International Journal of Advanced Research in

Chemistry and Chemical Engineering

Volume: 1 Issue: 1 25-Oct-2014,ISSN_NO: xxxx-xxx

Effect of rhizobial inoculation on growth, yield, nutrient and economics of summer urdbean (*Vigna mungo* L.) in relation to zinc and molybdenum

Khalil Khan[1] and Ved Prakash[2]

ABSTRACT–*Field experiment were conducted during two consecutive years of 2011 and 2012 at Student Instructional Farm of N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad to study the effect of rhizobial inoculation on growth, yield, nutrient uptake and economics of summer urdbean in relation to zinc and molybdenum. Result data revealed that the seed inoculation with Rhizobium culture significantly increased growth attributes viz., plant height, number of primary and secondary branches plant^{-1}, number and dry weight of nodules plant^{-1}, seed and stover yield, nitrogen, zinc and molybdenum uptake, gross and monetary return and benefit : cost ratio than without inoculation. Application of 2.5 kg Zn/ha significantly increased the growth attributes, nodulation, seed and stover yield, nutrient uptake and economics of urdbean over control. Zinc uptake significantly increased up to 5.0 kg Zn ha^{-1}. Application of molybdenum up to 1.0 kg ha^{-1} significantly increased growth characters, number and dry weight of root nodules, seed and stover yield, nutrient uptake, gross and net return and benefit : cost ratio*

Key words: Nodulation, symbiotic N fixation, Rhizobium, monitory returns, growth pattern.

1, INTRODUCTION

Pulses are one of the important segments of Indian agriculture after cereals and oilseeds. The split grains of the pulses called dahl which are excellent source of high quality protein, essential amino acids, fatty acids, fibres, minerals and vitamins. Pulses are not only improve soil health by enriching nitrogen status, long term fertility but also sustainability of the cropping systems. It meets upto 80% of its nitrogen requirement by symbiotic nitrogen fixation from air and leaves behind substantial amount of residual nitrogen and organic matter for subsequent crops. Black gram (*Vigna mungo* L. Hepper) also known as urdbean,

[1] Krishi Vigyan Kendra, Ruramallu, Jalaun (U.P.) Ph.D. Thesis Deptt. of Soil Science and Agricultural Chemistry, NDUA & T., Faizabad

[2] Associate Professor, Deptt. of Soil Science and Agricultural Chemistry, N.D. University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad-224229

urd and urad, is an important pulse crop grown throughout India. Micronutrients play an important role in black gram production. Among micro nutrients, zinc influences the synthesis of auxin in plant either by inhibiting the synthesis of tryptophane, a precursor of auxin. Besides, zinc, molybdenum is also required for growth of most of the biological organisms including plants and animals (Shanti *et al.*, 2008). Inoculating pulse crops with rhizobia to add nitrogen is routine for most growers but questions still linger about whether inoculation is essential for all pulses (Chakrabarti *et al.*, 2007). Therefore, keeping in view the above facts regarding vital role of zinc, molybdenum and *Rhizobium* inoculation in urdbean, the present investigation "effect of rhizobial inoculation on growth, yield, nutrient uptake and economics of summer urdbean in relation to zinc and molybdenum was carried out during summer season".

