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تأثير التسميد الأرضي بالنيتروجين و التسميد الورقي ببعض العناصر الكبرى و الصغرى على انتاجية و جودة محصول قمح الخبز

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الملخص العربي

أجريت تجربتان حقليتان في محطة البحوث الزراعية بالجميزة محافظة الغربية خلال موسمي الزراعة ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ بهدف دراسة تأثير مستويات التسميد النيتروجيني الأرضي (صفر – ٤٠ – ٨٠ كجم ن/فدان) و التسميد الورقي ببعض العناصر الكبرى (صفر – ٣ % يوريا "ن" – ٣% سوبر فوسفات الكالسيوم "فو" – ٣% كبريتات بوتاسيوم "بو" – ٩% مخلوط العناصر الكبرى الثلاثة "ن + فو + بو") و التسميد الورقي ببعض العناصر الصغرى (صفر – ١ % كبريتات منجنيز – ١ % كبرتات زنك – ١ % كبريتات حديد – ٠.٥ % بوراكس) على المحصول و مكوناته و جودة الحبوب لصنف القمح جميزة ١٠. و يمكن ايجاز أهم النتائج المتحصل عليها فيما يلي :

١- أدى اضافة التسميد النيتروجيني بمعدل ٨٠ كجم ن/فدان الى زيادة معنوية في صفات عدد السنابل / م٢ ، عدد الحبوب في السنبلة ، محصول السنبلة ، وزن ١٠٠٠حبة محصول الحبوب و القش و البيولوجي للفدان ، دليل الحصاد و المحتوى البروتيني للحبوب في كلا الموسمين في حين لم يكن هناك فروق معنوية بين المستويين ٤٠ و ٨٠ كجم ن / الفدان لعدد الحبوب في السنبلة في الموسم الأول و وزن ١٠٠٠ حبة في الموسم الثاني.

٢- تشير نتائج مقدار استجابة المحصول و مكوناته للتسميد النيتروجيني بأنه يمكن تعظيم قيم محصول القمح و مكوناته وذلك باضافة ٦٠.٣ و ٧٠.٧ كجم ن/الفدان لزيادة عدد الحبوب

في السنبلة و ٦٧.٨ و ٦٣.١ كجم ن/الفدان لزيادة محصول القش ، ٦٩.٥ و ٦٥.٨ كجم ن/الفدان لزيادة المحصول البيولوجي و ٩١.٦٩ و ٩٤.٢٩ كجم ن/الفدان لزيادة محتوي الحبوب من البروتين في الموسم الأول و الثاني على الترتيب و كذلك باضافة ٧٤.٧ و ٧٢.٦ كجم ن/الفدان لزيادة محصول السنبلة و دليل الحصاد في الموسم الأول و ٦٢.٥ كجم ن/الفدان لزيادة وزن ١٠٠٠حبة في الموسم الثاني. هذا و يمكن الوصول الى محصول الحبوب الأمثل (٣.٢٦٤ و ٣.٢٠٤ طن) و ذلك باضافة ٧٠.٢ و ٦٨.٨ كجم ن/الفدان في كلا الموسمين على الترتيب هذا و قد وجد أن هذه الاضافة يمكن أن تحقق صافي ربح كلى مقداره ٣٤٦٦.١ و ٣٦٩٦.٨ جنيه/فدان في كلا الموسمين على التوالي.

٣- أعطى التسميد الورقي بمخلوط العناصر الكبرى (ن + فو + بو) أعلى قيم معنوية لصفات عدد السنابل / م٢ و عدد الحبوب / السنبلة و وزن الألف حبة و محصول السنبلة و محصول الحبوب للفدان و محصول القش للفدان و المحصول البيولوجي للفدان والنسبة المئوية للبروتين في الحبوب في كلا الموسمين ، في حين تشير النتائج الى عدم وجود فروق معنوية بين الرش بالعناصر الكبرى المختبرة الثلاث بصورة منفردة او مخلوطة لعدد الحبوب / السنبلة في الموسم الثاني.

٤- أدى التسميد الورقي بكبريتات الزنك بتركيز ١ % الى تحقيق أعلى زيادة معنوية لجميع الصفات المدروسة. (عدد السنابل / م٢ و عدد الحبوب / السنبلة و وزن الألف حبة محصول السنبلة و محصول القش و البيولوجي و الحبوب للفدان و النسبة البروتين في الحبوب) مقارنة بالنباتات غير المعاملة (الكنترول) و ذلك خلال موسمي الزراعة في حين لم تتأثر صفة دليل الحصاد معنويا بأي من معاملات التسميد الورقي بالعناصر الصغرى في كلا الموسمين.

٥- تشير نتائج التفاعل بين عوامل الدراسة الثلاث الى :

أ- أمكن الحصول على أعلى قيم معنوية لصفات عدد السنابل / م٢ و وزن الألف حبة و محصول الحبوب والقش للفدان عند التسميد النيتروجيني الأرضي بمستوى ٤٠ كجم ن للفدان مع التسميد الورقي بمخلوط العناصر الكبرى (ن + فو + بو) في كل من موسمي الزراعة.

ب- أعطى التسميد النيتروجيني الأرضي عند مستوى ٨٠ كجم ن للفدان مع التسميد الورقي بكبريتات الزنك بتركيز ١ % أعلى قيم معنوية لصفات عدد السنابل / م٢ و عدد الحبوب / السنبلة و وزن ١٠٠٠ حبة و محصول السنبلة و محصول الحبوب للفدان في كل من موسمي الزراعة.

ج- أعطى التسميد الورقي بمخلوط العناصر الكبرى و التسميد الورقي بكبريتات الزنك أعلى زيادة معنوية لصفات عدد السنابل / م٢ و وزن ١٠٠٠ حبة و محصول الحبوب للفدان في كل من موسمي الزراعة.

د- تشير نتائج التفاعل من الدرجة الثانية الي انه لايوجد تاثير معنوى للتفاعل بين كل من مستويات التسميد النيتروجيني الأرضي ، التسميد الورقي بالعناصر الكبرى ، التسميد الورقي بالعناصر الصغرى وذلك على جميع الصفات المدروسة خلال موسمي الزراعة.

٦- يمكن التوصية بامكانية تحسين انتاجية و جودة محصول القمح (صنف جميزة ١٠) و ذلك بتسميد النباتات تسميدا نيتروجينيا أرضيا (باضافة ٤٠ كجم نيتروجين للفدان) مع التسميد الورقي بمخلوط العناصر الكبرى بتركيز ٩ % (٣ % يوريا + ٣ % سوبر فوسفات الكالسيوم + ٣ % كبريتات بوتاسيوم) مع التسميد الورقي بعنصر الزنك بتركيز ١ % كبرتات زنك على أن يتم رش النباتات بالعناصر الكبرى و الصغرى مرتين متتاليتين في أعمار ٣٥ و ٥٠ يوما من الزراعة.

