INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
13–1204/2014/16–6–1165–1170
http://www.fspublishers.org

Full Length Article

Boron Application Mitigates Salinity Effects in Canola (*Brassica napus*) under Calcareous Soil Conditions

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Abstract

Boron is widely deficient in calcareous soils. A field experiment was conducted to evaluate the response of B application [control, 0.5, 1.0 and 2.0 kg ha^{-1} as soil and 0.1% (w/v) B as foliar spray] to three canola (*Brassica napus* L.) cultivars (Hyola, Punjab Sarsoon and Bulbul) grown in calcareous soil degraded with salts. Application of B significantly increased seed and straw yields of canola cultivars. Maximum seed yield of various cultivars was achieved with 2.0 kg B ha^{-1}. However, seed yield of Punjab Sarsoon and Bulbul was non-significantly different at 1.0 and 2.0 kg B ha^{-1}. Hyola had the highest demand for B and significantly responded to foliar B application for seed and straw yields. The low yielding Hyola accumulated greater B concentration in seeds than other cultivars at various B treatments [minimum at control (3.3 mg B kg^{-1}) and maximum (4.8 mg B kg^{-1}) at 2.0 kg B ha^{-1}]. Boron application reduced Na concentration in canola straw and seed up to 37%. In conclusion, B application mitigated negative effects of salts and enhanced growth of canola and canola cultivars varied in their B requirement for optimum growth under salt affected conditions.

Keywords: Boron; Calcareous soils; Canola; Salt-affected soils; Sodium

Introduction

Boron (B) is essential micronutrient required for higher plants (Brown *et al*., 2002). Soil B deficiency is widespread in calcareous soils and it affects a number of agronomic and horticultural crops in Pakistan (Rashid *et al*., 2011). Under alkaline calcareous conditions, crop response to B application is expected due to its reduced soil availability from soil with increasing pH above 7 (Goldberg, 1997). This is partly because of its fixation with calcium carbonate causing deficiency of B (Chen *et al*., 2009).

Soil salinity and sodicity are main abiotic stress in semi-arid and arid regions that substantially lower the yield of many crops. Salinity has received more attention in recent years because of increase in affected area throughout the world and a large proportion of the agricultural production is currently affected by salt stress worldwide (Wicke *et al*., 2011). Osmotic stress and ion toxicity are the major adverse effects of salts on plant growth.

Tolerance of Brassicas to salt stress is a complicated trait, which is largely influenced by biological, climatic and cultural factors (Ashraf and McNeilly, 2004; Mahmoodzadeh, 2008). Salts deteriorate the produce quality and reduce the yield, size and height of Brassica plants. By disturbing the nutritional and water balance of plant, salts in soil may lower the crop yield (Islam *et al*., 2001). However, significant variation in growth stages and seed germination among cultivars of canola grown under soil salinity and sodicity is reported (Mer *et al*., 2000; Tunuturk *et al*., 2011).

Role of B in pollen tube formation makes it more important for economic yield of oil seeds crops (Wang *et al*., 2003). Canola is important oil crop in the world and also in Pakistan (FAO, 2013). During the peak vegetative, flowering, pod production and seed development stages, a steady supply of B is necessary for optimum seed yield of canola (Malhi *et al*., 2003; Yang *et al*., 2009;). Foliar application of B on such critical stages may be more beneficent than soil application (Fageria, 2009; Ullah *et al.,* 2013). Therefore, a comparison between soil and foliar B application to canola is required. Positive effects of B application to canola under calcareous soil conditions are reported (Nadian *et al*., 2010; Hossain *et al*., 2012; Rehman *et al.,* 2012). However, rare reports are available regarding B requirement of canola in salt degraded calcareous soils. Moreover, different canola cultivars are suited for different climatic conditions and vary in B requirement. Thus present research was conducted to evaluate B requirement of three *Brassica napus* L. cultivars under salt affected conditions.

Materials and Methods

Experimental Material

A field experiment was conducted at Directorate of Soil Salinity Research Institute, Pindi Bhattian (31°52′34.2″ N, 73°20′50.2″ E). Randomized samples (0–15 cm depth) from

To cite this paper: Abid, M., M.M.H. Khan, M. Kanwal and M. Sarfraz, 2014. Boron application mitigates salinity effects in canola (*Brassica napus*) under calcareous soil conditions. *Int. J. Agric. Biol.*, 16: 1165-1170

the experimental area were analyzed for various soil characteristics (Table 1). Soil was saline-sodic, alkaline calcareous and low in plant available B.

