Assiut J. of Agric. Sci., 43(4) September(30-48)

Response of Some Maize Cultivars to Potassium and Boron Fertilization Under New Valley Conditions

[1]H.A. Shoman; [2]R.A. Dawood; [2]F.M.F. Abdel-Motagally and [1]M.A. Abd El-Gawad

[1]Agron. Unit, Desert Research Center, Matariya, Cairo, Egypt.
[2]Agron. Dept., Fac. Agric., Assiut Univ., Assiut, Egypt.

Abstract:

Two field experiments were carried out in the Desert Research Center (D.R.C.), Agricultural Experiment Station at EL-Kharga Oasis, New Valley Governorate, Egypt, during the two summer growing seasons of 2010 and 2011. This study aimed to investigate the effect of potassium fertilizer rates (0, 36 and 72 kg K_2O per fad.) and boron foliar levels (0, 226, 452, and 678 ppm) on yield and its components of three maize cultivars i.e. Giza-10, Giza-321 and Giza-324. Results indicated that Giza-321 cultivar significantly surpassed Giza 10 and Giza-324 in all studied yield parameters. The use of boron fertilizer at the level of 452 ppm showed significant superiority for all studied yield components compared with the control (without boron foliar). Moreover, these parameters were significantly higher under using high level of potassium fertilizer (72 kg K_2O per fad.) compared with control treatment (without potassium fertilizer).

Maximum values of yield and its components were obtained by cultivating Giza-321 cultivar with spraying boron at the level of 452 ppm and fertilized with 72 kg K_2O per fad. in both seasons.

Key words: Maize, cultivars, potassium, boron and yield components

Introduction:

There are promising newly reclaimed lands in Egypt. One of the most suitable locations is the New Valley region with its Oasis, which represents large land resources and a good hope for agriculture expansion, since it represents 38 % (376000.51 km^2) of the total area of Egypt and has about 3.5 million faddan available to cultivation. In this region, weather is hot and dry, and is recognized as drought regions. Therefore, some of plant species i.e., maize can not give grain yield under this conditions due to high temperature, whereas, Maria Pilar and Johnson (1980) found that temperatures above 35º C can reduce pollen germination of many maize cultivars to levels near zero and to result in poor kernel set, following decreasing yield. In addition, Muchow (1990) detected increment in temperature from 27º C to 33º C

Received on: 26/7/2012 **Accepted for publication on**: 23/8/2012
Referees: Prof. Dr. Tawkl Youens, Prof. Dr. Eneam. H. Galal.

or to 38º C during pollen period results in a yield loss of around 10% and 42% for maize crop, respectively.

In Egypt, the total cropped area occupied by maize during season 2011 was 1.758 million faddan with total production 5.8 million ton (FAO, 2011). It is very important to increase production of maize to cover gab between production and consumption. The highest maize yield production in New Valley region depends on many factors which could be achieved through:

1- Cultivating the promising maize cultivars that characterized by high yielding, tolerance to heat stress and drought. Many investigators found that maize cultivars differed in yield and its components among them Soliman and Barakat (2006) who mentioned that there were significant differences among the two inbred lines. Also, Naushad Ali *et al.* (2007) revealed that the tested maize genotypes differed significantly for the ear length, 1000-grain weight and grain yield (kg ha^{-1}). All tested maize hybrids differed significantly for plant height, number of ears per plant, number of rows per ear, number of grains per ear, 1000-grain weight and grain yield/fad. (Muhammad *et al.* 2007). In addition, Akram *et al.* (2010) found that significant differences were found in the maize hybrids with respect to ear length, 1000-grain weight, grain yield and biological yield.

2- Using substances that increase the ability of endurance the heat stress as potassium element (K). Whereas, potassium enhances carbohydrate synthesis and translocation, protein and amino acid synthesis and enzyme activity. It controls transpiration, respiration, regulation of plant stomata and uptake of certain nutrients, like nitrogen and magnesium, enhances rooting, and stress tolerance of maize (Robert, 2005). Several research works have observed positive response of maize plants to potassium fertilizer and increasing yield and its components among them Muhammad *et al.* (2007) found that different potash levels had a significant effect on grain yield. The application of K_2O increased enzymes activation which increased flag leaf area, thus resulted in the highest grain yield of maize. Likewise, Maqsood *et al.* (2008) found that the application of potassium increased the yield and yield components of maize plants. Moreover, Ahmad *et al.* (2009) reported that grain yield was significantly increased by K application. The increase in yield up to 200 kg ha^{-1} was significant at each K level and significant reduction yield occurred at K level of 250 kg ha^{-1}.

