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Yield and nutrient status response of wheat plants (*Triticum aestivum* L.) to foliar spraying of boron and salicylic acid under newly reclaimed soil

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ABSTRACT

Two field experiments were conducted during two successive winter seasons of 2016/2017 and 2017/2018 in Research and Production Station, National Research Centre, Al-Nubaria District, Al Behaira Governorate, Egypt. This study was carried out to determine the effects of foliar applications of boron and salicylic acid on yield and nutrient status of wheat plant grown in sandy soil. The obtained results indicate that wheat plants differ in their response to boron application. The results showed that either boron or salicylic acid increased most yield components. The best results were obtained by combined application with salicylic acid and low level of boron.

***Keywords*:** Wheat, boron and salicylic acid, yield and nutrient status

Introduction

Wheat is considered as the major cereal crop in the world, in general and particularly in Egypt, it enjoys a privileged position amongst food grain crops. Wheat (*Triticum aestivum* L.) is the most important food crop in Egypt. Wheat provides 37 % of the total calories for the people and 40 % of the protein in the Egyptian diet (Mujeeb *et al*., 2008).There are many factors determining productivity of wheat, among these factors soil fertility status. Sandy soils are deficient in plant nutrient substance and low nutrients availability (Masoud *et al*., 2012). Recently, a great attention of several investigators has been directed to increase the productivity of wheat especially in the new reclaimed sandy soil, to minimize the gap between the Egyptian production and consumption (Masoud *et al.*, 2012 and Manal *et al.* 2016). Such effect can be replenished by foliar application of micro element nutrition and plant growth promoting substance, in addition to other field practices

The prevalent problem in the universal agricultural districts and management of boron nutrition is challenged by abrupt incidences of B absence (Wimmer *et al*., 2013).Importance of boron as an agricultural chemical has grown very rapidly and its availability in soil and irrigation water has become an important determinant of agricultural production (Saleem *et al*., 2011) .Boron is vital mineral among micronutrients compulsory for plants growth (Brown *et al*., 2002). It is involved in many physiological processes in plants like RNA and carbohydrates metabolism (Herrera-Rodriguez *et al*., 2010 and Siddiky *et al*., 2007) and development of cell wall. It has also a vital function in pollen tube growth and its germination, seed development, plasma membrane stimulation, floret fertility and anther development (Oosterhuis, 2001).

Salicylic acid (o-hydroxybenzoic acid) is among a group of plant growth modulator, naturally produced by the plants and function as growth regulator. Salicylic acid (SA) is known to affect various physiological and biochemical activities of plants and may play a key role in regulating their growth and productivity (Hayat *et al*, 2010). Researchers observed a significant increase in growth characteristic, pigment contents and photosynthetic rate in maize, sprayed with salicylic acid (Shakirova, 2007). In addition, salicylic acid has been reported to induce flowering in a number of plants (Hayat *et al*., 2010 and Dempsey and Klessig, 2017)

Thus, the main object of this study was to determine the effect of foliar feeding with boron and salsylic acid either as single nutrient or in combination on the yield and yield components of wheat.

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Materials and Methods

Two field experiments were conducted during two successive winter seasons of 2016/2017 and 2017/2018 in Research and Production Station, National Research Centre, Al-Nubaria District, Al Behaira Governorate, Egypt. Experiments were carried to study the effect of foliar application of boron and salicylic acid and their combination on the yield and yield components of wheat plants under newly reclaimed soil.

This experiment include six treatments in three replicates which were control (without boron and salicylic acid), boron at two levels (1.5 g/L and 3.0 mg/L) as well as salicylic acid at rate of (4m mol), boron (1.5 g/L)+Salicylic acid and boron (3.0 g/L.) + Salicylic acid.

The experimental design was complete block design with three replicates The plot size was 10.5 m^2 = 1/400 fed (Feddan = 4200 m^2). Grains of wheat (*Triticum aestivum* cv. Sakha-92) were sown in 15 November in both winter seasons.