2, MATERIALS AND METHODS

Field experiment were carried out during two consecutive years of 2011 and 2012 at Student Instructional Farm of N.D. University of Agriculture and Technology, Narendranagar (Kumarganj), Faizabad (U.P.) to study the Effect rhizobial inoculation on growth, yield, nutrient uptake and economics of summer urdbean in relation to zinc and molybdenum. The treatment combinations comprised with four levels of zinc *viz.*, 0 kg, 2.5 kg, 5.0 kg and 7.5 kg ha^{-1}; three levels of molybdenum viz., 0 kg, 0.5 kg and 1kg ha^{-1} and two levels of *Rhizobium viz.*, with and without inoculation of seeds. All twenty four treatments combination were replicated three times in factorial randomized block design. The soil of the experimental field was silty loam in texture, slightly alkaline in reaction (pH 8.22) with good drain ability having poor to medium fertility, low in organic carbon (0.48%) and available nitrogen (292 kg ha^{-1}) while, medium in available phosphorus (12.85 kg ha^{-1}) and potassium (217 kg ha^{-1}). The micronutrients like zinc (0.57 ppm) and molybdenum (0.28 ppm) was low and adequate, respectively. Urdbean variety Uttara was sown at 20 cm row to row and 10 cm plant to plant apart. The urdbean was sown on 28.02.2011 and 03.03.2012 during first and second year of experiment. An uniform and common dose of N and P_2O_5 was applied as basal @ 18 and 46 kg ha^{-1}, respectively through DAP. The micro nutrient like zinc and molybdenum were applied as per treatment in the form of zinc oxide and ammonium molybdate, respectively. To reduce weed infestation one hand weeding was done at 25 days after sowing. In all 4 irrigations were given at different stages of crop growth to fulfill the water requirement. To control the whitefly (*Bemisia tobaci*), Roger 30 EC @ 1.0 litre ha^{-1} was uniformly sprayed at

vegetative growth stage of the crop. Crop was harvested at proper maturity on 24.05.2011 and 27.05.2012. Periodical and quantitative observations were taken in order to assess the effect of zinc, molybdenum and *Rhizobium* inoculation on growth, yield, nutrient uptake and economics during both the years.

RESULTS AND DISCUSSION

Plant height and number of branches plant^{-1}:

Rhizobium inoculation on urdbean was significantly increased all growth characters *viz.*, plant height and number of primary and secondary branches plant^{-1} as compared to without inoculation but its efficacy was significantly enhanced when inoculation was supplemented with molybdenum and zinc either alone or in combination (Table 1). The increase in growth attributes of urdbean due to *Rhizobium* inoculation was corroborated with the findings of Asheesh Elamathi (2007) ans Khatkar *et al.* (2007).

The data on plant height and number of primary and secondary branches plant^{-1} of urdbean was significantly increased with the application of 2.5 kg Zn ha^{-1} as compared to control (Table) 1. The increase in plant height under zinc treatment may be due to its effect in the metabolism of growing plants, which may effectively explain the observed response of zinc application. Favourable response of zinc application on plant height has also been reported by Shanti *et al.* (2008).

It is evident from data that the application of Molybdenum significantly increased plant height primary & secondary branches upto 1 kg Mo ha^{-1} The increase in growth attributes due to molybdenum might be due to molybdenum is a structural component of nitrogenase, the enzyme actively involved in nitrogen fixation by root nodule bacteria of leguminous crops. Similar findings were also reported by Kumar and Shrama (2005).

Number and dry weight of nodules

Seed inoculation with *Rhizobium* significantly increased number and dry weight of root nodules. The increase in nodulation with the application of *Rhizobium* inoculation have also been reported by Khatkar *et al.* (2007).

The number and dry weight of nodules plant^{-1} at 30 and 45 days after sowing increased with increasing levels of zinc upto 7.5 kg ha^{-1}. Significantly higher number and dry weight of nodules plant^{-1} at 30 and 45 days after sowing was recorded with the application of 2.5 kg Zn ha^{-1} as compared to control, however, it was non-significant beyond 2.5 kg Zn ha^{-1}

during both the stages of crop growth (Table 1). The increase in nodulation might be due to the enhanced and established good rooting system with the application of zinc. Favourable responses of zinc application on nodulation have also been reported by Pavadai *et al.* (2004).

Application of molybdenum up to highest doses 1.0 kg ha^{-1} significantly plant height number of primary and secondary branches nodules number of and dry weight of nodules. This might be due to the fact that molybdenum is helpful in formation of root nodules in urdbean. Similar results were also reported by Singh et al. (2006) and Bhuiyan *et al.* (2008).

Yield

Rhizobium inoculation significantly increased yield of urdbean in comparison to inoculated *Rhizobium* inoculation fixed nitrogen from atmosphere and enhance nitrogen content in the rhizospheric zone of urdbean which ultimately increased yield of urdbean.

