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RESPONSE OF MUNG BEAN [VIGNA RADIATA (L.)] TO FYM AND ZINC-ENRICHED FYM IN LOAMY SAND SOIL OF JOBNER

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ABSTRACT

A field experiment was conducted on loamy sand soil (Typic Ustipasament) to find out the effect of zinc-enriched FYM on growth parameter, protein content, nutrient uptake, yield and yield attributes of mungbean during 2012-13. The total and effective number of nodules, total chlorophyll content, plant height and number of branches was significantly increased by 24.09, 25.53, 16.59, 26.55 and 29.36 % respectively under $EnZn_2$ over control (Zn_0) and it was at par with $EnZn_3$. The increasing in yield due to enrichment was achieved by 9.04 % over straight application of zinc in mungbean. The improvement in total uptake of N, P, K and Zn by mungbean was 44.87, 17.06, 46.45 and 48.71 % respectively achieved due to zinc enriched FYM than the straight application of zinc. .The protein content increased due to enrichment by 3.54% over straight application of zinc in mungbean.

INTRODUCTION

The pulses constitute important component of cropping system in arid and semi arid region of Rajasthan. Mung bean [*Vigna radiata* (L.) Wilczek.] is one of the important pulse crop grown in the arid and semi arid regions of the state. Being a leguminous crop, it has the capacity to fix atmospheric nitrogen. However, the yield levels are far below the potential mainly due to imbalance nutrient application. The imbalanced fertilizer application coupled micronutrient deficiency; particularly zinc is one of the main factors responsible for the low productivity of pulses in arid and semi arid region of Rajasthan. Micronutrient deficiencies in Indian soils and crops have been on the increase since the adoption of modern agricultural technology with increased use of NPK fertilizers generally free from micronutrients, intensive cultivation with high yielding varieties with more irrigation facilities, limited use of organic matter and restricted recycling of crop residues (Prasad, 1999). Coarse textured, calcareous, alkaline or sodic soils having sandy texture, high pH and low in organic matter are generally low in available zinc.

In many parts of the country, zinc as a plant nutrient now stands third in importance i.e. next to nitrogen and phosphorus (Takkar and Randhawa, 1978).

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The poor crop recovery of zinc necessitates the adoption of improved techniques like use of synthetic chelates. Zinc chelates, though more effective in maintaining Zn in soil solution, their use on large scale under field condition is prohibitive due to high cost. Since it is a costly technology, resorting to enrichment with organic manures which acts as natural chelates seems to be economically viable. Zinc application in the enriched form may enhance the fertilizer use efficiency and increase the yield of mung bean. However, information on the response of mung bean to zinc enriched cow dung and FYM is limited. Hence, the present study was conducted for assessing the effect of zinc-enriched FYM on growth parameters, nutrient uptake, yield and yield attributes of mung bean.

MATERIALS AND METHODS

The experiment was conducted in zinc deficient loamy sand soil at Agronomy farm, S. K. N. Collage of Agriculture, Jobner, Jaipur during *kharif* season (July 2012 to October 2012) to study the effect of FYM and zinc enriched FYM on growth nutrient uptake, yield attributes and yield of mung bean. The research farm is located at 26^0 5' North latitude and 75^0 28" east longitudes at an altitude of 427 meters above mean sea level.

The soil of experimental field is loamy sand soil (Inceptsol) belonging to series Chomu (Typic Ustipasament) having pH 8.2. The electrical conductivity, CEC and organic carbon content of soil were 1.35 dSm^{-1}, 9.4 c mol (p+) kg^{-1} soil and 0.21 per cent respectively. The fertility status of the experimental field was found to be low in available nitrogen (126.6 kg ha^{-1}), medium in available phosphorus (19.4 kg ha^{-1}) and high in available potassium (128.7 kg ha^{-1}) and the available zinc status of the soil was 0.41 mg kg-1 which is below the critical level of 1.2 mg kg^{-1}. The experiment was conducted in a randomized complete block design with triplicate replications. The treatment details are given in Table 1.

Mung bean (RMG-62) was sowed on 5 July at a depth of 5 cm keeping inter row spacing of 30 cm and plant to plant spacing of 10 cm using recommended seed rate of 20 kg ha^{-1} and fertilizers were applied at 20 kg N and 40 kg P_2O_5 ha^{-1}. Before sowing seed was treated with Rhizobium and PSB. The full of the recommended nitrogen (20 kg ha^{-1}) and phosphorus (40 kg ha^{-1}) were applied through urea and DAP as basal application in each plot. Based on the initial soil analysis K_2O was not added due to sufficient available potassium content in the soil. Zinc-enriched FYM was prepared by thoroughly mixing the required quantity of FYM (500 kg ha^{-1}) with the solution of $ZnSO_4.7H_2O$ having required concentration as per the enriched treatment *viz*., 2.5 kg ha^{-1}, 5 kg ha^{-1} and 7.5 kg ha^{-1}.