EFFECT OF SOIL NITROGEN FERTILIZATION AND FOLIAR APPLICATION WITH SOME MACRO AND MICRONUTRIENTS ON THE PRODUCTIVITY AND QUALITY OF BREAD WHEAT

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ABSTRACT: ***Two field trials carried out at El-Gemmeiza Agric. Research Station Farm, A.R.C., El-Gharbia Governorate, Egypt, during the two successive growing seasons 2005/2006 and 2006/2007 to study response of wheat (Gemmeiza 10 cv.) to soil application of nitrogen levels (0, 40 and 80 Kg N/fad) and foliar application of macronutrients (0, 3 % Urea, 3 % Calcium superphosphate, 3 % Potassium sulphate and 9 % Mixture of the three macro elements) and foliar application of micronutrients (0, 1 % Manganese sulphate, 1 % Zinc sulphate, 1 % Ferrus sulphate and 0.5 % Borax).***

1- Soil fertilization with 80 kg N/fad produced the highest significant values of number of spikes/m2, spike yield and yields/fad (grain, straw and biological yields/fad) and harvest index as well as grain protein percentage in both seasons, 1000-grain weight (in the first season) and number of grains/spike (in the second season) .

2- The respopnse equation show that the values of wheat yield and its components could have been maximized due to predicted additions of 60.3 and 70.7 kg N/fad for number of grains/spike, 67.8 and 63.1 kg N/fad for straw yield/fad, 69.5 and 65.8 kg N/fad for biological yield/fad and 91.69 and 94.29 kg N/fad for grain protein percentage in the first and second seasons, respectively, and 74.7 kg N/fad for spike yield in the first season and 62.5 kg N/fad for 1000-grain weight in the second season. The grain yield/fad could have beeen optimized to 3.262 and 3.204 ton/fad due to predicted N additions of 70.2 and 68.8 kg N/fad in the first and second

seasons, respectively. These additions could produce total profit of 3466.1 and 3696.8 L.E./fad in the two seasons, respectively.

3- Foliar application of 9 % NPK mixture produced the maximum values of number of spikes/m2, number of grains/spike, 1000-grain weight, spike yield, grain, straw and biological yields/fad and harvest index as well as grain protein percentage in the two seasons.

4- Foliar application of 1 % zinc sulphate recorded the highest values of number of spikes/m2, number of grains/spike, 1000-grain weight, spike yield, grain, straw and biological yields/fad and harvest index as well as grain protein percentage in both seasons.

5- Results of the interaction among the three studied factors refers to :

A- Soil application of 40 kg N/fad with foliar application of 9 % NPK mixture produced the highest values of number of spikes/m^2, 1000-grain weight, grain and straw yields/fad in the two seasons.

B- Soil application of 80 kg N/fad and foliar application of 1 % zinc sulphate produced the highest values of number of spikes/m^2, number of grains/spike, 1000-grain weight, spike yield and grain yield/fad in both growing seasons.

C- Foliar application of 9 % NPK mixture with 1% zinc sulphate produced the highest values of number of spikes/m2, 1000-grain weight and grain yield/fad in both growing seasons.

D- The second order interaction among the three studied factors, i.e soil application of nitrogen levels, foliar application of macronutrients and foliar application of micronutrients had no significant effect on all characters studied of growth, grain filling, yield and its components and grain protein % in the first and / or second seasons.

6- It can be concluded that the best results for high productivity and grain quality value mostly obtained when the plants were soil fertilized by 40 kg N/fad and sprayed with mixture of NPK (3% urea + 3% calcium superphosphate + 3% potassium sulphate) and 1 % zinc as compared with these either unsoil fertilized with N or soil fertilized with 80 kg N/fad.

Key words:** **Wheat, yield, soil and foliar fertilization, macro elements (N, P and K), micro elements (Zn, Mn, Fe and B).

INTRODUCTION

Wheat is the most important cereal crop in the world in terms of area and production and it is a stable food for more than one third of the world population.

In Egypt, wheat is the main winter cereal crop. It is used as a stable food grain for urban and rural societies and as a major source of straw for animal feeding. The wheat area in 2010 season was 3.002 million faddan and the average productivity per faddan was 2.39 ton/fad. This means that the local production estimated by 7.175 million. Nevertheless, Egypt imports about 40 percent of wheat requirements. This reflects the size of the problem and the efforts needed to increase wheat production. Thus, increasing productivity per unit area of wheat , appears to be one of the important factors for narrowing the wheat production gab, due to extremely limited lands. This can be achieved by planting high potential yield cultivars as well as conducted the best agricultural practices such as soil and foliar fertilization, with macro and micronutrients. Macro and micronutrients plays an important role in plant growth. Because of higher cost of chemical coupled with their limited production a part of fertilizer. In addition to the low efficiency of applied soil fertilization due to losses by leaching, volatilization and problems of alkali of land. Therefore, this led to draw considerable interest into foliar application of macro and micronutrients.

Many investigators reported that Soil application of nitrogen improved wheat yield and its components and grain quality such as number of spikes/m^2, 1000-grain weight and number of grains/spike (Abd El-Maksoud, 2002 and Abdul Galil *et al.*, 2003), grain yield/fad (Badran *et al.*, 2004; El-Zeky, 2005; Abu-Grab *et al.*, 2006; Hammad and El-Basuny, 2008 and Mohamed, 2010), spike yield and straw yield/fad (Allam,2005 and Abu-Grab *et al.*, 2006), biological yield/fad (Abdul Galil *et al.*, 2003 and Abdel-Mawgoud *et al.*, 2003) grain protein percentage (Badran *et al.*, 2004; El-Zeky, 2005 and Abu-Grab *et al.*, 2006). Moreover, other researchers found that foliar application of some macronutrients caused an improving in yield and its components and grain quality of wheat i.e N (Sarhan and Hammad, 1995; Ibrahim *et al.*, 2004 and Khan *et al.*, 2009), K (El-Sabbagh *et al.*, 2002 and El-Abady *et al.*, 2009) and NPK mixture (Jamal and Chaudhary, 2007). In addition, other investigators found that yield and its components and grain quality of wheat were increased with foliar application of some micronutrients such as Zn (Abd El-Mottaleb *et al.*, 1997; Zein *et al.*, 2001and El-Nasharty, 2005; Habib, 2009) and Mn (Zein *et al.*, 2001).

MATERIALS AND METHODS

Two field experiments were carried out at El-Gemmeiza Agric. Research Station El-Gharbeia Governorate to study the response of Gemmeiza 10 wheat cultivar to soil nitrogen fertilization and foliar application of some macro and micronutrients during the two seasons 2005/2006 and 2006/2007.

The tested experimental treatments are as follow:

A- Soil application of nitrogen levels :

1- Zero kg N/fad.
2- 40 kg N/fad.
3- 80 kg N/fad.

B- Foliar application of macronutrients :

1- 0 = Tap water (Control) .
2- 3% N = 3% Urea " CO $(NH_2)_2$" (46.5 % N) .
3- 3% P = 3% Calcium super phosphate "Ca $(H_2PO_4)_2$" (15.5 % P_2O_5).
4- 3% K = 3% Potassium sulphate " K_2SO_4 " (52 % K_2O) .
5- 9% NPK = 9% Mixture of the three macro elements (3% Urea +3% Calcium super phosphate + 3% Potassium sulphate).

C- Foliar application of micronutrients :

1- 0 = Tap water (Control) .
2- 1% Mn = 1% Manganese sulphate " Mn SO_4 " (36.75 % Mn) .
3- 1% Zn = 1% Zinc sulphate " Zn SO_4 " (40.60 % Zn) .
4- 1% Fe = 1% Ferrus sulphate " Fe SO_4 " (36.75 % Fe) .
5- 0.5% B = 0.5% Borax " Na_2 B_4 O_4 " (11.34 % B) .

