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The Effect of Application Methods and Treating with Various Growth Promoter Substances on Productivity of Maize

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ABSTRACT

Improving maize productivity can be succeeded by choosing the best methods of application of some growth promoter substances *i.e.* gibberellic acid (GA_3), oxalic acid and yeast extract as a new technique in enhancing maize growth and productivity. So, two trails were conducted at El-Hajarsh Village, Center of Kafr Saqr, Sharkia Governorate, Egypt, in 2013 and 2014 growing seasons to determine the effect of application methods and treating with various growth promoter substances and their interaction on productivity of maize hybrid single cross 10 (SC 10). A strip-plot design with four replications was used. Three application methods *i.e.* soaking, foliar application and soaking + foliar application were organized in the vertical plots. While, growth promoter substances *i.e.* without (control treatment), water, gibberellic acid "GA_3" (100 ppm), oxalic acid "OA" (400 ppm) and yeast extract "YE" (100 ml/L) were distributed on the horizontal plots. The results showed that seed soaking for about 18 hours plus foliar application twice later than 25 and 45 days since sowing of maize with YE (100 ml/200 liter water/fed) in order to obtained high growth, yield and its components under the environmental conditions of Sharkia Governorate, Egypt.

Keywords: Corn or maize (*Zea mays* L.), Growth Promoter (GA_3), Oxalic acid (OA), Yeast extract (YE), growth, yields.

INTRODUCTION

Maize or corn (*Zea mays* L.) considered the most important cereal grain in the world and Egypt came after wheat and rice. It has great nutritional value for humans and animals due to its contain starch, protein, oil, fiber, sugar and ash (Chaudhary, 1983). Egypt cultivated about 1.03* hectare, producing 8,05 million tonnes. While, the total cultivated area of the world reached about 184.8 million hectare, producing about 1037.79 million tonns. Soaking seeds with GA_3 improved the hypocotyls growth and cell division in cambial zone and lead to increase the leaves size, useful to growth and yield by increasing nutrient reserves through increased physiological activities and root proliferation Rood *et al.* (1990). Seed soaking in GA_3 enhancing growth characters and yield production of maize plants, Subedi and Ma (2005) and Ansari *et al.* (2012). Moreover, seed soaking plays a significant increment in germination and growth traits *i.e.* height of plant, leaves No./plant, area of leaves/plant, number of grain/ear and grain yield/plant and plant dry weight (Khan *et al.*, 2013). Adding various substances *i.e.* gibberellic acid (GA_3), oxalic acid (OA) and yeast extract as foliar application directly to their leaves is a practice of nurturing plants, which will be absorbed more rapidly. Consequently, considerable attention has recently been given to the use of foliar fertilization (Jezek *et al.,* 2015). Potarzycki and Grzebisz (2009) stated that maize plants significantly affected by foliar application by hormonal substances. Ling and Moshe (2002) reported that the efficiency of the proper application seems limited due to the absorptive capacity of the surface area of the liquid application. Methods of application of leaves regulating maize feed, and prevention of some nutritional deficiencies and nutrient cycle without effect (Bordea *et al.,* 2006), developed the area of leaves, height of plant, diameter of stalk, leaves No./plant of maize (Ali *et al.,* 2011 and Oprică *et al.*, 2011). Moreover, foliar application methods significantly caused the maximum plant and ear height, area of ear leaf, No. of rows per ear, grains No./row, 1000-grain weight, ears No./plant and grain yield/ha (Attia *et al.,* 2012 ; Kasraie *et al.,* 2012 and Shahzad *et al.*, 2012).

