might be due to reduced uptake of the nutrients and undesirable effects on growth development and metabolism plants.

Table- 6 Average effect of Molybednum and vermicompost with and without inoculation of biofertilizers on available nutrient status after harvesting of Mungbean

Treatments	Available Nutrients			
	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	Mo (g/ha)
Levels of Biofertilizers (BF)				
Without inoculation of BF	164.53	36.86	142.76	0.059
With inoculation BF	174.65	43.65	147.56	0.069
C.D. at 5%	3.22	2.80	4.85	0.003
Levels of Molybednum (Kg/ha)				
0.0	165.42	36.76	139.73	0.054
1.0	169.92	40.54	146.32	0.064
2.0	173.42	43.46	147.42	0.075
Levels of vermicompost (t/ha)				
0.0	162.08	35.79	138.63	0.059
2.5	171.45	41.52	147.05	0.064
5.0	175.23	43.46	149.78	0.070
C.D. at 5%	3.94	3.43	5.94	0.004

The development indicated that the yield of mung was dependent on the rates of nutrient applications, the higher rates shows autogonism with decline in yields. The increase in uptake may be associated with the absorption and desorption of PO_4^{-3} anions. The addition of P increased the adsorption of PO_4^{-3} and mobilize the availability of other nutrients hence increase concentration and uptake in plant. Molybednum plays a vital role in nitrogen fixation through its effect on nitrogenase enzymes in nodules of leguminous plants (Ali *et al*. 2002). The Mo uptake in seed increased with its addition at higher level (Singh and Singh 1992) (Table 5). A perusal of data presented in Table-6 revealed that mungbean showed significant increase in N, P,K and Mo in post harvest soils with increased in individual doses of Mo, VC, B.F at almost all the stages of growth. The response of Mo might be attributed to its low initial level in soil therefore, response of Mo in alkaline loamy sand soil (Arora *et. al* 1987). The Nitrogen and Phosphorus uptake increased significantly with increasing levels of Mo at higher level and V.C. might be be due to significant increase in nodulation and similar trend was observed by potassium uptake .

Conclusion

The nutrients applied together gave better response and collectively accelerated the absorption of nutrients and in turn resulted in higher concentration and uptake of nutrients in comparison to control. Beneficial effects of integrated use of biofertilizers and chemical fertilizers on uptake of nutrients have been repoted by many workers. The parameters were positively influenced by combined inoculation of biofertilizers (PSB, Rhizobia, PGPR) and molybdenum treatment with vermicompost. The efficiency of applied fertilizers also increased indicating better utilization of sources.

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