3- Applying elements that increase efficiency of pollination process under drought conditions like boron (B). Whereas, Loomis and Durst (1992) found that boron deficiency reduced pollen germination rate and retardation of pollen tube growth. Boron deficiency also caused morphological abnormalities, including swelling at the tip of the pollen tube. Walden (1993) reported that rates of germination of maize pollen grains was above 90% when was treated for 30 minute by 0.01% boric acid and continued pollen tubes 16 h after germination, Aydyn *et. al*. (2003) indicated that boron plays a vital role in pollination, viability of pollen grains, development of plant tissue, promote germination pollen grains, promote tube growth, water relations and sugar translocation. These results are in agreement with those obtained by Walden (1993); Ray (1999) Waqar *et al.* (2009) and Sittichai *et al.* (2010).

So, this study was designed to improve maize productivity by using three cultivars of maize plants fertilized with different potassium and boron levels under New Valley conditions.

Materials and Methods:

Two field experiments were carried out in the Desert Research Center (D.R.C.), Agricultural Experiment Station at EL-Kharga Oasis, New Valley Governorate, during the two summer growing seasons (2010 and 2011). This study aimed to investigate the effect of potassium and boron fertilization on yield and its components for some maize cultivars. The soil of the experiment was sandy clay loam texture, pH values, organic matter (%), Ec (ppm), available K (ppm), B and Fe (ppm) were 8.74, 0.58, 614, 31, 0.55 and 66.08, in the first season, while in the second season the respective values were 8.69, 0.67, 587, 36, 0.47 and 71.44, respectively.

The experiment included 36 treatments which were the combinations among the three cultivars, three potassium levels and four boron levels:

A – Maize cultivars:

1) Giza-10
2) Giza-321
3) Giza-324

The maize cultivars were obtained from Maize Breeding Section, Agriculture Research Center (A.R.C.), Ministry of Agric. Whereas, Giza-10 is a single cross but Giza-321 and Giza-324 are triple crosses. Grains of the three cultivars were sown at 15 March in both seasons at a rate of 15 kg fad^{-1}.

B - Potassium fertilizer treatments:

Potassium fertilizer treatments were:

1) Without potassium (K_2O)
2) 36 Kg K_2O per fad.
3) 72 Kg K_2O per fad.

Each potassium level splited into two equal doses, the first dose was added after 30 days, then the second dose at 60 days from sowing. Potassium was added in the form of potassium sulfate (48% K_2O).

C - Boron foliar application:

Boron foliar treatments were added at four levels as follows:

1) Without boon (water spray).
2) 226 ppm boron (0.20 % borax)
3) 452 ppm boron (0.40 % borax)
4) 678 ppm boron (0.60 % borax)

Boron was applied as foliar application in the form of borax ($Na_2B_4O_7.10H_2O$, 11.3% B) at 50 % from tasseling stage (60 days from sowing) with 300 liter water fad^{-1}.

A split split plot design with three replications was used. The main plots were occupied with maize cultivars, the sub plots allotted with boron foliar levels and the treatments of potassium assigned in the sub sub plots. Each experimental unit area in the two seasons was 10.5 m^2 (1/400 faddan). All recommended common agricultural practices were adopted throughout the two experimental seasons. First irrigation was applied at 15 days after sowing and then plants were irrigated every 8 days till the dough stage.

At harvest, Samples of 5 plants plot^{-1} were taken randomly after 119 and 124 days from sowing in 2010 and 2011 growing seasons, respectively, from the middle of plot for every treatment to determine the following characters: plant height (cm), number of ears plant^{-1}, ear weight (g), ear length (cm), number of grains ear^{-1}, 1000-grain weight (g), shelling (%), grain yield (kg/faddan) and biological yield (kg/faddan).

Where:

- Plant height (cm): measured as a distance from the ground surface to the base of tassel node.

-Grain yield (kg fad^{-1}.): Three center rows were harvested from each sub-sub plot to determine from the weight of grain adjusted to 15.5% moisture of each plot and expressed to kilogram fad^{-1}.