Gibberellins (GA_3) stimulates division and elongation of cells, growth of plant, increments the financial yield and to permit plants to adjust the unfavorable circumstances (Chauhan *et al.*, 2009). Moreover, gibberellic acid (GA_3) is a natural phytohormone, produced naturally and play a significant in the processes of cell division and elongation, leaf expansion encourage organ plant growth, reduced time to flowering and increased flower number and size (Srivastava and Srivastava, 2007 ; Halmer, 2004 and Magome *et al.*, 2004). Moreover, increase plant growth, yield and yield components of corn (Naghashzadeha *et al.,* 2009; Ghodrat *et al.*, 2012 ; Babakhaani *et al.,* 2013;Mustafa and Awang Soh,2016 ; Al-Delaimy and Al-Mamoori, 2016 and Lahmod *et al.,* 2016)

Oxalic acid is considered antioxidant substance, which acting a significant role in regulating a number of physiological processes *i.e.* ions uptake and transport, transpiration, photosynthesis, growth and plant metabolism (Singh *et al.,* 2010). Moreover, adding has received much attention in relation to, induced disease systemic resistance and its antioxidant capability (Malencic *et al.,* 2004). El-Shabrawi *et al.* (2015) indicated that foliar application with oxalic acid indicated significant increments in growth of plant, maize yield and its components.

Natural source of cytokinins *i.e.* yeast extract is optional to contribute in a significant role on the processes of division and enlargement of cells, synthesis of protein and nucleic acids and formation of chlorophyll and comprise the essential minerals and trace elements *i.e.* calcium, cobalt, iron etc. moreover, the best sources of the B-complex vitamins *i.e.* B1, B2, B6 and B12, contain trehalose-6-phosphate syntheses which had a key enzyme for treadles bio synthesis (Castelfranco and Beale, 1983 ; Barnett *et al.,* 1990 ; Wanas, 2002 ; Amer, 2004 and Shehata *et al.,* 2012). Ghoname *et al* (2009) reported that foliar application with bio fertilizers i.e. yeast extract caused gradual increase in growth characters, yield and its components of maize plants.

Regarding the interactions effects, there is shortage in the interaction between application methods of growth promoter substance and treatments with

declared substances. So, this investigation was suggested to determine the effect of application methods and treating with various growth promoter substances and their interaction on productivity of maize hybrid single cross 10 (SC 10).

MATERIALS AND METHODS

Two trials carried out in field at El-Hajarsh Village, Center of Kafr Saqr, Sharkia Governorate, Egypt, in 2013 and 2014 seasons. The major objective of this study was to decide the effect of application methods and treating with various growth promoter substances on productivity of maize hybrid single cross 10 (SC 10).

A strip-plot design with three replications used for both experiments. Where, application methods of growth promoter substances *i.e.* (soaking, foliar application and soaking and foliar application) were distributed on the vertical plots. While, growth promoter substances *i.e.* without (control treatment), water, gibberellic acid "GA_3" (100 ppm), oxalic acid "OA" (400 ppm) and yeast extract "YE" (100 ml/L) were occupied the horizontal plots. In soaking method, maize seeds were soaked before sowing in the aforementioned growth promoter substances for 18 hours, and then immediately sown. In foliar application method, maize plants were sprayed twice with aforesaid growth promoter substances. In soaking and foliar application method, maize seeds were soaked for 18 hours, and plants were sprayed with formerly mentioned growth promoter substances twice after 25 and 45 days from sowing. The optimum concentration of each growth promoter substances was determined from previous laboratory germination experiment carried out by researcher.

The experimental soil was clayey in texture with EC of 1.90 dS/m and pH of 7.70 as well as organic matter 1.68 over both years of study. The chemical fertilizer of calcium superphosphate (15.5 % P_2O_5) was adding with ploughing at rate of 150 kg/fed. Sowing of corn seeds were done by using dry sowing method (Afir) on one side of the ridge in hills 25 cm apart and put 2-3 grains/hill on the 1st week of May in both years of study, before the 1st irrigation plants thinning to give the optimum number of plant per unit area about 28 000 plant/fed.

Studied Characters:

- **Growth characters:**

- Height of plant and ears (cm).
- Area of ear leaf. It was calculated as described by Gardner *et al.* (1985):

- **Yields and their components:**

- Ears No./plant. 5- Length of ear (cm). 6- Diameter of ear (cm). 7- Rows No./ear. 8- Grains No./row. 9- Weight of ear (g). 10- Grains weight/ear (g). 11- Shelling (%). 12- Weight of hundred grains (g).

- **Yields:**

- Grain yield (ardab/fed).
- Stalk yield (t/fed).

