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Effect of boron on yield and economics of groundnut in boron-deficient soil series (Typic Rhodustalf) of Madurai district, Tamil Nadu

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ABSTRACT

Boron is the yield-limiting factor for groundnut production in sandy loam soils of Madurai district, Tamil Nadu. Therefore a field experiment was conducted to evaluate the effect of boron on yield and economics of groundnut in boron-deficient soil series (Typic Rhodustalf) of the district at the farmer's field located at Alangampatti village of Melur block during Sep-Dec 2017 in a randomized block design with three replications. Twelve treatments were included and the results revealed that the application of 15 kg/ha of B as soil application and 0.5 per cent of B as foliar application at critical stages of crop growth along with the recommended dose of fertilizers (RDF) resulted in maximum pod and haulm yield (2013 and 3017 kg/ha respectively). Regarding the economics the application of soil (15 kg/ha) and foliar B (0.5%) along with RDF recorded the highest net return (Rs 67165) and B-C ratio (2.5) over no-boron application.

Keywords: Boron; groundnut; fertilizers; soil; foliar application; yield; economics

INTRODUCTION

Groundnut is one of the most important food and oilseed crops cultivated and consumed in most parts of the world. It is widely accepted as an excellent source of nutrition to both human and animals due to its high protein content. It is grown on nearly 23.95 Mha worldwide with the total production of 36.45 MT with an average yield of 1520 kg/ha (Anon 2012). Presently the average productivity of groundnut in India is around 1100 kg/ha which is very low as compared to USA and China.

In India Gujarat, Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu states contribute about 90 per cent of the groundnut production and of these Gujarat, Tamil Nadu and Maharashtra have the major areas producing export quality groundnut. However due to deficiency of boron there is poor seed filling and hence low quality produce is obtained from these areas (Singh et al 2004). Thus looking to the export market which requires high quality and well-filled seed it is essential that these aspects be looked into carefully.

Boron deficiency is one of the major constraints to crop production (Sillanpaa 1982). Its deficiency has been realized as the second most important micronutrient constraint in crops after that of zinc on global scale (Ahmad et al 2012). Boron has emerged as an important micronutrient in Indian agriculture in the context of the spread of its deficiency (Sathya et al 2009). Boron deficiency is the important factor responsible for low yield in the cultivars with large seeds (Singh et al 2007). In B-deficient acid soils (below 0.4 ppm available B) low pod filling, shriveled seeds and hollow darkening or off-colour in the center of the seed are commonly observed symptoms causing 10-50 per cent yield losses (Singh et al 2007). There are only few reports on B nutrition of groundnut in India. Soil parent material and texture are considered to be the major soil factors associated with the occurrence of B deficiency that can readily be prevented and corrected by soil and foliar applications (Shorrocks 1997). Thus a field experiment was conducted to find out the effect of B nutrition on yield and economics of groundnut in B-deficient soil series of Madurai district, Tamil Nadu.

MATERIAL and METHODS

The field experiment was carried out to understand the response of boron on yield and economics of groundnut at farmer's field located at Alangampatti village of Melur block, Madurai district, Tamil Nadu during Sep-Dec on 2017. The experimental soil fell under Vylogam soil series with the taxonomical class of Typic Rhodustalf. The details of soil initial properties are given in Table.1.

Twelve treatments were replicated thrice in randomized block design with groundnut var TMV 13 as a test crop. The treatments applied were T_1: Recommended dose of fertilizers (RDF), T_2: RDF + 10 kg borax/ha, T_3: RDF + 15 kg borax/ha, T_4: RDF + 20 kg borax/ha, T_5: RDF + 0.25 per cent foliar spray of borax, T_6: RDF + 10 kg borax/ha + 0.25 per cent foliar spray of borax, T_7: RDF + 15 kg borax/ha + 0.25 per cent foliar spray of borax, T_8: RDF + 20 kg borax/ha + 0.25 per cent foliar spray of borax, T_9: RDF + 0.5 per cent foliar spray of borax, T_{10}: RDF + 10 kg borax/ha + 0.5% foliar spray of borax, T_{11}: RDF + 15 kg borax/ ha + 0.5 per cent foliar spray of borax, T_{12}: RDF + 20 kg borax/ha + 0.5 per cent foliar spray of borax. Foliar spray was given at critical stages of crop growth. The RDF of N, P and K were given as N, P_2O_5 and K_2O @ 25:50:75 kg/ha.

From each plot five plants were selected randomly, tagged and desired parameters were observed. The yield data were recorded at physiological maturity stage and after the harvest of the crop. The yield obtained in the study was subjected to statistical scrutiny by analysis of variance (ANOVA) as outlined by Panse and Sukhatme (1967). The net return was worked out for all the treatment combinations. The prevailing cost of inputs, labour charges and market rates of farm produce were taken into consideration for working out the economics. Cost-benefit analysis was worked out using the following formula:

Net income= Gross income – Total cost of cultivation

B-C ratio= Gross return (Rs)/Total cost of cultivation (Rs)

RESULTS and DISCUSSION

The maximum pod yield of 2013 kg/ha was recorded in RDF + 15 kg B as soil application along with 0.5 per cent foliar application of B at critical stages of crop growth (T_{11}) and the minimum 1251 kg/ha was recorded in control (T_1). The maximum haulm yield of 3017 kg/ha was also recorded in the treatment T_{11}. Proper fertilization at early stages with NPK and B could be the reason for increasing the yield by different mechanisms. The improved nutritional management as a result of the increased supply of B and other nutrients might have influenced the chlorophyll, photosynthetic process and enzyme activity as well as grain formation. These are also involved in carbohydrate metabolism which increases the uptake of nutrients that ultimately results in increasing the yield. The results are in conformity with those of Tripathi and Hazra (2003). The carbohydrate metabolism may be an additional reason through the increased transformation of photosynthesis towards yield. The results are supported by the findings of Pandian and Annadurai (2005).