- Shelling (%) = Weight of grains from ten ears/weight ten ears x 100.

All the obtained data were subjected to analysis of variance according to the method described by Gomez and Gomez (1985). Means comparison were done using least significant difference (LSD) at 5% level of probability.

Results and Discussion

Effect of cultivars:

Results presented in Table (1) revealed that plant height, ear weight, ear length, no. of grains ear^{-1}, 1000-grain weight, shelling%, grain yield and biological yield were significantly affected by maize cultivars in both seasons. On the other hand, maize cultivars did not significantly differ in number of ears plant^{-1} in both seasons. The highest values of these characters were recorded by cultivar Giza-321 followed by cultivar Giza-324, while the minimum values were recorded by cultivar Giza-10 in both growing seasons. Differences between Giza-321 and Giza-324 were not significant for shelling% in both seasons as well as for grain yield and biological yield in the first season only. It is worthy to mention that differences among the studied cultivars in grain yield may be due to differences in genetic structure between the three maize cultivars. In this respect Abd El-Gawad *et al.* (1985) reported that the

Three-Way Cross 310 surpassed the Single Cross. El-Koomy (2005) mentioned that differences between cultivars might be due to differences in number of roots and the average weight of blade. Moreover, it might be attributed to the differences in photosynthetic activity of the leaves, i.e., internal factor and/or differences in light distribution of leaf surface of the crop canopy resulted from differences in leaf arrangement and to differences in chlorophyll content and photosynthesis enzymes activity. Here, the highest grain yield might be due to its maximum numbers of ears plant^{-1} and grains ear^{-1}, the longest and the heaviest ear, and the highest 1000-grain weight and shelling percentage. Similar results were reported by Muhammad *et al.* (2007) and Nazir *et al.* (2010). Further, El-Gizawy and Salem (2010) mentioned that there were significant differences among maize hybrids in number of ears plant^{-1}, number of grains ear^{-1}, 100-grain weight, shelling %, ear weight, grain weight ear^{-1} and grain yield fad.$^{-1}$ in both seasons. Abdul Aziz *et al.* (2011) cleared that ear height, no. of ears plant^{-1}, ear length, no. of grains ear^{-1}, 1000-grain weight and grain yield ha^{-1} varied significantly among the varieties. The highest grain yield was attributed for its maximum number of ears plant^{-1}, grains ear^{-1} and the highest 1000-grain weight. Also, Ahmad *et al.* (2011) mentioned that different maize hybrids affected grain rows ear^{-1}, no. of grains ear^{-1}, grain weight ear^{-1} and grain yield significantly.

A- Effect of boron foliar:

Data recorded in Table (2) indicated that applying boron spray levels from zero to 678 ppm to maize under EL-Kharga soil conditions had a highly significant effect on all studied traits except plant height and number of ears plant^{-1} were not significantly affected. Maximum values of these parameters were produced by 452 ppm of B in both seasons. Therefore, the increases percentages in ear weight (87.80 & 99.44), ear length (16.09 & 19.23), no. of grains ear^{-1} (120.92 & 274.78), 1000-grain weight (6.35 & 5.18), shelling % (24.48 & 8.96), grain yield (120.44 & 135.08) and biological yield (47.99 & 40.16) outcome the foliar by this level (452 ppm boron) compared with control (without boron), in the first and second seasons, respectively. However, the differences between boron foliar application by 452 and 678 ppm were not significant on ear length and biological yield in the first season only, and on 1000-grain weight and shelling% in both seasons. Aydyn *et al.* (2003) indicated that boron plays a vital role in pollination, viability of pollen grains, development of plant tissue, promote germination pollen grains, promote tube growth, water relations and sugar translocation. This finding is in agreement with those obtained by Walden (1993); Ray (1999); Echarte *et al.* (2006) and Sittichai *et al.* (2010) who reported that B foliar increase no. of grains ear^{-1} and grain yield.

