Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 8 [10] September 2019 : 76-80

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Effect of soil and foliar applied boron on soil available boron, yield and quality of groundnut in Alfisols of Madurai District, Tamil Nadu

R. Susan Poonguzhali*, P. Saravana Pandian[2], R. Angelin Silviya[3]
*Assistant Professor, Karunya Institute of Technology and Sciences, Coimbatore
2. Professor (SS&AC), Department of S&E,AC&RI,Madurai
3. Assistant Professor (SS&AC), Department of Agriculture, SRM University, Chennai
Corresponding author email ID*: r.susanpoonguzhali@gmail.com

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 study the effect of boron on availability of boron in soils, yield and quality of groundnut in boron-deficient soil series of the Madurai district at the farmer's field located at Alangampatti village of Melur block 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). Regarding the quality the application of soil (15 kg/ha) and foliar B (0.5%) along with RDF recorded the highest oil and protein content as compared to the other treatments.
Keywords: Boron; groundnut; fertilizers; soil; foliar; availability; yield; quality

Received 21.07.2019 Revised 19.08.2019 Accepted 01.09. 2019

INTRODUCTION

India is one of the major producers of oilseeds across world and occupies an important position in the Indian Agricultural Economy. Among oilseeds, groundnut is called as the "King of oilseeds", it is one of the most important food and cash crops of our country. The growth rate of oilseed crops in terms of production was much higher after 1980's with the introduction of technology mission in oilseeds (TMO) in 1986 and it brought the new term "yellow revolution" in India, particularly for the oilseed crops [12]. In world scenario, India occupies first position in the area (7.5 m ha) but ranks second in production (6 m t yr^{-1}) of groundnut.

In order to meet the edible oil need of our ever increasing population, the groundnut production in India should be increased from the present level of 29.75 to 55 m t by 2020 A.D. The demand for groundnut oil is growing at the rate of six per cent per annum in India. This shows that, there is an urgent need to step up oil seed production on sustainable basis. The optimization of mineral nutrition is the key to optimize the groundnut production. The nutritional disorder causes yield reduction of groundnut from 30 to 70 per cent so it is high time to look into the nutrition aspects of groundnut for achieving higher yield. Among all the essential nutrients, boron influences the growth of groundnut through arresting the flower drop and also involves in the synthesis of carbohydrate and fats. Adequate boron application will enhance the groundnut growth, yield and quality. As B is the only non-metal element which is highly mobile in soils and immobile in plants this makes the element insufficient to crop throughout its life cycle, this shows that the application of B at critical stages of crop growth is crucial for groundnut crop. Keeping all this in view, the study has been focused on improving the availability of B, yield and quality through soil and foliar application boron.

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 below.

A field experiment was conducted in the Alfisol soil order (Vylogam soil series) with the area coverage of 50 cents. Twelve treatments were randomized and followed the randomized block design in the experimental plots. The beds and channels were formed at 30 cm interval and the seeds were sown. There were twelve treatments replicated thrice with the plot size of 20 m^2. The treatment details are as follows

T_1	RDF
T_2	RDF+10 kg Borax ha^{-1}
T_3	RDF+15 kg Borax ha^{-1}
T_4	RDF+20 kg Borax ha^{-1}
T_5	T_1 + 0.25% foliar spray of Borax
T_6	T_2 +0.25% foliar spray of Borax
T_7	T_3 + 0.25% foliar spray of Borax
T_8	T_4 + 0.25% foliar spray of Borax
T_9	T_1 + 0.5% foliar spray of Borax
T_{10}	T_2 + 0.5% foliar spray of Borax
T_{11}	T_3 + 0.5% foliar spray of Borax
T_{12}	T_4 + 0.5% foliar spray of Borax

(Foliar spray will be given at critical stages of crop growth)

Recommended dose of N, P_2O_5, K_2O @ 25:50:75 kg ha^{-1} as Urea, DAP and MOP were applied. N and K was given in three splits *viz.,* 50 per cent of N and K as basal + 25 per cent N and K at 20 DAS + 25 per cent N and K at 45 DAS, whereas P was completely given as basal according to the treatment schedule. Gypsum was applied @ 400 kg ha^{-1} in two splits before sowing and on 45th day after flowering. Foliar application of 0.25 and 0.5 per cent borax were applied to the selected plots as per the treatment schedule at 45 and 75 DAS of crop growth. The pods collected from the net plot area of different treatments were dried, threshed and after drying grain yield was recorded at 12 per cent moisture from each plot and expressed as kg ha^{-1}.The shells were removed completely and sun dried to a constant weight and then oven dried at 70˚ C and the plot wise yield recorded and expressed in kg ha^{-1}.

Regarding the quality, to determine the oil content, the oil was extracted from seeds of groundnut of each plot with the help of Soxhlet apparatus using hexane as a solvent.

The per cent of oil present in a sample was calculated with the help of following formula:

$$\text{Oil content (\%)} = \frac{W_2 - W_1}{W} X100$$

Where,

W_1 = Initial weight of beaker

W_2 = Final weight of beaker (beaker + oil)

W = Weight of powdered sample (1g)

Protein content in seed of groundnut was computed by multiplying per cent seed nitrogen with a factor of 6.25 [1].