Treatments

Boron was applied to soil (0.5, 1.0 or 2.0 kg ha^{-1}) or foliage (400 L of 0.1% w/v B solution each at pre- and post-flowering) along with control and three cultivars of canola (cv. Hyola, Punjab Sarsoon and Bulbul) were compared under field conditions. Source of B was disodium tetraborate pentahydrate ($Na_2B_4O_7 \cdot 5H_2O$) have greater than 98% purity. Treatments were randomized in blocks under split plot arrangement. Boron rates were kept in main plots and canola cultivars in subplots of 1.2 m × 5 m size.

Crop Husbandry

Canola was sown in row to row distance of 20 cm. One week old seedlings were thinned to 90 plants m^{-2}. Recommended rates of nitrogen (90 kg ha^{-1}), phosphorus (60 kg ha^{-1}) and potassium (60 kg ha^{-1}) were applied as urea [$(NH_2)_2CO$], di-ammonium hydrogen phosphate [$(NH_4)_2HPO_4$] and potassium sulphate (K_2SO_4). Weeds were controlled manually.

Agronomic Components

At maturity, ten plants were randomly harvested in three batches to measure pods per plant. Thousand seeds from each replication were weighed to estimate thousand seed weights. One m^2 area was harvested from each plot to measure straw and seed yield.

Boron and Sodium Analysis

Pods collected to measure pods per plant were threshed manually to separate seeds. Seed samples were washed with distilled water followed by blotting with tissue papers. Harvested straw samples were first washed in tap water. Then, straw samples were rinsed in 1% (v/v) acetic acid solution and finally in distilled water to remove adhered B. Seed and straw samples were then oven dried at 70°C for 42 h. Subsamples from this harvest were dry ashed at 550°C (Banuelos *et al*., 1992) followed by B measurements on a spectrophotometer as described for azomethine-H method (Gaines and Mitchell, 1979). Aliquot was also measured for Na on a flame photometer.

Statistical and Economic Analysis

Obtained data was analyzed for analyses of variance followed by least significant difference (LSD) test to separate significantly different treatments means. Treatment effects were considered significant at $P \leq 0.05$ (Steel *et al*., 1997). Various statistical analyses were performed on *Statistix 9® for Windows* (Analytical Software, Tallahassee, USA).

Added value (price of the additional produce, over control, at a specific B treatment) and cost incurred due to applied treatments were also calculated to compare different treatments based on boron economic efficiency (BEE). Economic analyses based on following rates: Rs. 93.75 kg^{-1} canola seed, Rs. 141 kg^{-1} of disodium tetraborate pentahydrate and Rs. 750 ha^{-1} spraying cost.

Results

Seed and Straw Yield

Main and interaction effects of B application and canola cultivars significantly ($P \leq 0.05$) influenced seed and straw yield of canola (Fig. 1). Foliar application of 0.1% (w/v) B significantly increased seed and straw yield only of Hyola. Compared to control, soil application of B at 1.0 and 2.0 kg B ha^{-1} significantly increased seed and straw yields of all cultivars. At 2.0 kg B ha^{-1}, increase in seed yield over control was 34, 18 and 15%, respectively for Hyola, Punjab Sarsoon and Bulbul. However, seed yield of Punjab Sarsoon and Bulbul was non-significantly different at 1.0 and 2.0 kg B ha^{-1}.

Number of pods per plant and thousand seed weight were also significantly ($P \leq 0.05$) influenced by B application, canola cultivars and interaction (Table 2). Only a non-significant increase was achieved with foliar B spray in thousand seed weight of the cultivars. Maximum number of pods per plant and thousand seed weight were achieved with 2.0 kg B ha^{-1}.

