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IMPACT OF DIFFERENT BORON LEVELS ON YIELD IN GROUNDNUT VARIETIES

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Abstract

An experiment was carried out to study the effect of different levels of boron (B) on yield of three bold seeded groundnut cultivars *viz*., Binachinabadam-1, Binachinabadam-2 and Binachinabadam-3. Plants were grown in sand using nutrient solution in the pots. The experiment comprised six levels of boron *viz*., 0, 1.5, 2.0, 2.5, 3.0 and 3.5 kg ha^{-1}. Results indicated that physiological parameters, reproductive characters, yield attributes and pod yield increased with increasing levels of boron application till 2.5 kg B ha^{-1}. The highest total dry matter (14.02 g $plant^{-1}$), number of opened flowers (44.07 $plant^{-1}$) and reproductive efficiency (46.53%) were recorded in 2.5 kg ha^{-1} and the lowest was recorded in 3.5 kg B ha^{-1} except reproductive efficiency. The highest number of pods $plant^{-1}$ (20.67), single pod weight (832 mg) and pod weight $plant^{-1}$ (17.09 g) was observed in 2.5 kg B ha^{-1} application followed by 2.0 kg B ha^{-1}. In contrast, application of B @ 3.5 kg ha^{-1} showed the lowest number of pods (8.60) and pod yield (6.94 g). Among the varieties, Binachinabadam-1 produced the highest pod yield (12.81 g $plant^{-1}$).

Keyword: Boron level, Physiological parameters, yield, groundnut

Introduction

Peanut (*Arachis hypogaea* L.) is an important legume crop used as oilseed as well as a food crop in Bangladesh and grown in all soil types, under tropical to subtropical climates. Groundnut seed is nutritionally rich due to presence of lipids, proteins, essential minerals, vitamins, phytosterols and phytochemicals. Moreover, it fixes atmospheric nitrogen in the soil through its nodule bacteria which enriches the soil with nitrogen (49-297 kg N ha^{-1} $season^{-1}$), reduces the uses of synthetic fertilizer and keeps the environment more friendly (Hoque, 1989).

Farmers of Bangladesh are mostly habituated with the use of macro-nutrients, especially nitrogen, phosphorus, sulphur and potassium for crop production but in case of micro-nutrients is limited. Boron (B) as a micronutrient plays an important role in the physiological process of plants, such as cell division, nitrogen and carbohydrate metabolism and water relation in plant growth (Ansari *et al.,* 2014). The need for B application in groundnut is therefore, to increase the growth, development and at the same time to increase the yield of crops. The application of B also promotes the absorption of N by groundnut and increases the plant height, plant dry weight and the total number of pods (Ahmad *et al.,*

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2011). Boron have important role on pollination, fruit set and total yield (Mondal *et al.,* 2016) which may have positive impact on increases the pod size, number of pods plant^{-1} and yield of oil seed crops (Newaz *et al.,* 2014).

Plant boron requirements of various peanut genotypes vary greatly and genotypes of the same plant species demonstrate a variable response to a specific nutrient supply deficiency (Rerkasem and Jamjod, 2004). Addition of boron (2 ppm) in groundnut increased the yield by 18 per cent and improved the quality through suitable changes in yield attributes (Ansari *et al.,* 2014). BINA has developed three bold seeded high yielding varieties (Binachinabadam-1, Binachinabadam-2 and Binachinabaadam-3) which need to determine B requirement for maximizing pod yield in sandy or sandy loam soil. Therefore, an attempt was made to study the response of bold seeded groundnut genotypes to boron in presence of N, P, K, and S.

Materials and Methods

The experiment was carried out at pot yard, Bangladesh Institute of Nuclear Agriculture, Mymensingh in pot culture condition in sands with three varieties of peanut viz., Binachinabadam-1, Binachinabadam-2 and Binachinabadam-3, bold seeded varieties. Each pots contained 10.0 kg sands. The pots were arranged in a completely randomized design with five replicates. Long Aston complete nutrient solution (-N) in ½ strength was provided in each pot in a week after germination of seeds (Hewitt, 1966). Plants were provided with adequate supply of distilled water when needed. Two plants were allowed to grow in each pot. The six levels of boron treatments were 25, 100, 125, 150 and 175 mg pot^{-1} corresponding to 0.5, 2.0, 2.5, 3.0 and 3.5 kg ha^{-1}. Seeds were sown on 29 November, 2014. Intercultural operations were done as and when necessary for normal plant growth and development.

