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THE ROLE OF FOLIAR APPLICATION IN REDUCING MAIZE NITROGEN REQUIREMENTS

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ABSTRACT

In order to determine the effect of foliar fertilization and mineral nitrogen fertilizer levels on growth, yield and its components and grains quality of maize hybrid single cross 131 (SC 131), two field experiments were carried out at the Experimental Station Farm, Faculty of Agriculture, Mansoura University, Egypt, during 2014 and 2015 seasons. To reduce mineral nitrogen requirements by using foliar fertilization treatments as a new trend in fertilizing maize. Each experiment was carried out in a strip-plot design with four replications. The vertical plots were assigned with foliar fertilization treatments. While, the horizontal plots were occupied with three mineral nitrogen fertilizer levels. The results showed that foliar spraying three times with the mixture of GA_3 at the rate of 50 ml + AA at the rate of 500 ml + YE at the rate of 2000 ml/200 liter water/fed produced the highest values of all studied characters in both seasons. Maize plants fertilized with 100 of the recommended dose (120 kg N/fed) resulted the highest means of all studied characters in both seasons. It can be concluded that foliar fertilizing maize hybrid SC 131 with the mixture of GA3 at the rate of 50 ml + AA at the rate of 500 ml + YE at the rate of 2000 ml/200 liter water/fed three times after 30, 37 and 44 days from sowing in addition mineral fertilizing with 96 kg N/fed in order to maximize productivity and grains quality and reduce production costs and environmental pollution under the environmental conditions of Dakahlia Governorate, Egypt.

Keywords: Maize, Foliar spraying treatments, Gibberellic acid (GA_3), Amino acids (AA), Yeast extract (YE), Nitrogen levels, Growth, Yield, Grains quality.

INTRODUCTION

Maize (*Zea mays* L.) is the most important cereal grain crops after wheat and rice in the world as well as in Egypt and Iraq, providing nutrients for humans and animals. Maize is very essential either for human food or animal feeding and a common ingredient for industrial products. Therefore, a great attention should be paid to raise maize productivity either by increasing cultivated area or maximizing yield per unit area in order to reduce the gap between its production and consumption. Whereas, maize is well known for its high demand for nutrients and other production inputs. Thereby, among factors that enhance maize productivity via foliar fertilization with growth regulators such as gibberellic acid (GA_3) and natural growth promoters *i.e.* amino acids and yeast extract as a modern tends in fertilizing maize as well as mineral nitrogen fertilization.

Foliar fertilization is a widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots. Foliar fertilizers becomes immediately available in the plant because they are 100% water soluble. This makes them perfect for correcting nutrient deficiencies. Also, foliar spraying stimulates the plants to create exudates in the roots which excite microbes to work harder and thus increases nutrient uptake from the soil. Foliar fertilizers exhibit a secondary fertilizing role, that determines a significant increase of the productive consumption for soil elements and soil-applied elements without substituting root fertilization methods, where foliar fertilizers are supplementary in balancing and optimizing the fertilization system applied to crops (Ryan, 2002).

Gibberellins (GA_3) which produced naturally by plants, moreover its applied to plants as a spray to foliage or as a liquid stimulates cell division and elongation, encourages plant growth, increases the economic yield and to enable the plant to adapt the adverse conditions (Rood *et al.*, 1990 ; Magome *et al.*, 2004 and Chauhan *et al.*, 2009).

Amino acids known as bio-stimulant which has positive effects on plant growth by increasing chlorophyll concentration leading to higher degree of photosynthesis, therefore its increment yield and significantly reduce the injuries caused by a biotic stresses (Thomas *et al.*, 2009 and Kasraie *et al.,* 2012). El-Moursy, Rasha (2013) found that foliar spraying maize plants with Aminototal as a source of amino acids twice after 25 and 35 days from sowing (DFS) resulted in the highest values of studied growth characters.

Yeast extract is natural source of cytokinins and has stimulatory effects on plants. Furthermore, yeast extract was recommended to participate in a beneficial role on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Khedr and Farid, 2000 ; Wanas, 2002 and Amer, 2004). Ferguson et al. (1995) showed that application of active dry yeast extract was very effective in releasing $CO_{,2}$ which reflected on improving net photosynthesis.

