Environment & Ecology 27 (2) : 685—688, 2009
 ISSN 0970-0420

Effect of Boron and Boron Enriched Organic Manure on Yield and Quality of Groundnut in Boron Deficient Alfisol

D. JENA, S. C. NAYAK, B. MOHANTY, B. JENA AND S. K. MUKHI

Department of Soil Science & Agricultural Chemistry, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar 751003, India
E-mail : dinabandhu_jena@yahoo.com

Abstract

Effects of boron and boron enriched organic manure on yield and quality of groundnut in boron deficient Alfisol were studied. Boron at 1 kg/ha and B enriched cow dung increased groundnut pod yield by 57 and 62%, respectively over control. High dose of B at 2 kg/ha recorded lower pod yield of 10.81 q/ha which was at par with control might be due to toxic effect of B. Oil content and protein content in groundnut increased by 1– 4 and 3–13%, respectively over control due to B application. Boron content in pod and vine and their total uptake by groundnut in B treatments increased significantly over control. There was mining of available B in control. There was build up in B status of soil by 14–66% in B treatments.

Key words : Boron, Organic manure, Groundnut, Alfisol, Yield.

Intensive cropping of high yielding crop varieties coupled with modern agricultural practices have led to high yield, but it caused high depletion of plant nutrients and that of micronutrients. Inadequate and imbalanced nutrition influences the yield and quality of crops. Next to Zn, deficiency of boron is observed to be wide spread in several soils. Its deficiency is found in nearly 33% of areas of the country. Boron (B) is important in agriculture because of its deficiency and toxicity in soils can both adversely affect plant growth. Deficiency of B is more wide spread than the deficiency of any other micronutrient (1). Boron deficient soils include those which are inherently low in B, calcareous and coarse textured soils (2) and those high in clay (3). Boron toxicity in plants has been reported from many parts of the world (4) but is mostly associated with the use of high B water (5).

There was wide range of variation in B deficiency in soils of Orissa. Jena (6) reported that about 44% of soils in Orissa are deficient in B. The minimum deficiency of 4.4% was reported in laterite soils of Nayagarh district and maximum deficiency of 89% in mixed red and brown soils of Koraput district. Saline soil of Puri district was adequate in available B. Jena (6) surveyed the intensive groundnut, rice and sugarcane growing areas of Orissa. The data showed that about 40–100% of sugarcane, 60–80% of groundnut and 42–72% of rice plant samples were found to be deficient in B. Mandal et al. (7). conducted 55 field experiments in the farmer's fields in three states namely, West Bengal, Jharkhand, and Orissa on three types of B deficient soils (alluvial soils of West Bengal and Orissa, and red and laterite soils of Jharkhand). The results showed that application of boronated NPK (0.3% B) increased yield of the crops to the tune of 4.3 to 66.7%, 6.0 to 22.9%, 1.9%, 9.4%, 2.4 to 27.2%, 4.8%, 5.4%, 15.1% and 5.0 to 16.2% for mustards, wheat, lentil, coriander, potato, tomato, chilli, groundnut and cauliflower, respectively, over NPK alone. Since the concentration range between deficiency and toxicity is narrow, the effects of applied B on its availability in soil are of interest. Boron applied to soils is adsorbed to a variable extent and equilibrium exists between solid-liquid phases. The organic manure may influence the availability of B by adsorbing more B than mineral constituents (8, 9) and coating the B fixing mineral surfaces. Also it is well established that much of the B in soil is associated with organic matter in tightly bound compounds, which is released in available form by microbial action (10). The application of B and FYM recorded a significantly enhanced removal of B in parts of cauliflower (11).

Groundnut is an important oilseed crop of Orissa grown in 0.90 lakh ha during *kharif* and 1.30 lakh ha during *rabi* season. The *kharif* groundnut is grown in upland red and laterite soils whereas *rabi* ground-

nut is grown in alluvial soil under residual soil condition. The yield of *kharif* groundnut is low (10.83 q/ha) as compared to *rabi* groundnut (18.68 q/ha), since the former is grown in low fertility eroded soils which suffer from Ca, S and B deficiency. Deficiency of B in crops leads to reduction in yield and quality. So an urgent need was felt to have a holistic approach to diagonize, delineate and assess responses of crops to boron and methods to increase B efficiency in soil. Hence, the present study was carried out to assess the effect of low cost boron enriched compost on yield and quality of groundnut.

