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EFFECT OF INTEGRATED USE OF BIO-FERTILIZERS AND VERMI COMPOST ON NUITRIENT AVAILABILITY, UPTAKE AND PERFORMANCE OF URD BEAN (*VIGNA MUNGO*) IN SANDY LOAM SOIL

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Abstract

An experiment was conducted to study the effect of integrated use of bio-fertilizers and vermicompost on availability, uptake of nutrients performance of urd bean (*Vigna mungo*) in sandy loam soil during *Kharif* 2007. Nine different treatments were replicated thrice in a randomized block design. The soil of experimental site was low in organic carbon and medium in available phosphorus and potassium. Significantly lower grain yield and number of effective nodules were obtained with $\mathbf{T_1}$ where no fertilizer was applied. The $\mathbf{T_5}$ (½ N + ½ P + *Rhizobium* + PSB) produce the highest grain and straw yield and it was statistically at par with the $\mathbf{T_3}$ where ½ N + Full P + *Rhizobium* was applied, $\mathbf{T_9}$ (Vermicompost @ 1 ton ha^{-1} + *Rhizobium* + PSB) and significantly superior over rest of the treatments. The highest values of organic carbon (0.48 per cent), available N (163.36 kg ha-1), available P (15.6 Kg ha^{-1}), available K (186.52 kg ha^{-1}) were observed in the treatment having application of ½ N + ½ P + *Rhizobium* + PSB ($\mathbf{T_5}$) and were significantly higher than the treatments where integration of nutrient sources was not followed. The highest N, P, K uptake by grain and straw were observed with the application of $\mathbf{T_5}$. From the above study, it can be concluded that application of half dose of recommended N and P alone with *Rhizobium* and PSB improved the availability of nutrients in soil and consequently improve the nutrients uptake and yield of urd bean.

Key words : Urd bean, bio-fertilizers, vermi compost, *Rhizobium* and PSB.

Introduction

Among the pulses, urd bean is an important crop grown mostly during *Kharif* season in Uttar Pradesh. In general, the productivity of most of the pulses crops is quite low. The main reason of lower productivity of pulse crop and specially urd bean is cultivation in the un-irrigated and unfertile land. Although, the requirement of the pulses for nitrogen and phosphorus is similar to cereal however few farmers prefer to apply fertilizers in pulses especially in urd bean. Urd bean cultivation is low remunerative farmers avoid the application of most of the chemical fertilizers therefore biofertilizers, which are cost effective can be used in the urd bean cultivation to supplement the N and P. Apart from biofertilizers, organic manures can also fulfill the nutritional demand to some extent.

Being leguminous plant urd bean has ability to fix atmospheric nitrogen in association with a soil inhabiting bacterium *Rhizobium* through the processes of symbiosis. The efficiency of symbiosis varies with the *Rhizobium* strain, host plant and also governed by several soil and environmental factors (Vincent, 1970). Although, Rhizobia nodulating urd bean are present in most of the soil in the country though, seed inoculation with an appropriate, effective and competitive *Rhizobium* strain at sowing time is recommended to ensure adequate nodulation and nitrogen fixation for maximum growth and yield. *Rhizobium* requires phosphorus for its growth and survival in soil, rhizosphere colonization, infection and nodule development and energy transformation during Nitrogen fixation in root nodules (O'Hara *et al*., 1988). Soil microorganism play significant role in mobilizing P for the use of plants from native soil pool as well as from added insoluble phosphates (Kapoor, 1995). Dual inoculation of *Rhizobium* and phosphate solubilizing bacteria (PSB) may help the plant to acquire both N and P. Coinoculation of PSB with *Rhizobium* have been found to improve the

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nodulation and nitrogen fixation in chickpea (Algawadi and Gaur, 1988). Similarly, application of vermicompost , *Rhizobium* and PSB in pulses markedly enhanced growth and yield attributes (Jat and Ahlawat, 2004).

The effectiveness of biofertilizers also depends on physico-chemical condition of soil which can be improved with the use of organic sources. Due to easiness in its preparation and better quality, vermicompost is most popular compost nowadays. Apart from improving the nutrient availability and physical condition of soil, application of vermicompost will also affect the microbial activity particularly of PSB. In the present circumstances where the farmers do not prefer to apply chemical fertilizer, it is desirable to find out the other options.