In each plant, flower count began from the date of opening of first flower and continued at every day until flowering ceased. Total flower production and flowering duration were later calculated from the collected data. Per cent pod set to opened flowers (reproductive efficiency, RE) was then estimated as: % pod set = (Number of pod plant^{-1} ÷ Number of opened flowers plant^{-1}) × 100 (Fakir *et al.,* 2011). Leaf Chlorophyll was determined at 70 DAS following the method of Yoshida *et al*. (1976). Total sugar was determined at 70 DAS following the method of Badruddin (2005). Nitrate reductase activity was determined at 75 DAS following the methods of Stewart and Orebamjo (1979). At harvest, the morphological and yield contributing characters were recorded. The total dry matter was calculated from summation of leaves, stem, root and siliqua dry weight per plant. The collected data were analyzed statistically (two factors CRD) to obtain the level of significance following the analysis of variance (ANOVA) technique and the mean differences were compared by Duncan's Multiple Range Test (DMRT) using the statistical computer package programme, MSTAT (Russell, 1986).

Results and Discussion

The effect of different doses of boron on chlorophyll content, total sugar content and nitrate reductase activity in leaves was significant (Table 1). Results showed that chlorophyll and sugar content in leaves, nitrate reductase activity in leaves, total dry mass (TDM), number of flowers and percent pods to opened flowers (Reproductive efficiency, RE) increased with increasing B level till 2.5 kg ha^{-1} followed by a decline. The highest chlorophyll (1.80 mg g^{-1} fw), total sugar (82.3 mg g^{-1} fw), nitrate reductase (0.43 µmol NO_2-g^{-1} fw), TDM $plant^{-1}$ (14.02 g), number of opened flowers $plant^{-1}$ (44.07) and RE (46.53%) was recorded in 2.5 kg ha^{-1} whereas the lowest value was recorded in 3.5 kg B ha^{-1} except RE. The increases in total dry weight due to B application may be attributable to the fact that B is known to help in absorption of N and P that help in development of more extensive root system (Newaz *et al*., 2014) and nodulation, and thus enables plants to absorb more water and nutrients from depth of the soil. This in turn could enhance the plant's ability to produce more assimilates which were reflected in the high dry weight. The lowest RE was observed in control plant (25.15%) indicating B has tremendous effect on percent pod setting in groundnut. Boron plays an important role in retaining flowering and fruit setting in pulses (Ansari *et al*., 2014). In the present experimental results, boron added plants showed higher RE than control plants indicating boron added groundnut plant has more capability to retain pods than control plant (where no boron was added). Varietal variation was also observed in chlorophyll, nitrate reductase, TDM and flower production and RE except total sugar content in leaves. The highest chlorophyll content in leaves (1.71 mg g^{-1} fw) and TDM (11.62g $plant^{-1}$) was recorded in Binachinabadam-2 while the highest flower numbers (35.58 $plant^{-1}$) and RE (42.54 %) were observed in Binachinabadam-1.

Table 1. Effect of boron on physiological parameters and reproductive characters in groundnut varieties

Treatments	Physiological parameters				Reproductive characters	
	Chlorophyll (mg g^{-1} fw)	Total sugar (mg g^{-1} fw)	Nitrate reductase (µmol NO_2-g^{-1} fw)	Total dry mass $plant^{-1}$ (g)	Flowers $plant^{-1}$ (no.)	Percent pods to opened flowers
Doses of boron (kg ha^{-1})						
0	1.66 bc	71.2 bc	0.28 c	13.04 e	26.5 d	25.2 f
1.5	1.70 b	80.0 a	0.34 b	16.03 d	34.0 c	37.4 cd
2.0	1.78 ab	80.5 a	0.40 a	18.39 c	40.3 b	39.8 c
2.5	1.80 a	82.3 a	0.43 a	21.03 a	44.1 a	46.5 a
3.0	1.82 a	79.6 b	0.44 a	20.02 b	35.7 c	43.4 ab
3.5	1.56 c	67.0 c	0.30 c	11.75 f	24.7 d	35.0 e
F-test	**	**	**	**	**	**
Varieties						
Binachinabadam-1	1.69 a	75.9	35.5 a	16.01 b	35.6 a	42.5 a
Binachinabadam-2	1.71 a	76.1	34.4 ab	17.42 a	34.8 a	38.5 b
Binachinabadam-3	1.52 b	75.0	32.9 b	16.69 ab	32.3 b	32.6 c
F-test	**	NS	*	*	*	**
CV (%)	4.93	8.67	5.98	4.73	6.92	6.52

In a column, within treatment, same figure (s) indicates do not differ significantly at P # 0.05 by DMRT