Methods

A field experiment was conducted during *kharif* of 2003-04 in upland red soil (Haplustalf) of Central Research Station, Orissa University of Agriculture and Technology, Bhubaneswar to study the effect of low cost B enriched compost on yield and quality of groundnut. The treatments consisted of T_1–Control (no boron), T_2–FYM at 5 t/ha, T_3–Poultry manure (PM) at 5 t/ha, T_4–Fresh cow dung (dry weight basis) at 5 t/ha, T_5–B at 1 kg/ha, T_6–B at 2 kg/ha, T_7–B at 1 kg/ha + FYM at 5 t/ha, T_8–B at 1 kg/ha + PM at 5 t/ha, T_9–B at 1 kg/ha + fresh cow dung (dry weight basis) at 5 t/ha. The experiment was carried out in a randomized block design with three replications. The experimental soil was sandy loam texture with pH 5.7, organic carbon 0.45%, low in available phosphorus (6.5 kg/ha) and medium in potassium (150 kg/ha) . The soil was deficient in available B (0.48 ppm). The boron enriched compost was prepared by mixing B with organic manure and incubated for 30 days before application in the field. Groundnut (cv Smruti) was sown in the third week of June and a common fertilizer dose of N, P_2O_5, and K_2O at 20, 40, and 40 kg/ha was applied in furrows at the time of sowing. Boron (borax) and B enriched manures were applied in furrows at the time of sowing. The crop was harvested at full mature stage. Pod and vine samples were digested in di-acid mixture (HNO_3 : $HClO_4$: : 10 : 4) and analyzed for B. Oil content in kernels was analyzed by extracting with petroleum ether (12). Nitrogen was estimated by micro-Kjeldhal method using semi-automatic N analyzer. Soill samples were collected after harvest of second crop and analyzed for available B by Azomethine-H method (13).

Results and Discussion

Pod and Vine Yield

Pod yield of groundnut increased signicantly by the application of B, FYM, poultry manure (PM), fresh cow dung and B enriched organic manure (Table 1). An increase of 17.3 to 30.8, 56.9 and 53.1 to 62.4% in pod yield over control (no Boron) was recorded with application of organic manure (FYM, poultry manure or fresh cow dung), boron (1 kg/ha) and B enriched organic manure, respectively. High dose of B (2 kg/ha) recorded lower pod yield (10.81 q/ha) and was at par with control might be due to toxic effect of B at this level. Among the treatments the B enriched fresh cow dung recorded highest yield followed by B enriched FYM. Similar effect of Zn and Fe enriched FYM on mustard was reported by Meena et al. (14).

Table 1. Effect of B enriched compost on pod and vine yield, shelling per cent, oil and protein content of groundnut (pooled over two years).

Treatments	Pod yield (q/ha)	Percent increase over control	Vine yield (q/ha)	Shelling (%)	Oil content (%)	Protein content (%)	Post harvest available B (mg/kg)
T_1	9.12	-	15.74	64.60	46.10	22.0	0.47
T_2	11.93	30.8	18.34	65.10	46.54	22.8	0.48
T_3	11.51	26.2	18.50	65.90	46.28	22.6	0.50
T_4	10.70	17.3	17.59	65.80	46.70	22.6	0.49
T_5	14.31	56.9	19.84	66.70	47.12	23.4	0.55
T_6	10.81	18.5	15.68	67.80	47.20	24.8	0.70
T_7	14.20	55.7	19.24	68.90	47.80	24.5	0.55
T_8	13.96	53.1	19.34	68.80	47.65	24.6	0.57
T_9	14.81	62.4	19.72	68.90	47.85	24.6	0.61
CD (P = 0.05)	2.42		2.48	1.20	0.18	0.40	0.12

Table 2. Effect of B enriched compost on B content and B uptake by groundnut.

Treatments	B content (mg/kg)		B uptake (g/ha)			B uptake response (g/ha)	B use efficiency (%)
	Pod	Vine	Pod	Vine	Total		
T_1	11.50	18.26	10.49	28.74	39.23	-	-
T_2	12.30	20.00	14.68	36.68	51.36	12.13	-
T_3	15.78	25.36	18.16	36.92	65.08	25.85	-
T_4	12.20	21.30	13.05	37.47	50.52	11.29	-
T_5	18.50	28.30	26.47	56.15	82.62	43.39	4.34
T_6	32.26	76.50	34.87	119.95	154.82	115.59	5.78
T_7	18.29	29.50	25.97	56.76	82.73	43.50	4.35
T_8	19.56	28.30	27.30	54.73	82.03	42.80	4.28
T_9	20.06	30.50	29.71	60.15	89.86	50.63	5.63
CD (P = 0.05)	3.40	4.36	3.46	8.51			

Shelling Percent

Shelling percent of groundnut increased significantly by the application of B, FYM, poultry manure (PM), fresh cow dung and B enriched organic manure (Table 1). The shelling percent was increased by 65.10 to 65.80%, 66.70 to 67.80% and 68.80 to 68.90% with application of organic manures, boron and B enriched organic manures, respectively.

Oil and Protein Content

Oil content of groundnut increased significantly over control (46.10%) with application of organic manures, boron and B enriched organic manures by 1—4%. The effect of B enriched organic manure on oil content was significantly higher over boron or organic manure alone. Organic manure and B have significant effect on protein content of groundnut (Table 1). Maximum protein content of 24.8% was observed in T_6 (B at 2 kg/ha) followed by B enriched organic manure treatments (24.5–24.6%). Effect of B enriched organic manure was significant over boron or organic manure alone and hence this treatments could be recommended for sustainable yield and pod quality. Increase in oil and protein content due to addition of B might be due to its effect on pod formation (15). Positive and significant effect of B and organic manure on oil and protein content of groundnut was reported by Patil et al. (16).