Materials and Methods

The experiment was conducted at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.), India in *Kharif* season 2007. Meerut is located at 29° 04'N latitude and 77° 42 'E longitude at an altitude of 237 meters above the mean sea level. The climate of this region is subtropical and semi arid characterized with hot summers and extremely cold winters. The mean maximum temperature of region is 43°C to 45°C, which is not uncommon during summer while very low temperature (3°C) accompanied by frost may be experienced in Dec.-Jan. The winters are cool; frost generally occurs towards the end of December and may continue till the end of January. The total rainfall as well as its distribution in this region is subjected to large variation. About 80-90% of it is received during July to September and few showers of cyclonic rains are also received during Dec.-Jan. or late spring season. Nine treatments were tested in the experiment. The treatments were control (without fertilizers) $\mathbf{T_1}$, recommended NP $\mathbf{T_2}$, ½ N + Full P + *Rhizobium* $\mathbf{T_3}$, Full N + ½ P + PSB $\mathbf{T_4}$, ½ N + ½ P + *Rhizobium* + PSB $\mathbf{T_5}$, vermicompost @ 1 t ha^{-1} $\mathbf{T_6}$ vermicompost @ 1 t ha^{-1} + *Rhizobium* $\mathbf{T_7}$, vermicompost @ 1 t ha^{-1} + PSB $\mathbf{T_8}$, vermicompost @ 1 t ha^{-1} + *Rhizobium* + PSB $\mathbf{T_9}$. Experiment was laid out in randomized block design with three replications. The experimental soil was sandy loam in texture, low in organic carbon and medium in available P and K. Experimental field was prepared by harrow ploughing and two deep ploughing by tractor drawn cultivator followed by pre-sowing irrigation; the field was finally prepared by disc harrow followed by planking. In order to create ideal condition for good germination, pre-sowing Irrigation was given 10 days before sowing. An area was marked for recording various growth observations on crop. Growth observations were recorded at 30, 60 DAS and at harvesting of the crop. Yield attributes were recorded at harvest. Chemical analysis for plant and soil was done by using standard methods in the Department of Soil Science, College of Agriculture, SVPUAT, Meerut (U.P.), India.

Results and Discussion

Residual soil fertility

Soil pH did not differ significantly under different treatment (table 1). Highest pH (8.3) with the treatment where only chemical fertilizers were applied ($\mathbf{T_2}$) followed by treatment Vermicompost @ 1 t ha^{-1} + *Rhizobium* ($\mathbf{T_7}$) and the minimum pH (8.03) was recorded with the treatment Vermicompost @ 1 t ha^{-1} + *Rhizobium* + PSB ($\mathbf{T_9}$). Slight reduction in soil pH was found in those treatments where PSB was applied.

The organic carbon in soil under different treatments ranged from 0.29 to 0.48 per cent (table 1). The highest organic carbon (0.48 per cent) observed in the treatment having application of ½ N + ½ P + *Rhizobium* + PSB ($\mathbf{T_5}$) was significantly higher than the treatments where integration of nutrient sources was not followed. Organic carbon in soil remained unaffected in all those treatments, where vermicompost was applied although the higher value (0.40%) was found in $\mathbf{T_9}$, where vermicompost, *Rhizobium* and PSB were applied. Significantly lower organic carbon (0.29 per cent) was found in $\mathbf{T_1}$. Organic carbon content in soil improved slightly due to integration of nutrient sources. Available N in soil estimated after crop harvest varied significantly under various treatments (table 1) and ranged from 121.98 to 163.36 kg ha^{-1}. The highest available N in soil 163.36 kg ha^{-1} observed with the application of ½ N + ½ P + *Rhizobium* + PSB, which was significantly higher than $\mathbf{T_1}$ and $\mathbf{T_2}$, which differ significantly from each other. Minimum and significantly lower available soil nitrogen (121.98 q ha^{-1}) than the remaining treatments was found in $\mathbf{T_1}$. Available nitrogen in soil improved slightly due to application of bio and organic sources of nutrients. Available P in soil differed significantly due to application of different treatments (table 1) and ranged between 8.96 to 15.55 kg ha^{-1}. The highest available P (15.6 Kgha^{-1}) in soil observed with the application of ½ N + ½ P + *Rhizobium* + PSB ($\mathbf{T_5}$) was significantly higher than all other treatments. In general, it was observed that available soil phosphorus was comparatively higher in all those treatments where integration of nutrient sources was adopted. Minimum and significantly lowest available soil phosphorus than the rest of the treatments was found in $\mathbf{T_1}$. Available phosphorus found in $\mathbf{T_2}$ was also found significantly lower than those treatments where different nutrient sources were applied. Available K in soil also varied significantly under various treatments and and ranged between 161. 90 to 186.52 kg ha^{-1} (table 1). The highest available K (186.52 kg ha^{-1}) found in soil with the application of ½ N + ½ P + *Rhizobium* + PSB (**T_5**) was significantly higher than the **T_1**. Minimum available K in soil 161.90 kg ha^{-1} was observed with the **T_1** (control) was significantly lower than the remaining treatments. Available soil potassium in remaining treatments other then **T_1** was more or less similar.