The tested treatments were arranged in a split-split plot design with four replicates, where the soil N levels was randomly distributed in main plots, the five foliar application of macronutrients was allocated in sub plots and the five foliar application of micronutrients was occupied in sub-sub plots.

The mechanical and chemical analysis of the experimental soil was done before the sowing as shown in Table (1).

Table (1): Mechanical and chemical properties of the experimental field soil during 2005 / 2006 and 2006 / 2007 seasons.

A- Mechanical properties.

Properties / Seasons	Fine sand %	Coarse sand %	Silt %	Clay %	$CaCo_3$ %	O. M. %	Soil pH (1:2.5)	E.C. dsm at 25 C^0	Textural class
2005/ 2006	15.98	0.75	42.10	37.06	3.54	1.94	7.6	1.88	Silty clay loam
2006/ 2007	15.20	0.97	41.70	37.99	3.11	1.82	7.8	1.91	Silty clay loam

B- Chemical properties.

properties	Soluble cations (meq/100g soil)	Soluble anions (meq/100g soil)	Avai lable N ppm	Avai lable P ppm	Avai lable K ppm

Seasons	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCo_3^{-}	Cl^{-}	So_4^{-2}			
2005/2006	0.87	0.73	0.56	0.02	0.73	0.32	1.13	40.4	5.86	400
2006/2007	0.90	0.77	0.52	0.04	0.70	0.35	1.09	43.3	5.94	420

At harvest (177 days after sowing), the eight middle rows were harvested to determine the following characters:

1- Number of spikes/ m^2 .
2- Number of grains/spike.
3- 1000-grain weight (g.).
4- Spike yield (g.).
5- Grain yield (ton/fad.).
6- Straw yield (ton/fad.).
7- Biological yield (ton/fad.).
8- Harvest index
9- Grain protein (%)
10- Response to N fertilization and total profit:

The response equations to N fertilization levels were calculated according to Snedecor and Cochran (1967) using orthogonal polynomial Tables. The significancy of the linear and quadratic components of each of these equations were tested, then the response could be described as linear (first order) or quadratic (second order). The predicted maximum values, i.e yield and its components (Y_{max}) which could have been obtained due to the addition of the predicted maximum N level (X_{max}) were calculated according to Neter *et al.* (1990). The predicted optimum grain yield (Y_{opt}) obtained due to the addition of the predicted optimum N level (X_{opt}) and the profit obtained due to this addition were calculated according to Sukhatme (1941) as explained by Abdul Galil *et al.* (2003) using the following equations:

1- Maximum yield ($Y_{max.}$) = $$Y_0 + \frac{b^2}{4c}$$

2- Maximum N level ($X_{max.}$) = $$X_0 + \frac{b}{2c} \quad (u)$$

3- Maximum response ($R_{max.}$) = $$\frac{b^2}{4c} = Y_{max} - Y_0$$

4- Average response $(R_{aver.}) = \dfrac{R_{max.}}{X_{max.}}$

5- Optimum yield $(Y_{opt.}) = Y_0 + \dfrac{b^2 - r^2}{4c}$

6- Optimum N level $(X_{opt}.) = X_0 + \dfrac{b - r}{2c}$ **(u)**

7- Profit (1) = p (Y_0) **in L.E.**
8- Profit (2) = p $[\ c\ (Xopt)^2\ ]$ **in L.E.**
9- Total profit = profit (1) + profit (2) in L.E.

Where:

Y_0 = Grain yield (ton/fad) at the lowest N level, i.e. zero kg N/fad
b = Measures the linear component of the response equation.
c = Measures the quadratic component of the response equation.
r = q/ p (the cost/ price ratio) where:
q = cost of N unit (u), i.e. 40 kg N/fad = 68.8 and 86.0 L.E. in the first and second seasons, respectively.
p = price of the unit grain yield (ton) = 1105.0 and 1199.8 L.E. in the first and second seasons, respectively.
u = unit of N = 40 kg N/fad.
Profit (1) = The expected profit which could have been obtained due to the addition of the first N level under study (control).
Profit (2) = The expected profit which have been obtained due to the increase of N level to the optimum N level (X_{opt}).

It worth to note down here that calculation of these profits, did not take in the consideration the price of straw as well as the other spent costs for the other agronomic practices or any other related expences as it was not under the interest of this study. However, the total profit obtained throught the aforementioned calculations still gives enough indication to the expected gain from addition of nitrogen fertilizer keeping in mind that all the other costs and expenses were the same for all treatments under study.

Statistical analyses:

The data were subjected to statistical analyses of variance according to the methods described by Snedecor and cochran (1957). The mean values were compared according to Duncan's Multiple Range Test (Duncan, 1955). The mean values within each column followed by the same letter (s) are not significant at 5 % level.

RESULTS AND DISCUSSION

A. Effect of soil application of nitrogen levels.

Data in Table (2) show the mean values of number of spikes/m2, number of grains/spike,1000-grain weight, spike yield, grain, straw and biological yields/fad and harvest index as well as grain protein percentage as affected by the tested nitrogen fertilization levels (0, 40 and 80 kg N/fad) during 2005/2006 and 2006/2007 seasons.

Table (2): Response equations of yield and its components as well as protein % as affected by N fertilization levels (over all foliar application of macronutrients and micronutrients) during 2005/2006 and 2006/2007 seasons.

Characters	Nitrogen levels (kg N/fad.)			Response equation $Y = a + b X – c X^2$	Max. value (Y_{max})	Max. N-level (X_{max}) "kg N/fad."	Maximum response "value"	Average response "value / kg N/fad"
	0	40	80					
2005/2006 season								
Number of spikes/m^2	237.4c	292.1b	327.6a	237.4 + 64.30 X	Linear	Linear	Linear	Linear
Number of grains/spike	54.19b	67.49a	67.56a	54.19 + 19.90 X – 6.600 X^2	69.19	60.3	15.00	0.249
1000-grain weight (g)	40.61c	42.96b	46.07a	40.61 + 3.490 X	Linear	Linear	Linear	Linear
Spike yield (g)	2.584c	2.988b	3.113a	2.584 + 0.560 X – 0.150 X^2	3.104	74.7	0.52	0.007
Straw yield (ton/fad)	3.598c	5.784b	6.139a	3.598 + 3.102 X – 0.916 X^2	6.217	67.8	2.619	0.386
Biological yield (ton/fad)	5.020c	8.679b	9.384a	5.020 + 5.136 X – 1.477 X^2	9.485	69.5	4.465	0.643
Harvest index (%)	28.33c	33.37b	34.58a	28.33 + 6.955 X – 1.915 X^2	34.65	72.6	6.32	0.087
Grain protein (%)	9.88c	11.26b	11.87a	9.88 + 1.765 X – 0.385 X^2	11.90	91.69	2.022	0.022
2006/2007 season								
Number of spikes/m^2	240.9c	293.6b	333.4a	240.9 + 59.15 X	Linear	Linear	Linear	Linear
Number of grains/spike	60.55c	66.21b	67.43a	60.55 + 7.950 X – 2.250 X^2	67.57	70.7	7.02	0.099
1000-grain weight (g)	39.12b	43.90a	44.19a	39.12 + 7.030 X – 2.250 X^2	44.61	62.5	5.49	0.009
Spike yield (g)	2.789c	2.900b	3.049a	2.789 + 0.170 X	Linear	Linear	Linear	Linear
Straw yield (ton/fad)	3.096c	5.447b	5.616a	3.096 + 3.442 X – 1.091 X^2	5.811	63.1	2.715	0.430