The enrichment process was started 50 days before their use in *kharif* season experiment on mung bean. The mixture was filled in a pre-dug pit and the pit was covered with polythene for natural chelation during the process of composting. The mixture was turned over periodically (weekly) and moisture loss was compensated during the process of enrichment for seven weeks. The FYM used for enrichment contained 53.5 mg kg^{-1} total zinc. The content of Zn in FYM after enrichment under different levels i.e. Zn (2.5 kg ha^{-1}), Zn (5.0 kg ha^{-1}) and Zn (7.5 ha^{-1}) were 4653, 9360 and 13568 mg kg^{-1} respectively. Zinc-enriched FYM was used to study its direct effect on growth and yield attributes in mung bean (var. RMG-62).

Observation for total and effective number of nodules at pre flowering stage, total chlorophyll content at flowering, plant height at harvest, number of branches per plant, number of pods per plant, number of seeds per pods, test weight, yields, nutrient uptake and protein content in grain was observed. Plant samples were collected at the harvest of mung bean for determination uptake of N, P, K and Zn. The oven dried plant samples were finely ground in a stainless still willey mill and were digested with H_2SO_4 and H_2O_2 (Jackson 1967) for estimation of nitrogen content and with HNO_3:$HClO_4$ (4:1) di-acid mixture for determination of P, K and Zn content as per the procedure given by Jackon (1973). The N, P, K and Zn uptake was calculated in kg ha^{-1} by following formula:

Total N/ P/ K uptake (kg ha^{-1}) = {Nutrient content (%) in seed x Seed yield (kg ha^{-1}) + Nutrient content in straw (%) x Straw yield (kg ha^{-1})} /100

Zn uptake (gm ha^{-1}) = { Nutrient content in seed (ppm) x Seed yield (kg ha^{-1}) + Nutrient content in straw (ppm) x Straw yield(kg ha^{-1})} /1000

RESULTS AND DISCUSSION

Growth

Application of FYM and zinc enriched FYM significantly influence the total and effective number of nodules, total chlorophyll content, plant height and number of branches per plant of mung bean. Total and effective number of nodules, total chlorophyll content, plant height and number of branches per plant increased significantly with increasing the dose of FYM (Table 2). Application of FYM significantly increased the total and effective number of nodules, total chlorophyll content, plant height and number of branches up to 30.52, 30.37, 21.21, 40.41 and 39.55 % respectively over control (no FYM). The total and effective number of nodules, total chlorophyll content, plant height and number of branches were significantly increased by 24.09, 25.53, 16.59, 26.55 and 29.36 % respectively under $EnZn_2$ over control (Zn_0) and it was at par with $EnZn_3$. The result indicated that improvement in growth parameters was higher when zinc was applied as $EnZn_2$ as well as $EnZn_3$. Among the treatments, $EnZn_2$ showed superior favorable effect in increasing growth parameters. The beneficial effect of zinc-enriched FYM clearly noticed over straight zinc application in mung bean. The significant effect of zinc-enriched FYM due to the fact that the zinc availability expected to be enhance through complexation or chelation and thereby inhibited zinc fixation in soil (Latha *et al*., 2001; Venkatasheshagiri *et al*., 1994).

Yield and yield attributes

Application of FYM significantly increased seed, straw and total yield mung bean by 44.75, 42.77 and 43.45 % respectively, over control (no FYM). Seed yield improvement significantly superior by 36.72 under $EnZn_2$ over control which is at par with $EnZn_3$. The result indicated that yield improvement was higher when zinc was applied as $EnZn_2$ as well as $EnZn_3$, followed by $EnZn_1$. Among the treatments, zinc-enriched FYM application showed more favorable effect in increasing seed yield of mung bean followed by Zn_0.the favorable effect of enriched zinc was significantly exhibited over straight zinc application in mung bean. The average improvements in seed yield of mung bean due to zinc-enriched FYM (11.79 q ha^{-1}) and their straight application (10.98 q ha^{-1}) was by 31.86 and 22.83% over control Zn_0 (8.96 q ha^{-1}).