Nitrogen plays a role in plant nutrition. It is the element that required in the greatest quantity by cereal crop plants especially maize and it is the nutrient most often deficit in the Egyptian soils. Thus, increasing application of nitrogen fertilizer levels led to significant increases in growth, yield and its components and quality characters of maize crop (Seadh and El-Zehery, 2007 ; Okumura *et al.,* 2011 ; Attia *et al..* 2012 ; Khan *et al.,* 2012 ; Asif et al., 2013 ; El-Moursy, Rasha, 2013 and Xue et al., 2014). In spite of mineral fertilizers have a good effect on plant productivity, nevertheless it's also have a pollutant effect on the environment especially dissolved ones like as nitrogen fertilizer. Whereas, it is more rapidly leaching to ground water, which affects human and animal health (Wopereis *et al.*, 2006).

Therefore, this investigation was conducted to study the effect of foliar fertilization treatments, mineral nitrogen fertilizer levels and their interactions on growth, yield and its components and chemical composition of maize grains hybrid Single Cross 131 under the environmental conditions of Dakahlia Governorate, Egypt.

MATERIALS AND METHODS

Two field experiments were carried out at the Experimental Station Farm, Faculty of Agriculture, Mansoura University, Egypt, during the two successive summer seasons of 2014 and 2015 to determine the effect of foliar fertilization treatments, mineral nitrogen fertilizer levels and their interactions on growth, yield and its components and chemical composition of maize grains hybrid single cross 131 (SC 131). In addition, reduce mineral nitrogen requirements by using foliar fertilization treatments as a new trend in fertilizing maize.

Each experiment was carried out in a strip-plot design with four replications. The vertical plots were assigned with the following five foliar fertilization treatments:

1- Without (control treatment).
2- Foliar spraying with gibberellic acid (GA_3) at the rate of 50 ml/200 liter water/fed (feddan = fed = 4200 m^2).
3- Foliar spraying with amino acids (AA) at the rate of 500 ml/200 liter water/fed.
4- Foliar spraying with yeast extract (YE) at the rate of 2000 ml/200 liter water/fed.
5- Foliar spraying with the mixture of gibberellic acid (GA_3) at the rate of 50 ml + amino acids (AA) at the rate of 500 ml + yeast extract (YE) at the rate of 2000 ml/200 liter water/fed.

Foliar fertilization treatments were carried out three times at the aforementioned rates after 30, 37 and 44 days from sowing (DFS). Gibberellic acid (GA_3) in the form of Gibbro-S (which contain 4 % gibberellic acid EC) was manufactured by Firmsea Industrial Co., LTD and obtained from Gaara Establishment for Import and Export Co. Amino acids (AA) in the form of Amin-Zn (which contain 15 % amino acids and 5.5 % zinc) was manufactured by Prosber Way Group and obtained from Gaara Establishment for Import and Export Co. Yeast extract (YE) as natural biostimulants was prepared by using a technique allowed yeast cells (pure dry yeast) to be grown and multiplied efficiently during conducive aerobic and nutritional conditions. Thus method allowed to produce denovo beneficial bioconstituent, (carbohydrates, sugars, proteins, amino acids, fatty acids, hormones, etc.), then these constituents could release out of yeast cells in readily form. Active dry yeast were dissolved in water at rate 1 g/L followed by adding sugar at ratio 1:1 and kept overnight for activation and reproduction of yeast and two cycles of freezing and thawing for disruption of yeast cells and releasing their content. Such technique for yeast preparation was modified by Spencer *et al.* (1983).

The horizontal plots were occupied with three mineral nitrogen fertilizer levels *i.e.* 60, 80 and 100% of the recommended dose (72, 96 and 120 kg N/fed). Mineral nitrogen fertilizer in the form of urea (46.0 % N) was added at the formerly mentioned levels in two equal portions, one half after thinning (before the first irrigation) and the other half before the second irrigation.

Each experimental basic unit (sub – plot) included five ridges, each of 60 cm width and 3.5 m length, resulted an area of 10.5 m^2 (1/400 fed). The preceding winter crop was Egyptian clover (*Trifolium alexandrinum* L.) in the first and second seasons.

