EFFECT OF BORON ON PEANUT GENOTYPES UNDER RAINFED CONDITIONS

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ABSTRACT:- A study was conducted during 2008 and 2009 to find out boron requirements and critical concentrations in diagnostic parts of three peanut genotypes, BARD-479, ICG-7326 and ICGV-92023. These genotypes were grown in boron deficient soil at National Agricultural Research Centre, Islamabad, Pakistan. Five rates 0.0, 0.5, 1.0, 2.0 and 4.0 kg B ha^{-1} as boric acid (H_3BO_3) were applied. Boron fertilizer applications significantly increased dry pod yield of all the tested genotypes over control. Dry pod yields of BARD-479, ICG-7326, and ICGV-92023 increased by 14- 20%, 21- 26% and 27- 34%, respectively. Genotype BARD-479 was the most boron efficient user, 83- 88% followed by ICG-7326, 79-83% and ICGV-92023, 75- 79%. Critical boron concentrations in plant shoot terminals recorded were 22-48, 23-50 and 25-54 mg kg^{-1} during 2008 and 27-51, 30-55 and 31-58 mg kg^{-1} during 2009 in BARD-479, ICG-7326 and ICGV-92023, respectively. Critical boron concentrations observed in pods of BARD-479, ICG-7326 and ICGV-92023 genotypes were 17-34, 20-38 and 22-40 mg kg^{-1} during 2008 and 21-36, 23-39 and 24-44 mg kg^{-1} during 2009, respectively. Total uptake of boron both in pods and haulm noted were 85-177, 88-188 and 89-189 g ha^{-1} during 2008 and 89-174, 93-183 and 89-190 g ha^{-1} during 2009, in BARD-479, ICG-7326 and ICGV-92023, respectively. Critical boron concentrations in different plant tissues were higher in all genotypes as compared to control treatments during the two years. The boron using efficiency of peanut genotypes declined in the order of BARD-479 > ICG-7326 > ICGV-92023. A boron fertilizer requirement observed for the highest dry pods yields was 1.0 kg B ha^{-1} for all genotypes and yield decreases gradually after certain level by increasing boron fertilizer rates.

Key Words: Peanut; Boron Requirement; Diagnostic Criteria; Plant Analysis; Dry Pods Yield; Pakistan.

INTRODUCTION

Peanut (*Arachis hypogaea* L.) is grown in more than 100 countries in the world. The top five main producers viz., China, India, Nigeria, USA and Indonesia contribute 74 % to the total world production. Peanut is grown on nearly 23.95 million ha worldwide with the total production of 36.45 million tons with an average yield of 1520 kgha^{-1} (FAO STAT,

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2011). In Pakistan, it was grown on 95.6 thousands hectares with annual production of 87.9 thousands tonnes with an average dry pods yield of 919 kg ha^{-1} (Anonymous, 2011-12). Boron is an essential nutrient required for plant growth and remains available for plant uptake during the growth period. It plays an important role in sugar transport, cell wall synthesis, cell wall structure, carbohydrate metabolism, Ribo Nucleic Acid (RNA) metabolism, respiration, root growth, pollination and part of the cell membrane (Ahmad et al., 2009). In soils, concentration of total boron is from 20 to 200 mg B kg^{-1} (Mengel and Kirkby, 1987) and its available concentration also varies greatly from soil to soil.

Boron deficiency has been reported in cotton, rice, wheat, maize, soybean rape/mustard and peanut (Niaz et al., 2007; Zia et al., 2006). Boron deficiency has been reported in soils which are highly leached or developed from calcareous, alluvial and loessial deposits (Imtiaz et al., 2010). In several studies, highest levels of boron adsorption by soil depicted close correlation with the pH of the soil solution (Shafique et al., 2008.) The critical concentration of boron in soils which is considered deficient to most crops in Pakistan was 0.45-0.50 mg B kg^{-1} until revised recently to 0.65 mg kg^{-1} (Rashid, 2006). Singh (1994) concluded that depending upon peanut genotypes and soil, the critical limits of boron may vary from 0.2 to 0.4 mg B kg^{-1}. In Pakistan, peanut is grown under rainfed conditions on relatively poor fertile alkaline-calcareous soils with no adequate fertilization history and 50% boron deficient sites have been reported in peanut areas (Rashid, 1994). A 10% increase in pods yield of peanut crop after boron fertilization over the control was obtained with 1 kg B ha^{-1} in Pakistan (Rashid et al., 1997). 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). Boron interactions either synergism or antagonism could affect plant nutrition of both deficient and toxic conditions. Therefore, differences and contradictions in plant nutrient absorption regarding boron fertilizer have been reported. These could be due to different growth media, crop species and varieties, plant parts analyzed, plant age, and environmental conditions (Tariq and Mott, 2007). Present paper reports plant boron requirements, critical boron concentrations in plant tissues and genotypic variation response to boron application of peanut crop.

