Indian J. Pulses Res. 19(2): 259–262, 2006

Short Communication

Response and nutrient uptake of urdbean and mungbean genotypes to optimum nutrient supply on nutrient deficient sandy loam soil

CH. SRINIVASARAO[1] and MASOOD ALI[2]

[1]*Global Theme-Agro-ecosystems, International Crops Research Institute for Semi Arid Tropics, Patancheru 502 324;* [2]*Indian Institute of Pulses Research, Kanpur 208 024*

Nutritional deficiency is one of the key factors for low productivity of various pulse crops as most of these crops are predominantly grown on marginal and sub-marginal lands. Despite this, fertilizer recommendations to these crops do not receive proper attention. With intensive cereal-pulse cropping systems, depletion of native soil nutrients is rapid and with that even the soils once sufficient become nutrient deficient. Soil profiles of major pulse growing regions of India were found multi-nutrient deficient (12). Urdbean (*Vigna mungo* L. Hepper) and mungbean (*Vigna radiata* L. Wilczek) are two major *kharif* pulse crops grown in many parts of India. Though nutrient recommendations are available to these crops, their application is very rare, resulting in the dependence of these crops mainly on soil nutrient source. Therefore, when these crops are grown on nutrient deficient soils, genotypes which can mobilize native soil nutrients or which can utilize limited added nutrients more efficiently, perform better than others. The present study examined the variations in the response and nutrient uptake of urdbean and mungbean genotypes to optimum nutrient supply on sandy loam soil tested deficient in many nutrients.

Bulk surface soil (0-15 cm) was collected from New Research Farm of Indian Institute of Pulses Research, Kanpur. Collected soil was processed and analyzed for various physico-chemical properties of soils (5). Mineralizable nitrogen (N) was estimated by an alkaline permanganate method (13), available phosphorus was extracted with sodium bicarbonate (9), potassium by 1M neutral ammonium acetate (4), sulphur by 0.01 M $CaCl_2$ (15) and available Zn by DTPA (6). Experimental soil was slightly alkaline in reaction (pH 7.7), non-calcareous ($CaCO_3$ content 8.5 g kg^{-1}), low in organic carbon (2.1 g kg^{-1}) and sandy loam in texture (sand, silt and clay content 64.5, 30 and 5.5% respectively) belonging to Ustrochrepts (Inseptisols) and was deficient in available N (140 kg ha^{-1}), P (3.2 kg ha^{-1}), K (90 kg ha^{-1}), S (6.8 kg ha^{-1}) and Zn (0.4 mg kg^{-1}). Four kg processed soil was filled in plastic pots and ten genotypes of urdbean and mungbean were grown up to flowering stage. Two levels of nutrient supply were tested *viz.*, control (no nutrient supply) and optimum nutrient supply (on the weight basis 20 kg N, 60 kg P_2O_5, 20 kg K_2O, 20 kg S and 25 kg $ZnSO_4$ ha^{-1}) with four replications of each treatment (during *kharif* 2002). At flowering stage, the crop was harvested. Root biomass was collected after gentle and proper washing of roots. Harvested shoot portion were dried, grounded and analyzed for total N content by Kjeldahl method (13). Total P content in the plant material was determined after diacid digestion and P content in the extract was determined by vanadomolybdophosphoric yellow colour method (5). Total uptake of N and P in above ground parts were obtained from dry matter yield and nutrient content.

Irrespective of crop and genotypes, significant increase in root and shoot biomass was obtained with optimum nutrient supply (N, P, K, S, Zn) over untreated control. However, considerable variations were observed among genotypes of both urdbean and mungbean with respect to dry matter production (Tables 1 and 2). Shoot responded more conspicuously to optimum nutrition compared to root growth in both the crops. The extent of dry matter yield response to optimum nutrient supply also varied between two crop species. Mungbean responded to greater extent in terms of root, shoot and total biomass to nutrient supply as compared to urdbean. The root dry matter of urdbean increased from 0.62 to 0.97 mg pot^{-1} (62 %) whereas shoot dry matter increased from 1.09 mg pot^{-1} to 1.86 mg pot^{-1} (71%). The overall increase in total dry matter was 68 % in nutrient supply treatment over control. In mungbean, response in terms of root, shoot and total dry matter to nutrient supply was 89, 98 and 95%,

