Effects of micronutrients on growth and yield of pigeonpea

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Pigeonpea (*Cajanus cajan*) is an important pulse crop of rainfed agriculture and a principal source of protein in the Indian diet. Rainfed soils are generally degraded with poor native fertility. Mineral nutrient deficiencies limit nitrogen fixation by the legume-rhizobium symbiosis, resulting in low legume yields. Nutrient limitations to legume production result from deficiencies of not only major nutrients but also micronutrients such as molybdenum (Mo), zinc (Zn), boron (B) and iron (Fe) (Bhuiyan et al. 1999). Inadequate nodulation of pigeonpea can be associated with low plant available Mo. Increase in flower numbers, pod set improvement, and reduction in days to flowering are influenced by Mo (Prasad et al. 1998). Application of recommended doses of fertilizers (RDF), the major, secondary and micronutrients, to pigeonpea is essential for higher yield under rainfed conditions. Little information is available on the response of pigeonpea to micronutrients under rainfed conditions in Vertisols. This investigation was carried out to find out the influence of micronutrients on production of pigeonpea in Vertisols under rainfed conditions.

A field experiment was conducted with pigeonpea variety ICPL 87119 at Regional Agricultural Research Station (RARS), Warangal, Andhra Pradesh, India during *kharif* (rainy season) 2005–06 under rainfed conditions. The characteristics of the experimental soil were: organic carbon 0.3%, available nitrogen (N) 252 kg ha^{-1}, available P_2O_5 20 kg ha^{-1}, available K_2O 390 kg ha^{-1} and sulfur (S) 11 mg kg^{-1} with pH 8.2. The micronutrient contents were 0.6 mg kg^{-1} B, 4 mg kg^{-1} Fe and 0.03 mg

Table 1. Influence of micronutrients on plant height, yield attributes and seed yield of pigeonpea.

Treatment	Plant height (cm)	Pods $plant^{-1}$	100-seed weight (g)	Seed yield (t ha^{-1})
T_1: 20, 50, 20 and 20 kg ha^{-1} N, P_2O_5, K_2O and S	166	159	10.9	1.9
T_2: T_1 + boron at 10 kg ha^{-1}	175	175	11.0	2.0
T_3: T_1 + boron at 20 kg ha^{-1}	181	182	11.2	2.1
T_4: T_1 + sodium molybdate at 1.5 kg ha^{-1}	179	179	11.0	2.1
T_5: T_1 + sodium molybdate at 3.0 kg ha^{-1}	198	214	11.5	2.3
T_6: T_1 + chelated iron at 2.0 kg ha^{-1}	190	196	11.4	2.1
T_7: T_1 + chelated iron at 3.0 kg ha^{-1}	192	198	11.3	2.2
T_8: T_1 + seed treatment with boron at 4 g kg^{-1} seed	189	192	11.2	2.1
T_9: T_1 + seed treatment with sodium molybdate at 4 g kg^{-1} seed	195	204	11.3	2.2
T_{10}: T_1 + seed treatment with chelated iron at 4 g kg^{-1} seed	193	201	11.3	2.2
SEm$\pm$	12.5	7	0.1	0.08
CD (P = 0.05)	NS[1]	21	NS	0.24

1. NS = Not significant.

Table 2. Status of soil available nutrients after harvest of pigeonpea.

Treatment	Available N (kg ha^{-1})	Available P_2O_5 (kg ha^{-1})	Available K_2O (kg ha^{-1})	S (ppm)	Mo (ppm)	B (ppm)	Fe (ppm)	Organic carbon (%)
T_1	252.0	19.0	391.0	11.0	0.03	0.50	4.0	0.32
T_2	252.5	20.0	391.0	11.5	0.03	0.64	4.1	0.31
T_3	251.5	20.0	390.0	11.0	0.03	0.65	4.0	0.33
T_4	251.5	19.0	391.5	11.4	0.04	0.60	4.2	0.31
T_5	252.5	20.0	391.0	11.6	0.05	0.55	4.3	0.31
T_6	252.0	19.5	391.0	11.3	0.04	0.53	4.5	0.30
T_7	252.0	19.5	391.0	11.0	0.03	0.60	4.6	0.29
T_8	251.0	19.5	391.0	10.0	0.04	0.58	4.4	0.30
T_9	252.0	20.0	392.0	11.5	0.04	0.60	4.2	0.28
T_{10}	252.5	20.5	391.5	11.0	0.04	0.61	4.4	0.31