The data statistically examined using the method of ANOVA for the strip – plot design by "MSTAT-C" (Gomez and Gomez, 1984). Moreover, LSD technique was used to exam the variances among treatments under study (5 % level of probability) as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Effect of Methods of Application:

The effect of growth promoter substances methods of application *i.e.* seed soaking, foliar application and seed soaking + foliar application on corn growth, yield and its components *i.e.* height of plant, height of ear, ears No./plant, rows No./ear, shelling %, 100-grain weight, grain yield and stalk yield were significant in together seasons as well as grains No./row and weight of ear in the second season and grains weight/ear in the first season only (Tables 1 and 2). On the other hand, methods of application insignificantly effects on averages of ear leaf area, ear length and ear diameter. From obtained results, it could be noticed that seed soaking plus foliar application exceeded other treatments and produced the maximum averages of all studied characters during growing seasons. Whereas, the treatment of seed soaking only came in the second rank. On the other wise, foliar application only recorded the lowest averages of considered characters in individually seasons of study. These results may be recognized to the treatment of soaking seeds play a good role in improving the hypocotyls growth and cell division in cambial zone and lead to increase the leaves size (Rood *et al.*, 1990). Besides, nutrients applied to the foliage will be absorbed more rapidly (Jezek *et al.*, 2015). These findings are in partial compatible with those found by Potarzycki and Grzebisz (2009), Ali *et al.* (2011), Oprică *et al.* (2011), Attia *et al.* (2012), and Ansari *et al.* (2012) Shahzad *et al.* (2012) and Khan *et al.* (2013).

Effect of growth promoter substances:

Regarding the effect of growth promoter substances treatments, there were significant impact on growth traits (height of plant and ears, area of ear leaf, length of ear and diameter of ear), yield and its components (number of ears/plant, rows No./ear, grains No./row, weigh of ear, grains weight/ear, shelling %, weight of 100-grains, grain yield/fed and stalk yield/fed) owing to growth promoter substances treatments in both seasons as shown in Tables 1 and 2. Treating with YE (at the rate of 100 ml/L) exceeded other treating with various substances and resulted in the highest averages of these characters in both years of study. While, treating with GA_3 (100 ppm) came in the second rank. It could be noticed that shelling (%),weight of 100-grain, yield of grain (ardab/fed) and stalk yield (t/fed) were increased by (12.01, 11.28, 10.81 and 8.10 %), (21.01, 16.54, 11.90 and 5.15 %), (6.13, 3.42, 2.01 and 1.00 %) by using YE (100 ml/L), GA_3 (100 ppm), OA (400 ppm) and treating with water as compare with control treatment (without treating) over both seasons. The desirable effect of seed treating with yeast extract (YE) at the rate of 100 ml/L may have been by reason of its efficient function in civilizing early growth of maize, cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation and comprise the

essential minerals and trace elements *i.e.* calcium, cobalt, iron etc. moreover, the best sources of the B-complex vitamins *i.e.* B1, B2, B6 and B12, contain trehalose-6-phosphate syntheses which had a key enzyme for treadles bio synthesis, additional dry matter buildup and encouraged the building of metabolites , which translocated to grains as reported with Wanas (2002), Amer (2004), Ghoname *et al*. (2009) and Shehata *et al.* (2012). Furthermore, the advantageous effects of gibberellic acid and oxalic acids generally and yeast extract particularly in regulating a number of physiological processes *i.e.* ions uptake and transport, , transpiration, photosynthesis, growth and plant metabolism. These findings are in partial well-matched with those recorded by Rood *et al.* (1990), Malencic *et al.* (2004), Chauhan *et al.* (2009), Singh *et al.* (2010), Ghodrat *et al*. (2012), Babakhaani *et al.* (2013), El-Shabrawi *et al.* (2015) and Mustafa and Awang Soh (2016).

Table 1. Plant height (cm), ear height (cm), ear leaf area (cm^2), number of ears/plant, ear length, (cm), ear diameter (cm) and number of rows/ear as affected by methods of application treatments and treating with various substances as well as their interactions during 2013 and 2014 growing seasons.