Boron and Sodium in Plant Tissues

There were significant ($P \leq 0.05$) main and interactive effects of B applications and cultivars on B concentration both in seeds and straw of canola (Fig. 2). Foliar application of 0.1% (w/v) B significantly increased seed B concentration only in Bulbul while it increased straw B concentration both in Bulbul and Punjab Sarsoon. For all the three cultivars, maximum seed and straw B concentration was achieved at 2.0 kg B ha^{-1}. The maximum increase in seed B concentration over control was 82, 94 and 97%, respectively in Hyola, Punjab Sarsoon and Bulbul. However, seed B concentration of all the three cultivars was statistically similar between 1.0 and 2.0 kg B ha^{-1}.

Main and interaction effects of B application and cultivars also significantly ($P \leq 0.05$) affected B content (total uptake) in straw and seeds (Table 3). A significant increase in seed B content with foliar B spray was achieved only in Bulbul. Similar to seed B concentration, content of B in seed and straw samples was maximum at 2.0 kg B ha^{-1} which was non-significantly different than for 1.0 kg B ha^{-1} for all cultivars.

Table 1: Physical and chemical properties of soil used in the experiment

Soil Property	Unit	Value	Method
Textural class		Sandy Loam	USDA textural classification
Sand	g kg^{-1} soil	597	Hydrometer method (Gee and Bauder, 1986)
Silt		261	
Clay		142	
pH_s		8.51	pH is saturated soil paste
EC_e	dS m^{-1}	4.62	EC of saturated soil paste extract
$Ca^{2+} + Mg^{2+}$	mmol L^{-1}	7.76	Analyzed in saturated soil paste extract
Na^+	mmol L^{-1}	41.0	Analyzed in saturated soil paste extract
SAR	$(mmol_c\ L^{-1})^{1/2}$	20.9	
Organic matter	g kg^{-1} soil	4.51	Walkley–Black method (Nelson and Sommers, 1996)
$CaCO_3$	g kg^{-1} soil	55.3	Acid dissolution (Loeppert and Suarez, 1996)
Available B	mg kg^{-1}	0.29	Hot water extractable (Mahler *et al*., 1984)

Table 2: Effect of different rates of B application on pods per plant and seed weight of canola varieties

Treatments	Variety		
	Hyola	Punjab Sarsoon	Bulbul
	Number of pods per plant		
Control	147 i	170 gh	178 fg
0.5 kg B ha^{-1}	158 hi	188 ef	195 de
1.0 kg B ha^{-1}	178 fg	212 c	232 b
2.0 kg B ha^{-1}	206 cd	235 ab	249 a
0.1 % B Spray	166 gh	188 ef	199 cde
	Thousand seed weight (g)		
Control	2.51 i	2.62 cd	2.53 hi
0.5 kg B ha^{-1}	2.53 hi	2.64 bc	2.53 hi
1.0 kg B ha^{-1}	2.55 fgh	2.66 b	2.56 fg
2.0 kg B ha^{-1}	2.59 de	2.69 a	2.57 ef
0.1 % B Spray	2.53 hi	2.64 bc	2.54 gh

Table 3: Effect of different rates of B application on B content in seeds and straw of canola varieties

Treatments	Variety		
	Hyola	Punjab Sarsoon	Bulbul
	Seed B Content (kg B ha^{-1})		
Control	2.30 f	2.50 ef	2.24 f
0.5 kg B ha^{-1}	3.83 cd	4.02 c	3.21 de
1.0 kg B ha^{-1}	5.43 a	5.05 ab	4.44 bc
2.0 kg B ha^{-1}	5.58 a	5.75 a	5.11 ab
0.1 % B Spray	3.00 ef	3.12 de	3.14 de
	Straw B Content (kg B ha^{-1})		
Control	14.70 h	19.07 gh	14.83 h
0.5 kg B ha^{-1}	19.37 gh	28.17 de	22.23 fg
1.0 kg B ha^{-1}	31.83 cd	39.03 ab	28.40 de
2.0 kg B ha^{-1}	36.53 bc	41.33 a	39.00 ab
0.1 % B Spray	20.43 g	26.100 ef	21.57 g

Values sharing similar letters are non-significantly different based on LSD test at $P \leq 0.05$

Main and interaction effects of B application and cultivar significantly ($P \leq 0.05$) influenced seed and straw Na concentration in canola (Table 4). Various B treatments significantly decreased tissue Na concentration in all cultivars. Minimum seed and straw Na concentration in various cultivars was observed at 2.0 kg B ha^{-1}. Decrease was 41, 43 and 39% in seed and 29, 31 and 40% in straw Na concentration, respectively of Hyola, Punjab Sarsoon and Bulbul. For control and various soil B application rates, seed Na concentration was significantly greater in Bulbul when compared to Hyola and Punjab Sarsoon. However, straw Na concentration was significantly greater in Bulbul when compared to other two cultivars only at control level of B application.