Thus, the increasing in yield due to enrichment was achieved by 9.04 % over straight application of zinc in mung bean. The interactive effect of FYM and zinc enriched FYM on seed yield was found to be significant (Table 4). Availability of zinc was expected to be improved through complexation or chelation with FYM thereby prevented fixation of zinc in soil (Latha *et al*., 2001; Venkatasheshagiri *et al*., 1994). The effect of treatments on straw yield exhibited similar trend where the significantly superior yield was recorded under the $EnZn_2$ which was at par with $EnZn_3$ followed by $EnZn_1$. The effect of treatments on yield attributes also depicted similar trend where the highest response on yield attributes *viz*. pods per plant, seed per pods and test weight by 33.92, 17.9 and 6% respectively were recorded under the $EnZn_2$ treatment which was at par with $EnZn_3$ followed by $EnZn_1$ (Table 3)

Table 1. Details of the treatments

1	NP (Recommended) – (Control)	F_0Zn_0
2	NP + 5 kg Zn ha^{-1} (inorganic salts)	F_0Zn_1
3	NP + 2.5 kg Zn enriched FYM @ 500 kg ha^{-1}	F_0EnZn_1
4	NP + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}	F_0EnZn_2
5	NP + 7.5 kg Zn enriched FYM @ 500kg ha^{-1}	F_0EnZn_3
6	NP+ 5 t FYM ha^{-1}	F_1Zn_0
7	NP + 5 t FYM ha^{-1} + 5 kg Zn ha^{-1} (inorganic salts)	F_1Zn_1
8	NP + 5 t FYM ha^{-1} + 2.5 kg Zn enriched FYM @ 500 kg ha^{-1}	F_1EnZn_1
9	NP + 5 t FYM ha^{-1} + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}	F_1EnZn_2
10	NP + 5 t FYM ha^{-1} + 7.5 kg Zn enriched FYM @ 500kg ha^{-1}	F_1EnZn_3
11	NP+ 10 t FYM ha^{-1}	F_2Zn_0
12	NP + 10 t FYM ha^{-1} + 5 kg Zn ha^{-1} (inorganic salts)	F_2Zn_1
13	NP + 10 t FYM ha^{-1} + 2.5 kg Zn enriched FYM @ 500 kg ha^{-1}	F_2EnZn_1
14	NP + 10 t FYM ha^{-1} + 5.0 kg Zn enriched FYM @ 500 kg ha^{-1}	F_2EnZ_2
15	NP + 10 t FYM ha^{-1} + 7.5 kg Zn enriched FYM @ 500kg ha^{-1}	F_2EnZ_3

Table 2. Effect of FYM and zinc-enriched FYM on growth attributes of mung bean

Treatments	Plant height at harvest (cm)	Number of branches per plant	Total chlorophyll content (mg g^{-1} leaves)	Total nodules per plant	Effective nodules per plant
FYM levels					
F_0	43.48	4.14	3.12	21.14	17.34
F_1	53.54	5.13	3.51	24.77	20.31
F_2	61.05	5.78	3.78	27.60	22.60
SEm+	1.43	0.14	0.06	0.64	0.52
CD (P = 0.05)	4.13	0.39	0.18	1.86	1.51
Zinc enriched FYM levels					
Zn0	45.08	4.23	3.14	21.34	17.35
Zn1	51.62	4.95	3.42	24.02	19.75
EnZn1	51.47	4.87	3.40	23.85	19.56
EnZn2	57.05	5.47	3.66	26.49	21.77
EnZn3	58.23	5.58	3.71	26.82	21.99
SEm±	1.84	0.17	0.08	0.83	0.67
CD (P=0.05)	5.34	0.51	0.23	2.40	1.94

Table 3. Effect of FYM and zinc enriched FYM on yield and yield attributes of mungbean

Treatment	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Number of pods per plant	Number of seeds per pod	Test weight (g)
FYM levels					
F_0	8.959	17.093	19.45	9.05	31.17
F_1	11.251	21.162	23.89	10.61	32.44
F_2	12.968	24.403	27.78	11.56	33.60
SEm±	0.313	0.564	0.64	0.15	0.24
CD (P = 0.05)	0.906	1.633	1.85	0.42	0.68
Zinc enriched FYM levels					
Zn_0	8.942	17.049	19.44	9.29	31.25
Zn_1	10.983	20.769	23.44	10.32	32.23
$EnZn_1$	10.742	20.207	23.04	10.25	32.15
$EnZn_2$	12.225	23.036	26.03	10.96	33.12
$EnZn_3$	12.405	23.370	26.57	11.21	33.26
SEm±	0.404	0.728	0.83	0.19	0.30
CD (P=0.05)	1.169	2.109	2.39	0.55	0.88

