Effect of molybdenum and seed inoculation on nodulation, growth and yield in urdbean [*Vigna mungo* (L.) Hepper]

P. K. BISWAS[1], M. K. BHOWMICK[2] AND ANJAN BHATTACHARYYA[3]

[1]*Soil Testing Laboratory, Raiganj-733 130, West Bengal,*
[2]*Rice Research Station, Chinsurah -712 102, West Bengal,*
[3]*Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741 252, West Bengal,*

ABSTRACT

A two-year field experiment was conducted during kharif season of 2005 and 2006 at the Pulses and Oilseeds Research Sub-station, Beldanga, Murshidabad, West Bengal, India to study the effect of molybdenum spray and seed inoculation on nodulation, growth and seed yield in urdbean. The results revealed that two rounds of foliar spray of 0.05% ammonium molybdate solution at 25 and 40 days after sowing (1269.50 kg ha^{-1}) increased seed yield by 9.02% over water spray (1164.50 kg ha^{-1}). Combined inoculation of seeds with Rhizobium + Azotobacter + PSB (1629 kg ha^{-1}) and Rhizobium + PSB remarkably increased the seed yield due to better nodulation along with improvement in growth and yield attributes. The effect of interaction between foliar spray and seed inoculation on seed yield was found significant.

Key words: Molybdenum, nodulation, seed inoculation, seed yield and urdbean.

Urdbean [*Vigna mungo* (L.) Hepper] is an important *kharif* food legume, generally grown under marginal lands by resource-poor farmers in West Bengal. Being grown mainly on the soils poor in fertility, use of biofertilizer along with balanced fertilization with micronutrient is necessary to realize good yields. Molybdenum is one of the most recognized nutrient elements considered to be essential for the growth of plants (Gupta and Lipsett, 1981). As a constituent of nitrate reductase and nitrogenase enzymes, molybdenum directly influences nitrogen assimilation and its fixation in pulse crops (Srinivasarao *et al.*, 2003). Foliar spray of this micronutrient is more effective and fast-acting than soil application (Gupta and Lipsett, 1981). Besides, combined inoculation of seeds with *Rhizobium* + phosphate solubilizing bacteria (PSB) + plant growth promoting rhizobacteria (PGPR) was found to record significantly more grain and straw yields than either *Rhizobium* alone or *Rhizobium* + PSB (Prasad *et al*., 2002 and Sarna *et al*.,2004, Biswas and Bhowmick, 2008). With this view, the present study was undertaken.

MATERIALS AND METHODS

A field experiment was conducted for two consecutive years during *kharif* season of 2005 and 2006 at the Pulses and Oilseeds Research Sub-station, Beldanga, Murshidabad, West Bengal, India located at 22^{o} 55′ N latitude and 88^{o} 15′ E longitude. The experimental soil was sandy loam having pH 7.6, organic carbon 0.32%, available P_2O_5 65 kg ha^{-1}, available K_2O 102 kg ha^{-1} and Mo content 0.03 µg g^{-1}. The experiment consisting of two levels of foliar spray (water and 0.05% ammonium molybdate solution) in main plots, and eight levels of seed inoculation (uninoculated control, *Rhizobium* strain BKR 01-04, PSB, *Azobobacter*, *Rhizobium* + PSB, *Rhizobium* + *Azotobacter*, *Azotobacter* + PSB, and *Rhizobium* + *Azotobacter* + PSB) and uninoculated control in sub-plots, was laid out in a split-plot design with each treatment replicated thrice, keeping the individual plot size as 4 x 3m. A recommended dose of 20:40:20 kg N:P_2O_5:K_2O ha^{-1} as basal was applied to all the plots through urea, single super phosphate and muriate of potash, respectively. Ammonium molybdate [$(NH_4)_6Mo_7O_{24}.4H_2O$] with 54% Mo content (Gupta and Lipsett, 1981) was applied as foliar spray (0.05 %) twice at 25 and 40 days after sowing (DAS). The crop cv. Sarada (WBU 108) was sown at a spacing 30 x 10 cm using a seed rate 30 kg ha^{-1} on August 24 and 23 during 2005 and 2006, respectively . The crop was raised following recommended package of practices, and harvested on November 23 and 30 during 2005 and 2006, respectively. In order to study the nodulation in urdbean, five plants from each plot were uprooted, their roots were gently washed with water , nodules were removed and counted. Dry weight of root nodules and crop plants were recorded at periodic interval after drying in hot-air oven at 80ºC till constant weight . Observations on plant height and dry matter accumulation were recorded at 45 DAS and harvest. Yield components and seed yield were also recorded after crop harvest.