MATERIALS AND METHOD

Field experiments were conducted under rainfed conditions on April 23, 2008 and 2009 at National Agricultural Research Centre, Islamabad, (latitude 33^0 43′ 12″ N; longitude 73^0 5′ 45″ E) Pakistan. Experiments were conducted on soil series Rasulpur (course loamy mixed, hyperthermic Ustochreptic Camborthids). Soil received 9 mm to 334 mm rainfall with an annual average rainfall from 53 mm to 118 mm with a mean value of 85 mm (Table 1). More than half rain is received in the form of high-intensity down-pours during July and August. Initial physicochemical characteristics of soils during the both years were pH 8.3 and 8.1;

Table 1. Rainfall data of Experimental Area

Month	Rainfall (mm)	
	2008	2009
January	122.1	57.2
February	45.4	69.54
March	24.4	58.54
April	80.9	93.55
May	10.1	36.61
June	272.7	14.97
July	333.7	78.45
August	333.7	153.99
September	75.1	45.01
October	28.4	8.94
November	17.6	14.95
December	66.1	0

$CaCO_3$ equiv. 4.8% and 3.6%; organic matter 0.55% and 0.31%; clay 20% and 16%; silt 48% and 26%; AB-DTPA extractable (Soltanpour and Workman, 1979) NO_3-N 4.2 and 3.1 mg kg^{-1}, P 2.5 and 1.9 mg kg^{-1}, K 70 and 85 mg kg^{-1}, Zn 0.36 and 0.34 mg kg^{-1}, HCl extractable-B 0.25 and 0.14 mg kg^{-1} (Ponnamperuma et al., 1981). The experiment consisted of 45 plots, each measuring 7.2 m^2 arranged in a randomized complete block design (RCBD) with a split-plot structure with three replications. Three peanut genotypes BARD-479 (received from ICRISAT as ICG-4989 and originated in Zimbabwe with identity PI-270259), ICG-7326 (received from ICRISAT as ICG-7326 in 1984 and originated in Azumay Taka, Japan) and ICGV-92023 (received from ICRISAT cross of ICGV-86251xICGV-86010) were in the main plots and fertilizers @ 0.0, 0.5, 1.0, 2.0, and 4.0 kg B ha^{-1}as boric acid (H_3BO_3) were in the sub-plots. Basal fertilization included 30 kg N ha^{-1} as urea, 80 kg P_2O_5 ha^{-1} as single super phosphate, 50 kg K_2O ha^{-1} as potassium sulphate.

All agronomic and plant protection practices were kept uniform in all treatments. Pre-sown soil samples for analysis were taken for soil fertility status. Upper parts of peanut plants (4cm of shoot terminals) were taken at early peg formation stage as suggested by Jones et al. (1991). Young leaves samples at the time of flowering for boron uptake analyses were taken. At harvest, data on dry pods yield (kg ha^{-1}) and on other desired parameters like boron concentration in shoot terminal (mg kg^{-1}), boron concentration in pods (mg kg^{-1}) and total boron uptake in pods and haulm (g ha^{-1}) were recorded and analyzed. Leaves and pods samples from each treatment were taken for boron uptake analysis. After necessary processing, plant tissues (shoot terminals, pod and haulm) were dry-ashed at 550°C overnight, the ash was taken up in 0.36 *N* H_2SO_4 (Gaines and Mitchell, 1979) and was filtered. The boron concentration in the digests was determined colorimetrically using Azomethine-H method (Keren, 1996). The data collected were analyzed statistically by using Least Significant Difference test at 5% level of probability (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Results showed that boron concentration in diagnostic plant parts of peanut is wide-ranging (Table 2) because response to boron fertilizer was diverged among the peanut genotypes (Oyinlola, 2007). Boron concentration in shoot terminals, pods and total uptake increases as the levels of boron application increases (Ahmad