Soil samples were taken at random from the experimental field area at a depth of 15 and 30 cm from soil surface before soil preparation during the growing seasons to measure the physical and chemical soil properties as shown in Table 1.

The experimental field well prepared for each experiment through two ploughing, leveling, compaction, ridging and then divided into the experimental units (10.5 m^2).

Calcium superphosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 150 kg/fed. Potassium sulphate (48 % K_2O) at the rate of 50 kg/fed was applied with the first dose of nitrogen fertilizer.

Table 1: Mechanical and chemical soil characteristics at the experimental site during the two growing seasons of 2014 and 2015.

Soil analysis	2014 season	2015 season
A: Mechanical analysis		
Fine sand (%)	20.65	20.55
Coarse (%)	2.85	2.85
Silt (%)	27.25	27.65
Clay (%)	49.25	48.95
Texture	Clayey	Clayey
B: Chemical analysis		
Organic matter %	1.65	1.72
$CaCo_3$ (%)	3.73	3.67
Available N (ppm)	22.25	31.45
Available P (ppm)	7.75	9.45
Exchangeable K (ppm)	145.50	173.50
EC m. mohs/cm at 25^{0}C	1.93	1.88
pH	7.75	7.66

Maize grains were hand sown in hills 25 cm apart at the rate of 2 – 3 grains/hill using dry sowing method (Afir) on one side of the ridge during the first week of May in 2014 and 2015 seasons. The plants were thinned to one plant per hill before the first irrigation. The first irrigation was applied after 21 days from sowing and the following irrigations were applied at 15 days intervals during the growing seasons. The other agricultural practices were kept the same as normally practiced in maize fields according to the recommendations of Ministry of Agriculture and Land Reclamation, except for the factors under study.

Studied Characters:

A- Growth characters:

1- Plant height (cm).
2- Stalk diameter (cm).
3- Ear leaf area (cm^2). It was calculated by the following formula according to Gardner *et al.* (1985). Ear leaf area = Ear leaf length X maximum width of ear leaf X 0.75

B- Yield attributes:

1- Ear length (cm).
2- Ear diameter (cm).
3- Ear grains weight (g).
4- 100-grain weight (g).

C: Yields:

1- Grain yield (ardab/fed). It was determined by the weight of grains per kilograms adjusted to 15.5 % moisture content of each plot, then converted to ardab per feddan (ardab = 140 kg).
2- Stover yield (t/fed). The stover resulted from all plants of each plot was weighted in kg/plot, then it was converted to ton per feddan.

D- Grains quality:

1- Crude protein percentage (%). It was estimated by the improved Kjeldahl – method according to A.O.A.C. (2007).
2- Total carbohydrates percentage (%). It was estimated using the anthrone method as described by Sadasivam and Manickam (1996).
3- Oil percentage (%). It was estimated in dried grains as described by A.O.A.C. (2007) using Soxhelt apparatus.

Statistical analysis

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip – plot design as published by Gomez and Gomez (1984) by using "MSTAT-C " computer software package. Least significant of difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

I- Effect of foliar fertilization treatments:

The effect of foliar fertilization treatments *i.e.* without (control treatment), foliar spraying with gibberellic acid (GA_3), amino acids (AA) and yeast extract (YE) as well as the mixture of GA_3, AA and YE on maize growth characteristics *i.e.* plant height, stalk diameter and ear leaf area was significant in both seasons (Tables 2). From obtained results, it could be recommend that foliar spraying maize plants with the mixture of gibberellic acid (GA_3) at the rate of 50 ml + amino acids (AA) at the rate of 500 ml + yeast extract (YE) at the rate of 2000 ml/200 liter water/fed, which exceeded other foliar fertilization treatment and produced the highest values of these characters in the first and second seasons. Whereas, foliar spraying plants with yeast extract (YE) at the rate of 2000 ml/200 liter water/fed gave the best values of all studied characters after aforementioned treatment in the two growing seasons. On the other wise, control treatment (without foliar fertilization) resulted in the lowest values of these characters in both seasons. These increases growth characters by three times foliar spraying with the mixture of gibberellic acid GA_3 + AA + YE may be due to foliar fertilization may partially compensate for insufficient uptake by the roots (Ling and Moshe, 2002), in addition combined the favourable effects of GA_3, AA and YE. Where, gibberellic acid (GA_3) promotes germination, intermodal length, hypocotyls growth, cell division and leaves size (Rood *et al.*, 1990). Besides, the role of growth promoters such as amino acids (AA) in synthesis of some hormones such as auxins, increasing chlorophyll concentration, consequently increasing photosynthesis (Thomas *et al.*, 2009). Also, the positive effects of yeast extract as natural substances in encourages plant growth by stimulatory effect on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Wanas, 2002), which was reflect on increases in plant height. These results were parallel with those reported by Attia *et al.* (2012) and El-Moursy, Rasha (2013).