2-Effect of potassium fertilizer:

Data in Table (3) revealed that increasing potassium fertilization rates from 0 to 72 kg K_2O/fad. caused significant increase in all yield components of maize plants in the both seasons, except number of ears plant^{-1} in the second season. The increasing percentages with using the high rate of potassium fertilizer (72 kg K_2O/fad) at comparing with the control treatment were for plant height (66.99 & 67.39), no. of ears plant^{-1} (11.59 & 5.14), ear weight (104.98 & 62.07), ear length (76.28 & 70.65), no. of grains ear^{-1} (119.75 & 37.55), 1000-grain weight (26.59 & 26.61), shelling % (30.48 & 42.07), grain yield (163.86 & 117.49) and biological yield (62.42 & 59.01), in 2010 and 2011 seasons, respectively. Robert (2005) mentioned that potassium enhances carbohydrate synthesis and translocation, protein and amino acid synthesis and enzyme activity. Also, it controls transpiration, respiration, regulation of plant stomata, enhances rooting and stress tolerance of maize. These results are in accordance with those mentioned by Muhammad *et al*. (2007); William (2008); Maqsood *et al*. (2008); Ahmed *et al*. (2009) and Masood *et al*. (2009).

Further, Akram *et al*. (2010) showed that the effect of the application of potassium was more pronounced in improving and increasing the yield components of the maize crop (plant height, no. of grains ear^{-1} and 1000-grain weight). Application of potassium at the optimal level (125 kg ha^{-1}) significantly improved maize yield. This may be due to turgor pressure and maintenance of water and nutrient uptake because potassium plays an important role in osmoregulation. As well as, Ahmad *et al.* (2011) indicated that number of grains ear^{-1} and grains weight ear^{-1} varied significantly by the application of potassium. Crop receiving no fertilizer had significantly low number of grains ear^{-1} and grains weight ear^{-1} than rest of the K treatments.

B-Effect of the interactions:

1- Effect of the interaction between cultivars x boron foliar application

According to the data in Table (4) the effect of the interaction between maize cultivars and spraying boron was significant on ear weight, ear length, 1000-grain weight and yields of grain and biological in both seasons, as well as the shelling percentage was significant in the second season only. On the other hand, the effect of this interaction was not significant on plant height and no. of ears plant^{-1}.

Maximum values of the interaction between maize cultivars and boron spraying on yield and its components was obtained from plants Giza-321 cultivar which had received 452 ppm as boron foliar application on the two seasons. While, the minimum values were obtained by

Giza-10 cultivar and the control treatment of boron (without boron foliar) in both season. Aydyn *et al*. (2003) reported that grain yield increased significantly up to 2 kg B/ha, then decreased with higher B level in Kiziltan cultivar. Moreover, Sittichai *et al*. (2010) mentioned that B benefit the production of hybrid maize grain, which the primary concern being successful pollination and fertilization.

2- Effect of the interaction between cultivars x potassium rates

Available data in Table (5) revealed that all above traits of yields and its components were significantly affected by the interaction between maize cultivars and rates of potassium fertilizer in both seasons except, no. of ears plant^{-1} don't reach the significant level in the two seasons. The highest values of yield and its components of maize plants were obtained by Giza-321 cultivar with the highest rates of potassium fertilizer (72 kg K_2O/fad.) in both seasons. In this respect, the lowest values were achieved by the combinations of Giza 10 cultivar with control (without potassium) in the two seasons. Nazim *et al*. (2007) stated that the interaction of V x K showed that more no. of grains ear^{-1} was noted in Azam var. with 90 kg potassium per faddan. On the other hand, Akram *et al*. (2010) mentioned that the interaction between maize hybrids and potassium levels was non significant on plant height, no. of grains ear^{-1} and 1000-grain weight.

3- Effect of the interaction between boron x potassium

Results in Table (6), generally, indicated that plant height, ear weight, ear length, no. of grains/ear, 1000-grain weight, grain and biological yields were significantly affected by the interaction between boron foliar application and potassium fertilizer, as well as the shelling percentage was significant in the first season only. While, no. of ears/plant did not significantly affected by the interaction in both seasons. The maximum increments for yield and its components were obtained by spraying maize plants by 452 ppm boron with adding high rate of potassium fertilizer (72 kg K_2O/fad.) in both seasons. The lowest values were achieved by the control treatments for the two factors (boron and potassium) in the two seasons.