After 30 days from sowing each treatment were sprayed with water or one of the following aquas solution containing boron (1.5 g/ L.), boron (3.0gm/L)., Salicylic acid, mixture of boron (1.5 g/L) +Salicylic acid and mixture of boron (3.0 g/ L) +Salicylic acid. The second spray was carried 30 days later and the spray volume was 200 liter per feddan. The normal agriculture practices of growing wheat were practiced till harvest as recommended. The mechanical and chemical analysis of the soil was conducted according to the method described by Klute (1986) and is presented in Table (1).

Table 1: Mechanical and physic-chemical properties of the experimental soil (average of 2016/2017 and 2017/2018 seasons),

Mechanical analysis %			Texture	Physical properties				Macronutrients (mg/100g)				Micronutrients (ppm)			
Sand	Silt	Clay		pH	E.C mS/m	CaCO	O.M %	P	K	Ca	Mg	Fe	Mn	Zn	Cu
92.3	3.1	4.6	Sandy	7.4	0.3	1.3	0.3	3.0	19.8	62	14.7	3.8	1.8	0.72	0.6

At harvest time one square meter was taken at random from the middle area of each plot from the three replicates to determine, plant height, spike length, spike weight, grains weight/spike, tillers No./ m^2, spikes weight /m^2, grain weight /m^2 and straw weight /m^2. In addition, grain, straw and biological yields ton/fed and Harvest index were estimated. Representative samples from grains were taken to determine the following nutrient constituents N, P, K, and Ca. Macro NPK in grains were determined according to the method described by A.O.A.C., (1985). Calcium was measured in the digested suspension using the Flame photometer, (Eppendorf, DR Lang) according to the methods described by Chapman and Pratt (1961).

The experimental design was randomized complete block design with three replicates. Statistical analysis was performed according to Snedecor and Cochran (1990) and the combined analysis of the two seasons results were conducted. Treatments mean were compared by L.S.D. test at 5%.

Results and Discussion

Effect of boron and salicylic acid application on yield components

a- Plant height:

The obtained data in Table (2) showed that foliar spraying with either boron or salicylic acid significantly increased plant height of wheat plants as compared with control. These results were in agreement with those obtained by ZoZ *et al.* (2016) who reported that this increase in plant height of wheat with B application is related to the functions of these nutrients on several physiological processes in the plants. The same table also show that foliar application with salicylic acid significantly affected plant height more than boron and recorded the highest result (97.23 cm). The positive effect of salicylic on plant height confirmed by findings of Kareem *et al.* (2017) and Metwally *et al.* (2018). Also, means

comparison revealed that combined application of both boron and salicylic resulted in significantly taller plants than single use. In this respect, El-Feky *et al.* (2014) revealed that interestingly, treatment with salicylic acid induced almost the ameliorative effect on growth of B treated barely.

Tillers No.:

Data of tillers number per m^2 shows that foliar application with boron and salicylic clearly increased number of tillers as compared with unsprayed ones and such effect was more pronounced under low level of boron (Table 2) .The same table also show that combined application with boron and salicylic acid has promoting effect on this criteria and enhanced the tillering capacity of the plants. However, the maximum value of tillers number (37.3) was noted when sprayed with both boron under low level and salicylic acid. Positive effects of B application on tillers number supported by the findings of, Ahmad and Irshad (2011) and ZoZ *et al.* (2016) who showed that B application had significant effect on fertile tillers No. of rice and wheat, respectively. The promoting effect of salicylic on tillers number reported by Sanaz *et al.* (2013), Ibrahim *et al.* (2014) and Rihan *et al.* (2017). Thus, the obvious effect of combined application of boron and salicylic may be resulted from the collective effect of both of them.

Spikes characters:

Data presented in Table (2) clearly show that either foliar spraying of low level of boron or salicylic acid significantly increased spike length as compared with control plants. However, the data in the same table showed that foliar application of high level of boron greatly restricted spike length due to its toxicity on plant growth. The same table also show that combined application of boron with salicylic acid resulted in more positive impact on spike length.