There was significant effect on yields and its attributes (ear length and diameter, ear grains weight, 100-grain weight, grain and stover yield/fed) due to foliar fertilization treatments in the two seasons (Tables 2 and 3). There were substantial differences in yields and its attributes among all foliar fertilization treatments and control treatment in 2014 and 2015 seasons. Foliar spraying three times with the mixture of GA_3 at the rate of 50 ml + AA at the rate of 500 ml + YE at the rate of 2000 ml/200 liter water/fed produced the highest values of yields and its attributes in the two growing seasons. This treatment followed by foliar spraying three times with YE alone at the rate of 2000 ml/200 liter water/fed with significant differences between them in both seasons. However, foliar spraying with GA_3 at the rate of 50 ml/200 liter water/fed ranked as the third best treatment and followed by foliar spraying with AA as the forth best treatment in both seasons. On the other hand, maize plants grown without foliar spraying gave the lowest values of yields and its attributes in the first and second seasons of this investigation. The desirable effect of spraying maize plants three after 30, 37 and 44 days from sowing with the mixture of GA_3 + AA + YE as a modern trends in fertilization maize might have been due to its effective role in improving early maize growth, more dry matter accumulation and stimulated the building of metabolic products which translocated to grains. Furthermore, the advantageous effects of gibberellic acid and amino acids generally and yeast extract particularly in improving plant growth characters such as plant height, stalk diameter, number of leaves/plant and ear leaf area which reflected on increasing the different yield components such as number of ears/plant, ear length and diameter, ear grains weight and 100-grain weight, which consequently increasing grain yield per unit area. These findings are coincidence with those recorded by Kasraie *et al.* (2012).

Foliar fertilization treatments under study showed significant effect on grains quality characters *i.e.* the percentages of crude protein, total carbohydrates and oil in the first and second seasons (Tables 3). Maize plants that foliar sprayed with the mixture of gibberellic acid (GA_3) at the rate of 50 ml + amino acids (AA) at the rate of 500 ml + yeast extract (YE) at the rate of 2000 ml/200 liter water/fed led to enhance maize growth, afterward produced the highest parentages of grains quality characters in both seasons. The second best treatment was foliar spraying with YE at the rate of 2000 ml/200 liter water/fed in both growing seasons of this study. The third best treatment was foliar spraying with GA_3 at the rate of 50 ml/200 liter water/fed in both seasons. While, the forth best treatment was foliar spraying with AA at the rate of 500 ml/200 liter water/fed in both seasons. On the other hand, the lowest values of grains quality characters were resulted from plants grown without foliar spraying in the two growing seasons. The favourable effect of foliar spraying maize plant many times during growth stage with the mixture of GA_3 + AA + YE on grains quality may be ascribed to these substances especially YE had pronounced role in improving plant growth traits and accumulation of more assimilates that translocated to grains, therefore increasing in crude protein content in maize grains. These results stand in harmony with those obtained by Kasraie *et al.* (2012).

Effect Of Nitrogen Fertilizer Levels:

Regarding the effect of nitrogen fertilizer levels on maize growth characteristics *i.e.* plant height, stalk diameter and ear leaf area, the obtained results of this study apparently cleared that there was a significant effect in both seasons (Tables 2). It could be noticed that each increase in nitrogen fertilizer levels from 72 to 96 and 120 kg N/fed accompanied with significant increase these characters. Therefore, the highest values of maize growth characteristics were resulted from mineral fertilizing with 100 of the recommended dose (120 kg N/fed) in both seasons. Adversely, the lowest values of maize growth characteristics were obtained from fertilizing with 60 % of the recommended dose (72 kg N/fed) in both seasons. This increase in growth traits allied with increasing nitrogen fertilization may be recognized to the role of nitrogen in protoplasm and chlorophyll formation, enhancement meristematic activity and cell division, consequently increases cell size which caused increase in internodes length, accordingly increases in plant height. These results are in harmony with those recorded by Attia *et al.* (2012), Khan *et al.* (2012), Tarighaleslami *et al.* (2012) and El-Moursy, Rasha (2013).