4- Effect of the second order interaction

Regarding the effect of the interaction among maize cultivars, boron foliar application and potassium fertilizer rates on yield and its components, data in Tables (7 and 8) indicated that significant increases in plant height, ear weight, ear length, no. of grains ear^{-1}, 1000-grain weight, shelling %, grain yield and biological yield during 2010 and 2011 seasons were detected. However, no significant effects were achieved for no. of ears plant^{-1} in both seasons.

The maximum increases due to this interaction were obtained by Giza- 321 maize cultivar with spraying 452 ppm boron and fertilization with 72 kg K_2O/fad. in both seasons. It could be concluded that Giza-321 cultivar surpassed Giza-324 and Giza 10 under spraying by 452 ppm boron and high rate of potassium fertilizer which was adaptive to environmental conditions and subsequently in increasing the efficiency of the plants in more building metabolites leading to increase yield and its components

References:

Abd El-Gawad, A.A.; A.S. Edris and A.M.Abo-Shetaia. 1985. Intercropping soybean with maize. Ann. Agric. Sci. Fac. Agric., Ain Shams Univ., 30 (1): 237-248.

Abd El-Maksoud, M.F. and A.A. Sarhan. 2008. Response of some maize hybrids to bio and chemical nitrogen fertilization. Zagazig J. of Agric.Res. 935(3): 497-515.

Abdul Aziz, M.D.; A.K. Rahman; R. Chakma; M. Ahmed and A.F. Ahsan. 2011. Performance of bari hybrid maize varieties in the Hilly areas of Bangladish. J. Expt. Biosci. 2 (2): 25-28.

Ahmad, A.H.; M.A. Bukhsh1; A. Riaz; M. Ishaque and A.U. Malik. 2009. Response of maize hybrids to varying potassium application in Pakistan. Pak. J. Agri. Sci., 46 (3): 233-246.

Ahmad, A.H.; M.A. Bukhsh1; A. Riaz; J. Iqbal; S. Hussain, A. Ur Rehman and M. Ishaque. 2011. Potassium application reduces bareness in different maize hybrids under crowding stress conditions. Pak. J. Agri. Sci., 48 (1): 41-48.

Akram, M.; M.Y. Ashraf; A. Rashid; M. Rafiq; I. Ahmad and J. Iqbal. 2010. Allometry and yield components of maize (*Zea mays* L.) hybrids to various potassium levels under saline conditions. Arch. Biol. Sci., Belgrade, 62(4): 1053-1061.

Aydyn, G.N.; M. Alpaslan and A. Unal. 2003. Effects of boron fertilization on the yield and some yield components of bread and durum wheat. Turk. J. Agric (27): 329-335.

Echarte, L.; F.H. Andrade; V.O. Sadras and P. Abbate. 2006. Kernel weight and its response to source manipulations during grain filling in Argentinean maize hybrids released in different decades. Field Crops Res. 96: 307-312.

El-Gizawy, N.Kh.B. and H.M. Salem. 2010. Influence of nitrogen sources on yield and its components of some maize varieties. World. J. Agric. Sci., 6 (2): 218-223.

El-Koomy, M.B. 2005. Significance of some agronomic indices in maize breeding program. Ph. D. Thesis, Agron. Dept. Fac. of Agric., Ain Shams Univ.

FAO. 2011. Food and Agricultural Organization. www. Fao. Org. (C.F. Computer research).

Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agriculture Research. A Wiley- Inter Science Publication, John Wiley & Sons, Inc. New York, USA.

Loomis, W.D. and R.W. Durst. 1992. Chemistry and biology of boron. Biofactors 3: 229–239.

Maria Pilar, H. and R.R. Johnson. 1980. High temperature stress and pollen viability of maize. Crop Sci., 20: 796-800.

Maqsood, T.; J. Akhtar; M.R. Farooq; M.A. Hag and Z.A. Saqib. 2008. Biochemical attributes of salt tolerant and salt sensitive maize cultivars to salinity and potassium nutrition. Pakistan J. Agric. Sci., 45: 1-5.

Masood, A.; A. Rashid and K.H. Ahmad. 2009. Response of maize to applied potassium. Asian J. Plant Sci., 1(4): 470-471.

Muchow, R. C. 1990. Effect of high temperature on grain growth in field grown maize.Field Crops Research. 23: 145-158.