Economic Analysis

For all the three cultivars, maximum added value (Rs. ha^{-1}) of the produce was achieved at 2.0 kg B ha^{-1} (Table 5). However, maximum BEE of 16.9 was achieved with 1.0 kg of B applied ha^{-1} to Hyola. Punjab Sarsoon and Bulbul gave approximately similar BEE at 0.5 and 1.0 kg B ha^{-1}.

Discussion

Experimental soil was calcareous with greater than 5% calcium carbonate (Table 1) and deficiency of B is common problem of calcareous soils due its fixation (Chen *et al*., 2009). Critical B in soil required for optimum growth of canola is about 0.5 mg kg^{-1} (Bell, 1997) and lower B levels resulted in lower plant growth and seed yield (Savic *et al*., 2012) as depicted from present study (Fig. 1), optimum B application is required for optimum seed yield (Nadian *et al*., 2010).

Foliar application is considered as quick remedy of nutrient deficiency and it is recommended in situations when availability of nutrient is limited from soil (Fageria, 2009). This is particularly true for availability of various micronutrients from calcareous soils. In present study, foliar application of 0.1% (w/v) B significantly increased seed yield only of Hyola, which produced lowest seed yield (Fig. 1). However, Hyola achieved significantly greater yield at 2.0 kg B ha^{-1} indicating its better response to B application. For other cultivars too, maximum seed yield was achieved with 1.0 or 2.0 kg B ha^{-1}. Application of B to canola is specifically required for pollen tube formation and cell wall synthesis; however it plays several vital roles in plant metabolism (Brown *et al*., 2002). This may be the reason for increased number of pods per plant and thousand seed weight in our study (Table 3). Moreover, this may also relate with greater flower retention with B application (Table 3).

Table 4: Effect of different rates of B application on Na concentration in seeds and straw of canola varieties

Treatments	Variety		
	Hyola	Punjab Sarsoon	Bulbul
	Seed Na Concentration (g kg^{-1})		
Control	5.73 b	5.36 bc	6.46 a
0.5 kg B ha^{-1}	4.63 de	4.36 def	5.40 bc
1.0 kg B ha^{-1}	4.13 efg	3.70 gh	4.76 d
2.0 kg B ha^{-1}	3.40 hi	3.06 i	3.93 fgh
0.1 % B Spray	4.90 cd	4.53 de	4.90 cd
	Straw Na Concentration (g kg^{-1})		
Control	5.66 b	5.63 b	6.96 a
0.5 kg B ha^{-1}	4.86 cd	5.06 bc	5.43 bc
1.0 kg B ha^{-1}	4.40 de	4.40 de	4.86 cd
2.0 kg B ha^{-1}	4.03 e	3.86 e	4.20 e
0.1 % B Spray	5.36 bc	4.93 cd	5.66 b

Values sharing similar letters are non-significantly different based on LSD test at $P \leq 0.05$

Table 5: Economic analysis

Treatments	Variety		
	Hyola	Punjab Sarsoon	Bulbul
	added value due to applied treatments (Rs. ha^{-1})		
Control	0	0	0
0.5 kg B ha^{-1}	4364	4891	3407
1.0 kg B ha^{-1}	16421	10283	6834
2.0 kg B ha^{-1}	18464	12192	10719
0.1% B Spray	9455	3517	2882
	boron economic efficiency		
Control	0.0	0.0	0.0
0.5 kg B ha^{-1}	9.0	10.1	7.0
1.0 kg B ha^{-1}	16.9	10.6	7.0
2.0 kg B ha^{-1}	9.5	6.3	5.5
0.1% B Spray	6.3	2.3	1.9

Addition cost (Rs. ha^{-1}) over control was 485, 970, 1940 and 1512 respectively for 0.5 kg B ha^{-1}, 1.0 kg B ha^{-1}, 2.0 kg B ha^{-1} and 0.1% B Spray

The lower B concentration in straw and seeds in control (Fig. 2) may relate to B deficiency under control conditions. Optimum supply of B ensured optimum B concentration in shoots and seeds along with increased seed and straw yields (Nadian *et al.*, 2010; Manoharan *et al.*, 2012). Therefore, seed and straw B content was also significantly increased for various canola cultivars (Table 3).