Grain and strover yield of urdbean significantly increased upto 5.0 kg Zn ha^{-1} and grain and stover yield at this level were 11.60 q ha^{-1} and 21.87 q ha^{-1}, respectively. The yield was increased 101 kg ha^{-1} with per cent response of 9.54 with the use of 5.0 kg zinc per hectare over control. The increased in yield might be due to positive effect of zinc on yield attributes and it play an important role in metabolic process. This finding is also in the line of Shanti *et al.* 2008 and Ahmed *et al.* 2013.

Application of molybdenum significantly increased grain and stover yield of uedbean over control. Molybdenum application @ 0.5 kg ha^{-1} significantly increased grain and straw yield of urdbean and further increased dose increased yield but increased was net at the level of significance. The grain and stover yield at 0.5 kg Mo ha^{-1} was 11.32 & 20.88 q ha^{-1}. The increase in yield might be due to molybdenum enhance nodule formation which ultimately affect yield of urdbean. Similar result were also reported by Singh *et al.* (2008).

Nutrient uptake:

Application of zinc @ 2.5 kg ha^{-1} significantly increased nitrogen, zinc and molybdenum uptake in both grains, stover, while molybdenum application of its highest rate i.e. up to 1.0 kg ha^{-1} significantly increased nitrogen zinc and molybdenum uptake in seed and stover. *Rhizobium* inoculation increased nitrogen, zinc & molybdenum uptake significantly in both grain and stover of urdbean increased yield in grains and stover both. It may be due to zinc molybdenum and *Rhizobium* inoculation increased yield of urdbean and increased yield is directly related with uptake of nutrients. Khatkar *et al.* (2007) also reported similar findings.

Application of zinc upto 5 kg ha^{-1} significantly increased nitrogen, zinc and molybdenum uptake by urdbean, total uptake of nitrogen, zinc and molybdenum were 74.72 kg ha-1, 565.78 g ha^{-1} and 231.65 g ha^{-1} respectively at 5.0 kg Zn ha^{-1}. Similarly molybdenum application upto its higher dose 1.0 kg ha^{-1} significantly increased total N, Zn and Mo uptake by urdbean. *Rhizobium* inoculation significantly increased nitrogen, zinc & molybdenum uptake. The increased in uptake due to zinc, molybdenum & *Rhizobium* inoculation is due to increased in yield by these factors of which ultimately increased uptake of nitrogen, zinc and molybdenum (Table 2).

Economics:

The urdbean was inoculated with *Rhizobium* culture produced significantly highest gross (Rs. 42547 ha^{-1}), net (Rs. 20780 ha^{-1}) monetary return and benefit : cost ratio (0.96) as compared to uninoculation. The increase profit of urdbean might be due to seed inoculation with *Rhizobium* with increase in productivity. The increase in monetary returns of urdbean has also been reported by Seema et al. (2009).

A perusal of data (Table 3) revealed that the application of 7.5 kg ha^{-1} zinc recorded highest gross return (Rs. 42547 ha^{-1}) of urdbean followed by 5.0 kg (Rs. 42138 ha^{-1}), 2.5 kg ha^{-1} (Rs. 40502 ha^{-1}) and control (Rs. 38456 ha^{-1}). Maximum net monetary return (Rs. 19637 ha^{-1}) was obtained with the application of 2.5 kg Zn ha^{-1} (Rs. 19498/ha) The benefit : cost ratio (1.01) was registered maximum without zinc followed by 2.5 kg Zn ha^{-1} (0.94). The increase in gross return with the application of zinc might be due to increase in grain and straw yield of urdbean. Similar results was also observed by Mevada *et al.* (2005).

Application of 1.0 kg Mo ha^{-1} recorded significantly highest gross (Rs. 42752 ha^{-1}) and net return (Rs. 20099 ha^{-1}) returns as compared to rest of the treatments. The minimum gross (Rs. 38865 ha^{-1}) and net (Rs. 18013 ha^{-1}) return was obtained when molybdenum will not applied. Highest benefit : cost ratio (0.90) was recorded with 0.5 kg Mo ha^{-1}. The increase in gross and net return might be due to increase in grain and straw yield of urdbean and due to high cost of cultivation thus decrease the benefit cost ratio under highest tested dose of molybdenum. These results are in close conformity with the findings of Seema *et al.* (2009).

