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MAXIMIZING WHEAT YIELD UNDER N, K AND B FERTILIZATION

Gazia, E. A. E. and M. A. Abd EL Aziz
Soils, water and Environment Res. Inst., Agric. Res. Center, Egypt.

ABSTRACT

Two field experiments were conducted at Sakha Agricultural Research Station, North Delta, Egypt during two successive growing seasons (2010-2011 and 2011-2012) to study the effect of nitrogen fertilization with and without K and B application on wheat yield in addition to evaluate quantitatively the response of wheat grain yield to fertilizer application using a polynomial quadratic equation. Five N levels (0, 30, 60, 90, and 120 kg N fed^{-1}) were applied as a main plots, with 2 levels of K (0 and 50 kg K_2O fed^{-1}) as sub-plot, and B solution at 0.1% concentration sprayed after 70 days from sowing as sub-sub plots. The cultivated wheat variety was Sakha 69.

The main results could be summarized as follows:

1- Increasing N levels up to 90 kg fed^{-1} led to a significant increase in the grain yield. Also, the grain yield was increased with potassium application in average by 2.5 %. Foliar application of boron resulted in increasing the grain yield in average by 2.48%.

2- The estimated values of the maximum N rate (x_{max}) were 2.76, 2.83, 2.78 and 2.77 units of N fed^{-1}. (one N unit = 30 kg) for the treatments of N only (A), N with B (B), N with K(C) and N with B and K(D), respectively. The estimated values of maximum wheat grain yield (Y_{max}) (17.051, 17.586, 17.788 and 18.140 ardab fed^{-1} for the four treatments, respectively) were increased by applying K and B fertilizers.

3- The economic optimum yield (Y_{opt}) was obtained by applying the economic optimum rates (x_{opt}). The values of x_{opt} were 2.63, 2.70, 2.65 and 2.64 N units fed^{-1} for the four treatments, respectively. The values of Y_{opt} were 17.03, 17.57, 17.76 and 18.13 ardab fed^{-1} for the previous mentioned treatments, respectively. The net returns of using N fertilizer were 2612.80, 2753.82, 2766.34 and 2865.10 LE fed^{-1} for the four treatments, respectively. Hence, it could be concluded that the maximum and optimum wheat grain yield (Y_{max} and Y_{opt}) were increased by applying K and B fertilizers.

4- Relative efficiency of applied N fertilizer (E_X) with different treatments could be arranged in the following descending order: D > C > B > A. The highest efficiency of soil N (ex_s) was obtained under treatment B. The highest value of soil N (x_s) (1.486 unit fed^{-1}) was obtained with A treatment. The contribution of applied N fertilizer increased with increasing N level and the highest value of applied N fertilizer contribution was obtained under D treatment. Also, the contribution of soil N decreased with increasing N application level up to 120 kg fed^{-1} (N_4). The net return due to Boron spraying was 299.8 L.E fed^{-1}.

Generally it could be concluded that increasing N level up to 90 kg/fed led to a significant increase in wheat grain yield. The maximum, optimum wheat grain yield (Y_{max} and Y_{opt}), N use efficiency and the net return were increased by applying K and B fertilizers. Also the contribution of soil N decreased with increasing N application level up to 120 kg fed^{-1}.

Keywords: Wheat yield response, N, K and B fertilization, optimum wheat yield, N Relative efficiency and net return.

INTRODUCTION

In Egypt, wheat consumption surpasses its production. The imported amount of wheat is about 50% of its consumption. Consequently, increasing wheat production is a must to narrowing the gap between the production and demand. Proper fertilization program is a good way to achieve this goal. The optimum rate of N, K and B fertilization is one of the important tools to conserve soil properties and improve its productivity as well as getting the maximum wheat yield. Faizy *et al.* (2012) showed that the grain yield of wheat was increased significantly by increasing N levels and the highest grain yield (2.25 tons fed^{-1}) was obtained with 120 kg N/fed. Rashed (2011) and Allam (2005) stated that the highest wheat grain and straw yields were produced by applying 90 kg N/fed. Also, Shams El-Din and El-Habbak (1992) stated that the highest grain wheat yield and its components were produced by applying 80 kg N fed^{-1}. On the other hand, grain yield of wheat increased by 8% with potassium application compared without K and each Kg K_2O increased grain yield by 3.33Kg (Abd ELhadi, 2004). Haikel *et al.* (1996) found that raising potassium doses up to 24 kg fed^{-1} (K_2O) markedly increased the wheat grain yield by 1.97 ardab fed^{-1}. El-Banna *et al.* (2004) and Magda and El-Mahgoby (2006) found that increasing the dose of K-fertilizer increased wheat grain yield and its components. Moreover, Saleh *et al.* (1982) stated that addition of N at any rate in combination with B at 1.2 kg fed^{-1} caused significant increase in wheat yield and its yield components. Hanafy Ahmed *et al.*, (2008) stated that foliar application of boron to wheat (40 and 70 days after sowing) significantly increased shoots height and leaf area as well as grains yield/plant and weight of 1000 grains.