It is reported increased uptake of B in presence of Na and increased uptake of Na in presence of B (Farr, 2010; Naeem *et al.*, 2013). Moreover, B ion toxicity is considered a hazard to plant growth under soil sodicity (Nable *et al.*, 1997). However, application of B to saline-sodic soil significantly increased seed and straw yields (Fig. 1). Decreased Na concentration in plant parts is important to mitigate negative effects of Na and reports are also available which indicate an antagonistic relationship between Na and B with positive effects of B application under salt-affected conditions (Hosaini *et al.*, 2009; Mehmood *et al.*, 2009).

Due to contradiction in reports regarding B requirement in salt-affected soils, further detailed studies are required to categorize interaction of B with soluble cations in soil and at root surfaces.

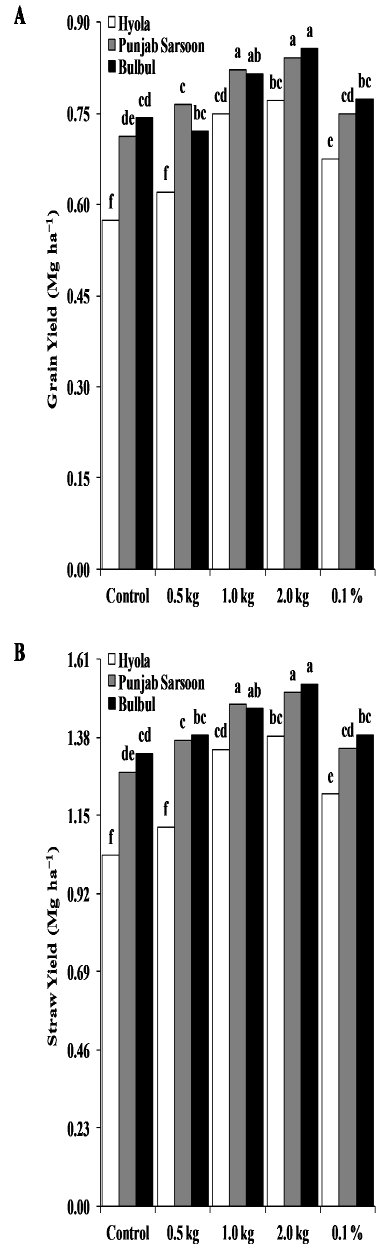

Fig. 1: Effect of different rates of B application on seed (A) and straw yield (B) of canola varieties. Values sharing similar letters are non-significantly different based on LSD test at $P \leq 0.05$

Probably, the effect of B application to saline-sodic soils depends on inherent level of soil B and salts whereas optimum supply of B may be required when availability of B from soil is low. This was also confirmed from economic analysis of applied B treatments in present study (Table 5). A rate of 1.0 or 2.0 kg B ha^{-1} may be applied based on desired BEE and capital available.