Muhammad, A.; B. Amanullah and A. Mohammad. 2007. Phenology, leaf area and yield of spring maize (Cv. Azam) as affected by levels and timings of potassium application. World Appl. Sci. J., 2 (4): 299-303.

Naushad Ali, T.; S. Salim Shah; S. Ali; H. Rahman; T. Ali and M. Sajjad. 2007. Genetic variability for yield parameters in maize (*Zea Mays* L.) genotypes. J. Plant Nutr. 4: 81-87.

Nazim, H.; Z. Amir and A. Habib. 2007. Response of maize varieties to phosphorus and potassium levels. Sarhad J. Agric. 23 (4): 231-244.

Nazir, H.; Qamar-u-Zamin; A.N. Muhammad and A. Abdul Aziz. 2010. Response of maize varieties under Agro-cological conditions of Dera Ismail Khan. J. Agric. Res., 48 (1): 511-520.

Ray, J.D. 1999. Physiological roles and transport mechanism of boron: perspective from plants. Eur. J. Physiol. 456: 671-677.

Robert, B. 2005. Potassium deficiency symptoms in drought stressed crops, plant stress resistance and the impact of potassium application south china. Agron. J., 98: 1354-1359.

Sittichai, L.; D. Bernard; J. Sansanee and R. Benjavan. 2010. Boron deficiency in maize. Adv. Agron., 43: 107-153.

Soliman, M.S.M. and A.A. Barakat. 2006. Growth and yield analysis of two inbred lines and sixteen crosses of white maize cultivars (*Zea Mays* L.) cultivated in Egypt. J. Appl. Sci. Res., 2 (11): 936-941.

Walden, D.B. 1993. In vitro pollen germination. The Maize Handbook, pp 723-724, Springer, New York, Inc.

Waqar, A.; A. Niaz; S.K. Rahmatullah and M.K. Rasheed. 2009. Role of boron in plant: A review. J. Agric. Res., 47(3):1122-1134.

William, T.P. 2008. Potassium influences on yield and quality production for maize, wheat, soybean and cotton. Physiologia Plantarum 133: 670–681.

إستجابة بعض أصناف الذرة الشامية للتسميد بالبوتاسيوم والبورون تحت ظروف الوادي الجديد

حسام الدين احمد ثابت شومان[1] و رجب احمد داوود[2]
و فتحي محمد فتحي عبد المتجلي[2] و محمود احمد عبد الجواد[1]
[1]وحدة المحاصيل – مركز بحوث الصحراء – المطرية – القاهرة
[2]قسم المحاصيل – كلية الزراعة – جامعة اسيوط

أقيمت تجربتان حقليتان بالمزرعة البحثية بالخارجة التابعة لمركز بحوث الصحراء بمحافظة الوادي الجديد خلال موسمي ٢٠١٠ و ٢٠١١ لدراسة تأثير التسميد بالبوتاسيوم بمعدلات (صفر ، ٣٦ و ٧٢ كجم بو٢أ / فدان) و الرش بالبورون بمعدلات (صفر، ٢٢٦ ، ٤٥٢ و ٦٧٨ جزء فى المليون) على المحصول ومكوناته لبعض أصناف الذرة الشامية (هجين فردى جيزة ١٠، هجين ثلاثى جيزة ٣٢١ و هجين ثلاثى ٣٢٤) تحت ظروف منطقة الوادي الجديد.

وكانت أهم النتائج المتحصل عليها كالتالى:

١- تفوق الصنف جيزة ٣٢١ معنويا على كلا من الصنفين جيزة ١٠ و جيزة ٣٢٤ فى كل صفات المحصول ومكوناته.

٢- أدى استخدام الرش بالبورون بمعدل ٤٥٢ جزء فى المليون الى زيادة معنوية كبيرة فى جميع صفات حاصل البذور ومكوناته التى تم دراستها مقارنة بمعاملة المقارنة (بدون رش بالبورون).

٣- ادت زيادة التسميد البوتاسى من صفر الى ٧٢ كجم بو٢أ / فدان الى زيادة معنوية فى جميع مكونات المحصول.

٤- تم الحصول علي أعلى القيم للمحصول ومكوناته بزراعة الصنف جيزة ٣٢١ عند الرش بمعدل ٤٥٢ جزء فى الميليون يورون مع اضافة ٧٢ كجم بو٢أ / فدان في كلا الموسمين.