The objective of the current work is to study the effect of nitrogen fertilization with and without K and B application on wheat yield in addition to evaluate quantitatively the response of wheat yield to fertilizer application using a polynomial quadratic equation.

MATERIALS AND METHODS

Two field experiments were conducted at Sakha Agricultural Research Station, North Delta, Egypt during two successive seasons (2010-2011 and 2011-2012) to study the effect of different N, K and B fertilization levels on wheat grain and straw yields. The experiment was conducted in split-split plot design with four replicates, using 5 N levels (0, 30, 60, 90, and 120 kg N fed^{-1} in urea form 46.5%) as a main plots, with 2 levels of K (0 and 50 kg K_2O fed^{-1} in K_2SO_4 form) as sub plots and with B solution at 0.1% concentration (in boric acid form) sprayed after 70 days from sowing as sub-sub plots. Wheat variety Sakha 69 was planted on 9^{th} and 15^{th} of Dec. in the first and second seasons, respectively and all agronomic practices were conducted according to the standard recommendation for North Delta.

Surface soil samples (0-30cm depth) from experimental site were taken before planting in the two seasons and prepared for physical and chemical analysis. Soil salinity, anions and cations were determined according to Page *et al.* (1982). Available N was determined according to Jackson (1967). Available P was determined according to Olsen *et al.*, (1954). Available K was determined according to Page *et al.* (1982). Particle size distribution of soil was carried out using the pipette method as described by Dewis and Fertias (1970). The soil characteristics before planting of the two seasons are presented in Table (1).

The crop yield was statistically analyzed according to procedures outlined by Cochran and Cox (1960).

Table (1):Some soil physical and chemical properties of the experimental field (0 - 30 cm).

Season	Particle size distr.			Texture	Soluble cations meq/L				Soluble anions meq/L				Available ppm				EC dS/m	pH 1:2.5	O M%	Total carbonate
	Sand%	Silt%	Clay%		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K	B				
1^{st} season	24.2	31.3	44.5	clay	5.5	2.7	7.8	0.7	-	0.51	5.03	1١.١٦	20	7.9	390	0.64	1.6	7.9	1.6	1.9
2^{nd} season	26.3	28.4	45.3	clay	6.6	2.6	8.2	0.9	-	1.3	4.85	1٢.١٥	26	8.85	420	0.58	1.8	8.1	1.7	2.2

The polynomial quadratic equation has been used to evaluate the wheat yield response to different N application rates under two levels of both B and K. The mean values of experimental data in the two seasons were used to calculate the estimated values of B_o, B_1 and B_2 of the following equation:

$$Y = B_o + B_1 x + B_2 x^2$$

Where Y: the obtained wheat yield at the applied x N rate, B_o: grain yield without N addition, B_1: linear coefficient and B_2: quadratic coefficient.

The maximum yield and the relative efficiency were calculated according to Capurro and Voss (1981). The maximum and optimum addition rate of N fertilizer x_{max} and x_{opt}, the optimum yield (Y_{opt}) and the soil N content (x_s) were calculated according to Balba (1989). The efficiency and contribution of soil nitrogen were calculated according to Balba and Shabanah (1971).

RESULTS AND DISCUSSION

I- Effect of N, K and B application on wheat yield:

A- Grain yield:

Data in Table (2) indicate that increasing N level up to 90 N fed^{-1} led to increase wheat grain yield, but with N application rate above 90 kg N fed^{-1} a decrease in the grain yield is observed. The highest grain yield (17.98 and 18.26 ardab fed^{-1}. for the first and second seasons, respectively) were obtained under 90 kg N fed^{-1} in the presence of K and B. These results are agreed with that obtained by Abd El-Gawad *et al.*, (1993), El-Leithi *et al.* (1996), Abou-Ahmed (1999), Allam (2005) and Rashed (2011).