Characters / Seasons	Plant height (cm)		Ear height (cm)		Ear leaf area (cm^2)		Number of ears/plant		Ear length (cm)		Ear diameter (cm)		Number of rows/ear	
Treatments	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
A- Methods of application treatments:														
Soaking	312.3	312.8	135.3	133.7	811.0	816.3	1.538	1.525	22.34	22.27	3.55	3.50	12.20	12.31
Foliar	310.4	311.4	134.2	132.6	810.9	824.6	1.554	1.545	21.79	22.03	3.46	3.42	11.94	12.15
Soaking + foliar	315.3	315.5	138.5	136.6	834.2	847.9	1.609	1.633	22.54	22.76	3.66	3.56	12.52	12.64
F. test	*	*	*	*	NS	NS	*	*	NS	NS	NS	NS	*	*
LSD 5 %	2.1	2.9	1.8	2.3	-	-	0.041	0.037	-	-	-	-	0.17	0.21
B- Treating with various substances:														
Without	306.4	306.5	129.3	126.0	777.9	774.5	1.430	1.424	21.11	21.26	2.82	2.79	11.39	11.65
Water	309.8	310.0	131.8	129.7	792.1	802.8	1.484	1.469	21.52	21.65	3.26	3.19	11.69	12.00
GA_3 (100 ppm)	315.2	315.6	135.4	135.0	832.4	854.1	1.636	1.653	22.83	22.95	3.79	3.75	12.59	12.75
Oxalic acid (400 ppm)	312.6	313.3	139.6	138.3	807.3	827.9	1.530	1.512	22.17	22.11	3.39	3.30	12.17	12.20
Yeast extract (100 ml/L)	319.3	320.7	144.0	142.6	883.7	888.8	1.754	1.779	23.50	23.80	4.52	4.45	13.27	13.23
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD 5 %	1.9	2.1	2.1	2.4	36.5	34.2	0.090	0.116	0.42	0.34	0.17	0.26	0.36	0.38
C- Interaction (F. test):														
A × B	*	NS	*	*	NS	NS	NS	NS	NS	NS	NS	NS	*	NS

Table 2. Number of grains/row, ear weight (g), ear grains weight (g), shelling (%),100-grain weight (g), grain yield (ardab/fed) and stalk yield (t/fed) as affected by methods of application treatments and treating with various substances as well as their interactions during 2013 and 2014 growing seasons.

Characters / Seasons	Number of grains/row		Ear weight (g)		Ear grains weight (g)		Shelling (%)		100-grain weight (g)		Grain yield (ardab/fed)		stalk yield (t/fed)	
Treatments	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
A- Methods of application treatments :														
Soaking	47.27	47.08	300.0	300.4	238.0	236.3	79.30	78.64	36.14	36.34	25.15	26.31	9.895	9.829
Foliar	46.77	46.40	293.1	290.2	233.0	233.0	79.42	80.21	36.05	36.12	24.48	24.92	9.826	9.759
Soaking + foliar	47.63	48.97	298.8	304.0	243.8	239.6	81.48	78.70	36.64	37.00	26.05	27.30	9.947	9.978
F. test	NS	*	NS	*	*	NS	*	*	*	*	*	*	*	*
LSD 5 %	-	1.08	-	9.57	3.2	-	1.40	1.02	0.29	0.36	1.33	1.44	0.059	0.055
B- Treating with various substances:														
Without	44.25	44.35	282.7	280.5	204.6	204.5	72.50	72.97	34.12	34.29	22.38	23.08	9.612	9.627
Water	45.76	46.07	282.9	284.6	222.8	226.2	78.78	79.51	35.25	35.83	23.24	24.71	9.714	9.720
GA_3 (100 ppm)	48.29	48.84	310.7	311.3	256.0	251.1	83.20	80.81	37.23	37.31	26.84	27.63	9.963	9.957
Oxalic acid (400 ppm)	47.30	47.51	291.5	293.2	242.9	240.1	82.44	80.69	36.07	36.32	25.23	26.38	9.823	9.810
Yeast extract (100 ml/L)	50.51	50.63	318.6	321.3	264.8	259.5	83.41	81.94	38.70	38.67	28.45	29.10	10.333	10.163
F. t	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD 5 %	0.90	1.05	10.0	8.57	4.6	3.73	3.45	2.62	0.53	0.52	0.60	0.71	0.065	0.054
C- Interaction (F. test):														
A × B	*	*	NS	*	NS	NS	NS	NS	*	NS	*	*	*	*