Table 1: Effect of zinc, molybdenum and *Rhizobium* on yield attributes of urdbean (average of two years)

Treatments	Plant height (cm)	No of primary branches plant^{-1}	No of secondary branches plant^{-1}	No. of nodules		Dry weight of nodules	
				35 DAS	45 DAS	35 DAS	45 DAS
Zinc levels (kg ha^{-1})							
0.0	23.50	3.90	12.78	5.26	22.58	7.20	12.93
2.5	24.75	4.11	13.46	5.55	23.78	7.58	13.82
5.0	25.75	4.27	14.00	5.76	24.74	7.88	14.16
7.5	26.00	4.32	14.14	5.81	25.23	7.96	14.30
SEm(±)	0.40	0.07	0.21	0.09	0.48	0.12	0.23
CD (p=0.05)	1.13	0.19	0.60	0.27	1.38	0.33	0.63
Molybdenum levels (kg ha^{-1})							
0.0	23.76	3.94	12.92	5.31	22.82	7.27	13.07
0.5	25.13	4.17	13.71	5.64	24.19	7.73	13.82
1.0	26.13	4.38	14.28	5.88	25.40	8.00	14.82
SEm(±)	0.34	0.07	0.18	0.08	0.42	0.10	0.24
CD (p=0.05)	0.97	0.18	0.53	0.23	1.20	0.29	0.69
***Rhizobium* levels**							
Uninoculated	23.8	3.95	6.47	5.32	22.87	7.28	13.09
Inoculated	26.2	4.35	7.13	5.86	25.18	8.02	14.41
SEm(±)	0.28	0.05	0.08	0.07	0.34	0.08	0.20
CD (p=0.05)	0.79	0.14	0.22	0.19	0.98	0.23	0.57

Table 2: Nutrient uptake in seed and stover of urd bean as influenced by zinc, molybdenum and *Rhizobium* (average of two years)

Treatments	Nitrogen kg ha^{-1}			Zinc g ha^{-1}			Molybdenum g ha^{-1}		
	Seed	Stover	Total	Seed	Stover	Total	Seed	Stover	Total
Zinc levels (kg ha^{-1})									
0.0	36.68	29.54	66.90	357.25	147.7	504.95	130.04	79.92	209.98
2.5	38.88	31.90	70.78	376.73	155.80	532.54	137.57	84.45	222.02
5.0	40.96	32.80	74.72	392.51	163.27	565.78	143.54	88.11	231.65
7.5	41.63	33.53	76.04	396.87	164.08	560.95	145.40	89.27	234.68
SEm(±)	0.78	0.60	0.97	6.66	2.6	7.53	2.51	1.41	3.01
CD (p=0.05)	2.22	1.71	2.76	18.9	7.42	4.52	7.16	4.02	8.6
Molybdenum levels (kg ha^{-1})									
0.0	37.38	29.68	67.93	360.27	153.56	509.33	131.49	80.83	212.23
0.5	39.68	32.00	72.56	380.93	158.34	578.27	139.93	85.96	225.89
1.0	41.36	33.48	75.71	391.33	165.01	564.34	146.52	89.62	236.14
SEm(±)	0.67	0.52	0.84	6.03	2.4	7.32	2.17	1.28	3.60
CD (p=0.05)	1.92	1.48	2.39	17.23	6.93	23.15	6.20	3.73	10.04
***Rhizobium* levels**									
Uninoculated	37.47	30.12	68.07	262.46	149.9	512.35	132.13	81.14	213.27
Inoculated	42.01	33.36	76.69	399.23	165.03	465.26	146.15	89.74	235.9
SEm(±)	0.55	0.42	0.68	4.92	1.83	5.32	1.77	1.00	2.12
CD (p=0.05)	1.57	1.21	1.95	14.07	5.25	15.21	5.06	2.85	6.08