RESULTS AND DISCUSSION

Soil B

A clear and significant relationship between applied B and soil B was observed in the treatment on application of different doses of borax along with RDF. As the initial status of available of B was low, the application of B at various levels enhanced the soil B status. As the dosage increased, the available B content in the soil was also increased. The boron applied to the soil would have been dissociated to soluble boric acid form which would have increased the boron availability in soil. The content of boron in plant is also conspicuously high for the above treatments. Therefore, after meeting the requirement of the crop, the added boron might have helped to increase the boron status of the soil [10].Increase in boron availability as a result of boron application was also reported by several workers [2].

Increase in B concentration in soil may also be due to the boron concentration in the soil solution is generally controlled by boron adsorption reaction and this could directly increase the water-soluble boron content which is available for plant growth [5]. The boron addition through fertilizers under the non- calcareous nature of experimental site might have contributed towards less adsorption and in turn increased the available boron in soil [7] whereas in calcareous soil, the excess amount of application of B can meet out the adsorption of borate by Ca^{2+} and $CaCO_3$ requirement of B for plant and increasing the B

uptake in plants, these trend were in accordance with the treatment received with 15 and 20 kg ha^{-1} of borax.

Pod and Haulm yield

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 [11]. The carbohydrate metabolism may be an additional reason through the increased transformation of photosynthesis towards yield [9].

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 [10]. 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.

Quality parameters

The oil and crude protein content of the groundnut crop grown in the soils of Vylogam soil series is an important finding in understanding the significance of boron in enhancing the quality parameters of the groundnut crop. The application of 15 kg ha^{-1} of borax as soil application and 0.5 per cent as foliar application of borax along with RDF recorded the highest oil and crude protein content in the soil series with the values of 50.6 per cent oil content 15.0 per cent of crude protein content in the soils of Vylogam soil series.

The boron deficiency in plant causes internal tissue disintegration, causing abnormalities such as aborted pollen grains, distorted seed set, poor pod filling capacity, hallow heart symptoms in the pods and shriveled seeds, these are the major causes for the yield and quality reduction in the crops [8]. As boron have a significant effect on plant physiology and is involved in biochemical process, the application of borax as soil and foliar application played a vital role firstly in alleviating the shriveled and hallow heart symptoms in groundnut which helped in the enhancement of regular metabolic process, secondly the foliar application of B was found to be more effective on enhanced oil and protein content, this might be due to the effective absorption of B through leaves leading to biochemical process like synthesis of lipids and proteins [3]. Accordingly other workers have reported that, the insufficiency of B to plants will cause infertility of flowers, premature pods which makes it unfit for oil production, when B is applied in the critical stages, the flower bloom and pod viability increases, and after the pollination and seed set, the protein is formed and thereafter oil synthesis starts [10]. Boron also have a positive role on the enhancement of oil content perhaps due to the indirect effect on the synthesis of fat [4]. The above said reasons might be the causes for the increased oil and protein content in the treatments received with soil and foliar applied borax.

In line, the increment in crude protein content might be due to the application of boron which could have influenced the protein and nucleic acid metabolism, maintaining the structural integrity of the plant and protects plasma membrane from external damage. It helps in sugar transport, division and elongation of cell, involve in transport of auxin and metabolism in roots and improve ATPase activity thereby increasing the oil and protein content of oilseeds [6].

Further, B plays a key role in nitrogen metabolism, protein synthesis which will stimulate the activity of RNA synthase and reduce the activity of RNA-ase and thereby contributing to protein synthesis, influence the nucleic acid and protein metabolism, cell development and differentiation, membrane permeability and transport of substances. Foliar B can alter the seed composition, by increasing protein and oil content and decreasing linoleic and linolenic acid (unsaturated fatty acids) which would be the ultimate cause for the increased quality parameters of groundnut grain in the B deficient soils of Vylogam soil series.

Table 1. Initial properties of the of experimental soil

A.PHYSICAL PROPERTIES	
Texture	Sandy loam
B. PHYSICO CHEMICAL PROPERTIES	
Soil reaction (pH)	7.22
Electrical Conductivity (dSm^{-1})	0.31
CEC (c mol (p+) kg^{-1})	11.3
C. CHEMICAL PROPERTIES	
Organic Carbon (g kg^{-1})	1.63
Available Nitrogen (kg ha^{-1})	213
Available Phosphorus (kg ha^{-1})	11.4
Available Potassium (kg ha^{-1})	273
Available sulphur (mg $kg^{-1)}$	8.4
Exchangeable Ca (c mol(p+) kg^{-1})	3.21
Exchangeable Mg (c mol(p+) kg^{-1})	1.63
Available B (mg kg^{-1})	0.34
D. SOIL SERIES	Vylogam
E. TAXONOMICAL CLASS	*Typic Rhodustalf*

Table 2. Effect of boron on available B (mg kg^{-1}) status of soil at different growth stages of groundnut in two different soil series