Concerning spike weight per spike, similar effect observed with either boron orsalysilic acid but high rate of boron has more negative effect on this criteria. In this concern, ZoZ *et al* (2016) reported that foliar application of B resulted in significant increase of spike mass of wheat. The same table also show that combined application with both boron and salicylic acid has promoting effect on spikes weight. Such effect may be resulted from the effect of salicylic acid in mitigating the harmful impact of high level of boron.

Regarding grain weight per spike Table (2) clearly show that, individual as well as combined application of boron and salicylic acid caused a significant enhancement in grain weight per spike and per m^2. These results were in the same line of results of Tahir *et al*. (2009) who found that foliar application of boron at different growth stages increased grains weight per spike of wheat. In addition, Ibrahim *et al* (2014) indicate that exogenous application of SA significantly increased grain weight per spike as well as per m^2. The obvious effect of combined application of boron and salicylic may be attributed to the enhancing effect on spikes weight and the highest efficiency of salicylic acid in alleviation the adverse effects of high level of boron (El- Feky *et al.*, 2014).

Effect of foliar application with boron and salicylic acid on yield parameters:

Grain yield:

The present study showed that grain yield affected differently at various boron levels (Table 2). It is clearly showed that grain yield greatly depressed by high level of boron .The data also reveal that foliar application with either salicylic acid or low level of boron had significant effect on grain yield per m^2 and per Feddan in comparison with the control. The same table (2) also revealed that application of boron and salicylic acid together proved to be more effective and over exceed their effect lonely. These results in evident agreement with those obtained by Masoud *et al.* (2012) and El-Feky *et al.* (2012) In this respect, El-Feky *et al.* (2012) reported that addition of 0.5 mg L^{-1} B significantly increased the weight of straw and grains by 5.5%, as compared with control. They also added that lower concentrations of B (0.5 and 1.5 mg/L) stimulated barley growth parameters and yield by 5.5%, compared to non-boron treated barley. In general, the results presented in this work confirm the hypothesis applications of boron could improve the fertilization of flowers and wheat yield (ZOZ *et al*., 2016). The effect of salicylic acid supported by findings of Ibrahim *et al*. (2014) and Rihan *et al.* (2017). The obtained results also show that the best results were obtained when plants were treated with both Salicylic acid and low level of boron. The positive effect of combined application of boron and salicylic

Table 2: Effect of foliar spraying of boron and salicylic acid on yield components of wheat plants in newly reclaimed soil.

Treatment	Plant height (cm)	Spike length cm/spike	Spike weight g/spike	Grains weight g/spike	Tillers No. No./m^2	Spikes weight g/m^2	Grains weight g/m^2	Straw weight g/m^2	Grain yield Kg/fad.	Straw yield Kg/fad.	Bio. Yield Kg/fad.	Harvest Index %
Control	88.00	29.33	9.78	3.26	26.0	1289.7	790.2	873.0	3052.2	3666.6	6718.8	45.5
Boron (1):1.5 g/ L	94.33	31.44	10.48	3.49	36.3	1502.9	1002.7	1299.7	4211.4	5458.6	9670.0	43.6
Boron (2): 3.0 g/ L	90.10	30.03	10.01	3.34	29.7	1399.3	802.4	1169.7	3370.2	4912.6	8282.8	40.7
Salicylic acid	97.23	32.41	10.80	3.60	32.0	1437.3	943.7	1229.3	3963.7	5163.2	9126.9	43.4
Sal.+ boron (1)	95.23	31.74	10.58	3.53	37.3	1676.3	1108.6	1360.3	4656.3	5713.4	10369.7	44.9
Sal.+ boron (2)	94.10	31.37	10.46	3.49	32.0	1554.0	921.0	1198.7	3868.0	5034.4	8902.4	43.5
LSD 5%	3.25	0.34	0.19	0.04	4.92	65.05	19.2	33.3	80.6	139.8	152.7	1.0

resulting from the enhancing effect of salicylic on plant growth and its effect on decreasing the toxicity effect of high level of boron .These results confirmed by the results obtained by Gunes *et al.* (2007) and Reld (2010) who reported that the exogenous application of 0.5 mM salicylic acid significantly decreased the hazardous effect of boron toxicity in maize. In this respect, Metwally *et al.* (2018) also concluded that growth and yield of canola plants grown under high B concentration improved after external application of SA.