Effect of foliar spray

Foliar spray of 0.05% ammonium molybdate solution(1269.50 kg ha^{-1}) was found superior to water spray (1164.50 kg ha^{-1}) in respect of seed yield in urdbean (Table 3). Seed yield obtained with

Email: ppabitra07@rediffmail.com

molybdenum spray was 9.02% higher over water spray. This was obviously due to improvement in nodulation (Table 1), dry matter accumulation (Table 2) and yield attributes *viz.*, pods plant^{-1} and seeds pod^{-1} (Table 3). Higher number and dry weight of nodules were recorded under the foliar spray of molybdenum as compared to water spray at 30, 45 and 60 DAS. This might be attributed due to the active role of molybdenum in regulating synthesis and activity of nitrogenase enzyme and thereby governing nitrogen fixation in urdbean. Beneficial effect of B, Mo and Zn in french-bean (Kushwaha,1999), and Mo in soybean (Kumar and Singh, 1980) and urdbean (Mevada *et al*., 2005 Chaudhary and Das,1996) was also reported earlier.

Effect of seed inoculation

Combined inoculation of seeds with *Rhizobium* + *Azotobacter* + PSB significantly increased the seed yield (1629 Kg ha^{-1}) in urdbean (Table 4). This was followed by seed inoculation with *Rhizobium* + PSB (1408 kg ha^{-1}) and *Azotobacter* + PSB (1321 kg ha^{-1}), irrespective of foliar spray. The yield increments under these treatments were 89.09, 63.44 and 53.34% over uninoculated control, and 48.16, 28.06 and 20.15 % over *Rhizobium* alone, respectively. This might be due to improvement in dry matter accumulation (Table 2), yield attributes (Table 3) and better nodulation (Table 1). Prasad *et al*.(2002) reported significantly higher seed yield and nodulation due to seed inoculation with *Rhizobium* + PSB + PGPR than *Rhizobium* applied either alone or in combination with PSB. Higher dry matter accumulation was recorded under combined inoculation of *Rhizobium* + *Azotobacter* + PSB. This was followed by inoculation with *Rhizobium* + PSB and *Azotobacter* + PSB as compared with uninoculated control, *Azotobacter* alone and *Rhizobium* alone (Table 2). Higher nodulation under seed inoculation with *Rhizobium* + *Azotobacter* + PSB and *Rhizobium* + PSB was also observed in both the years of experimentation (Table 1). These results were in agreement with the earlier findings of Chaudhary and Das (1996) and Prasad *et al*.(2002) in urdbean.

Effect of interaction

The effect of interaction between foliar spray and seed inoculation on seed yield was found significant (Table 3).There was also significant interaction effect on nodule dry weight (Table 1) and dry matter accumulation (Table 2) during both the years of study.

Based on the results obtained from the two-year field study, it could, thus, be concluded that seed inoculation with *Rhizobium* + *Azotobacter* + PSB along with two rounds of foliar spray of 0.05% ammonium molybdate solution (25 and 40 days after sowing) would be an effective recommendation for improving crop growth, nodulation and seed yield in urdbean.

REFERENCES

Biswas, P.K., and Bhowmick, M.K., 2008 Symbiotic effeteness of Urdbean (*Vigna mungo L*, Hepper) through inoculation with *Rhizobium* along with co-inoculants. Jr. Crop and weed, **4**:21-23

Chaudhary, H.P. and Das, S.K. 1996. Effect of P, S and Mo application on yield of rainfed black gram and their residual effect on safflower and soil and water conservation in an eroded soil. *J. Indian Soc. Soil Sci.* **44**: 741-45.

Gupta, U. C. and Lipsett, 1981. Molybdenum in soils, plants and animals. *Adv. Agron.* **34**: 73-115.

Kumar, V. and Singh. 1980. S, P and Mo interactions in relation to growth, uptake and utilization of S in soybean. *Soil Sci.* **129**: 297-304.

Kushwaha, B.L. 1999. Studies on response of frenchbean to zinc, boron and molybdenum application. *Indian J. Pulses Res.* **12** : 44-48.

Mevada, K.D., Patel, J.J. and Patel, K.P. 2005. Effect of micronutrients on yield of urdbean. *Indian J. Pulses Res.* **18**:214-16.