Table-3: Effect of zinc, molybdenum and *Rhizobium* on economics in urdbean

Treatments	Yield (q ha^{-1})		Monetary return (Rs ha^{-1})		B : C ratio
	Seed	Stover	Gross	Net	
Zinc levels (kg ha^{-1})					
0.0	10.59	19.50	38456.00	19366.00	1.015
2.5	11.13	20.50	40502.00	19637.00	0.941
5.0	11.60	21.87	42138.00	19498.00	0.860
7.5	11.71	21.97	42547.00	18132.00	0.742
SEm(±)	0.20	0.34	739.40	345.70	0.007
CD (p=0.05)	0.57	0.98	2113.31	988.06	0.021
Molybdenum levels (kg ha^{-1})					
0.0	10.70	19.71	38865.00	18013.00	0.874
0.5	11.32	20.88	41115.00	19363.00	0.900
1.0	11.77	21.67	42752.00	20099.00	0.894
SEm(±)	0.18	0.30	640.34	299.39	0.006
CD (p=0.05)	0.50	0.84	1830.18	855.69	0.018
***Rhizobium* levels**					
Uninoculated	10.72	19.75	39274.00	17537.00	0.815
Inoculated	11.80	21.74	42547.00	20780.00	0.964
SEm(±)	0.15	0.24	522.84	244.45	0.005
CD (p=0.05)	0.41	0.69	1494.33	698.67	0.015

REFERENCES:

Ahmad, I., Akhtar, M. J., Asgar, H. N. and Khalid, M. (2013). Influence of *Rhizobium* applied in combination with micronutrient on mungbean. Pak. J. Life Soc. Sci. X (X): XXX.

Asheesh Elamathi, S. (2007). Effect of nitrogen levels and *Rhizobium* application methods on yield attributes, yield and economics of black gram (*Vigna mungo*). *International J. Agric. Sci.*. **3**(1): 179-180.

Bhuiyan, M. M. H., Rahman, M .M., Afroz, F., Sutradhar, G. N. C. and Bhuiyan, M. S. I. (2008). Effect of phosphorus, molybdenum and *Rhizobium* inoculation on growth and nodulation of mungbean. *J. Soil Nature.* **2**(2) : 25-30.

Chakrabarti, J., Chatterjee, N.C. and Dutta, S. (2007). Interactive effect of VAM and *Rhizobium* on nutrient uptake and growth of *Vigno mungo*. *J. Mycopathological Res.,* **45**(2): 289-291.

Khatkar, Rahul, Abraham Thomas and Joseph Ann Shalu. (2007). Effect of Bio fertilizers and sulphur levels on growth and yield of black gram (*Vigna mungo* L.) *Legume Res.,* **30** (3):233-234.

Kumar, J. and Sharma, M. (2005). Effect of phosphorus and molybdenum on yield and nutrient uptake by chickpea (*Cicer arietinum* L). *Advances in Plant Sci.,* **18 (2)**: 869-873.

Mevada, K.D., Patel, J.J. and Patel, K.P. (2005). Effect of micronutrients on yield of urdbean. *Indian J. Pulses Res.,* **18**(2): 214-216.

Pavadai, P., Dhanavel, D., Vijayarengan, P., Seetharaman, N. and Selvaraju, M. (2004). Efficacy of zinc on germination, seedling growth and biochemical contents of blackgram (*Vigna mungo* (L.) Hepper. Var. CO3). *Plant Archives*. **4**(2): 475-478

Seema, S. and. Singh, P.K. (2009). Effect of micronutrients and biofertilizer inoculation on grain yield, protein content, micronutrients content and economics of chickpea crop. *Ann. Agric. Res. New Series* Vol **30** (1&2) 32-35.

Shanti, M., Babu, B.P., Prasad, B.R. and Minhas, P.S. (2008) Effect of zinc on blackgram in rice-blackgram cropping system of coastal saline soils. *Legume Res.,* **31**(2): 79-86.

Singh R.P., Singh, Bisen, Yadav, Jay Singh, P.K., Singh, S.N., Singh, R.K. and Singh J., (2008). Integrated use of sulphur and molybdenum on growth, yield and quality of black gram (*Vigna mungo* L.) *Legume Res.*, **31**: 214-217.

Singh, R.P., Singh, R.K., Yadav, P.K., Singh, S.N., Prasad, L. and Singh, J. (2006). Effect of sulphur and molybdenum on yield and quality of blackgram (*Vigna mungo* L.). *Crop Res., Hisar*. **32**(3): 336-338.