Nutrient content and uptake

Nitrogen : Grain N content as shown in table 2 was affected significantly by different treatments. The highest grain nitrogen content (4.03 per cent) observed in **T_5** was significantly higher than the treatments other than **T_3** and **T_4**. Nitrogen content in **T_3** (3.94 per cent) and (3.82 per cent) in **T_4** were found statistically at par with the N content of **T_5**. Significantly lowest grain N content than the remaining treatments was found in **T_1** where no fertilizer was applied. The highest N content 1.70 per cent in straw was observed with the **T_5**, which was significantly higher than the **T_1**, **T_2** and **T_6** and **T_8**. Minimum N content in straw (1.32 per cent) was observed with the **T_1** (control).

Assimilation of nitrogen by grain differs significantly under different treatments (table 2), the highest uptake of nitrogen 42.18 $kgha^{-1}$ by grain found with the application of **T_5** was significantly higher than the rest of the treatments. Nitrogen assimilation in grain found in **T_2** (100% NP) and vermin compost treated plot @ 1 t ha^{-1} (**T_6**) was similar. The highest nitrogen uptake 83.66 Kg ha^{-1} in straw found with the application of ½ N + ½ P + *Rhizobium* + PSB was significantly higher other than **T_3** and **T_9**. Assimilation of nitrogen by urd bean straw was similar in the **T_2** where 100% NP and **T_6** where 1 ton of vermicompost were applied.

Phosphorus : P content of grain and straw under different treatments varied significantly (table 2). The maximum grain P content 0.33 and straw content 0.21 per cent was observed with in **T_5**, which was significantly higher than the treatments where either only organic sources were applied to supply N and P or 100% N P was applied through chemical fertilizers. Minimum P content 0.23 per cent was observed with the **T_1** (control) among vermin compost treatments **T_7** had high P content 0.30 per cent in grain. With exception of **T_1**, **T_2** and **T_6** the straw P content under remaining treatment was more or less similar.

Uptake of phosphorus by grain and straw varied significantly (table 2). The highest P uptake 3.56 and 10.30 kg ha^{-1} by grain and straw respectively observed in **T_5** was significantly higher other than **T_3**. Phosphorus assimilation was comparatively lower in those treatments where only organic sources were applied. Phosphorus assimilation by urd grain and straw in **T_1** was lowest and it differs significantly from rest of the treatments with exception of **T_2**. Assimilation of phosphorus by urd grain remained similar in those treatments where either only chemical fertilizers or organic sources were applied. Uptake of phosphorus in **T_2** was found significantly lower than the treatments where integration was followed. Phosphorus assimilation in **T_2** was similar to **T_6** while significantly higher than the **T_1**.

Potassium : Grain and straw K content was affected significantly by different treatments (table 2). The highest K concentration in grain and straw 0.68 and 1.74 per cent respectively in **T_5** was significantly higher than the K content found in **T_1** and **T_2**. This shows that grain and straw K content in the treatment of integration was similar to those where only organic sources were applied for nutrition. Grain and straw K content improved due to application of vermicompost with *Rhizobium* and PSB treated seeds in comparison to those treatments where vermicompost was applied either alone or with *Rhizobium* or PSB.

Assimilation of potassium by grain and straw varied significantly under different treatments (table 2). The highest K uptake in grain and straw 7.13 Kg ha^{-1} and 86.09 $kgha^{-1}$ in must cases **T_5** and was found significantly higher other than **T_3**. Accumulation of K in **T_3** and **T_5** was similar. Due to integration of nutrient sources K assimilation increased significantly over **T_2** in mus. Minimum and significantly lower K assimilation than the remaining treatments was found in **T_1**. All the treatments having application of vermicompost were found statistically similar.

Yield

Grain yield : Effect of different treatments on grain, straw and biological yield are presented in table 3. Grain yield recorded under different treatments varied from 6.36 to 10.57 q ha^{-1}. The higher grain yield 10.57 q ha^{-1} was recorded in **T_5**, where nitrogen and phosphorus doses were halved and seed was inoculated with *Rhizobium* and PSB while lowest grain yield 6.36 q ha^{-1} was found in **T_1** (control). No significant difference was found between **T_2** and **T_6** where recommended NP or vermicompost were applied although a reduction of 6.2 per cent in grain yield was recorded due to application of vermicompost @ 1 t ha^{-1} instead of recommended NP.