Table 1. Response of urdbean genotypes to optimum nutrient supply on sandy loam soil

Genotype	Urdbean biomass (g/pot)					
	Root		Shoot		Total	
	Control	Optimum	Control	Optimum	Control	Optimum
PDU 1	0.56	0.68	0.99	1.28	1.65	1.96
IPU 94-1	0.54	0.72	0.73	1.23	1.27	1.95
Pant U 19	0.68	0.95	1.07	1.54	1.41	2.49
Pant U 20	0.62	0.85	0.93	1.68	1.55	2.53
WBG 26	0.75	1.05	1.46	2.07	2.21	3.12
WBU 108	0.60	0.91	1.28	1.67	1.88	2.58
TU 94-2	0.48	0.89	0.85	1.75	1.33	2.64
RBU 38	0.80	1.41	1.69	2.94	2.49	4.35
(Bharkha)	0.65	1.30	1.13	2.57	1.78	3.87
TPU 4	0.40	0.92	0.77	1.86	1.17	2.78
Sarla						
Mean	0.62	0.97	1.09	1.86	1.67	2.83
CD (5%)		0.27		0.65		0.92

Table 2. Response of mungbean genotypes to optimum nutrient supply on sandy loam soil

Genotype	Mungbean biomass (g/pot)					
	Root		Shoot		Total	
	Control	Optimum	Control	Optimum	Control	Optimum
HUM 1	0.29	0.58	0.75	1.17	1.04	1.75
TDRM 1	0.36	0.66	0.66	1.66	1.02	2.26
HUM 12	0.51	0.68	1.10	1.60	1.61	2.28
Co 4	0.53	1.05	1.04	2.09	1.57	3.14
Pant Mung	0.38	0.75	0.73	1.55	1.11	2.30
4	0.29	0.72	0.54	1.46	0.84	2.18
BM 4	0.54	0.84	1.06	1.57	1.60	2.41
Ganga 8	0.38	0.65	0.65	1.26	1.03	1.91
Pant Mung 3	0.27	0.68	0.41	1.28	0.68	1.96
Dholi 1	0.39	0.80	0.74	1.63	1.13	2.43
PDM 54						
Mean	0.39	0.74	0.77	1.53	1.16	2.27
CD(5%)		0.17		0.18		0.71

respectively. Significant response of both the crop plants to nutrient supply was attributed due to multi-nutrients deficiency such as N, P, S, K and Zn in experimental soil.

In both the crops, considerable genotypic variation in response to nutrient supply was observed. In urdbean, total biomass yield ranged from 1.17 g pot^{-1} in Sarla to 2.49 g pot^{-1} in RBU 38 in control treatment. With the addition of nutrients, the biomass yield increased to 1.95 g pot^{-1} (IPU 94 1) to 4.35 g pot^{-1} (RBU 38). In case of mungbean, total biomass ranged from 0.68 g pot^{-1} (Dholi 1) to 1.61 g pot^{-1} (HUM 12) in control treatment. This range increased to 1.75 g pot^{-1} (HUM 1) to 3.14 g pot^{-1} (Co 4) with nutrient supply. This indicates that the yield pattern of particular genotype also differed between nutrient supply treatments. Some genotypes performed better than others under nutrient stress condition whereas the same genotype did not perform superior to others under optimum nutrient supply. Thus, blanket recommendation of nutrients to all genotypes may not result in full benefits of nutrient supply to particular crop species.