Table 1. Initial properties of the of experimental soil

Parameter	Type/value
Physical properties	
Texture	Sandy loam
Physico-chemical properties	
Soil reaction (pH)	7.22
Electrical conductivity (dS/m)	0.31
CEC [c mol (p+)/kg]	11.3
Chemical properties	
Organic carbon (g/kg)	1.63
Available nitrogen (kg/ha)	213
Available phosphorus (kg/ha)	11.4
Available potassium (kg/ha)	273
Available sulphur (mg/kg)	8.4
Exchangeable Ca [c mol (p+)/ kg]	3.21
Exchangeable Mg [c mol (p+)/ kg]	1.63
Available B (mg/kg)	0.34
Soil series	Vylogam
Taxonomical class	Typic Rhodustalf

When B was applied aerially substantial amount of it must have been transported to the reproductive organs thus developing the pods and increasing the pod and haulm yield subsequently. These results are supported by the early reports of Campbell et al (1975). On the other hand the increase in yield was due to the higher number of filled pods and least number of unfilled pods due to B application. The cumulative reduction in yield and growth attributes in control could be due to no B application. Nayak et al (2009) also reported that groundnut significantly responded to B application than recommended NPK dose alone. Hence B is essential to improve the productivity of groundnut. The steady rate of B release into soil solution may be attributed to B application through soil to match the required absorption pattern of groundnut thus resulting in increased yield. This

Table 2. Effect of treatments on yield and economics of groundnut (TMV 13)

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Cost of cultivation (Rs)	Gross return (Rs)	Net return (Rs)	B-C ratio
T_1	1251	1967	31518	55055	23537	1.7
T_2	1275	2259	39518	70125	30607	1.8
T_3	1349	2293	43518	74199	30681	1.7
T_4	1392	2284	47518	76560	29042	1.6
T_5	1089	2157	31534	59881	28347	1.9
T_6	1479	2488	39534	81326	41792	2.1
T_7	1503	2506	43534	82665	39131	1.9
T_8	1461	2491	47534	80355	32821	1.7
T_9	1121	2198	31550	61651	30101	2.0
T_{10}	1653	2789	39550	90915	51365	2.3
T_{11}	2013	3017	43550	110715	67165	2.5
T_{12}	1725	2854	47550	94875	47325	2.0
Mean	1443	2442	-	-	-	-
SEd	35.5	50.5	-	-	-	-
$CD_{0.05}$	73.6	104.7	-	-	-	-

T_1: Recommended dose of fertilizers (RDF), T_2: RDF + 10 kg borax/ha, T_3: RDF + 15 kg borax/ha, T_4: RDF + 20 kg borax/ha, T_5: RDF + 0.25 per cent foliar spray of borax, T_6: RDF + 10 kg borax/ha + 0.25 per cent foliar spray of borax, T_7: RDF + 15 kg borax/ha + 0.25 per cent foliar spray of borax, T_8: RDF + 20 kg borax/ha + 0.25 per cent foliar spray of borax, T_9: RDF + 0.5 per cent foliar spray of borax, T_{10}: RDF + 10 kg borax/ha + 0.5% foliar spray of borax, T_{11}: RDF + 15 kg borax/ha + 0.5 per cent foliar spray of borax, T_{12}: RDF + 20 kg borax/ha + 0.5 per cent foliar spray of borax

corroborates the earlier report of Subramaniyan et al (2001).

The economics of groundnut varied due to application of boron when compared with its control. B application @ 15 kg/ha as soil application and 0.5 per cent foliar application along with RDF (T_{11}) on an average fetched Rs 67165 of net return and thus had higher B-C ratio (2.5) over no boron application. The higher groundnut productivity coupled with the corresponding haulm yield and with increase in cost of cultivation resulted in higher net return and B-C ratio in B as soil and foliar application treatment. B application increased mean groundnut productivity over no application of boron.

Similar results were reported by Chitdeswari and Poongothai (2003). Due to lower availability of B in soils the B uptake in plants might have reduced which in turn resulted in reduction of yield. Therefore the application of B as soil and foliar spray paved the way to enhance B uptake in plants in B-deficient soils. These results are in accordance with the work of Singh (2003).

The value cost ratio (VCR) indicated that by spending one rupee on B fertilizers, crop yield increase was Rs 5 to 20 (average Rs 16) in cotton (Anon 1998). Use of B and Zn fertilizers proved highly profitable and benefit-cost ratio being 15:1 for soil application and 30:1 for foliar spray (Rashid and Akhtar 2006). Similarly Anon (1998) indicated that by spending one rupee on B fertilizer, crop yield increase was Rs 11 in groundnut. Quddus et al (2011) reported the maximum net benefit of mungbean obtained from the treatment where boron was applied.

CONCLUSION

Groundnut is a short duration crop; the crop source and sink develop together so top dressing and soil application plays a vital role in improving the crop productivity. Foliar spray of B seems to represent an easily applicable strategy to enhance the groundnut growth and productivity by enhancing soil and foliar B along with certain nutrients. In the present study B as soil and foliar application along with RDF had a synergistic effect on the yield of groundnut. Thus results of the present investigations demonstrate that boron as soil application @ 15 kg/ha along with 0.5 per cent as foliar spray can be applied to achieve better land utilization, high yield as well as productivity and profitability than other treatments under sandy loam soils of Madurai district, Tamil Nadu.

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