Also, the results show that application of potassium increased the grain yield by 3 % and 2% over the control in the first and second season respectively. The effect of potassium on grain yield was more pronounced with 90 kg N fed^{-1}. Similar result was recorded by El-Leithi *et al.* (1996) and Faizy *et al.* (2012).

On the other hand, data indicted that foliar application of Boron resulted in increasing the grain yield by 3.48 % and 1.44 % over the control in the first and second seasons, respectively (in the presence of boron and absence of potassium). This increase in grain yield could be attributed to the ability of boron in affecting plant metabolism through controlling of hormonal level within plant tissues. Similar results were obtained by Thalooth *et al.* (1989) and Hanafy Ahmed *et al.*, (2008). However, the grain yield was increased by 5.77 % and 3.41 % in the first and second seasons, respectively with increasing N levels up to 90 kg fed^{-1} in presence of K and B.

Table (2): Interaction effect of N, K and B levels application on wheat grain yield (ardab fed^{-1}) in the two growing seasons:

Treatments		**First season**		**Second season**	
N Kg fed^{-1}	B %	0 kg K_2O fed^{-1}	50 kg K_2O fed^{-1}	0 kg K_2O fed^{-1}	50 kg K_2O fed^{-1}
0	0.0	9.75	10.05	10.33	10.53
30	0.0	13.46	14.20	13.85	14.65
60	0.0	16.53	16.96	16.92	17.64
90	0.0	16.93	17.63	17.40	18.02
120	0.0	14.95	15.81	16.01	16.67
0	0.1	9.87	10.13	10.41	10.62
30	0.1	14.00	14.48	14.15	15.05
60	0.1	17.00	17.40	17.35	17.90
90	0.1	17.52	17.98	17.65	18.26
120	0.1	15.60	16.13	16.86	16.94

Interactions	**L.S.D**	**N**	**K**	**B**	**NK**	**NB**	**KB**	**NKB**
1 st season	**5%**	**	**	**	**	**	**	**
					0.034	**0.046**	**0.029**	**0.065**
2 nd season	**5%**	**	**	**	**	**	**	**
					0.048	**0.032**	**0.020**	**0.046**

B- Straw yield (ton/fed):

Data in Table (3) show that the increase of N levels up to 120 kg/fed. led to increase the straw yield by 37 % over the control. In the first season, the highest straw yield value (4.75 ton fed^{-1}) was obtained under 120 kg N fed^{-1} in presence of both K and B. While in the second season, the highest value (4.32 ton fed^{-1}) was recorded with 90 kg N/fed in presence of both K and B. These results are in good agreement with that obtained by Rady and Abou-Al-Zahab (1990), Allam (2005) and Rashed (2011).

Table (3): Interaction effect of N, K and B levels application on wheat straw yield (ton/fed.) in the two growing seasons:

Treatments		First season				Second season		
N Kg fed^{-1}	B %	0 kg K_2O fed^{-1}		50 kg K_2O fed^{-1}		0 kg K_2O fed^{-1}		50 kg K_2O fed^{-1}
0	0.0	3.27		3.29		3.04		3.09
30	0.0	3.64		3.69		3.30		3.37
60	0.0	3.92		4.00		3.60		3.64
90	0.0	4.35		4.53		4.06		4.20
120	0.0	4.48		4.57		3.97		4.00
0	0.1	3.28		3.30		3.07		3.11
30	0.1	3.75		3.76		3.41		3.43
60	0.1	4.10		4.15		3.67		3.74
90	0.1	4.55		4.70		4.15		4.32
120	0.1	4.70		4.75		4.11		4.20

Interactions	L.S.D	N	K	B	NK	NB	KB	NKB
1 st season	5%	**	**	**	**	**	**	N.S
					0.034	0.018	0.011	N.S
2 nd season	5%	**	**	**	**	**	N.S	**
					0.017	0.016	N.S	0.023

II- Quantitative Analysis:

The polynomial quadratic equations were established to express the response of wheat grains yield to N application with and without application of K or B as shown in Table(4).

Table (4): The polynomial equations expressing wheat grain yield at different treatments (means of two seasons).