Nitrogen content and uptake differed considerably among genotypes (Fig 1a and 1b). Shoot nitrogen content of urdbean ranged from 1.93 to 2.48 % (Mean 2.19 $\pm$ 0.10) in control treatment (CV 9.5%) and with optimum nutrient supply, this range increased to 2.27 to 2.67 % (mean 2.44 $\pm$ 0.10, CV 5.3%). Mungbean shoot also maintained more or less similar levels of nitrogen content with the mean values of 2.13 $\pm$ 0.07% in control (CV 7.0%) and 2.55 $\pm$ 0.15% with nutrient supply (CV 11.9%). Shoot nitrogen content in both the crop plants showed significant correlation with shoot dry matter yield in both the treatments and correlation coefficient values varied from 0.81 to 0.87 in urdbean and from 0.75 to 0.76 in mungbean. However, lower correlation coefficients were observed between shoot N content and total dry matter yield. Significant correlation between nitrogen content and dry matter yield could be attributed to the limitation of nitrogen in plant tissue. Genotypes, which maintain relatively higher nitrogen content tend to produce higher biomass. As soil was very low in organic carbon content, symbiotic nitrogen fixation process also affected negatively for want of carbon source. Therefore, plants responded tremendously to optimum nutrients supplied externally. Ali *et al.* (1) reported that the variability in the proportion of N derived from N fixation varied widely from 0 to 100 % in urdbean and mungbean mainly because of fluctuations in soil temperature and moisture during monsoon season. Dey and Tilak (2) indicated that biological N fixation often affected adversely with adverse soil conditions like salinity and excess moisture. Pulse crops depend on external nitrogen supply in absence of favourable soil conditions for biological N fixation.

Mean nitrogen uptake of different genotypes of urdbean and mungbean is presented in Fig. 1b. It indicates a lot of variation in N uptake among genotypes in control treatments, urdbean N uptake ranged from 15.6 to 41.4 mg pot^{-1} (CV 37.4%) and mungbean N uptake ranged from 8.3 to 27.6 mg pot^{-1}(CV 38.9%). With optimum nutrient supply, N uptake increased to more than two-fold over control ranging between 20.1 to 78.5 mg pot^{-1} in urdbean (CV 37.7%) and to 27.5 to 59.8 mg pot^{-1} in mungbean (CV 39.4%) with nutrient supply. Different

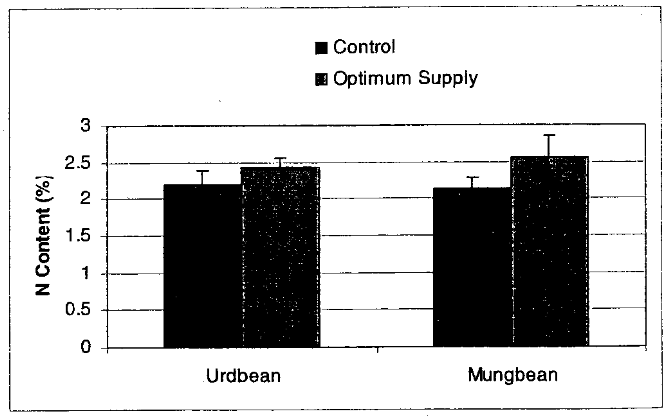

Fig 1a. Nitrogen content of urdbean and mungbean as influenced by nutrient supply (Mean of 10 genotypes)

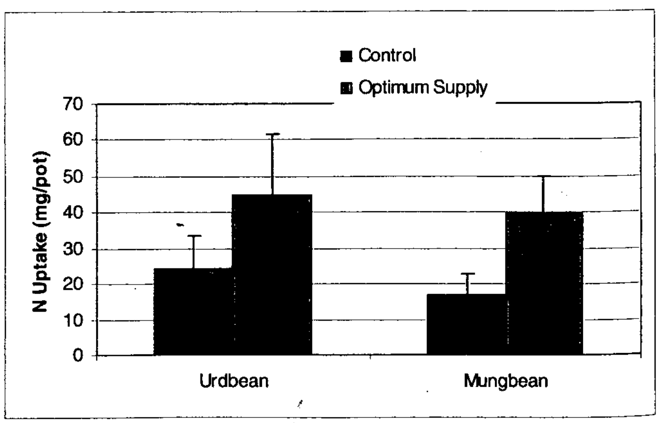

Fig 1b. Nitrogen uptake by urdbean and mungbean as influened by nutrient supply (Mean of 10 genotypes)

genotypes of these pulse crops need different amounts of nitrogen to produce unit biomass, thus requiring variable amounts of nitrogen.