Interaction Effects:

Regarding to the interaction between application methods and treating with various substances had significant effect on plant height, number of rows/ear and 100-grain weight (in 1st season), ear weight (in 2nd season). While, the interaction had significant effect on ear height, number of grains/row, grain yield (ardab/fed) and stalk yield (t/fed) in both seasons (Tables 1 and 2). The data illustrated in Figs 1 and 2 indicated that highest averages of grain yield (ardab/fed) and stalk yield (t/fed) were resulted from seeds soaking and foliar spraying with yeast extract (YE) at the recommended rate. The second best interaction treatment was obtained from seeds soaking and foliar spraying with gibberellic acid (GA_3) and followed by seeds soaking and foliar spraying oxalic acid (OA) and followed water, and the lowest averages of mentioned characters were resulted from without (control treatment).

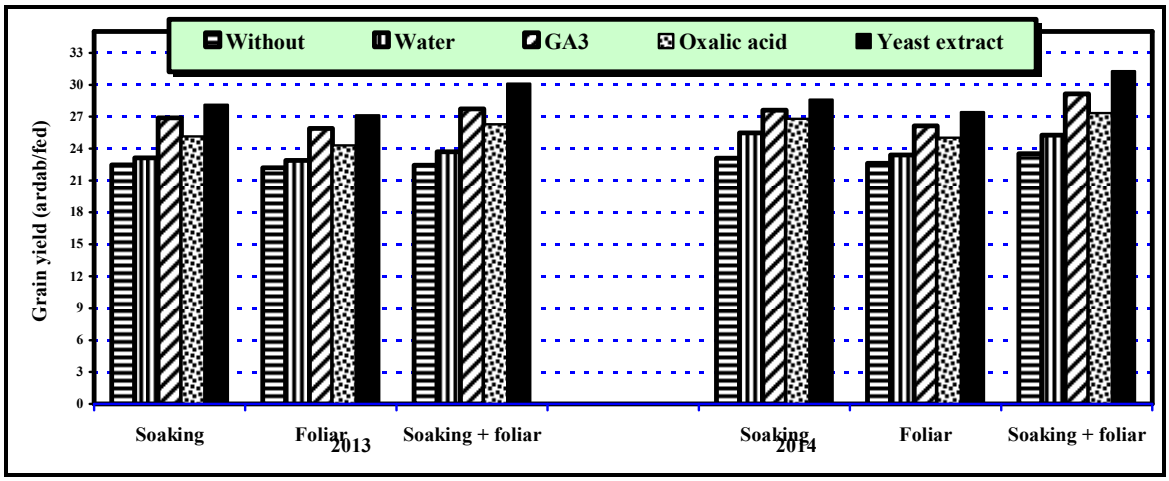

Fig. 1. Grain yield (ardab/fed) of maize as affected by the interaction between application methods and treating with various substances during 2013 and 2014 seasons.