Treatment		The polynomial quadratic equations ($Y = B_o + B_1 x + B_2 x^2$)
A	N only	$Y_N = 9.845 + 5.219 x - 0.945 x^2$, $R^2 = 0.9753$ (1)
B	N with B	$Y_{N,B} = 10.012 + 5.357 x - 0.9471 x^2$, $R^2 = 0.9812$ (2)
C	N with K	$Y_{N,K} = 10.186 + 5.47 x - 0.985 x^2$, $R^2 = 0.9855$ (3)
D	N with B and K	$Y_{N,B\ and\ K} = 10.302 + 5.6718 x - 1.026 x^2$, $R^2 = 0.9889$ (4)

Where Y: the obtained wheat yield at the applied x N rate, B_o: grain yield without N, B_1: linear coefficient and B_2: quadratic coefficient.

1 – The maximum N rate (x_{max}):

The maximum N rate (x_{max}) for each treatment is calculated according the following relation derived from the equations 1 – 4 according to Balba (1961) as follow:

$x_{max} = - B_1 / 2 B_2$

The estimated values of the maximum N rate (x_{max}) are 2.76, 2.83, 2.78 and 2.77 units of N fed^{-1} for A, B, C and D treatments, respectively (one N unit = 30 kg) as shown in Table (5).

Table (5): The maximum N rate (x_{max}), the corresponding maximum yield (Y_{max}) and grain yield with 75 kg N fed^{-1} as affected by different rates of N, B and K.

Treatment		x_{max} (unit fed^{-1})	Y_{max} (ardab fed^{-1})	Grain yield at 75* (2.5 unit) kg N fed^{-1} (ardab fed^{-1})
A	N only	2.761	17.051	16.986
B	N with B	2.828	17.586	17.484
C	N with K	2.777	17.788	17.705
D	N with B and K	2.765	18.140	18.068

*** The recommended dose according to Ministry of Agric. in North Delta.**

2 – The maximum wheat grain yield (Y_{max}):

The maximum wheat grain yield(Y_{max}) for each treatment were calculated according to the following relation derived from the equations 1 – 4 according to **Capurro** and **Voss**, (1981) as follow:

$Y_{max} = B_o - (B_1^2 / 4 B_2)$

The estimated values of maximum wheat grain yield (Y_{max}) are given in Table (6).

3 – The economic optimum yield (Y_{opt}):

The optimum rate of N fertilizer applied are calculated by differentiating " Y" in the polynomial equations 1-4 with respect to "*x*" (*dy/dx*) and then equating this derivative with the relative price (the ratio of the fertilizer unit price) to grain yield unit price. This relation can be derived as follows:

$dy/ dx= B_1 – 2B_2 x$

$$\frac{dy}{dx} = B_1 - 2B_2 x = \frac{\text{N fertilizer unit price}}{\text{Wheat grain unit price}}$$

$$x_{opt} = \frac{1}{2B_2} \left(B_1 - \frac{\text{N fertilizer unit price}}{\text{Wheat grain unit price}}\right)$$

Table (6): The calculated wheat grain yield (ardab fed^{-1}) as affected by different rates of N with /without B and K.

Treatment		calculated wheat grain yield (ardab/fed)				
		N_o 0 kg N fed^{-1}	N_1 30 kg N fed^{-1}	N_2 60 kg N fed^{-1}	N_3 90 kg N fed^{-1}	N_4 120 kg N fed^{-1}
A	N only	9.845	14.119	16.503	16.997	15.601
B	N with B	10.012	14.42	16.94	17.56	16.29
C	N with K	10.186	14.67	17.18	17.73	16.31
D	N with B and K	10.302	14.95	17.52	18.09	16.57

The economic optimum yield (Y_{opt}) obtained by applying the economic rates (x_{opt}). x_{opt} and Y_{opt} are presented in Table (7). The values of x_{opt} are 2.63, 2.70, 2.65 and 2.64 units of N fed^{-1} for the previous mentioned treatments, respectively. The values of Y_{opt} are 17.03, 17.57, 17.76 and 18.13 ardab fed^{-1}, respectively. Generally, it could be concluded that the maximum (Y_{max}) and optimum (Y_{opt}) wheat grain yield are increased by applying K and B.

4 – The predicted return from applying optimum rates:

The predicted return per feddan due to applying the optimum N rate for A, B, C and D treatments are presented in Table (7). The highest value of net return was belonging to N application with B and K. The values of the net return could be arranged in the following descending order: D > C > B > A.