Table 2. Boron concentration in different plant parts and total uptake by peanut genotypes

	2008				2009			
Boron (kg ha^{-1})	BARD-479	ICG-7326	ICGV-92023	Mean	BARD-479	ICG-7326	ICGV-92023	Mean
Shoot terminals (mg kg^{-1})								
0.0	22^{e}	23^{e}	25^{e}	23	27^{e}	30^{e}	31^{e}	29
0.5	27^{d}	31^{d}	33^{d}	30	32^{d}	36^{d}	38^{d}	35
1.0	33^{c}	37^{c}	40^{c}	37	37^{c}	42^{c}	45^{c}	41
2.0	39^{b}	42^{b}	45^{b}	42	44^{b}	47^{b}	51^{b}	47
4.0	48^{a}	50^{a}	54^{a}	51	51^{a}	55^{a}	58^{a}	55
L.S.D 0.05	1.85	1.98	2.24	-	1.87	2.01	2.13	-
C.V %	2.62	2.86	3.04	-	3.34	3.04	2.54	-
Pods (mg kg^{-1})								
0.0	17^{e}	20^{e}	22^{e}	20	21^{e}	23^{e}	24^{e}	23
0.5	23^{d}	26^{d}	27^{d}	25	26^{d}	28^{d}	30^{d}	28
1.0	28^{c}	30^{c}	32^{c}	30	30^{c}	32^{c}	35^{c}	32
2.0	31^{b}	34^{b}	35^{b}	33	33^{b}	36^{b}	40^{b}	36
4.0	34^{a}	38^{a}	40^{a}	37	36^{a}	39^{a}	44^{a}	40
L.S.D 0.05	2.39	1.65	2.48	-	1.88	2.21	2.19	-
C. V %	4.77	2.96	4.22	-	3.04	3.73	3.36	-
Total boron uptake in pods and haulm (g ha^{-1})								
0.0	85^{e}	88^{e}	89^{e}	87	89^{d}	93^{d}	89^{d}	90
0.5	116^{d}	121^{d}	128^{d}	122	116^{c}	131^{c}	129^{c}	125
1.0	149^{c}	158^{c}	16^{c}	158	143^{b}	166^{b}	170^{b}	160
2.0	165^{b}	177^{b}	179^{b}	174	166^{a}	179^{a}	182^{a}	176
4.0	177^{a}	188^{a}	189^{a}	185	174^{a}	183^{a}	190^{a}	182
L.S.D 0.05	9.43	6.73	8.08	-	8.04	9.50	8.73	-
C.V %	3.62	2.44	2.86	-	3.10	3.36	3.09	-

Means followed by same letters do not differ significantly at P<5%

et al., 2011). Reduction in crop yield in the boron deficient soils could be due to weak reproductive development and it has often been observed that reproductive growth including flowering, fruiting, seed set and yield, is more sensitive to boron deficiency than vegetative growth (Dear and Lipsett, 1987.)