Table 1: Effect of different treatments on soil pH, organic carbon % and available NPK (kg ha^{-1}) in soil after harvesting.

Treatments	Soil pH	Organic carbon %	Available nitrogen	Available phosphorus	Available potassium
Control	8.13	0.28	121.98	8.96	161.90
Recommended N & P	8.32	0.31	151.38	10.21	183.60
Half nitrogen + full phosphorus + *Rhizobium*	8.14	0.43	157.75	13.60	185.21
Full nitrogen + half phosphorus + PSB	8.07	0.42	156.46	13.31	183.28
Half nitrogen + *Rhizobiium* + PSB	8.04	0.48	163.36	15.55	186.52
Vermicompost @ 1 t ha^{-1}	8.16	0.37	154.30	11.35	182.92
Vermicompost @ 1 t ha^{-1} + *Rhiozobium*	8.16	0.38	158.87	12.40	184.83
Vermicompost @ 1 t ha^{-1} + PSB	8.03	0.37	155.75	12.36	183.84
Vermicompost @ 1 t ha^{-1} + *Rhizobium* + PSB	8.03	0.40	157.08	12.54	183.55
CD (p = 0.05)	N.S.	0.08	9.74	1.05	7.61

Table 2 : Effect of different treatments on NPK content (%) of grain and straw and uptake (kg ha^{-1}) by grain and straw.

Treatments	N content (%)		N uptake (kg ha^{-1})		P content (%)		P uptake (kg ha^{-1})		K content (%)		K uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	2.96	1.32	18.81	41.36	0.23	0.15	1.49	4.67	0.40	1.42	2.53	44.67
T_2	3.38	1.40	27.10	57.64	0.24	0.16	2.02	6.73	0.50	1.45	4.13	61.24
T_3	3.95	1.62	37.71	77.46	0.32	0.19	3.11	9.37	0.64	1.69	6.07	81.08
T_4	3.82	1.60	33.62	70.53	0.31	0.18	2.75	8.52	0.57	1.57	5.03	71.01
T_5	4.03	1.70	42.18	83.66	0.33	0.21	3.56	10.30	0.68	1.74	7.13	86.10
T_6	3.43	1.40	26.60	54.53	0.25	0.16	1.93	6.46	0.55	1.55	4.28	67.01
T_7	3.58	1.57	30.11	70.26	0.3‘0	0.18	2.52	8.36	0.57	1.57	4.81	70.63
T_8	3.52	1.51	30.17	66.80	0.25	0.18	2.09	8.37	0.57	1.50	4.77	66.26
T_9	3.61	1.60	31.73	75.56	0.28	0.20	2.46	9.73	0.61	1.64	5.21	77.30
CD(p = 0.05)	0.33	0.18	4.25	8.86	0.36	0.03	0.6	1.58	0.13	0.11	1.1	8.4

Table 3 : Effect of different treatments on grain, straw and biological yields (q ha^{-1}).

Treatments	Yield (q ha^{-1})		
	Grain	Straw	Biological yield
Control	6.36	31.48	37.84
Recommended N & P	8.25	42.20	50.45
Half nitrogen + full phosphorus + *Rhizobium*	9.55	47.90	57.45
Full nitrogen + half phosphorus + PSB	8.83	45.20	54.03
Half nitrogen + *Rhizobiium* + PSB	10.57	48.00	58.57
Vermicompost @ 1 t ha^{-1}	7.74	38.95	46.69
Vermicompost @ 1 t ha^{-1} + *Rhiozobium*	8.41	44.90	53.31
Vermicompost @ 1 t ha^{-1} + PSB	8.37	44.20	52.57
Vermicompost @ 1 t ha^{-1} + *Rhizobium* + PSB	8.65	47.10	55.75
CD (p = 0.05)	1.15	2.62	10.96

Although, grain yield of urd bean increased slightly due to sowing of inoculated seed in vermicompost treated plot, but increment was non significant. Grain yield of urd bean increased by 16 and 28 per cent over $\mathbf{T_2}$ (recommended NP) due to reducing the nitrogen application by 50% and inoculating the seed with *Rhizobium* or *Rhizobium* + PSB. Similarly, 7 and 28 per cent increase in yield over $\mathbf{T_2}$ (recommended NP) was also recoded due to cutting down P application by 50 per cent and sowing of inoculated seed with PSB. Gain of 32.23 to 36 per cent in grain yield over control was also noticed due to application of different bio fertilizer with vermicompost.