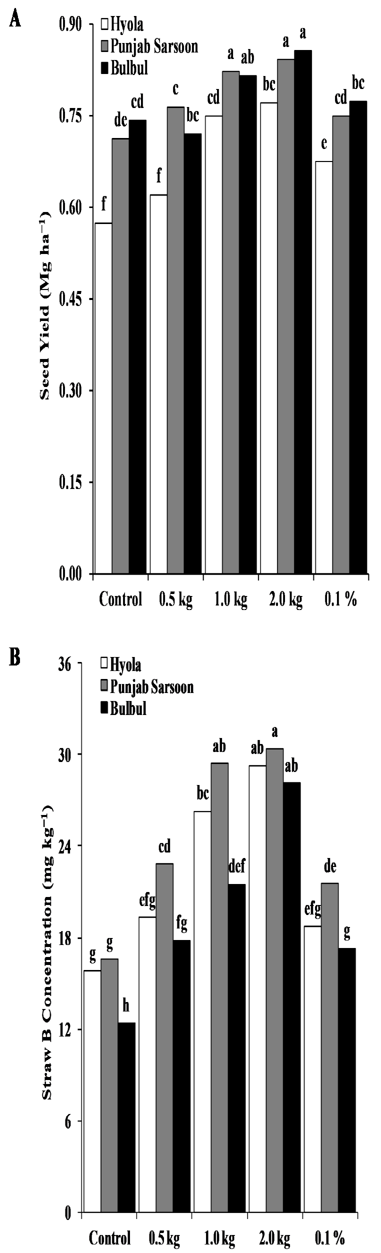

Fig. 2: Effect of different rates of B application on B concentration in seeds (A) and straw (B) of canola varieties. Values sharing similar letters are non-significantly different based on LSD test at $P \leq 0.05$

In crux, application of B significantly increased seed and straw yields of canola cultivars and maximum seed yield of all the three cultivars was achieved with 2.0 kg ha^{-1}. However, seed yield of Punjab Sarsoon and Bulbul was non-significantly different at 1.0 and 2.0 mg B kg^{-1} soil. Therefore, Hyola had high demand for B and it also significantly responded to foliar B application for seed and straw yields. Hyola accumulated greater B concentration in seeds than other cultivars at various B treatments. Increase in seed yield by B application to salt affected soil low in inherent B availability may relate to mitigation of Na toxicity as indicated by decreased Na concentrations in plant tissues. The study warrants further focused research on physiological mechanisms of crop plants that response to B application under soil salinity/sodicity.

References

Ashraf, M. and T. McNeilly, 2004. Salinity tolerance in *brassica* oilseeds. *Crit. Rev. Plant Sci.,* 23: 157–174

Banuelos, G.S., G. Cardon, T. Pflaum and S. Akohoue, 1992. Comparison of dry ashing and wet acid digestion on the determination of boron in plant tissue. *Commun. Soil Sci. Plant Anal.,* 23: 2383–2397

Bell, R.W., 1997. Diagnosis and prediction of boron deficiency for plant production. *Plant Soil,* 193: 149–168

Brown, P.H., N. Bellaloui, M.A. Wimmer, E.S. Bassil, J. Ruiz, H. Hu, H. Pfeffer, F. Dannel and V. Romheld, 2002. Boron in plant biology. *Plant Biol.,* 4: 205–223

Chen, W.T., S.B. Ho and D.Y. Lee, 2009. Effect of pH on boron adsorption-desorption hysteresis of soils. *Soil Sci.,* 174: 330–338

Fageria, N.K., M.B. Filho, A. Moreira and C.M. Guimaraes, 2009. Foliar fertilization of crop plants. *J. Plant Nutr.,* 32: 1044–1064

FAO, 2013. *Food and Agriculture Organization's crop production database 2011*. Online at <http://faostat.fao.org/site/567/default.aspx#ancor> (assessed on 30 July, 2013)

Farr, H.J., 2010. *Early Growth Tolerance to Boron and Salt in Wheat and Barley*. Thesis of Bachelor of Agribusiness with Honours (Agricultural Technology), Curtin University, Perth, Australia

Gaines, T.P. and G.A. Mitchell, 1979. Boron determination in plant tissue by the azomethine H method. *Commun. Soil Sci. Plant Anal.,* 10: 1099–1108

Gee G.W. and J.W. Bauder, 1986. Particle-size analysis. *In*: *Methods of Soil Analysis: Part 1—Physical and Mineralogical Methods*, pp: 383–411. Klute, A. (ed.). American Society of Agronomy, Madison, USA

Goldberg, S., 1997. Reactions of boron with soils. *Plant Soil,* 193: 35–48

Hosaini, Y., M. Homaee, N.A. Karimian and S. Saadat, 2009. Modeling vegetative stage response of canola (*Brassica napus* L.) to combined salinity and boron tresses. *Int. J. Plant Prod.,* 3: 91–104

Hossain, M.A., M. Jahiruddin and F. Khatun, 2012. Response of mustard (*Brassica*) varieties to boron application. *Bangl. J. Agric. Res.,* 37: 137–148

Islam, M.R., M.A.R. Bhuiyan, B. Prasad and M.A. Quddus, 2001. Salinity effect on yield and component characters in rapeseed and mustard varieties. *J. Biol. Sci.*, 1: 840–842