Table 4. Interactive effect of FYM and zinc enriched FYM on seed yield (q ha^{-1})

Treatments	Zinc enriched FYM levels				
FYM levels	Zn_0	Zn_1	$EnZn_1$	$EnZn_2$	$EnZn_3$
F_0	8.43	8.56	8.53	9.57	9.71
F_1	9.15	11.70	11.33	11.94	12.13
F_2	9.24	12.69	12.37	15.16	15.38
SEM±					0.70
CD (P=0.05)					2.03

Nutrient Uptake

The total uptake of N, P, K and Zn was significantly higher with increasing the levels of FYM over control (Table 5). The uptake of N, P, K and Zn was recorded significantly higher under the $EnZn_2$ (80.17, 6.06, 78.90 kg ha^{-1} and 143.96 g ha^{-1}, respectively) which was at par with $EnZn_3$ (82.17, 5.80, 81.23 kg ha^{-1} and 148.23 g ha^{-1} respectively) followed by $EnZn_1$ (67.57, 5.69, 66.13 kg ha^{-1} and 118.50 g ha^{-1} respectively) all these values are significantly higher than that with Zn_0 (52.90, 5.03, 51.50 kg ha^{-1} and 92.02 g ha^{-1}, respectively) (Table 3). The average improvement in total uptake of N, P, K and Zn by mung bean was 44.87, 17.06, 46.45 and 48.71 % respectively achieved due to zinc enriched FYM than the straight application of zinc. Interaction effect of FYM, and zinc enriched FYM was significant in total zinc uptake by mung bean (Table 6).

Higher application of FYM coupled with high rate of zinc enrichment caused higher utilization of zinc by the crop. The results clearly indicated that Zn use efficiency due to Zn-enrichment of FYM at 2.5 kg ha^{-1} improved over its application as zinc sulphate in the crop. Further, with increasing the levels of enrichment of FYM, zinc use

Table 5. Effect of FYM and zinc-enriched FYM on nutrient uptake, zinc use efficiency and protein content in seed

Treatment	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})	Zinc uptake (g ha^{-1})	Zinc use efficiency	Protein content in seed (%)
FYM levels						
F_0	52.45	4.290	50.56	95.90	-	19.47
F_1	71.53	5.730	70.02	127.02	-	21.27
F_2	87.28	6.978	86.94	152.53	-	22.40
SEm±	1.63	0.120	1.89	2.88	-	0.22
CD (P = 0.05)	4.71	0.346	5.47	8.35	-	0.64
Zinc enriched FYM levels						
Zn_0	52.90	5.003	51.50	92.02	-	19.68
Zn_1	69.30	5.785	68.11	123.21	0.62	20.88
$EnZn_1$	67.57	5.692	66.13	118.50	1.06	20.84
$EnZn_2$	80.17	6.055	78.90	143.96	1.04	21.82
$EnZn_3$	82.17	5.796	81.23	148.06	0.75	22.02
SEm±	2.10	0.154	2.44	3.72	-	0.29
CD (P=0.05)	6.08	0.447	7.06	10.78	-	0.83

Table 6 Interactive effect of FYM and zinc enriched FYM on total zinc uptake (g ha^{-1})

Treatments	Zinc enriched FYM levels				
FYM levels	Zn_0	Zn_1	$EnZn_1$	$EnZn_2$	$EnZn_3$
F_0	85.72	90.48	88.40	106.10	108.79
F_1	91.31	129.94	122.29	144.63	146.94
F_2	99.04	149.20	144.80	181.16	188.44
SEM±					6.44
CD (P=0.05)					18.67

Table 7 Interactive effect of FYM and zinc enriched FYM on phosphorus uptake in seed (kg ha^{-1})

Treatments	Zinc enriched FYM levels				
FYM levels	Zn_0	Zn_1	$EnZn_1$	$EnZn_2$	$EnZn_3$
F_0	2.31	2.27	2.37	2.57	2.42
F_1	2.90	3.34	3.30	3.06	3.27
F_2	2.77	3.53	3.73	4.71	4.61
SEM±					0.22
CD (P=0.05)					0.63