Straw yield:

Regarding straw yield the obtained results obviously indicate that individual as well as combined application of low level of boron and salicylic acid caused a significant enhancement in straw yield per m^2 as well as per Faddan. The effect of boron on straw yield supported by the finding of ZoZ *et al.* (2016). The stimulating effect of salicylic acid recorded by El Feky *et al.* (2014) and Ibrahim *et al.* (2014) who reveal that exogenous application of 50 and 100 ppm SA resulted in significant increase in grain yield, straw yield, and biological yield. These results again indicate that application of boron and salicylic acid together proved to be more effective. These results were in line with those obtained by Gunes *et al.* (2007), El- Feky *et al*. (2012) and Metwally *et al.* (2018).

Biological yield:

Results of mean comparison of data (Table 2) of the studied treatments showed correspondingly similar behavior as that of grain and straw yield, i.e. either boron or salicylic acid increased biological yield . In this respect, considerable differences were induced by the various levels of B. These results were in agreement with the results of Soomro *et al.* (2012) who reported that application of B (0.5%) as foliar spray getting higher fodder yield of maize. Metwally *et al.* (2012) also reported that elevated concentration of boron had a notable inhibitory effect on dry matter gain. In support of our findings on salicylic acid effect , studies of Hayat *et al*. (2007) revealed that SA application enhanced the activities of various physiological and biochemical characteristics, such as photosynthetic reactions, flowering and plant development Examined Data in Table (2) also show that combined application of boron and salicylic acid resulted in more pronounced effect on biological yield .Such effect supported by the finding of Gunes *et al.* (2007) and Khdair (2015) who reported that boron interaction with salicylic acid has more significant effected than single traits.

Harvest Index:

The data presented in Table (2) indicate that harvest index decreased by foliar application with either salicylic or boron at both levels as compared with unsprayed plants. The same table also show that dual use of boron and salicylic acid and boron increased harvest index as compared with single application. Similar results obtained by Gunes *et al* (2007) and Khdair (2015).

Nutrient status of wheat grains as affected by salicylic acid and boron application:

According to the data presented in Table (3), it is clearly indicated that in general, foliar application with boron at both levels as well as salicylic acid increased NPK and Ca in wheat grains as compared with control. However, the effect of salicylic acid was more pronounced.

Table 3: Effect of foliar spraying of boron and salicylic acid on the chemical constituents of wheat grains.

Treatments	N %	P %	K %	Ca %
Control	1.700	0.198	0.402	0.235
Boron 1: 1.5 gm/L	2.230	0.273	0.406	0.243
Boron 2: 3.0 m/L.	2.060	0.246	0.390	0.232
Salicylic acid	2.920	0.360	0.518	0.462
Salicylic + boron 1	2.720	0.373	0.460	0.392
Salicylic + boron 2	2.600	0.372	0.430	0.363

These results confirmed by results of Ateeque and Malewar (1992) and Muhammad Zafar-ul-Hye *et al* (2016) who reported that maximum phosphorus and potassium concentration in grains was found where boron was applied at 2 kg ha^{-1}. In this concern, Rao and Vidyasagar (1981) recorded that Boron

when sprayed on foliage influenced the absorption and preferential translocation of mineral elements. Gunes *et al.* (2007) and Grown (2012) also demonstrated that salicylic acid improved the uptake of minerals.

Conclusion

The present study showed that wheat yield was affected differently at various B levels. When B was applied at low level (1.5 g/L), all of the measured yield parameters significantly increased. On contrary, presence of high amount of B (3.0 g/L.) adversely affects plant yield. Thus, the obtained results aims to study the benefit level of boron application for high wheat yield. The present study aims also to study the effect of combined application of salicylic acid and boron in increasing productivity of wheat plant. Besides, the effect of salicylic acid in counteracting the hazardous effect of high level of boron

References

A.O.A.C., 1985. Official Methods of Analysis of the Official Analytical Chemists: 14^{ed}. Washington, D.C.