Biological yield (ton/fad)	4.578c	8.320b	8.798a	$4.578 + 5.374 X – 1.632 X^2$	9.002	65.8	4.424	0.672
Harvest index (%)	32.37c	34.53b	36.17a	32.37 + 2.42 X	Linear	Linear	Linear	Linear
Grain protein (%)	10.69c	11.34b	11.64a	$10.69 + 0.825 X – 0.175 X^2$	11.66	94.29	0.972	0.010

The data show that number of spikes/m2, number of grains/spike,1000-grain weight and spike yield were significantly and gradually increased with increasing N application up to the highest level (80 kg N/fad) in both seasons. Soil application of 80 kg N/fad produced the highest values of these characters in both seasons except number of grains/spike which responded positively up to 40 and 80 kg N/fad in the first and second seasons respectively and the highest significant values of 1000-grain weight was obtained by the application of 80 and 40 kg N/fad in the first and second seasons respectively. Moreover, with regard to the response equation, the data show that there are linear increase in number of spikes/m^2 (in both seasons), 1000-grain weight (in the first season) and spike yield (in the second season). However, there were quadratic increase in the other these characters, where the values of studied characters could have been maximized due to predicted additions of 60.3 and 70.7 kg N/fad for number of grains/spike and 91.69 and 94.29 kg N/fad for grain protein percentage in the first and second seasons, respectively and 74.7 and 72.6 kg N/fad for spike yield and harvest index, respectively in the first season and 62.5 kg N/fad for 1000-grain weight in the second season. In this concern, many researchers reported that increasing nitrogen fertilization levels caused a significant increase in each of number of spikes/m^2, 1000-grain weight and number of grains/spike (Abd El-Maksoud, 2002 and Abdul Galil *et al.*, 2003), spike yield (Allam,2005 and Abu-Grab *et al.*, 2006).

With regard to straw and biological yields/fad, harvest index and grain protein percentage, the data show that the values of these characters were significantly increased with increasing nitrogen fertilization levels up to 80 kg N/fad in both seasons. Moreover the response equation show that the values of these characters could have been maximized due to predicted additions of 67.8 and 63.1 kg N/fad for straw yield/fad, 69.5 and 65.8 kg N/fad for biological yield/fad and 91.69 and 94.39 for grain protein % in the first and second seasons, respectively as well as 72.6 kg N/fad for harvest index in the first season only. In this respect many researchers reported that increasing nitrogen fertilization levels caused a significant increase in each of straw yield (Allam,2005 and Abu-Grab *et al.*, 2006), biological yield (Abdul Galil *et al.*, 2003 and Abdel-Mawgoud *et al.*, 2003) grain protein percentage (Badran *et al.*, 2004; El-Zeky, 2005 and Abu-Grab *et al.*, 2006).

Data in Table (3) reveal that significant differences were registered in grain yield/fad among the various tested nitrogen levels compared to unfertilized plants in both seasons. It is apparent that the addition of the first 40 kg N/fad increased grain yield/fad by 36.83 and 34.78 kg grain for every kg N over the control treatment (unfertilized plants) in the first and the second seasons, respectively. The application of the second dose 40 kg N/fad increased grain yield/fad by 8.75 and 7.73 kg grain for each kg N applied over the first 40 kg N/fad in the first and second seasons, respectively. From these results, it could be concluded that grain yield/fad of wheat can be inconstantly increased through the application of the two tested N levels (40 and 80 kg N/fad). Moreover, the response equation of grain yield/fad to N level was quadratic response where a diminishing increase in grain yield was obtained by increasing N levels up to 80 kg N/fad in both seasons. The predicted maximum yield (3.264 and 3.207 ton/fad) can be obtained if the N level was increased only up to 72.48 and 71.44 kg N/fad in the first and second seasons, respectively. This means that 72.48 and 71.44 kg N/fad were quite enough to maximize grain yield to 3.264 and 3.207 ton/fad in the first and second seasons, respectively. Moreover, it can be found that N levels produced average response amounted to 25.41 and 24.15 kg grain per every kg N applied over zero level (control) in the first and second seasons, respectively.

Table (3): Response equations of grain yield/fad and its components as affected by N fertilization level (over all foliar application of macronutrients and micronutrients) during 2005/2006 and 2006/2007 seasons.

Nitrogen levels (kg N/fad)			Response equation $Y = a + b X – c X^2$	Max. N-level ($X_{max.}$) "kg N/fad."	Opt. N-level ($X_{opt.}$) "kg N/fad."	Max. yield ($Y_{max.}$) "ton/fad."	Opt. yield ($Y_{opt.}$) "ton/fad."	Max. response "ton/fad."	Average response "kg grains/kg N"	Profit (L.E.)		
0	40	80								$P_{(1)}$	$P_{(2)}$	Total
2005/2006 season												
1.422c	2.895b	3.245a	$1.422 + 2.035X - 0.562X^2$	72.48	70.18	3.264	3.262	1.842	25.41	1564.2	1901.9	3466.1
2006/2007 season												
1.482c	2.873b	3.182a	$1.482 + 1.932X - 0.541X^2$	71.44	68.76	3.207	3.204	1.725	24.15	1778.4	1918.4	3696.8

From the economic point of view, the grain yield/fad can be optimised to 3.262 and 3.204 ton/fad if the N level have been optimised to 70.18 and 68.76 kg N/fad in the first and second seasons, respectively. These additions, could afford wheat growers net profits (P_2) of 1901.9 and 1918.4 L.E obtained due to the addition of the formentioned optimum N levels in the first and second seasons, respectively over the net profit obtained by the control treatment (P_1) which amounted to 1564.2 and 1778.4 L.E in the first and second seasons, respectively. This led to the total profits (P_1 + P_2) were 3466.1 and 3696.8 L.E in the first and second seasons, respectively. In this concern, other investigators concluded previously that grain yield/fad can be increased with increasing N levels up to 75 kg N/fad (Badran *et al.*, 2004), 80 kg N/fad (Gheith *et al.*, 1989), 90 kg N/fad (Allam, 2005 and Abu-Grab *et al.*, 2006), 105 kg N/fad (Hammad and El-Basuny, 2008) and 120 kg N/fad (Sabry *et al.*, 1999).

B. Effect of foliar application of macronutrients.

Data in Table (4) show the values of yield and its components, i.e number of spikes/m^2, number of grains/spike, 1000-grain weight, spike yield, grain, straw and biological yields/fad and harvest index as well as grain protein percentage as affected by foliar application of some macronutrients (3 % N, 3% P, 3 % K and 9 % NPK mixture) in 2005/2006 and 2006/2007 seasons.

Table (4): Effect of foliar application of macronutrients on yield and its components as well as grain protein % during 2005 / 2006 and 2006 / 2007 seasons.