Table (7): Economic optimum N rate (x_{opt}), optimum yield (Y_{opt}) and net return of grain yield of wheat as affected by different treatments (mean of two seasons).

Treatment	(xopt) (unit fed^{-1})	(Y_{opt}) (ardab fed')	Fert. Price (LE $unit^{-1}$)	U P W (LE $ardab^{-1}$)	T V W (LE fed^{-1})	T V W C (LE fed^{-1})	G R F (LE fed^{-1})	F C (LE fed^{-1})	N R F (LE fed^{-1})
A	2.63	17.03	100	400	6813.80	3938.0	2875.80	263	2612.80
B	2.70	17.57	100	400	7028.62	4004.8	3023.82	270	2753.82
C	2.65	17.76	100	400	7105.74	4074.4	3031.34	265	2766.34
D	2.64	18.13	100	400	7249.90	4120.8	3129.10	264	2865.10

Where:

U P W = unit price of wheat grain (LE $ardab^{-1}$).

T V W = Total value of wheat grain (LE fed^{-1}).

T V W C = Total value of wheat grain at control treatment(LE fed^{-1}) .

G R F = Gross return of fertilizer (LE fed^{-1}).

F C = Fertilizer cost (LE fed^{-1}), N R F = Net return of fertilizer (LE fed^{-1}).

5 – The efficiency of applied N fertilizer (E_x):

The efficiency of any fertilizer is the amount of yield produced by the fertilizer unit. The relative efficiency of fertilizer at each increment is calculated by **Cappuro** and **Voss** (1981) according the following equation:

$$E_x = \frac{1}{10} * (B_1^2 - 4*B_o*B_2)^{1/2}$$

Where : E_x = Relative efficiency index, B_o = grain yield without N, B_1 = linear coefficient and B_2 = quadratic coefficient.

Data in Table (8) shows that the values of N fertilizer efficiency (E_x) are increased by applying K and B. The values of E_x could be arranged in the following descending order: D > C > B > A.

Table (8): The relative efficiency of N fertilizer (E_x), efficiency of soil N (ex_s) and soil N (x_s) as affected by different treatments (mean of two seasons).

Treatment	E_x	ex_s (ardab/unit/fed.)	x_s (unit/fed.)
A	0.803	7.410	1.486
B	0.816	7.539	1.481
C	0.837	7.133	1.472
D	0.863	6.788	1.441

6 – Efficiency of soil N (ex_s):

In equations 1- 4 the first term B_o represent the yield obtained without N fertilizer application. Efficiency of soil N could be calculated by dividing B_o by K_2SO_4-extractable soil N as representative to soil N according to Balba and Shabanah (1971). Data in Table (8) show that the highest efficiency of soil N (7.539) is obtained under B treatment (N with B). Efficiency of soil N with different combinations could be arranged dissentingly as follows: B > A > C > D.

7 – The soil N (x_s):

The equation $Y = B_o + B_1x - B_2x^2$ could be used to calculate soil N. substituting the appropriate values for B_o , B_1 and B_2 in the polynomial equation resulted in the value of x, which is the soil N as no fertilizer is present when Y=0 (Balba, 1989). Table (8) shows the values of soil N (x_s). The highest value of x_s (1.486 unit fed^{-1}) was obtained with A treatment. The values of x_s could be arranged descendingly as follows: A> B > C >D.

8 - Contribution of soil-N and fertilizer -N in grain yield:

The polynomial equations 1-4 show that the yield "Y" consists of two components, namely: yield produced by soil-N and that produced by the applied N-fertilizer. The yield produced by N-fertilizer alone is the difference between the yields produced with and without fertilizer application. The values of x_s were used to calculate the contribution of soil N and added N-fertilizer in grain yield as shown in Table (9) according to the following formulas:

$$\textbf{Contribution of soil N} = \frac{x_s}{x_s + x_f} * \textbf{Calculated yield}$$

$$\textbf{Contribution of applied N} = \frac{x_f}{x_s + x_f} * \textbf{Calculated yield}$$

Where: x_s and x_f are soil N and applied N, respectively.