Shoot P content ranged from 0.09 to 0.13% in urdbean (CV 12.3%) and from 0.09 to 0.14 % in mungbean (CV 17.5%) in absence of nutrient supply (Fig 2a and 2b). With optimum nutrient supply, P content in shoot increased to 0.13 to 0.18% in both the crops (CV 11.9 and 11.1% in urdbean and mungbean, respectively). Variation in P content among genotypes in both the crops was higher in control than in optimum nutrient supply. Under control treatment, urdbean genotype RBU 38 and mungbean genotypes HUM 12, Co 4 and Ganga 8 maintained higher P content in the shoot than the other genotypes under nutrient deficient condition. Genotypes with higher P content showed higher shoot dry matter yield and correlation ranged from 0.94 to 0.96 in urdbean and from 0.91 to 0.95 in mungbean.

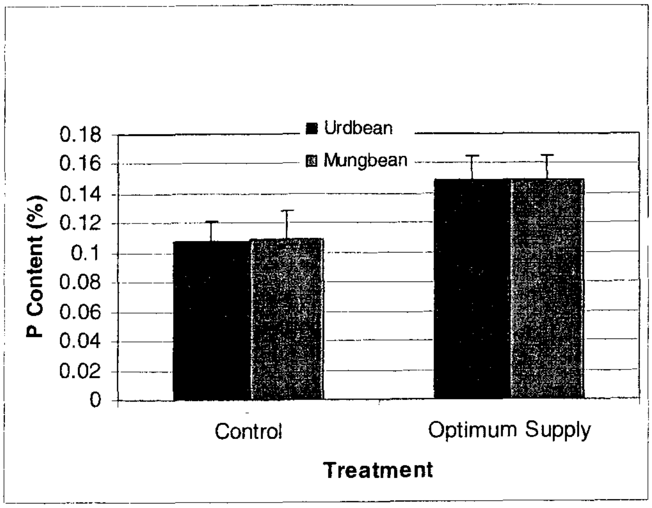

Fig 2a. Variations in P content in urdbean and mungbean genotypes

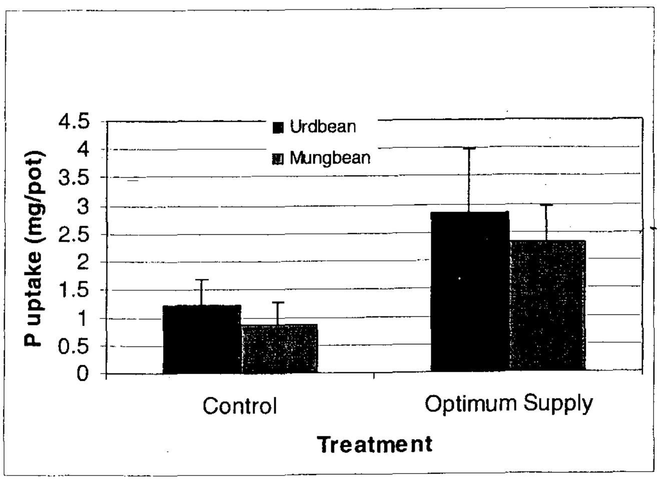

Fig 2b. Variations in P uptake by urdbean and mungbean genotypes

Wide variation in P uptake was observed among genotypes irrespective of the nutrient supply (Fig. 2b). In urdbean, P uptake varied from 0.69 to 1.75 mg pot^{-1} (CV 38.9%) in control and from 1.60 to 5.29 mg pot^{-1} in optimum nutrient supply treatment (CV 39.4%). In mungbean, P uptake ranged from 0.37 to 1.54 mg pot^{-1} in control (CV 46.6 %) and from 1.52 to 3.76 mg pot^{-1} with optimum nutrient supply (CV 28.4 %). Such variations in P uptake among genotypes were reported earlier in wheat and barley (10, 16). Among grain legumes, variations in potassium use efficiency were reported in common bean by Fageria *et al.* (3) and genotypic variations in P use efficiency in pigeonpea from iron-bound P was reported by Subbarao *et al.* (14). Variations in genotypes in nutrient acquisition arise primarily through differences in root characteristics such as root system, size, morphology and physiology and the associated changes in root surface area for absorption of nutrients and changes in rhizosphere chemistry (8). Root characteristics that result in exploration of larger soil volume or alter the release of phosphate ions from soil particle are of great importance in P uptake because of the low mobility of P in soils. In the present study also, in absence of nutrient supply, genotypes with larger root dry weight showed higher P content and P uptake in shoot. However, this trend was not clear with external P supply to crop plants. Mobilization of insoluble Fe or Ca – bound P in soil may vary among crop species. Many crop plants particularly pulses are known to produce different organic acids, phenolic compounds, acid and alkaline phosphotases which can mobilize P from insoluble P sources (1). In a recent study on genotypic variation in P use efficiency contributed more than P utilization efficiency to the variation of grain yield among 42 wheat genotypes (7). Therefore, considering a genotype as one of the factors in formulating nutrient requirements of a crop or cropping system would results in precise fertilizer recommendations and higher efficiency of applied nutrients.