Characters / Macronutrients	No. of spikes / m^2.	No. of grains/ spike	1000-grain weight (g.)	Spike yield (g.)	Grain yield (ton/fad)	Straw yield (ton/fad)	Biological yield (ton/fad)	Harvest index (%)	Grain protein %
2005 / 2006 season									
0	251.7e	57.8 c	40.31d	2.712 c	2.146e	4.562d	6.708e	31.99c	10.06d
3 % N	301.8b	64.1ab	44.07b	2.971ab	2.583b	4.920c	7.503b	34.43a	11.14b
3% P	281.1c	63.7 b	42.60c	2.910 ab	2.558c	5.038b	7.596c	33.68b	11.10b
3 % K	276.0 d	63.4b	42.61c	2.881b	2.471d	4.910c	7.381d	33.48b	10.95c
9 % NPK	320.8 a	66.4a	46.47a	3.010a	2.819a	6.439a	9.258a	30.45d	11.73a
2006 / 2007 season									
0	253.4e	60.2b	39.7 c	2.720 c	2.204 e	4.198 d	6.402 e	34.43 b	10.47 d
3 % N	301.8b	66.0a	43.0 ab	2.940 b	2.574 b	4.904 b	7.478 b	34.42 b	11.32 c

3% P	285.6c	65.5 a	42.7 b	2.921 b	2.498 c	4.819 b	7.317 c	34.14 b	11.36 c
3 % K	283.1d	65.2a	42.3 b	2.912 B	2.472 d	4.604 c	7.076 d	34.93 b	11.45 b
9 % NPK	322.7a	66.7a	44.3 a	3.081 a	2.800 a	5.074 a	7.874 a	35.56 a	11.51 a

The data show that the number of spikes/m^2, number of grains/spike, 1000-grain weight and spike yield were significantly increased by foliar application with the three tested macronutrients either separately or mixed together as compared to unsprayed plants in the two growing seasons. Among the tested macronutrients, the data show that the highest values of these characters were recorded when the plants were sprayed with the mixture of the three elements (9 % NPK) in both seasons. Many investigators found that yield components of wheat were increased with foliar application of some macronutrients such as N for number of spikes/m^2 and 1000-grain weight (Sarhan and Hammad, 1995), number of grains/spike (Khan *et al.*, 2009) and spike yield (Ibrahim *et al.*, 2004) and also K for number of spikes/m^2 and 1000-grain weight (El-Abady *et al.*, 2009), number of grains/spike (Ibrahim *et al.*, 2004), spike yield (El-Sabbagh *et al.*, 2002 and El-Abady *et al.*, 2009) as well as NPK mixture for number of grains/spike (Jamal and Chaudhary, 2007).

In addition, the data reveal that foliar application of wheat plants with the tested macronutrients (N, P, K and NPK) significantly increased grain, straw and biological yields/fad in both seasons. Moreover, it can be noticed that foliar application of wheat plants with 9 % NPK mixture produced the highest significant values of grain, straw and biological yields/fad in both seasons. The superiority of grain yield/fad due to the foliar application of NPK mixture may be attributed to the increase in number of spike/m^2, spike yield and its main components (number of grains/spike and 1000-grain weight) and the superiority of biological yield/fad obtained herein by foliar application of tested macronutrients mainly attributed to the increase in grain and /or straw yields/fad. Many reseachers found that yield and its components of wheat were increased with foliar application of some macronutrients such as N for grain and straw yields/fad (Ibrahim *et al.*, 2004 and Khan *et al.*, 2009), K for grain and straw yields/fad (El-Sabbagh *et al.*, 2002 and El-Abady *et al.*, 2009).

With regard to harvest index, it can be noticed that the values were significantly affected by the (N, P and K) either separatly or mixed in both seasons. Moreover, it can be noticed that the highest significant values of harvest index were obtained by foliar application of 3 % N and 9 % NPK mixture in the first and second seasons, respectively. This superiority in the values of harvest index may be due to the high response of grain yield to the application of macronutrients more than that of biological (grain and straw)yield. In this concern, Sarhan and Hammad (1995) found that the

highest significant value of harvest index was obtained by foliar application of 1 % urea.

The data show that protein percentage in grains was significantly increased with foliar application of the three tested macronutrients (N, P and K) either separatly or mixed together compared to unsprayed plants in the two growing seasons. Among the tested macronutrients, the data show that the highest significant value of protein percentage in grains (11.73 and 11.51%) were recorded when the plants were sprayed with the mixture of the three elements (9 % NPK) in both growing seasons. Many investigators found that grain protein percentage of wheat was increased with foliar application of some macronutrients such as N (Salwau, 1994 and Seilsepour, 2007) and K (El-Abady *et al.*, 2009).

C- Effect of foliar application of micronutrients.

Data represented in Table (5) show the number of spikes/m^2, number of grains/spike, 1000-grain weight, spike yield, grain, straw and biological yields/fad and harvest index as well as grain protein percentage as affected by foliar application of some micronutrients (0, 1 % Mn, 1 % Zn, 1 % Fe, and 0.5 % B) in 2005/2006 and 2006/2007 seasons.

Table (5): Effect of foliar application of macronutrients on yield and its components as well as grain protein % during 2005 / 2006 and 2006 / 2007 seasons.

Characters / Micronutrients	No. of spikes / m.^{2}	No. of grains/ spike	1000-grain weight (g.)	Spike yield (g.)	Grain yield (ton/fad)	Straw yield (ton/fad)	Biological yield (ton/fad)	Harvest index (%)	Grain protein %
2005 / 2006 season									
0	245.8 c	52.9 d	37.20 c	2.440 c	2.139 d	4.365 c	6.504 d	32.89 a	9.90 d
1 % Mn	292.5 b	65.3 b	44.03 b	3.000 b	2.595 b	5.309 b	7.904 b	32.83 a	11.29 b
1 % Zn	310.2 a	69.5 a	47.01 a	3.131 a	2.705 a	5.812 a	8.517 a	31.76 a	11.58 a
1 % Fe	289.0 b	63.8 c	43.90 b	2.940 b	2.548 c	5.179 a	7.727 c	32.98 a	11.06 c
0.5 % B	291.0 b	63.9 c	43.92 b	2.970 b	2.589bc	5.203 b	7.792 bc	33.23 a	11.22 b
2006 / 2007 season									
0	248.6 d	56.1 d	36.30 d	2.509 d	2.184 d	4.336 c	6.520 c	33.50 a	10.61 d
1 % Mn	298.0 b	66.9 b	44.10 b	3.017 b	2.595 b	4.871 a	7.466 a	34.76 a	11.46 b
1 % Zn	308.5 a	69.9 a	45.80 a	3.186 a	2.689 a	4.870 a	7.559 a	35.57 a	11.59 a

1 % Fe	294.4 c	65.0 c	42.6 c	2.914 c	2.531 c	4.790 b	7.321 b	34.57 a	10.98 c
0.5 % B	297.0 b	65.7 c	43.10bc	2.958 c	2.544 c	4.821 b	7.365ab	34.54 a	11.46 b

The data show that the number of spikes/m^2, number of grains/spike, 1000-grain weight and spike yield were significantly increased by foliar application of wheat plants with any tested micronutrients compared to unsprayed plants in the two seasons.The highest significant values of those characters among the tested micronutrients, were obtained by foliar application of zinc sulphate at a rate of 1 % in both seasons. In this respect, many researchers found that foliar application of Zn increased each of number of spikes/m^2 (Zein *et al.*, 2001and El-Nasharty, 2005), 1000-grain weight (Abd El-Mottaleb *et al.*, 1997), number of grains/spike (El-Nasharty, 2005), spike yield (Abd El-Mottaleb *et al.*, 1997; Zein *et al.*, 2001and El-Nasharty, 2005).