Straw yield : Straw yield under various treatment combinations showed a significant difference. Straw yield varied from 31.48 to 48.0 q ha^{-1} under different treatments (table 3). The highest straw yield 48.0 q ha^{-1} was found in $\mathbf{T_5}$ while lowest 31.48 q ha^{-1} in $\mathbf{T_1}$ (control). Straw yield obtained in $\mathbf{T_5}$ was found statistically at par to the straw yield found in $\mathbf{T_3}$ and $\mathbf{T_9}$ and significantly higher than the remaining treatments. Significantly lower straw yield (31.48 q ha^{-1}) than the other treatments was found in $\mathbf{T_1}$. Treatment where bio fertilizer were applied with inorganic fertilizer yielded significantly higher straw yield over $\mathbf{T_2}$ (recommended dose of NP). Similarly application of *Rhizobium* and vermicompost resulted in significantly higher straw yield over $\mathbf{T_2}$ (recommended dose of NP).

The result reveals that available nitrogen, phosphorus and potassium were higher in those treatments, where integration of nutrient sources was followed. It may ensure the optimum nutrient supply throughout the crop cycle. Higher available NPK in these treatments may be due to addition of higher biomass in the form of leave fall and roots which may have build up the organic matter level in soil which contains a substantial amount of NPK and improvement in the physico- chemical properties of soil. Similarly due to biological nitrogen fixation and solubilization of insoluble phosphate owing to *Rhizobium* and PSB inoculation available NPK may increase as a consequence the uptake of NPK by plants increase and the vegetative as well as reproductive growth increase which ultimately affects the grain yield of urd bean.

Rajkhowa (2003) and Mohan (2007) also reported that availability of NPK in soil and uptake by plant increased due to combined application of chemical fertilizer and vermicompost. Jat *et al*. (2006) and Jain (2003) also reported that available N in soil increased due to inoculation of *Rhizobium* with or without PSB, over control while soil P content remained unaffected by *Rhizobium* alone but improved with *Rhizobium* + PSB over no inoculation. Higher availability of nutrients in soil and consequently higher uptake of nutrients by plants increase the plant height, number of plant, number of branches per plant and ultimately biological and grain yield of urd bean.

Conclusion

From the above study, it can be concluded that the application of *Rhizobium* and PSB along with half doses of recommended N and P gave best result and proved to be beneficial. Grain yield increased by 66% due to application of biofertilizers with inorganic fertilizers. Application of vermicompost @ 1 t ha^{-1} with PSB and *Rhizobium* gave better result as compare to application of 1 t ha^{-1} vermicompost alone.

References

Algawadi, A. R. and A. C. Gaur (1998). Associative affect of *Rhizobium* and Phosphate solubilizing bacteria on the yield and nutrient uptake of chickpea. *Plant and Soil*, **105** : 241-246.

Jain, N. K., H. C. Jain and U. R. Khandhar (1988). Response of kharif legumes to fertilizers and *Rhizobium* inoculation. *Indian Journal of Agronomoy*, **33** : 347-350.

Jat, R. S. and I. P. S. Ahlawat (2004). Effect of vermicompost, biofertilizer and phosphorus on growth, yield and nutrient uptake by gram (*Cicer arietinum*) and their residual effect on fodder maize (*Zea mays*). *Indian Journal of Agricultural Sciences*, **74(7)** : 359-361.

Jat, R. S. and I. P. S. Ahlawat (2006). Direct and residual effect or vermicompost biofertilizers and phosphorus on soil nutrient dynamics and productivity of chickpea-fodder maize sequence. *Journal of Sustainable Agriculture*, **28(1)** : 41-54.

Kapoor, K. K. (1995). Phosphate mobilization through soil microorganisms. In : *Plant Microbe Interaction in Sustainable Agriculture* (Eds. Behl, R.K. Khurana, A.L. and Dogra, R.C.). Bio Science Pub. Hisar. pp. 46-61.

Mohan, S. C. and K. K. Chandragiri (2007). Nutrient uptake and post harvest available soil nutrient under organic forming system in cotton + blackgram inter-cropping system. *International Journal of Plant Science*, **2(1)** : 120-123.

O' Hara, G. W., N. Bookerd and M. J. Dilworth (1988). Mineral constraints to nitrogen fixation. *Plant and Soil*, **198** : 93-110.

Rajkhowa, D. J., M. Saikia and K. M. Rajkhowa (2003). Effect of vermicompost and levels of fertilizers on green gram. *Legume Research*, **26(1)** : 63-65.

Vincent, J. M. (1970). *A manual for the practical study of root nodule bacteria*. IBP Hand book No. 15 Blackwell Scientific Publication Oxford.