Ahmad, R., and M. Irshad, 2011. Effect of boron application time on yield of wheat, rice and cotton crop in Pakistan. Soil & Environment, Faisalabad, 30(1):50-57.

Ateeque, M. and G.U. Malewar, 1992. Uptake of N, P and boron by sunflower as influenced by sources and levels of phosphorus with and without boron. J. Soils Crops, 2: 12-14.

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 Biology 4: 205-223.

Chapman, H. O. and P. E. Pratt, 1961. Methods of analysis for soil, plants and waters. Univ. Calif. Div. Agic. Sci., P. 309.

Dempsey, D.A. and D.F. Klessig, 2017. How does the multifaceted plant hormone salicylic acid combat disease in plants and are similar mechanisms utilized in humans? BMC Biol., 15:23.

El-Feky, S.S., F.A. El-Shintinawy, E.M. Shaker and H.A. Shams El-Din, 2012. Effect of elevated boron concentrations on the growth and yield of barley (*Hordeum vulgare* L.) and alleviation of its toxicity using different plant growth modulators. Australian Journal of Crop Science, 6, 12: 1687-1695.

El-Feky, S.S., F.A. El-Shintinawy and E.M. Shaker, 2014. Role of $CaCl_2$ and salicylic acid on metabolic activities and productivity of boron stressed barley (*Hordium vulgare* L.). Int. J. Curr. Microbiol. App. Sci., 3(2): 368-380.

Grown, B., 2012. Physiological role of salicylic acid in improving performance, yield and some biochemical aspects of sunflower plant grown under newly reclaimed sandy soil. Australian Journal of Basic and Applied Sciences 6(4): 82-89.50.

Gunes, A., A. Inal, M. Alpaslan, F. Eraslan, E.G. Bagci and N. Cicek, 2007. Salicylic acid induced changes on some physiological parameters symptomatic for oxidative stress and mineral nutrition in maize (*Zea mays* L.) grown under salinity. J. Plant Phsiol., 164: 728-736.

Hayat, Q., S. Hayat, M. Irfan and A. Ahmad, 2010. Effect of exogenous salicylic acid under changing environment a review. Environmental and Experimental Botany, 68: 14-25.

Herrera-Rodriguez, M.B., A. Gonzalez-Fontes, J. Rexach, J.J. Camacho-Cristobal, J.M. Maldonado and M.T. Navarro-Gochicao, 2010. Role of boron in vascular plants and response mechanism to boron stresses. Plant Stress, 4: 115-122.

Ibrahim O.M, B.A. Bakry, A.T. Thalooth and M.F. El-Karamany, 2014.Influence of nitrogen fertilizer and foliar application of salicylic acid on wheat. Agricultural Sciences, 5, 1316-1321.

Kareem F., H. Rihan and M. Fuller, 2017. The Effect of Exogenous Applications of Salicylic Acid and Molybdenum on the Tolerance of Drought in Wheat. Agri. Res & Tech: Open Access J 9(4): ARTOAJ.MS.ID.555768.

Khdhair, A. M., 2015. Effect of salicylic acid and Boron on growth and yield of okra (*Abelmoschus esculentus* L. Journal of El- Forat for Agriculture Science, 7(2):27-35.

Klute, A., 1986. Methods of Soil Analysis". 2nd ed. Part 1: Physical and mineralogical methods. Part 2: Chemical and Microbiological properties. Madifon, Wesconsin, USA.

Manal, F.M., A.T. Thalooth, Amal G. Ahmed, Magda H. Mohamed and T.A. Elewa, 2016. Evaluation of the effect of chemical fertilizer and humic Acid on yield and yield components of wheat plants (*Triticum aestivum*) grown under newly reclaimed sandy soil. International Journal of Chem Tech Research, 9(8):154-161.