With regard to grain, straw and biological yields/fad, the data show that the values were significantly increased when the wheat plants were sprayed with any tested micronutrients as compared with the unsprayed plants in the two seasons. In comparison among the tested micronutrients, the results show that foliar application of 1 % zinc sulphate caused the highest significant increase in grain, straw and biological yields/fad. The superiority of grain yield/fad with the application of zinc may be attributed to the increase in both of the number of spikes/m^2 and spike yield and its main components (number of grains/spike and 1000-grain weight) and the superiority of biological yield with the foliar application of zinc may be due to its favourable effect on increasing grain and straw yields/fad. With this regard, many investigators found that foliar application of Zn caused increase in each of grain and straw yields/fad (Abd El-Mottaleb *et al.*, 1997 and El-Nasharty, 2005), grain yield/fad (Habib, 2009), biological yield (Abd El-Mottaleb *et al.*, 1997) and Mn for grain and straw yields/fad (Zein *et al.*, 2001).

Reversely, the data of harvest index was not significantly affected by foliar application of the tested micronutrients in both seasons. This means that translocation rate of assimilates from vegetative organs to grain and /or straw were equal and not affected by different such micronutrients.

The data of grain protein % indicate that the values of grain protein percentage were significantly increased with foliar application of any tested micronutrients as compared with the control treatment especially Zn, Mn and B. Moreover, it is clear that the highest grain protein percentage was obtained by foliar application of 1 % zinc sulphate in both seasons. These results could be due to the essential role of micronutrients for the activity of various types of enzymes including dehydrogenase, aldolase and transphosphorylases as well as DNA and RNA polymerase which are

associated with carbohydrate metabolism and protein synthesis. In this respect, Gheith *et al.*, (1989) found that foliar application of Zn increased protein percentage in grain wheat compared to untreated plants.

D- Effect of the interactions:

I- Effect of the interaction between soil application of nitrogen levels and foliar application of some macronutrients. (A x B)

The interaction between soil application of nitrogen levels (0, 40 and 80 kg N/fad) and foliar application of some macronutrients (0, N, P, K and NPK) had significant effect on yield and yield components, i.e spike attributes (number of spikes/m^2 and 1000-grain weight) and yields/fad (grain and straw yields/fad) during 2005/6 and 2006/7 seasons as shown in Table (6). However, number of grains/spike, spike yield, biological yield, harvest index and grain protein percentage were not significantly affected by such interaction in both seasons, therefore, the data were excluded.

The data show that the highest values of number of spikes/m^2, 1000-grain weight, grain and straw yields/fad were obtained when the plants were soil fertilized by 40 kg N/fad and foliar applied with of 9 % NPK mixture in both growing seasons.

Table (6): Effect of the interaction between soil application of nitrogen levels and foliar application of macronutrients on yield and its components during 2005/2006 and 2006/2007 seasons.

N-Levels (Kg. N/fad)	Macronutrients	2005 / 2006				2006 / 2007			
		No. of spikes/m^2	1000-grain weight (g.)	Grain yield (ton/fad)	Straw yield (ton/fad)	No. of spikes/m^2	1000-grain weight (g.)	Grain yield (ton/fad)	Straw yield (ton/fad)
0	0	224.3 h	40.63 fg	1.338 l	2.849 k	229.5 k	36.99 g	1.350 l	2.591 k
	3 % N	245.4 f	41.89 ef	1.601 g	3.529 i	253.1 h	40.93 de	1.377 k	3.614 g
	3% P	233.3 g	39.75 gh	1.389 j	3.290 j	236.6 j	37.47 fg	1.388 k	3.188 i
	3 % K	228.1 gh	38.12 i	1.254 k	3.663 h	231.9 k	39.59 ef	1.589 j	2.729 j
	9 % NPK	255.9 e	42.64 e	1.524 h	4.659 g	253.6 h	40.60 de	1.647 i	3.359 h
40	0	248.0 e	39.39 hi	2.278 f	5.111 f	234.6 i	41.12 de	2.202 h	4.805 f
	3 % N	301.1 c	44.31 d	2.970 d	5.585 e	296.9 e	43.73 bc	2.967 f	5.507 cd
	3% P	281.7 d	42.09 e	2.870 e	5.575 e	287.5 g	44.89a-c	2.950 f	5.530 cd

	3 % K	276.1 d	40.79 fg	2.817 e	5.318 g	290.1 f	42.56 cd	2.724 9	5.412 de
	9 % NPK	353.7 a	48.69 a	3.468 a	7.330 a	359.0 a	47.05 a	3.424 a	5.979 a
80	0	282.9 d	41.36 f	2.825 e	5.725 cd	296.1 e	40.90 de	2.960 f	5.188e
	3 % N	359.0 a	46.02 c	3.180 c	5.645 d	355.3 b	44.38 bc	3.375 b	5.591 cd
	3% P	328.3 b	45.97 c	3.414 a	6.249 c	332.7 c	45.87 ab	3.155 d	5.739 bc
	3 % K	323.9 b	48.91 a	3.341 b	5.749 cd	327.2 d	44.61a-c	3.045 e	5.670b-d
	9 % NPK	352.7 a	48.07 ab	3.465 a	7.327 a	355.5 b	45.18 ab	3.329 c	5.883 ab

II- Effect of the interaction between soil application of nitrogen levels and foliar application of micronutrients. (A x C)

Data represent in Table (7) indicate that yield and yield components, i.e spike attributes (number of spikes/m^2, number of grains/spike, 1000-grain weight and spike yield) and grain yield/fad were significantly affected by the interaction between soil application of nitrogen levels (0, 40 and 80 kg N/fad) and foliar application of some micronutrients (0, 1 % Mn, 1 % Zn, 1 % Fe, and 0.5 % B) during 2005 /2006 and 2006 /2007 seasons. On the contrary, the effect on straw and biological yields/fad as well as harvest index and grain protein percentage were not significantly affected by such interaction in both seasons, therefore, the data were excluded.

The data show that the highest values of number of spikes/m^2, number of grains/spike, 1000-grain weight, spike yield and grain yield/fad were obtained when the plants were soil fertilized by 80 kg N/fad and foliar applied with of 9% 1 % zinc sulphate. These results are fairly true in the two seasons.

Table (7): Effect of the interaction between soil application of nitrogen levels and foliar application of micronutrients on yield and its components during 2005/2006 and 2006/2007 seasons.