For yield attributes and yield, results indicated that number of pods, single pod weight, pod yield and harvest index increasing levels of boron application till 2.5 kg B ha^{-1} followed by a decline (Table 2). The highest number of pods plant^{-1} (20.67), single pod weight (832 mg), pod weight plant^{-1} (16.09 g) and harvest index (43.35%) was observed in 2.5 kg B ha^{-1}. In contrast, application of B @ 3.5 kg ha^{-1} showed the lowest number of pods and pod yield (8.60 pods plant^{-1} and 6.94 g plant^{-1}, respectively). Among the varieties, Binachinabadam-1 produced the highest number of pods (15.92 plant^{-1}), resulting the highest pod yield (12.81 g plant^{-1}) and Binachinabadam-3 showed the lowest pod yield (9.54 g plant^{-1}) due to production of fewer numbers of pods.

Table 2. Effect of boron on yield attributes and yield in groundnut varieties

Treatments	Number of pods plant^{-1}	Single pod weight (mg)	Pod weight plant^{-1} (g)
Doses of boron (kg ha^{-1})			
0	9.61 d	782 b	7.15 d
1.5	12.75 c	810 a	10.55 c
2.0	16.10 b	825 a	14.06 b
2.5	20.67 a	832 a	16.09 a
3.0	15.58 b	833 a	13.00 b
3.5	8.60 e	813 a	6.94 d
F-test	**	**	**
Variety			
Binachinabadam-1	15.92	804 b	12.81 a
Binachinabadam-2	14.42	808 b	11.55 b
Binachinabadam-3	11.31	835 a	9.54 c
F-test	**	*	**
CV (%)	7.04	2.92	6.50

In a column, within treatment, same figure (s) indicates do not differ significantly at P # 0.05 by DMRT

Interaction effect between variety and boron dose on number of pods, harvest index and pod yield plant^{-1} was significant but non-significant in pod size (single pod weight) (Table-3). The higher number of pods, harvest index and pod yield was observed at 2.5 kg B ha^{-1} with Binachinabadam-1 and Binachinabadam-2 being the highest in BINA chinabadam-1 × 2.5 kg B ha^{-1} (25.50 plant^{-1} and 20.78 g plant^{-1}, respectively). Binachinabadam-3 showed the highest pod yield under 3.0 kg B ha^{-1}. Control plants showed the lowest pod yield due to production of less number of pods and smaller pod size. Both absolute boron deficient and luxurious condition, grey colour in the leaf edges was observed and the plants became stunted (visual observation, not shown in Table). Many researchers reported increased yield of different crops with application of boron (Singh, 2001; Shankhe *et al,* 2003; Singh *et al*., 2014) that supported the present results. However from the results, it is clearly brought out the need and the benefit of application of boron for improving groundnut production in Bangladesh.

Table 3. Interaction effect between varieties and doses of boron on yield attributes and yield in groundnut varieties.

Treatments		Number of pods plant^{-1}	Single pod weight (mg)	Pod weight plant^{-1} (g)	Harvest index (%)
Varieties	Doses				
	0	10.25 i	770	7.50 g	37.04 f
	1.5	12.50 fgh	800	10.19 ef	41.95 d
	2.0	15.80 d	815	15.88 c	48.19 ab
Binachinabadam-1	2.5	25.50 a	817	19.78 a	49.67 a
	3.0	19.00 c	820	15.49 c	45.48 b
	3.5	12.50 fgh	800	10.00 ef	41.81 d
	0	11.25 ghi	780	7.95 g	35.30 f
	1.5	15.00 de	801	12.25 d	40.78 de
	2.0	18.75 c	817	15.32 c	43.90 c
Binachinabadam-2	2.5	21.25 b	820	16.36 b	42.94 cd
	3.0	13.00 fg	823	10.62 e	49.26 a
	3.5	7.30 j	810	5.77 h	36.78 f
	0	7.33 j	795	6.01 h	33.78 g
	1.5	10.75 hi	828	9.22 f	36.24 f
	2.0	13.75 ef	842	10.97 e	37.21 f
Binachinabadam-3	2.5	15.25 de	858	12.12 d	35.85 f
	3.0	14.75 de	860	12.90 d	38.56 e
	3.5	6.00 j	825	5.04 h	30.68 h
F-test		*	NS	*	**
CV (%)		7.04	2.92	6.50	7.88

In a column, same figure (s) indicates do not differ significantly at P # 0.05 by DMRT

Conclusion

Application of B @ 2-2.5 kg ha^{-1} may be used for getting higher pod yield of groundnut.

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