kg^{-1} Mo. Postharvest soil samples were drawn and analyzed for organic carbon by wet digestion method (Walkley and Black 1934), available N by alkaline permanganate method (Subbiah and Asija 1956), available phosphorus (P) by Olsen's method (Watanable and Olsen 1965) and available potassium (K) by neutral normal ammonium acetate method (Muhr et al. 1965). Available S (Palaskar et al. 1981), Fe (Lindsay and Norvell 1978), B by hot water soluble B method (Berger and Truog 1939) and Mo by Grigg's reagent method (Grigg 1953) were also determined. The crop was sown on 30 June 2005 and harvested on 20 January 2006. The experiment was laid out in randomized complete block design in three replications with ten treatments – T_1: 20, 50, 20 and 20 kg ha^{-1} of N, P_2O_5, K_2O and S; T_2: T_1 + B at 10 kg ha^{-1}; T_3: T_1 + B at 20 kg ha^{-1}; T_4: T_1 + sodium molybdate at 1.5 kg ha^{-1}; T_5: T_1 + sodium molybdate at 3.0 kg ha^{-1}; T_6: T_1 + chelated Fe at 2.0 kg ha^{-1}; T_7: T_1 + chelated Fe at 3.0 kg ha^{-1}; T_8: T_1 + seed treatment with B at 4 g kg^{-1} seed; T_9: T_1 + seed treatment with sodium molybdate at 4 g kg^{-1} seed; and T_{10}: T_1 + seed treatment with chelated Fe at 4 g kg^{-1} seed. The plot size was 5 m × 4 m. The crop was sown at interrow spacing of 1 m and intrarow spacing of 0.2 m. About 665 mm rainfall was received in 39 rainy days during crop growth period. The crop was not subjected to moisture stress at critical stages, as rainfall was well distributed during the study period. The average maximum temperature ranged from 28.4°C to 38.4°C and minimum temperature ranged from 17.7°C to 27.1°C.

Application of N, P, K and S at 20, 50, 20 and 20 kg ha^{-1} along with sodium molybdate at 3.0 kg ha^{-1} to soil has recorded significantly higher yield (2.3 t ha^{-1}) and was on par with all other treatments, except application of recommended doses of N, P, K and S (RDF) at 20, 50, 20 and 20 kg ha^{-1} (1.9 t ha^{-1}). Similar trend was observed in case of pods $plant^{-1}$ (Table 1). In addition to RDF, either seed treatment or soil application of micronutrients significantly increased the yield compared to RDF only. Yield increase in these treatments may be the result of inhibition in flower and pod abscission, improvement in morpho-physiological characters (stem girth, early vigor and crop establishment) and enhanced dry matter production and its partitioning in addition to higher pods per plant. The plant height and 100-seed weight were not influenced significantly by micronutrients when applied along with RDF either through seed treatment or soil application. Similar results have been observed by Velayutham et al. (2003) in black gram (*Vigna mungo*) under rainfed conditions. Boron's involvement in hormone synthesis and translocation, carbohydrate metabolism and DNA synthesis probably contributed to additional growth and yield (Ratna Kalyani et al. 1993). Wankhade et al. (1995) also reported that application of Fe significantly increased the yield of pigeonpea compared to control. Among micronutrients, superiority of sodium molybdate (either soil application or seed treatment along with RDF) was observed, followed by chelated Fe. There was no significant change in soil nutrient status after harvest of pigeonpea compared to initial values (Table 2). It is inferred that regular application of micronutrients along with major nutrients is essential for sustainable yield in pigeonpea, as rainfed soils are highly vulnerable to nutrient deficiencies. This study indicates that application of micronutrients like Mo, Fe, B along with N, P_2O_5, K_2O and S to soil before sowing enhances the productivity of pigeonpea in Vertisols.

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