The effect of nitrogen fertilizer levels on yields and its attributes (ear length and diameter, ear grains weight, 100-grain weight, grain and stover yield/fed) was significant in the two seasons of this study (Tables 2 and 3). Overall, yields and its attributes were significantly increased as nitrogen fertilizer levels increased from 60 of the recommended dose (72 kg N/fed) to 80 of the recommended dose (96 kg N/fed) and 100 of the recommended dose (120 kg N/fed), and the differences among nitrogen fertilizer levels were significant in the two growing seasons. Maize plants fertilized with% 100 of the recommended dose resulted in the highest means of yields and its attributes in the first and second seasons of this study. On the contrary, the lowest values of maize yields and its attributes were obtained from fertilizing with 60 % of the recommended dose (72 kg N/fed) in both seasons. This increments in yields and its attributes resulting from increasing nitrogen fertilizer levels can be easily ascribed to the role of nitrogen in activating growth of plants, consequently enhancement yield components (ear dimension, number and weight of grains/ear as well as 100-grain weight) and accordingly increasing grain. These results are in compatible with those found by Seadh and El-Zehery (2007), Khan *et al.* (2012) and El-Moursy, Rasha (2013).

Nitrogen fertilizer levels had a significant effect on grains quality characters *i.e.* the percentages of crude protein, total carbohydrates and oil in the two growing seasons of this study (Tables 3). The highest percentages of grains quality characters were obtained from fertilizing maize plants with 120 kg N/fed (%100 of the recommended dose) in the first and second seasons. On the other hand, the lowest percentages of grains quality characters were given when fertilizing plants with 72 kg N/fed (%60 of the recommended dose) in the two growing seasons. Such increases in grains quality as a result of increasing nitrogen fertilizer levels may be ascribed to the role of nitrogen in improving growth and dry matter accumulation in addition the effect of nitrogen availability at critical stages of ear initiation and the development of plant metabolism in a manner which leading to increase synthesis of amino acids and their assimilation into grain protein. These findings are supported by those of Okumura *et al.* (2011) and El-Moursy, Rasha (2013).

Effect Of Interaction:

About the effect of interaction, there are many significant effects of the interaction between both studied factors (foliar fertilization treatments and mineral nitrogen fertilizer levels) on the studied characters (Tables 2 and 3). We present only the effect of significant interactions on grain yield.

Maximum values of grain yield/fed were produced from plants that foliar sprayed three times during growth stage with the mixture of GA_3 + AA + YE at the recommended rate of them in addition mineral fertilizing with 100 of the recommended dose (120 kg N/fed), followed by plants that foliar sprayed three times with the mixture of GA_3 + AA + YE at the recommended rate of them plus mineral fertilizing with 80 of the recommended dose (96 kg N/fed) and plants that foliar sprayed three times with the mixture of GA_3 + AA + YE at the recommended rate of them and mineral fertilizing with 60 of the recommended dose (72 kg N/fed) during 2014 and 2015 seasons as graphically demonstrated in Fig. 1. While, fertilizing with 60 of the recommended dose (72 kg N/fed) without foliar fertilization resulted in the lowest values of grain yield/fed in both seasons.