Treatment	Vylogam		
	45 Days after sowing	**75 Days after sowing**	**Harvest Stage**
T_1	0.27	0.24	0.23
T_2	0.62	0.28	0.59
T_3	0.67	0.3	0.66
T_4	0.79	0.73	0.72
T_5	0.68	0.26	0.25
T_6	0.67	0.63	0.6
T_7	0.71	0.69	0.66
T_8	0.98	0.75	0.73
T_9	0.76	0.27	0.26
T_{10}	0.74	0.66	0.62
T_{11}	0.72	0.61	0.55
T_{12}	0.81	0.75	0.71
SEd	**0.04**	**0.07**	**0.08**
CD(P=0.05)	**0.08**	**0.12**	**0.14**

Table 3. Effect of boron on pod and haulm yield (kg ha^{-1}) of groundnut in two different soil series

Treatment	Vylogam	
	Pod yield (kg ha^{-1})	**Haulm yield (kg ha^{-1})**
T_1	1051	1967
T_2	1275	2259
T_3	1392	2293
T_4	1349	2284
T_5	1089	2157
T_6	1479	2488
T_7	1503	2506
T_8	1461	2491
T_9	1121	2198
T_{10}	1653	2789
T_{11}	2013	3017
T_{12}	1725	2854
SEd	**37.5**	**50.5**
CD(P=0.05)	**77.8**	**104.7**

Table 4. Effect of boron quality parameters of groundnut in two different soil series

Treatment	Vylogam	
	Oil content (%)	Crude protein (%)
T_1	47.3	13.1
T_2	48.3	13.9
T_3	48.6	14.1
T_4	48.4	14.0
T_5	47.5	13.2
T_6	48.7	14.2
T_7	48.9	14.4
T_8	48.6	14.3
T_9	47.7	13.4
T_{10}	49.1	14.4
T_{11}	50.6	15.0
T_{12}	49.3	14.7
SEd	**0.65**	**0.15**
CD(P=0.05)	**1.30**	**0.30**

CONCLUSION

A groundnut is a short duration crop, the crop source and sink develops 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. The present study indicated that B as soil and foliar application along with RDF have a synergistic effect on the soil available boron and yield of groundnut. It also has a positive role in improving the quality parameters. Hence it is recommended that along with RDF 15 kg B ha^{-1} as soil application and 0.5% B as foliar spray at critical stages of crop growth can boost up the crop yield and quality of groundnut in the sandy loam soils of Madurai region. Added to it, the availability of soil B is also increased with the increased application of B, hence the supply of B is stabilized through the soil and foliar application which ultimately will help in augmenting the groundnut yield as well as quality and in turn will help in alleviating the global problem of micronutrient malnutrition especially B deficiency in soil-plant-animal-human continuum.

REFERENCES

1. A.O.A.C. (1980). Official methods of analysis, 13th ed. Association of official Oil Analytical chemists. Washington D.C. pp.376-384.
2. Chaudhury, S. G., and Debnath, A. (2008). Effect of liming on retention and availability of boron in Entisol and Alfisol. *Journal of the Indian Society of Soil Science, 56*(1), 64-70.
3. Cheniae, G., & Martin, I. (1970). Sites of function of manganese within photosystem II. Roles in O_2 evolution and system II. *Biochimica et Biophysica Acta (BBA)-Bioenergetics, 197*(2), 219-239.
4. Gaina, R., &Silli, E. (1973). Copper and boron on some physiological in corn plant. *Stud. Cerect. Biol.Ser. Bot, 25*, 151-158.
5. Goldberg, S. (1997). Reactions of boron with soils. *Plant and soil, 193*(1-2), 35-48.
6. Gupta, S., Singh, M., & Dixit, M. (2007). Deficiency and management of micronutrients. *Indian Journal of Fertilisers, 3*(5), 57.
7. Janaki, D. (2001). Studies on the use of agribor as a source of boron for grapes. *M. Sc.(Agri.) Thesis*.
8. Josten, P., &Kutschera, U. (1999). The micronutrient boron causes the development of adventitious roots in sunflower cuttings. *Annals of Botany, 84*(3), 337-342.
9. Pandian SP and Annadurai K 2005. Studies on the interaction effect of phosphorus and sulphur on gingely in Typic Ustochrept. Madras Agricultural Journal **92:** 449-455.
10. Sathya, S., Pitchai, G. J., &Indirani, R. (2009). Quality- A Review. *30*(2), 139-144.
11. Tripathi SB and Hazra CR 2003. Sulphur requirement of groundnut (*Arachis hypogaea*) under wheat (*Triticum aestivum*)-based cropping system. Indian Journal of Agricultural Sciences **73(7):** 368-372.
12. Veeramani, P., Subrahmaniyan, K., &Ganesaraja, V. (2012). Organic manure management on groundnut; A review. *Wudpecker Journal of Agricultural Research, 1*(7), 238-243.

CITATION OF THIS ARTICLE

R. Susan Poonguzhali, P. Saravana Pandian, R. Angelin Silviya. Effect of soil and foliar applied boron on soil available boron, yield and quality of groundnut in Alfisols of Madurai District, Tamil Nadu. Bull. Env. Pharmacol. Life Sci., Vol 8 [10] September 2019: 76-80