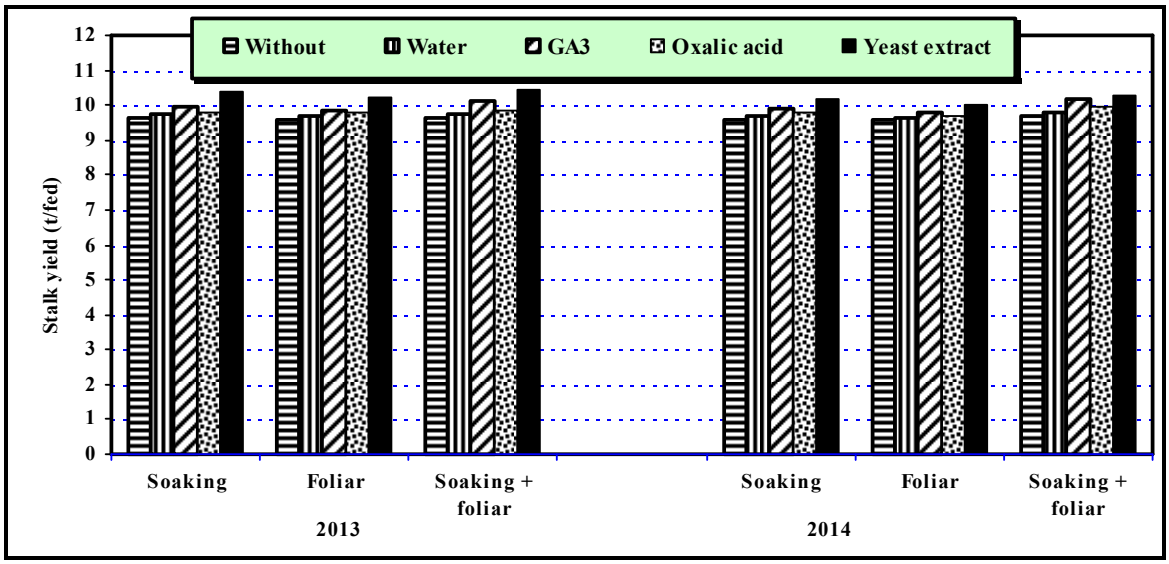

Fig. 2. Stalk yield (t/fed) of maize as affected by the interaction between application methods and treating with various substances during 2013 and 2014 seasons.

CONCLUSION

It can be recommended that seed soaking for about 18 hours plus foliar application at twice time after 25 and 45 days from sowing of maize hybrid SC 10 with the yeast extract (100 ml/200 liter water/fed) in order to obtained high growth, yield and its components under the environmental conditions of Sharkia Governorate, Egypt.

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تأثير طرق إضافة بعض المواد المنشطة على النمو والمحصول ومكوناته لنباتات الذرة الشامية

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لدراسة تأثير معاملات طرق الإضافة والمعاملة ببعض المواد المنشطة على النمو وإنتاجية وجودة نباتات الذرة الشامية هجين فردى ١٠. أجريت تجربتان حقليتان بمزرعة خاصة بقرية الهجارسة ، مركز كفر صقر ، محافظة الشرقية خلال موسمى ٢٠١٣ و٢٠١٤. تم تنفيذ التجارب فى تصميم الشرائح المتعامدة فى أربع مكررات. حيث إشتملت الشرائح الرأسية على ثلاث طرق للإضافة وهي (نقع التقاوى قبل الزراعة، الرش الوقي، نقع التقاوى قبل الزراعة بالإضافة إلى الرش الورقى)، بينما إحتوت الشرائح الأفقية على خمس معاملات للمواد المستخدمة في عملية النقع والرش وهي كالتالى (بدون معاملة، الماء، حمض الجبريلليك، حمض الأوكساليك، مستخلص الخميرة).أظهرت النتائج تفوق معاملة نقع التقاوى بالإضافة الى الرش الورقى معاً عن المعاملات الأخرى تحت الدراسة للحصول على أعلى القيم لجميع الصفات المدروسة فى كلا موسمى الزراعة. أدى الرش بمستخلص الخميرة بمعدل ١٠٠ مل/لتر إلى الحصول على أعلى القيم لجميع الصفات تحت الدراسة، تلتها المعاملة بحمض الجبريلليك بمعدل ١٠٠ جزء في المليون ثم المعاملة بحامض الأوكساليك بمعدل ٤٠٠ جز في المليون ثم المعاملة بالماء مقارنة بمعاملة الكنترول (بدون مواد منشطة).من النتائج المتحصل عليها فى هذه الدراسة يمكن التوصية بنقع التقاوى ورش نباتات الذرة الشامية هجين فردى ١٠ بمستخلص الخميرة وذلك لتحقيق أعلى نمو ومحصول لوحدة المساحة تحت الظروف البيئية لمحافظة الشرقية، مصر.