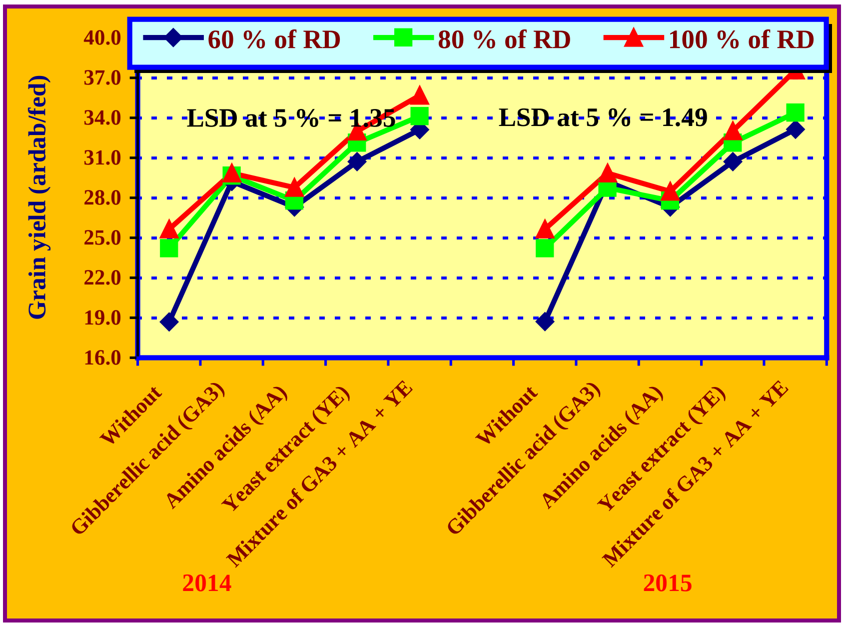

Fig 1: Grain yield (ardab/fed) of maize as affected by the interaction between foliar fertilization treatments and nitrogen fertilizer levels during 2014 and 2015 seasons.

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CONCLUSION

It can be concluded that foliar fertilizing maize hybrid SC 131 with the mixture of GA_3 at the rate of 50 ml + AA at the rate of 500 ml + YE at the rate of 2000 ml/200 liter water/fed three times after 30, 37 and 44 days from sowing in addition mineral fertilizing with 96 kg N/fed in order to maintain high productivity and grains quality at the same time reduce production costs and environmental pollution under the environmental conditions of Dakahlia Governorate, Egypt.

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دور التسميد الورقى فى خفض إحتياجات الذرة الشامية من التسميد النيتروجينى

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لدراسة تأثير معاملات التسميد الورقى ومستويات السماد النيتروجينى المعدنى على نمو وإنتاجية وجودة حبوب الذرة الشامية هجين فردى 131 أجريت تجربتان حقليتان بمحطة التجارب والبحوث الزراعية بكلية الزراعة – جامعة المنصورة خلال موسمى 2014 و 2015. بالإضافة لذلك دراسة إمكانية تقليل احتياجات الذرة الشامية من السماد النيتروجينى المعدنى بإتباع التسميد الورقى كإتجاه جديد لتسميد الذرة الشامية. نفذت التجارب فى تصميم الشرائح المتعامدة فى أربع مكررات. حيث إشتملت الشرائح الرأسية على معاملات للرش الورقى ، بينما إحتوت الشرائح الأفقية على مستويات السماد النيتروجينى المعدنى.

أظهرت النتائج أن الرش الورقي ثلاث مرات بخليط من حمض الجبريليك معدل 50 مل + الأحماض الأمينية بمعدل 500 مل + مستخلص الخميرة بمعدل 2000 مل/200 لتر ماء/فدان للحصول على أعلى القيم لجميع الصفات المدروسة فى كلا موسمى الزراعة.

أدى تسميد نباتات الذرة الشامية بـ 100% من المعدل الموصى به للحصول على أعلى القيم لجميع الصفات المدروسة في الموسمين الأول والثاني من هذه الدراسة.

من النتائج المتحصل عليها فى هذه الدراسة يمكن التوصية بالتسميد الورقي لنباتات للذرة الشامية هجين فردى 131 بخليط من حمض الجبريليك بمعدل 50 مل + الأحماض الأمينية بمعدل 500 مل + مستخلص الخميرة بمعدل 2000 مل/ 200 لتر ماء/فدان بالإضافة إلى التسميد النيتروجينى بمعدل 96 كجم نيتروجين/فدان وذلك للحفاظ على إنتاجية وجودة عالية للحبوب وفى نفس الوقت خفض تكاليف الإنتاج والتلوث البيئي تحت الظروف البيئية لمحافظة الدقهلية، مصر.