LITERATURE CITED

1. Ali, M., Ganeshmurthy, A.N. and Srinivasarao, Ch. 2002. Role of plant nutrient management in pulse production. *Fertilizer News* **47**: 83-90.

2. Dey, B.K. and Tilak, K.V.B.R. 1984. Biological nitrogen fixation as influenced by soil environment. In: Nitrogen in Soils, Crops and Fertilizers, *Bulletin of the Indian Society of Soil Science* **13**: 30-50.

3. Fageria, N.K., Filho, M.P.B. and Da Costa, J.G.C. 2001. Potassium-use efficiency in common bean genotypes. *Journal of Plant Nutrition* **24**: 1937-1945.

4. Hanway, J.J. and Heidel, H. 1952. Soil analysis methods as used in Iowa State College Soil testing laboratory. *Bulletin of the Iowa State College of Agriculture* **57**: 1-31.

5. Jackson, M. L. 1973. Soil Chemical Analysis (Reprint). Prentice Hall of India Pvt. Ltd. New Delhi.

6. Lindsay, W.L. and Norvell, W.A. 1978. Development of a DTPA test for Zn, Fe, Mn and Cu. *Soil Science Society America Journal* **42**: 421-428.

7. Manske, G.G.B., Ortiz-Monasterio, J.I., Van Ginkel, M., Gonza'lez, R.M., Rajaram, S., Molina, E. and Vlek, P.L.G. 2000. Traits associated with improved P-uptake efficiency in CIMMYT's semi-dwarf spring wheat grown on an acid Andisol in Mexico. *Plant and Soil* **221**: 189-204.

8. Marschner, H. 1998. Role of root growth, arbuscular mycorrhiza and root exudates for the efficiency of nutrient acquisition. *Field Crops Research* **56**: 203-207.

9. Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *USDA Circular* No. **939**.

10. Osborne, L.D. and Rengel, Z. 2002. Screening cereals for genotypic variation in efficiency of phosphorus uptake and utilization. *Australian Journal of Agricultural Research* **53**: 295-303.

11. Srinivasarao, Ch., Ali, M., Ganeshamurthy, A.N., Singh, R.N. and Singh K.K. 2002. Distribution and availability of nutrients in different soil types of pulse growing regions of India. *Indian Journal of Pulses Research* **15**: 49-56.

12. Srinivasarao, Ch., Ganeshamurthy, A.N. and Ali, M. 2003. Nutritional constraints in pulse production. *Bulletin of the Indian Institute of Pulses Research* **8**: 1-34.

13. Subbaiah, B. V. and Asija, G.L. 1956. A rapid procedure for the determination of available nitrogen in soils. *Current Science* **25**: 259-260.

14. Subbarao, G.V., Ae, N. and Otani, T. 1997. Genetic variation in acquisition and utilization of phosphorus from iron-bound phosphorus in pigeonpea. *Soil Science and Plant Nutrition* **43**: 511-519.

15. William, C.H. and Steinbergs, A. 1959. Soil sulphur fractions as chemical indices of available sulphur in some Australian soils. *Australian Journal of Agricultural Research* **10**: 342-352.

16. Zhu, Y.G., Smith, F.A. and Smith, S.E. 2002. Phosphorus efficiencies and their effects on Zn, Cu and Mn nutrition of different barley (*Hordeum vulgare*) cultivars in sand culture. *Australian Journal of Agricultural Research* **53**: 211-216.