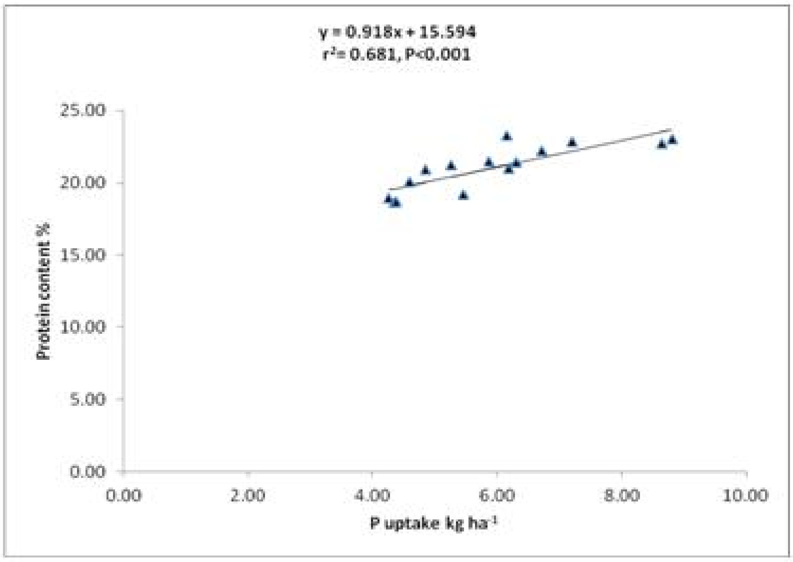

Fig.1. Relationship between phosphate uptake and protein content in mung bean

efficiency was found to decrease. Among the different treatments of zinc enrichments, the highest Zn use efficiency in mung bean was recorded with $EnZn_1$ followed by $EnZn_2$. The relative efficiency of the Zn-enriched FYM levels for zinc use efficiency can be arranged as $EnZn_1 > EnZn_2 > EnZn_3$ (Table 5). The same trend was observed by Rathod *et al*., (2012).

The zinc enriched FYM caused utilization of nutrients mainly due to its beneficial effect in mobilizing the native nutrients to increase their availability besides addition of zinc to the soil in naturally chelated form this might have provided better nutrition over longer time to cause better crop growth there by higher yield. The higher removal of zinc and N, P, K due to zinc enriched FYM along with recommended dose of nitrogen and phosphorus application could also be attributed to the priming effect of externally added nutrients to improve crop growth. The increase in yield may be a reason of higher removal of nutrient due to balanced fertilization (Meena *et al*., 2006; Latha *et al*., 2001 and Krishna and Singh, 1992).

Protein Content

Application of FYM significantly increased protein content of mung bean by 15.05 % with increasing FYM doses up to 10 t ha^{-1} as compare to control (Table 5). Protein content improvement was significantly superior under the treatment of $EnZn_2$ which was at par with $EnZn_3$ followed by $EnZn_1$.The result indicated that protein content improvement was higher when zinc were applied as $EnZn_2$ as well as $EnZn_3$ followed by $EnZn_1$. The beneficial effect of enriched zinc in improvement of protein content was clearly noticed over straight zinc application in mung bean. The average improvement in protein content due to zinc enriched FYM and their straight application was by 9.55 and 6.01 % respectively over control. Result in increased in protein content due to enrichment was higher by 3.54 over straight application of zinc in mung bean. Increased in protein content with FYM could be assigned to supplementation of soil reservoir on mineralization of organic N and P of FYM as well as enhance microbial activity of ammonifires, nitrifires and phosphate solublizing bacteria in particular due to available organic carbon (Shuman and Hargrover, 1985) which might have increase root growth and nodulation resulting in increase in nitrogen and phosphorus content hence protein content.

The results of present investigation show the significant interactive effect of FYM and zinc enriched FYM on phosphorus uptake (Table7). Regression analyses have been carried out between the protein content in grain and P uptake by the crop. The linear regressions showed protein content in grain vs P uptake ($r^2 = 0.681$, $p < 0.001$) (Fig. 1). Koshalendra *et al*. (1992) have also reported such increase in protein content attributed firstly to increase in nitrogen content and secondly to the role of phosphorus in energy storage and transfer in form of ADP and ATP which are essential for protein synthesis.

Conclusion

The study indicated that zinc application in enriched form of FYM was beneficial in increasing crop yield. Also, the zinc use efficiency was found enhance as the lower rate of *i.e*. FYM at 500 kg ha^{-1} enriched with 2.5 kg ha^{-1} was sufficient to meet zinc requirement of mung bean when applied in enriched form. But the grain yield improvement significantly superior by under $EnZn_2$ over control which is at par with $EnZn_3$. The practice of zinc application through enriched technique either improved or maintained the nutrient available status of soil.

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