Table 2: Plant height. stalk diameter, ear leaf area, ear length and diameter, ear grains weight as affected by foliar fertilization treatments and nitrogen fertilizer levels as well as their interactions during 2014 and 2015 seasons.

Characters	Plant height (cm)		Stalk diameter (cm)		Ear leaf area (cm^2)		Ear length (cm)		Ear diameter (cm)		Ear grains weight (g)	
Seasons / Treatments	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
A- Foliar fertilization treatments:												
Without	246.2	252.4	1.90	1.75	637.0	626.2	21.25	20.58	4.41	4.39	204.7	171.4
Gibberellic acid (GA_3)	281.1	281.9	2.19	2.19	784.2	751.4	23.00	23.16	4.85	4.78	277.2	247.1
Amino acids (AA)	270.0	270.7	2.07	2.09	731.1	722.3	22.58	22.58	4.70	4.63	263.5	227.0
Yeast extract (YE)	289.2	288.9	2.39	2.28	840.3	834.6	23.83	23.75	4.92	4.86	289.8	265.1
Mixture of GA_3 + AA + YE	296.1	301.1	2.81	2.46	941.0	960.8	24.66	24.33	5.25	5.10	317.3	291.0
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	8.7	7.0	0.13	0.09	57.9	60.1	0.63	0.78	0.14	0.12	8.6	9.0
B- Nitrogen fertilizer levels:												
60 % of RD (72 kg N/fed)	271.5	275.1	2.19	2.05	754.7	744.8	22.60	22.45	4.72	4.67	256.0	226.1
80 % of RD (96 kg N/fed)	276.5	278.8	2.26	2.18	787.3	778.8	23.20	22.95	4.86	4.75	273.7	239.9
100 % of RD (120 kg N/fed)	281.6	283.1	2.36	2.23	818.1	813.6	23.40	23.25	4.91	4.84	281.8	255.0
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	3.0	2.0	0.05	0.04	14.7	16.6	0.25	0.31	0.07	0.09	3.3	3.6
C- Interaction (F. test) (F. test):												
A × B	*	NS	*	*	NS	*	*	*	NS	NS	*	*

Table 3: 100-grain weight, grain and stover yields/fed, the percentages of crude protein, total carbohydrates and oil as affected by foliar fertilization treatments and nitrogen fertilizer levels as well as their interactions during 2014 and 2015 seasons.

Characters / Treatments	100-grain weight (g)		Grain yield (ardab/fed)		Stover yield (t/fed)		Crude protein percentage (%)		Total carbohydrates percentage (%)		Oil percentage (%)	
Seasons	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
A- Foliar fertilization treatments:												
Without	41.33	40.08	22.85	22.85	4.931	4.880	8.35	8.39	71.73	71.73	3.36	3.35
Gibberellic acid (GA_3)	49.14	48.63	29.58	29.28	6.562	6.687	9.52	9.50	73.14	73.12	4.78	4.98
Amino acids (AA)	45.41	45.68	27.95	27.86	5.852	5.825	8.93	9.16	72.46	72.43	4.22	4.21
Yeast extract (YE)	53.77	54.24	31.95	31.96	7.091	7.052	10.00	10.14	73.84	73.82	5.62	5.59
Mixture of GA_3 + AA + YE	64.02	59.09	34.31	35.03	8.290	8.163	10.50	10.64	74.60	74.58	6.51	6.52
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	3.80	4.15	1.45	1.41	0.648	0.523	0.05	0.08	0.09	0.05	0.06	0.03
B- Nitrogen fertilizer levels:												
60 % of RD (72 kg N/fed)	48.81	48.48	27.81	27.82	6.207	6.183	9.29	9.43	72.89	72.88	4.54	4.62
80 % of RD (96 kg N/fed)	50.75	49.19	29.58	29.45	6.583	6.388	9.51	9.51	73.15	73.10	4.96	5.00
100 % of RD (120 kg N/fed)	52.63	50.97	30.59	30.92	6.844	6.992	9.68	9.76	73.41	73.43	5.20	5.17
F. test	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	1.27	1.57	0.61	0.71	0.439	0.586	0.03	0.05	0.06	0.07	0.05	0.03
C- Interaction (F. test) (F. test):												
A × B	NS	NS	*	*	*	*	*	*	*	*	*	*