N-Levels (Kg. N/fad)	Micronutrients	2005/2006					2006/2007				
		No. of spikes/m^2	No. of grain/spike	1000-grain weight (g.)	Spike yield (g.)	Grain yield (ton/fad)	No. of spikes/m^2	No. of grain/spike	1000-grain weight (g.)	Spike yield (g.)	Grain yield (ton/fad)
0	0	212.5 i	47.80g	36.88fg	2.317 g	1.190 h	316.3 k	54.0 k	35.80 g	1.980 k	2.580g
	1% Mn	243.9gh	55.53e	41.30e	2.651 e	1.468 g	249.7 h	61.9 h	39.88ef	2.240 i	2.841ef
	1 % Zn	254.1 f	61.00d	42.51c-e	2.757 e	1.529 f	250.4 h	64.2 g	41.96de	2.310 h	2.910de
	1% Fe	236.9h	53.07 f	40.77 e	2.593 e	1.440 g	241.9 j	62.3 h	37.76fg	2.260 i	2.860ef
	0.5% B	239.5gh	53.53 f	41.58de	2.604 e	1.481 g	246.4 i	63.3 i	40.18ef	2.170 ij	2.770 f
	0	245.5g	55.27e	36.14 g	2.428 f	2.432 e	248.5hi	56.8 j	36.47g	2.42 g	2.421 h

40	1% Mn	296.7d	69.33bc	43.29cd	3.091 c	2.944 d	304.0 e	68.7cd	45.37bc	3.00 e	3.003cd
	1% Zn	327.1c	74.07a	48.15 b	3.263 b	3.103cd	315.1 d	71.3 b	47.30ab	3.22 d	3.221 b
	1% Fe	296.7d	70.07Bc	43.83 c	3.063 c	2.969d	301.7 e	65.9 f	45.30bc	2.80 f	2.800 f
	0.5%B	293.1 d	68.73bc	43.41cd	3.197 c	2.955d	298.7 f	68.3 de	44.90bc	3.06 e	3.06 c
80	0	279.3 e	55.60 e	38.56 e	2.567 e	2.796 e	281.1 g	57.6 j	36.75 g	3.110 e	2.511gh
	1% Mn	335.4 b	71.00 b	47.42 b	3.250 b	3.373 b	340.4 c	70.1 Bc	47.07 b	3.800 b	3.201b
	1 % Zn	349.6 a	73.47 a	50.38 a	3.373 a	3.484 a	359.9 a	74.3 a	48.04 a	3.020 a	3.420a
	1% Fe	333.3bc	68.40 c	47.13 b	3.168bc	3.239 c	339.5 c	66.8 ef	44.81bc	3.680 c	3.080 c
	0.5%B	340.3 b	69.33bc	46.85b	3.210 b	3.333 b	346.0 b	68.3 de	44.28cd	3.640 c	3.041 c

III- Effect of the interaction between foliar application of macronutrients and foliar application of micronutrients. (BxC)

The mean values of yield and yield components, i.e spike attributes (number of spikes/m^2 and 1000-grain weight) and grain yield/fad were significantly affected by the interaction between foliar application of tested macronutrients (0, N, P, K and NPK) and foliar application of tested micronutrients (0, Mn, Zn, Fe, and B) during 2005/6 and 2006/7 seasons as shown in Table (8). The data declare that the foliar application of 9 % NPK mixture with 1 % zinc sulphate produced the highest values of number of spikes/m^2, 1000-grain weight and grain yield/fad. These results are fairly true in the two seasons.

Table (8): Effect of the interaction between foliar application of macronutrients and foliar application of micronutrients on yield and its components during 2005/2006 and 2006/2007 seasons.

Macronutrients	Micronutrients	2005/2006			2006/2007		
		No. of spikes/m^2	1000-grain weight (g.)	Grain yield (ton/fad)	No. of spikes/m^2	1000-grain weight (g.)	Grain yield (ton/fad)
0	0	236.9 n	36.24 k	1.944 ij	241.4 n	36.12 fg	2.079 r
	1% Mn	245.6 m	38.52 jk	2.194 h	250.9 m	43.08 a-d	2.320 lm
	1%Zn	265.9 k	44.48 ef	2.245 g	251.4 m	42.31 de	2.231 o
	1 % Fe	253.9 l	40.99 i	2.103 h	261.1 k	37.26 fg	2.218 p
	0.5 % B	256.0 l	41.30 hi	2.248 g	262.3 k	38.86 ef	2.272 no
3%N	0	246.5 jk	38.66 j	2.222 g	251.4 m	35.39 fg	2.172 q
	1% Mn	319.6 d	45.83 d	2.678 c	326.0 e	44.75 a-d	2.528 gh
	1%Zn	302.7 ef	48.37 b	2.819 b	307.9 gh	45.89 a-d	2.774 a-c
	1 % Fe	305.4 ef	44.35 e	2.618 c	312.0 g	44.52 a-d	2.670 ef
	0.5 % B	303.0 ef	43.13 g	2.583 d	311.6 g	44.52 a-d	2.723 de
	0	244.6 m	36.81 k	2.037 i	246.5 m	37.14 fg	2.232 o
	1% Mn	276.8 hi	41.08 i	2.610 c	281.7 j	42.86 b-d	2.756 cd

3%P	1%Zn	312.9 de	46.60 d	2.804 b	318.3 f	46.67 ab	2.748 c-e
	1 % Fe	294.7 g	45.54 d	2.697 c	299.3 i	41.87 de	2.315 mn
	0.5 % B	276.2 hi	42.97 gh	2.640 c	282.5 j	45.17 a-d	2.429 ik
3%K	0	243.7 m	35.41 l	2.097 i	247.3 m	34.39 g	2.168 p
	1% Mn	286.4 gh	46.58 d	2.501 de	294.6 ij	44.58 a-d	2.457 i
	1%Zn	303.6 ef	44.63 ef	2.613 c	311.0 g	46.40 a-c	2.715 de
	1 % Fe	271.0 ij	43.33 g	2.481 f	279.6 j	43.46 a-d	2.578 g
	0.5 % B	275.0 hi	43.08 g	2.663 c	282.9 j	42.44 cd	2.445 ij
9% NPK	0	253.6 l	38.87 j	2.396 g	256.6 l	38.66 ef	2.368 l
	1% Mn	330.4 c	48.03 bc	2.990 a	337.0 c	44.67 a-d	2.921b
	1%Zn	362.5 a	51.00 a	3.046 a	353.9 a	47.46 a	2.980 a
	1 % Fe	316.3 d	45.35 dc	2.846 b	320.0 d	46.00 a-c	2.876 c
	0.5 % B	341.2 b	49.26 b	2.815 b	346.0 b	44.60a-d	2.857 cd

Concerning with number of grains/spike, spike yield, straw and biological yields/fad as well as harvest index and grain protein percentage, the data were not significantly affected by the interaction between foliar application of macronutrients and foliar application of micronutrients in both seasons, therefore, the data were excluded.

IV- Effect of the interaction among soil application of nitrogen levels, foliar application of macronutrients and foliar application of micronutrients. (A x B x C)

The second order interaction among the three studied factors, i.e soil application of nitrogen levels, foliar application of macronutrients and foliar application of micronutrients had no significant effect on all characters studied yield and its components as well as grain protein % in the first and / or second seasons, therefore, the data were excluded and not tabulated.