B Uptake by Groundnut

Boron content in pod (12.30 to 32.26 mg/kg) and vine (18.26 to 76.50 mg/kg) increased significantly over control with application of B and organic manure alone or enriched with B (Table 2). Significant effect of higher dose (2 kg B/ha) of boron was observed in B content of pod and vine although the pod yield was decreased significantly at higher dose.

Total uptake of B by pod and vine was significantly higher with treatments over control (39.23 g/ha). Maximum significant uptake of 154.82 g/ha was recorded with 2 kg B/ha followed by 1 kg B/ha. On the other hand, the effects of B enriched organic treatments were at par with B alone but higher than organic manure alone.

The effect of B enriched organic manure treatments recorded higher yield, protein content, oil content and shelling per cent must be due to better availability of B to groundnut which were applied in chelated form. This might have provided better nutrition over longer time that caused better growth and higher yield. Similar findings were reported by Meena et al. (14).

Post-Harvest Available B

The effect of different treatments was found to be significant on hot water soluble B after harvest of second crop (Table 1). The available B content in control was reduced from 0.48 to 0.47 mg/kg over two seasons of cropping. On the other hand, there was build up in B status of soil in other treatments. Maximum B build up was recorded inT_6 (B at 2 kg/ha). Effect of B enriched organic manures was higher as compared to B or organic manure alone.

Conclusion

It could be inferred from the above study that B at 1 kg/ha significantly increased pod yield and pod quality. Boron enriched organic manure further could enhance the efficiency of B fertilizer.

References

1. Reisenauer H. M., L. M. Walsh and R. G. Hoeft. 1973. Testing soils for S, B, Mo and Cl. Page 175—200 *in* L. M. Walsh and J. D. Beaton, editors. Soil testing and plant analysis. Soil Sci. Soc. of America, Madison, Wisconsin, USA.
2. Luca R. E. and B. D. Knezek. 1972. Climate and soil conditions promoting micronutrient deficiencies in plants. Pages 265—283 *in* J. J. Mortvedt, Giondorron P. M. and Lindsay, W. L., editors. Soil Sci. Soc. of America, Madison, Wisconsion, USA.
3. Mengel K. and E. A. Kirkby. 1982. Boron. Pages 53—54 *in* Principles of Plant nutrition, 3rd edition. Int. Pot. Inst., Berne, Switzerland.
4. Gupta U. C. 1984. Boron nutrition of alfalfa, red clover and timothy grown on podzol soils of eastern Canada. Canadian J. Soil Sci. 137 : 16—22.
5. Kanwar J. S. and S. S. Sharma. 1972. Boron in normal and saline alkali soils of irrigated area of the Punjab. Soil Sci. 92 : 207—211.
6. Jena D. 2006. Annual report. All India Co-ord. Res. Proj. on micro-secondary and pollutant element in soils and plants. OUAT, Bhubaneswar, India.
7. Mandal B., A. K. Sarkar, S. Singh, D. Jena, D. P. Patra and M. Phillips. 2006. Performance of boronated NPK in B deficient soils. Indian J. Fert. 1 : 57—59.
8. Yermiyaho U., R. Keren and Y. Chen. 1988. Boron sorption on composted organic matter. Soil Sci. Soc. Am. J. 52 : 1309—1313.
9. Gu B. and L. E. Lowe. 1990. Studies on the adsorption of boron on humic acids. Canadian J. Soil Sci., 143 : 305—311.
10. Berger K. C. and P. F. Pratt. 1963. Advances in secondary and micronutrient fertilization. Pages 281— 340 *in* M. H. McVickar, G. L. Bridger and L. B. Nelson, editors. Fertilizer technology and usage. Soil Sci. Soc. America, Madision, WI, USA.
11. Girish C., T. S. Verma and S. Sahrma. 2007. Influence of boron and farm yard manure on available boron and exchangable calcium and their removal by cauliflower in the boron-deficient soils of Himachal Pradesh. J. Indian Soc. Soil Sci. 55 : 62—66.
12. AOAC. 1970. Official methods of analysis. Assoc. Off. Anal. Chem. Washington, DC, USA.
13. Page A. L., R. H. Miller and D. R. Keeny. 1982. Methods of soil analysis, Part II. American Soc. Agron. Inc. and Soil Sci. Soc. of America Inc., Madison, USA.
14. Meena M. C., K. P. Patil and D. D. Rathod. 2006. Effect of Zn and Fe enriched FYM on mustard yield and micronutrient availability in loamy soil (Typic Hapludtept) of Anand. J. Indian Soc. Soil Sci. 54 : 495—499.
15. Tandon H. L. S. 1991. Sulfur research and agricultural production in India, 3rd edition. Fertilizer development and consultation organization, New Delhi, India.
16. Patil J. D., P. H. Shinde, D. A. More and G. K. Zende. 1981. Effect of the application of boron, sulfur and FYM on the yield and quality of groundnut. J. Maharastra Agric. Univ. 6 : 17–18.