Data recorded during the study showed that the highest levels of boron concentrations 51 and 55 mg kg^{-1} were recorded in shoot terminals at 4 kg B ha^{-1} and the lowest concentrations of 23 and 29 mg kg^{-1} were observed in control, respectively (Table 2). In pods the maximum boron concentrations of 37 and 40 mg kg^{-1} were also recorded @ 4 kg B ha^{-1} and the lowest concentrations of 20 and 23 mg kg^{-1} were observed in control during 2008 and 2009, respectively (Table 2). Content of total boron uptake by genotypes grown varied from 85 to 177 g ha^{-1} in BARD-479, from 88 to 188 g ha^{-1} in ICG-7326 and from 89 to 189 g ha^{-1} in ICGV-92023 during 2008 and results obtained 89 and 174 g ha^{-1} in BARD-479, 93 and 183 g ha^{-1}in ICG-7326 and 89 and 190 g ha^{-1}in ICGV-92023 during 2009 (Table 2). Noticeably greater uptake by ICGV-92023 was due to greater plant boron requirements in foliar parts. Total boron uptakes in pods and haulm were higher 185 and 182 g ha^{-1} when boron applied @4kg ha^{-1} and the lowest concentrations 87 and 90 g ha^{-1} were noted in control (Table 2). It is evident that total boron uptake by all the peanut genotypes increased with increasing boron fertilizer levels over control. Genotype BARD-479 indicated the highest boron efficiency of 83-88% followed by genotypes ICG-7326 and ICGV- 92023 with boron use efficiency of 79-83% and 75-79%, respectively during the tested years (Table 3). Results are supported by Ceyhan et al. (2008) who tested four sunflower genotypes in boron-deficient calcareous soils and found different boron use efficiency. Data recorded on pods yield during 2008 and 2009 (Table 3) showed that application of boron @1kg ha^{-1} increased the dry pods yield of 14 and 20% in BARD-479, 21% and 26% in ICG 7326 and 27% and 34% in ICGV-92023 over control, respectively and yield decreases gradually after

Table 3. Increase over control and boron use efficiency

Genotypes	Dry pods yield (kg ha^{-1})		Increase over control (%)	Boron use efficiency (%)
	Control	With Boron		
2008				
BARD-479	1745	1988	14	88
ICG-7326	1603	1943	21	83
ICGV-92023	1546	1967	27	79
2009				
BARD-479	1545	1856	20	83
ICG-7326	1467	1850	26	79
ICGV-92023	1350	1810	34	75

certain level by increasing boron fertilizers levels and it was not possible to determine toxicity level of boron for genotypes under experiment. These results are in line with Sinha et al. (2009) who found that pods yield of peanut increases as the doses of boron increases but after certain level pods yield decreases. Peanut pods yield obtained, differed significantly ($P \leq 0.05$) due to boron application during 2008 and 2009. During both cropping seasons, pod yield increased linearly with increasing of doses of boron fertilizer and response was packed down after certain level. Data recorded during 2008 showed that the highest pods yield of 1948 kg ha^{-1} was obtained when boron applied @ 1 kg ha^{-1} followed by 1940 kg ha^{-1} when boron applied @ 2 kg ha^{-1} (Table 4) and both remained statistically at par. The lowest pod yield of 1631 kg ha^{-1} was recorded in control and the trend was same during 2009. These findings are in line with those of Abid et al. (2007) and Nabi et al. (2006).

All the three peanut genotypes used in this study were responsive to boron fertilization invariably. Boron concentration in diagnostic plant parts corresponded to the boron fertilizer rates and it can be used as an indicator of nutritional status of a crop. Extensive research work has already established the utility of boron application in crops such as cotton and rice. However, micronutrient application such as B, Zn and Fe is not commonly being practiced for peanut crop under rainfed (Pothwar) conditions. The results of this study clearly demonstrated the beneficial effect of boron application on pod yield of peanut crop under rainfed conditions.

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Table 4. Effect of boron fertilization on dry pod yield of peanut genotypes

	2008				2009			
Boron (kg ha^{-1})	BARD-479	ICG-7326	ICGV-92023	Mean	BARD-479	ICG-7326	ICGV-92023	Mean
0.0	1745 c	1603 c	1546 d	1631	1545 d	1467 e	1350 a	1454
0.5	1885 b	1806 b	1810 c	1834	1737 c	1700 d	1620 c	1686
1.0	1953 ab	1925 a	1967 a	1948	1800 b	1850 a	1810 a	1820
2.0	1988 d	1943 a	1890 b	1940	1856 a	1783 b	1677 b	1772
4.0	1911 ab	1833 b	1780 c	1841	1715 c	1615 d	1512 d	1614
L.S.D 0.05	82.26	66.60	74.44	-	47.34	47.27	46.94	-
C.V %	2.30	1.94	2.20	-	1.45	1.49	1.59	-

Means followed by same letters do not differ significantly at P<5%

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