Masoud, B., R. Abdolshahi, G.M. Nejad, K. Yousefi and S.M. Tabatabaie, 2012. Effect of different microelement treatment on wheat (*Triticum aestivum* L.) growth and yield. Intl. Res. J. Appl. Basic. Sci., 3(1): 219-223.

Metwally, A., R. El-Shazoly and A.M. Hamada, 2012. Effect of boron on growth criteria of some wheat cultivars. J. Biol Earth Sci., 2(1): B1-B9.

Metwally, A.M., A.A. Radi, R.M. El-Shazoly and A.M. Hamada, 2018.The role of calcium, silicon and salicylic acid treatment in protection of canola plants against boron toxicity stress. J Plant Res., 131(6):1015-1028.

Muhammad Zafar-ul-Hye, K. Munir, M. Ahmad and M. Imran, 2016. Influence of boron fertilization on growth and yield of wheat crop under salt stress environment. Soil Environ. 35(2): 181-186.

Mujeeb, R., A.S. Umed, Z. Mohammad and G. Shereen, 2008. Effects of NaCl salinity on Wheat (*Triticum aestivum* L.) Cultivars. World J. Agri. Sci., 4(3): 398-403.

Oosterhuis, D.M., 2001. Physiology and nutrition of high yielding cotton in the USA. In. Informacoes Agronomicas N-Setembro. pp. 18-24.

Rao, H.G. and C. Vidyasagar, 1981. Effect of nitrogen, phosphorus and potassium along with foliar and soil applied boron on sunflower (*Helianthus annus* L.) I. Growth, yield, seed oil content and varietal performance. Andhra Agric. J., 28: 150-155.

Reid, R., 2010. Can we really increase yields by making crop plants tolerant to boron toxicity? Plant Sci., 178:9–11.

Rihan, H., F. Kareem and M. Fuller, 2017. The Effect of Exogenous Applications of Salicylic Acid and Molybdenum on the Tolerance of Drought in Wheat. Agri Res & Tech: Open Access J.,(4): 555768.

Sanaz, R.Kh, F. Shekari, J. Sabaand, and Z. Esmaiel, 2013. Effects of Salicylic Acid on Emergence and Seedlings Growth of Three Wheat Cultivars under Rainfed Conditions. International Journal of Agronomy and Plant Production, 4, 3057-3062.

Saleem, M., Y.M. Khanif, I. Fauziah, A.W. Samsuri and B. Hafeez, 2011. Importance of boron for agriculture productivity. International Research Journal of Agricultural Science and Soil Science, 1, 8: 293-300.

Shakirova, F., 2007 .Role of hormonal system in the manifestation of growth promoting and anti stress action of salicylic acid. In: Hayat S, Ahmad A (Eds.), Salicylic acid: a plant hormone. Springer, Netherlands, pp. 69-89.35.

Siddiky, M.A., N.K. Halder, K.U. Ahammad, K. Anam and M. Rafiuddin, 2007. Response of brinjal to zinc and boron fertilization. International Journal of Sustainable Agriculture and Technology 3(3): 40-45.

Snedecor, G.W. and W.G. Cochran, 1990. Statistical Methods 8th Ed. Iowa State Univ. Press Ames, Iowa, U.S.A.

Soomro, Z.H., P.A. Baloch and A.W.P. Gandhai, 2012. Comparative effects of foliar and soil applied boron on growth and fodder yield of maize. Pakistan Journal of Agriculture: Agricultural Engineering Veterinary, 27(1):18-26.

Taher, M., A. Tanveer, T.H. Shah, N. Fiaz and A. Wasaya, 2009. Yield response of wheat (*Triticum aestivum* L.) to boron application at different growth stages. Pakistan Journal of Life and Social Sciences, Oxfordshire, 7(1):39-42.

Zoz, T., Steiner Fábio; Seidel Edleusa Pereira; Castagnare Deise Dalazen; Gabriel Elias de Souza Biosci, 2016. J. Uberlândia, 32(4): 873-880.

Wimmer, M.A. and T. Eichert, 2013. Mechanisms for boron deficiency-mediated changes in plant water relations. Plant Science, 203–204.