Prasad, H., Chandra, R., Pareek, R.P. and Kumar, N. 2002. Synergism among phosphate solubilizing bacteria, rhizobacteria and *Rhizobium* in urdbean. *Indian J. Pulses Res.* **15**:131-35.

Sarna, S. Sharma, P. Khurana, A.S. and Sharma, S. 2004. Synergistic effect of combined inoculation of *Azotobacter chroococcum* and *Rhizobium* sp. in chickpea. *Indian J. Pulses Res.* **17**:35-37.

Srinivasarao, Ch., Ganeshamurthy, A.N. and Ali, Masood. 2003. *Nutritional Constraints in Pulse Production.* Bulletin No. IIPR 2003/8. Indian Institute of Pulses Research, Kanpur, India. P. 1-34.

Table 1: Effect of different treatments on nodulation in urdbean

Treatments	Nodule no. plant^{-1}						Nodule wt. (mg plant^{-1})					
	30 DAS		45 DAS		60 DAS		30 DAS		45 DAS		60 DAS	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Foliar spray (F)												
Water	15.25	6.20	22.33	17.40	8.20	11.31	21.29	11.69	26.27	14.75	10.34	7.98
Molybdenum	16.98	8.60	24.93	19.10	9.25	14.06	21.84	13.93	31.19	16.39	12.66	10.16
S. Em (±)	**0.25**	**0.38**	**0.07**	**0.16**	**0.09**	**0.14**	**0.54**	**0.59**	**0.25**	**0.03**	**0.33**	**0.02**
LSD (p=0.05)	**0.65**	**1.14**	**0.20**	**0.49**	**0.25**	**0.42**	**1.59**	**1.77**	**0.74**	**0.09**	**0.96**	**0.06**
Seed inoculation (S)												
Control	12.98	5.90	19.00	14.60	7.03	11.67	12.13	7.72	15.75	12.92	5.92	10.32
Rhizobium (Rh.)	13.78	6.65	20.03	16.30	7.43	12.32	13.62	11.88	17.83	13.66	7.07	10.68
PSB	15.17	7.33	22.32	17.30	8.12	12.39	19.28	12.00	26.25	15.32	10.50	11.72
Azotobacter (Azo.)	14.82	6.36	21.75	15.70	8.00	12.26	14.13	11.05	18.63	13.52	7.45	10.10
Rh. + PSB	16.15	8.65	23.88	21.10	8.65	13.32	27.63	15.88	37.88	17.68	15.25	12.71
Rh. + Azo.	15.32	7.67	22.47	18.10	8.95	12.88	21.87	12.73	29.52	16.07	11.93	10.03
Azo.+ PSB	16.17	7.83	23.62	19.40	13.30	13.12	28.55	13.87	37.88	17.27	15.27	13.17
Rh.+ Azo.+ PSB	24.53	8.85	35.98	23.60	13.91	13.52	35.28	17.33	46.10	18.13	18.63	15.67
S. Em (±)	**0.82**	**0.45**	**0.12**	**0.45**	**0.72**	**0.40**	**1.00**	**0.64**	**0.83**	**0.33**	**0.42**	**0.21**
LSD (p=0.05)	**1.32**	**1.35**	**1.97**	**1.36**	**2.09**	**1.20**	**2.97**	**1.92**	**2.44**	**0.99**	**1.24**	**0.57**
Interaction (F x S)												
S. Em (±)	**0.63**	**0.83**	**0.96**	**0.71**	**1.02**	**0.60**	**1.43**	**0.92**	**1.17**	**0.48**	**0.60**	**0.34**
LSD (p=0.05)	**NS**	**NS**	**NS**	**1.92**	**NS**	**1.71**	**4.21**	**2.70**	**3.44**	**1.38**	**1.73**	**1.19**

DAS: Days after sowing; PSB: Phosphate solubilizing bacteria; NS: Not significant