Nevertheless, it can be found that the favorable results were mostly obtained when the plants were soil fertilized by 40 kg N/fad and sprayed with mixture of NPK (3% urea + 3% calcium superphosphate + 3% potassium sulphate) and 1 % zinc as compared with these either unsoil fertilized with N or soil fertilized with 80 kg N/fad.

From the obtained data herein, it can be concluded that using macro and micronutrients as foliar application caused a saving about 50 % of soil nitrogen levels which have been required for having high yielding without significant depression in yielding ability of wheat plants.

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تأثير التسميد الأرضي بالنيتروجين و التسميد الورقي ببعض العناصر الكبرى و الصغرى على انتاجية و جودة محصول قمح الخبز

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الملخص العربي

أجريت تجربتان حقليتان في محطة البحوث الزراعية بالجميزة محافظة الغربية خلال موسمي الزراعة ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ بهدف دراسة تأثير مستويات التسميد النيتروجيني الأرضي (صفر – ٤٠ – ٨٠ كجم ن/فدان) و التسميد الورقي ببعض العناصر الكبرى (صفر – ٣ % يوريا "ن" – ٣% سوبر فوسفات الكالسيوم "فو" – ٣% كبريتات بوتاسيوم "بو" – ٩% مخلوط العناصر الكبرى الثلاثة "ن + فو + بو") و التسميد الورقي ببعض العناصر الصغرى (صفر – ١ % كبريتات منجنيز – ١ % كبرتات زنك – ١ % كبريتات حديد – ٠.٥ %

بوراكس) على المحصول و مكوناته و جودة الحبوب لصنف القمح جميزة ١٠. و يمكن ايجاز أهم النتائج المتحصل عليها فيما يلي :

١- أدى اضافة التسميد النيتروجيني بمعدل ٨٠ كجم ن/فدان الى زيادة معنوية في صفات عدد السنابل / م٢ ، عدد الحبوب في السنبلة ، محصول السنبلة ، وزن ١٠٠٠حبة محصول الحبوب و القش و البيولوجي للفدان ، دليل الحصاد و المحتوى البروتيني للحبوب في كلا الموسمين في حين لم يكن هناك فروق معنوية بين المستويين ٤٠ و ٨٠ كجم ن / الفدان لعدد الحبوب في السنبلة في الموسم الأول و وزن ١٠٠٠ حبة في الموسم الثاني.

٢- تشير نتائج مقدار استجابة المحصول و مكوناته للتسميد النيتروجيني بأنه يمكن تعظيم قيم محصول القمح و مكوناته وذلك باضافة ٦٠.٣ و ٧٠.٧ كجم ن/الفدان لزيادة عدد الحبوب في السنبلة و ٦٧.٨ و ٦٣.١ كجم ن/الفدان لزيادة محصول القش ، ٦٩.٥ و ٦٥.٨ كجم ن/الفدان لزيادة المحصول البيولوجي و ٩١.٦٩ و ٩٤.٢٩ كجم ن/الفدان لزيادة محتوي الحبوب من البروتين في الموسم الأول و الثاني على الترتيب و كذلك باضافة ٧٤.٧ و ٧٢.٦ كجم ن/الفدان لزيادة محصول السنبلة و دليل الحصاد في الموسم الأول و ٦٢.٥ كجم ن/الفدان لزيادة وزن ١٠٠٠حبة في الموسم الثاني. هذا و يمكن الوصول الى محصول الحبوب الأمثل (٣.٢٦٤ و ٣.٢٠٤ طن) و ذلك باضافة ٧٠.٢ و ٦٨.٨ كجم ن/الفدان في كلا الموسمين على الترتيب هذا و قد وجد أن هذه الاضافة يمكن أن تحقق صافي ربح كلى مقداره ٣٤٦٦.١ و ٣٦٩٦.٨ جنيه/فدان في كلا الموسمين على التوالي.

٣- أعطى التسميد الورقي بمخلوط العناصر الكبرى (ن + فو + بو) أعلى قيم معنوية لصفات عدد السنابل / م٢ و عدد الحبوب / السنبلة و وزن الألف حبة و محصول السنبلة و محصول الحبوب للفدان و محصول القش للفدان و المحصول البيولوجي للفدان والنسبة المئوية للبروتين في الحبوب في كلا الموسمين ، في حين تشير النتائج الى عدم وجود فروق معنوية بين الرش بالعناصر الكبرى المختبرة الثلاث بصورة منفردة او مخلوطة لعدد الحبوب / السنبلة في الموسم الثاني.

٤- أدى التسميد الورقي بكبريتات الزنك بتركيز ١ % الى تحقيق أعلى زيادة معنوية لجميع الصفات المدروسة. (عدد السنابل / م٢ و عدد الحبوب / السنبلة و وزن الألف حبة

محصول السنبلة و محصول القش و البيولوجي و الحبوب للفدان و النسبة البروتين في الحبوب) مقارنة بالنباتات غير المعاملة (الكنترول) و ذلك خلال موسمي الزراعة في حين لم تتأثر صفة دليل الحصاد معنويا بأي من معاملات التسميد الورقي بالعناصر الصغرى في كلا الموسمين.

٥- تشير نتائج التفاعل بين عوامل الدراسة الثلاث الى :

أ- أمكن الحصول على أعلى قيم معنوية لصفات عدد السنابل / م٢ و وزن الألف حبة و محصول الحبوب والقش للفدان عند التسميد النيتروجيني الأرضي بمستوى ٤٠ كجم ن للفدان مع التسميد الورقي بمخلوط العناصر الكبرى (ن + فو + بو) في كل من موسمي الزراعة.

ب- أعطى التسميد النيتروجيني الأرضي عند مستوى ٨٠ كجم ن للفدان مع التسميد الورقي بكبريتات الزنك بتركيز ١ % أعلى قيم معنوية لصفات عدد السنابل / م٢ و عدد الحبوب / السنبلة و وزن ١٠٠٠ حبة و محصول السنبلة و محصول الحبوب للفدان في كل من موسمي الزراعة.

ج- أعطى التسميد الورقي بمخلوط العناصر الكبرى و التسميد الورقي بكبريتات الزنك أعلى زيادة معنوية لصفات عدد السنابل / م٢ و وزن ١٠٠٠ حبة و محصول الحبوب للفدان في كل من موسمي الزراعة.

د- تشير نتائج التفاعل من الدرجة الثانية الي انه لايوجد تاثير معنوى للتفاعل بين كل من مستويات التسميد النيتروجيني الأرضي ، التسميد الورقي بالعناصر الكبرى ، التسميد الورقي بالعناصر الصغرى وذلك على جميع الصفات المدروسة خلال موسمي الزراعة.

٦- يمكن التوصية بامكانية تحسين انتاجية و جودة محصول القمح (صنف جميزة ١٠) و ذلك بتسميد النباتات تسميدا نيتروجينيا أرضيا (باضافة ٤٠ كجم نيتروجين للفدان) مع التسميد الورقي بمخلوط العناصر الكبرى بتركيز ٩ % (٣ % يوريا + ٣ % سوبر فوسفات الكالسيوم + ٣ % كبريتات بوتاسيوم) مع التسميد الورقي بعنصر الزنك بتركيز ١ % كبرتات زنك على أن يتم رش النباتات بالعناصر الكبرى و الصغرى مرتين متتاليتين في أعمار ٣٥ و ٥٠ يوما من الزراعة.