Mahmoodzadeh, H., 2008. Comparative study of tolerant and sensitive cultivars of *Brassica napus* in response to salt conditions. *Asian J. Plant Sci.,* 7: 594–598

Malhi, S.S., M. Raza, J.J. Schoenau, A.R. Mermut, R. Kutcher, A.M. Johnston and K.S. Gill, 2003. Feasibility of boron fertilization for yield, seed quality and B uptake of canola in northeastern Saskatchewan. *Can. J. Soil Sci.,* 83: 99–108

Manoharan, V., I.A.M. Yunusa, P. Loganathan, R. Lawrie, B.R. Murray, C.G. Skilbeck and D. Eamus, 2010. Boron contents and solubility in Australian fly ashes and its uptake by canola (*Brassica napus* L.) from the ash-amended soils. *Soil Res.,* 48: 480–487

Mehmood, E., R. Kausar, M. Akram and S.M. Shahzad, 2009. Is boron required to improve rice growth and yield in saline environment? *Pak. J. Bot.,* 41: 1339–1350

Mer, R.K., P.K. Prajith, D.H. Pandya and A.N. Pandey, 2000. Effect of salts on germination of seeds and growth of young plants of *Hordeum vulgare*, *Triticum aestivum*, *Cicer arietinum* and *Brassica juncea*. *J. Agron. Crop Sci.,* 185: 209–217

Nable, R.O., G.S. Banuelos and J.G. Paull, 1997. Boron toxicity. *Plant Soil,* 193: 181–198

Nadian, H., R. Najarzadegan, K.A. Saeid, M.H. Gharineh and A. Siadat. 2010. Effects of boron and sulfur application on yield and yield components of *Brassica napus* L. in a calcareous soil. *World Appl. Sci. J.,* 11: 89–95

Naeem, M.A., M.A. Maqsood, S. Hussain, M.K. Khan and S. Kanwal, 2013. Irrigation with brackish water modifies the boron requirement of mungbean (*Vigna radiata* L.) on Typic calciargid. *Arch. Agron. Soil Sci.,* 59: 133–145

Rashid, A., E. Rafique, A.U. Bhatti, J. Ryan, N. Bughio and S.K. Yau. 2011. Boron deficiency in rainfed wheat in Pakistan: Incidence, spatial variability and management strategies. *J. Plant Nutr.,* 34: 600–613

Rehman, A.U., M. Farooq, A. Nawaz, S. Iqbal and A. Rehman, 2012. Optimizing the boron seed coating treatments for improving the germination and early seedling growth of fine grain rice. *Int. J. Agric. Biol*., 14: 453–456

Savic, J., V. Roemheld and M. Nikolic, 2012. Oilseed rape (*Brassica napus* L.) genotypic variation in response to boron deficiency. *Turk. J. Agric. For.,* 36: 408–414

Steel, R.G.D., J.H. Torrie and D.A. Dickey, 1997. *Principles and Procedures of Statistics: A Biometrical Approach*. McGraw-Hill Book Co., Inc., New York, USA

Tunuturk, M., R. Tuncturk, B. Yildirim and V. Ciftci, 2011. Effect of salinity stress on plant fresh weight and nutrient composition of some Canola (*Brassica napus* L.) cultivars. *Afr. J. Biotechnol.,* 10: 1827–1832

Ullah, S., A.S. Khan, A.U. Malik and M. Shahid, 2013. Cultivar and harvest location influence fruit softening and antioxidative activities of peach during ripening. *Int. J. Agric. Biol.,* 15: 1059–1066

Wang, Q., L. Lu, X. Wu, Y. Li and J. Lin, 2003. Boron influences pollen germination and pollen tube growth in *Picea meyeri*. *Tree Physiol.,* 23: 345–351

Wicke, B., E. Smeets, V. Dornburg, B. Vashev, T. Gaiser, W. Turkenburg and A. Faaij, 2011. The global technical and economic potential of bioenergy from salt-affected soils. *Energy Environ. Sci.,* 2011: 2669–2681

Yang, M., L. Shi, F.S. Xu, J.W. Lu and Y.H. Wang, 2009, Effects of B, Mo, Zn, and their interactions on seed yield of rapeseed (*Brassica napus* L.). *Pedosphere,* 19: 53–59

(Received 01 October 2013; Accepted 28 April 2014)