Table 2: Effect of different treatments on crop growth in urdbean

Treatments	Dry matter accumulation (g plant^{-1})				Plant height (cm)			
	45 DAS		Harvest		45 DAS		Harvest	
	2005	2006	2005	2006	2005	2006	2005	2006
Foliar spray (F)								
Water	3.54	3.78	6.23	5.06	33.31	32.90	56.46	48.32
Molybdenum	4.20	4.52	7.37	6.21	38.91	36.37	64.62	56.75
S. Em (±)	**0.07**	**0.31**	**0.13**	**0.05**	**0.97**	**1.44**	**0.35**	**1.97**
LSD (P=0.05)	**0.20**	**0.93**	**0.35**	**0.15**	**2.81**	**4.12**	**1.01**	**5.71**
Seed inoculation (S)								
Control	2.77	3.19	4.87	4.33	28.30	29.90	50.60	46.33
Rhizobium (Rh.)	3.28	3.84	5.80	5.45	32.33	33.63	57.55	51.50
PSB	3.72	4.11	6.53	5.70	34.00	34.37	59.42	52.72
Azotobacter (Azo.)	3.07	3.63	5.38	5.11	31.48	33.04	55.67	49.34
Rh.+ PSB	4.80	4.58	8.40	6.32	40.87	37.47	66.80	55.68
Rh. + Azo.	3.80	4.39	6.67	5.90	37.83	34.63	62.28	53.28
Azo.+ PSB	4.20	4.45	7.40	5.85	39.17	36.00	61.67	54.73
Rh.+ Azo.+ PSB	5.35	5.02	9.37	6.46	44.95	38.02	70.37	56.73
S. Em (±)	**0.11**	**0.03**	**0.20**	**0.46**	**0.94**	**1.09**	**1.63**	**3.41**
LSD (P=0.05)	**0.32**	**0.09**	**0.58**	**1.38**	**2.72**	**3.27**	**4.72**	**10.22**
Interaction (F x S)								
S. Em (±)	**0.16**	**0.46**	**0.28**	**0.67**	**1.33**	**1.27**	**2.30**	**1.99**
LSD (P=0.05)	**0.52**	**1.32**	**0.81**	**1.95**	**NS**	**NS**	**NS**	**NS**
CV (%)	**6.96**	**18.42**	**7.11**	**19.95**	**6.41**	**7.69**	**6.58**	**15.90**

DAS: Days after sowing; PSB: Phosphate solubilizing bacteria; NS: Not significant

Table 3. Effect of different treatments on yield attributes and seed yield in urdbean

Treatments	Branches plant^{-1}		Pods plant^{-1}		Seeds pod^{-1}		1000-seed weight (g)		Seed yield (Kg ha^{-1})		
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	Pooled
Foliar spray (F)											
Water	2.97	3.43	21.80	14.32	5.30	5.09	40.5	34.4	1164	1165	1164
Molybdenum	3.40	3.85	22.73	17.11	5.65	5.47	40.8	38.0	1229	1310	1269
S.Em(±)	**0.03**	**0.17**	**0.92**	**0.67**	**0.07**	**0.11**	**0.4**	**0.1**	**68.58**	**63.50**	**66.04**
LSD(P=0.05)	**0.08**	**0.51**	**2.66**	**1.94**	**0.20**	**0.33**	**1.2**	**0.3**	**NS**	**NS**	**NS**
Seed inoculation (S)											
Control	2.65	2.97	18.05	11.34	4.58	4.79	27.5	33.5	892	831	861
Rhizobium (Rh.)	3.00	3.40	21.08	13.91	5.32	5.16	48.8	35.7	1116	1083	1099
PSB	3.18	3.68	21.28	15.26	5.53	5.28	40.7	37.0	1125	1208	1166
Azotobacter (Azo.)	2.78	3.08	19.72	13.03	4.97	5.05	38.3	34.7	1008	1017	1012
Rh. + PSB	3.57	4.25	25.23	17.11	5.83	5.50	33.7	34.7	1408	1408	1408
Rh. + Azo.	3.28	3.71	21.80	16.27	5.73	5.34	41.9	35.7	1166	1308	1237
Azo.+ PSB	3.37	4.08	23.32	16.58	5.77	5.47	42.5	36.2	1275	1367	1321
Rh.+ Azo.+ PSB	3.67	3.95	27.65	22.19	6.08	5.63	45.8	37.3	1583	1675	1629
S.Em(±)	**0.13**	**0.45**	**0.90**	**1.21**	**0.17**	**0.28**	**1.5**	**1.7**	**64.50**	**31.30**	**47.90**
LSD(P=0.05)	**0.31**	**1.30**	**2.61**	**3.52**	**0.49**	**0.80**	**4.3**	**5.1**	**189.70**	**93.80**	**141.75**
Interaction (F x S)											
S.Em(±)	0.18	0.14	1.28	1.38	0.24	0.19	2.2	2.7	91.25	47.72	69.49
LSD(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	138.19	201.52
CV (%)	9.77	19.26	9.92	18.90	8.62	13.20	6.00	11.87	13.20	12.60	12.90