It could be concluded from the data that the fraction of soil N was decreased when the fraction of applied N fertilizer increased at the same ratio. Also, the contribution of N fertilizer was increased with increasing N application level. The highest contribution values of applied N fertilizer were obtained under D treatment. In addition, data show that the contribution of soil N was decreased with increasing N application levels from N_o to N_4.

Table (9): Contribution fraction and contribution of soil and applied N fertilizer to grain yield at different treatments (mean of the two seasons)

Treatment		Applied N		Soil N	
		Contribution fraction	Contribution (ardab fed^{-1})	Contribution fraction	Contribution (ardab fed^{-1})
A	N_o	0.000	0.000	1.000	9.845
	N_1	0.402	5.676	0.598	8.443
	N_2	0.574	9.473	0.426	7.030
	N_3	0.669	11.371	0.331	5.626
	N_4	0.729	11.373	0.271	4.228
B	N_o	0.000	0.000	1.000	10.012
	N_1	0.403	5.812	0.597	8.610
	N_2	0.575	9.739	0.425	7.198
	N_3	0.669	11.747	0.331	5.812
	N_4	0.730	11.889	0.270	4.397
C	N_o	0.000	0.000	1.000	10.019
	N_1	0.405	5.874	0.595	8.630
	N_2	0.576	9.803	0.424	7.216
	N_3	0.671	11.785	0.329	5.778
	N_4	0.731	11.797	0.269	4.341
D	N_o	0.000	0.000	1.000	10.302
	N_1	0.410	6.129	0.590	8.819
	N_2	0.581	10.192	0.419	7.350
	N_3	0.676	12.224	0.324	5.859
	N_4	0.735	12.181	0.265	4.392

9 – Feasibility analysis of Boron fertilization:

Table (10) show that spraying boron led to increase grain and straw yields of wheat by 0.6 ardab fed^{-1} and 0.6 heml fed^{-1}, respectively. The increase in wheat yield resulted in increase in return by about 360 L.E fed^{-1} (grain and straw wheat price in 2011 was 400 L.E. $ardab^{-1}$ and 200 L.E $heml^{-1}$ straw, respectively). On the other hand increase in the cost of Boron foliar spraying was 60.2 L.E fed^{-1}. So, the net return due to Boron spraying was 299.8 L.E fed^{-1}.

Table (10) :Feasibility analysis of Boron fertilization

Return&cost	Item	Quantity	Price (L.E/unit)	Value(l.E)
Increase in Return	Grain Straw	0.6 ardab/fed. 0.6 heml/fed.*	400.0 200.0	240.0 120.0
Total return				360.0
Increase in cost	N B Labour			10.2 10 40
Total cost				60.2
Net return				299.8

*** heml of straw wheat = 250 kg.**

Generally it could be concluded that increasing N level up to 90 kg/fed led to a significant increase in wheat grain yield. The maximum, optimum wheat grain yield (Y_{max} and Y_{opt}), N use efficiency and the net return were increased by applying K and B fertilizers. Also the contribution of soil N decreased with increasing N application level up to 120 kg fed^{-1}.

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تعظيم محصول القمح تحت التسميد الآزوتي والبوتاسي والرش بالبورون

السيد عامر السيد جازية و محمد أحمد عبدالعزيز
معهد بحوث الاراضي والمياه والبيئة – مركز البحوث الزراعية

إن الكمية المستهلكة من القمح في مصر تفوق الكمية المنتجة منه بكثير، فالكمية المستوردة من القمح تمثل حوالي ٥٠% من الاستهلاك لذلك فان زيادة إنتاجية القمح هدف هام للغاية يجب أن نسعى لتحقيقه بكل السبل والوسائل. ومن هذه الوسائل هو تعظيم الاستفادة من الوحدات السمادية من خلال التسميد المتوازن. ويهدف هذا البحث إلى دراسة تأثير التسميد بمستويات مختلفة من السماد النتروجينى والتسميد البوتاسى والرش بالبورون على محصول القمح (صنف سخا ٦٩) وكذلك استخدام بعض العلاقات الكمية لتقييم مدى استجابة محصول القمح للتسميد.

أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بسخا – كفر الشيخ خلال موسمي النمو ٢٠١٠-٢٠١١ و ٢٠١١-٢٠١٢ حيث استخدم التصميم الاحصائى في قطع منشقة مرتين بأربعة مكررات وكانت القطع الرئيسية تمثل التسميد النتروجينى بخمسة معدلات (صفر، ٣٠، ٦٠، ٩٠، ١٢٠كجم نتروجين/ فدان في صورة يوريا ٤٦.٥% ن) وتمثل القطع المنشقة الأولى التسميد البوتاسى بمعدلين (صفر ، ٥٠ كجم /فدان في صورة كبريتات بوتاسيوم ٤٨.٥%) وتمثل القطع المنشقة الثانية الرش بالبورون بمعدلين (صفر ، ٠.١% في صورة حمض بوريك).

ومن أهم النتائج المتحصل عليها ما يلي:

١) ازداد محصول الحبوب زيادة معنوية نتيجة زيادة التسميد النتروجينى من ٠ حتى ٩٠ كجم/ فدان. وكذلك ازداد محصول الحبوب نتيجة التسميد البوتاسى بحوالي ٢.٥%. وقد أدى الرش بالبورون الى زيادة محصول الحبوب بنسبة حوالي ٢.٤٨ %.

٢) بلغت القيمة المقدرة لمعدل التسميد النيتروجيني الأعظم ٢.٧٦، ٢.٨٣، ٢.٧٨ و٢.٧٧ وحدة N /فدان (وحدة N = ٣٠ كجم N) للمعاملات الأربعة: A (نيتروجين فقط) ، B (تسميد نيتروجيني مع بورون) ، C (تسميد نيتروجيني مع بوتاسيوم)وD (تسميد نيتروجيني مع بورون وبوتاسيوم) علي الترتيب. وبلغ المحصول الأعظم المقدر لهذه المعاملات الأربعة ١٧.٠٥١، ١٧.٥٨٦، ١٧.٧٨٨ و١٨.١٤٠ أردب للفدان علي الترتيب.

٣) بلغ المحصول الاقتصادي الأمثل ١٧.٠٣، ١٧.٥٧، ١٧.٧٦ و١٨.١٣ أردب/فدان للمعاملات الأربعة علي الترتيب , وهذا المحصول يمكن الحصول عليه بإضافة المعدل الاقتصادي الأمثل من التسميد النيتروجيني والذي يقدر ب ٢.٦٣، ٢.٧٠، ٢.٦٥ و ٢.٦٤ وحدة N/فدان. وبلغ صافى العائد لهذه المعاملات الأربعة ٢٦١٢.٨٠، ٢٧٥٣.٨٢، ٢٧٦٦.٣٤ و ٢٨٦٥.١٠ جنيه/ فدان على الترتيب. من ذلك يتضح زيادة المحصول الأعظم والامثل للقمح بإضافة التسميد البوتاسي والبورون. وأن كفاءة التسميد النيتروجيني تزداد في حالة التسميد البوتاسي والبورون عنها في حالة عدم استخدامهما.

٤) يمكن ترتيب كفاءة استخدام التسميد النيتروجيني تنازليا كما يلي: D > C > B > A وكانت أعلي كفاءة لنيتروجين التربة مع المعاملة B وأعلي قيمة مقدرة لنيتروجين التربة مع المعاملة A. وجد أن إسهام التسميد النيتروجيني قد ازداد بزيادة معدلات النيتروجين المضاف وقد امكن الحصول على أعلي قيمة للإسهام تحت معاملة التسميد النتروجينى مع البوتاسيوم و البورون (المعاملة D). كذلك وجد ان إسهام نيتروجين التربة قد تناقص بزيادة معدلات اضافة التسميد النيتروجيني . هذا وقد بلغ صافي العائد من استخدام التسميد بالبورون ٢٩٩.٨ جنيه مصري/فدان.

الاستنتاج العام: يمكن بصفة عامة استنتاج أن زيادة معدل التسميد النتروجينى حتى ٩٠ كجم/ فدان يعمل على زيادة محصول حبوب القمح زيادة معنوية.وان المحصول الأعظم و الأمثل للقمح وكذلك كفاءة استخدام التسميد النتروجينى و صافى العائد يزداد بإضافة التسميد البوتاسي والبورون عنها في حالة عدم استخدامهما. كذلك أظهرت البيانات أن إسهام نيتروجين التربة قد تناقص بزيادة معدلات التسميد النيتروجيني

قام بتحكيم البحث

أ.د / ايمن محمد الغمرى	**كلية الزراعة – جامعة المنصورة**
أ.د / السعيد حماد عمر	**مركز البحوث الزراعيه**