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EFFECT OF DIFFERENT RATES OF NPK FERTILIZATION ON WHEAT (*Triticum aestivum*, L) UNDER NEWLY CULTIVATED SANDY SOIL CONDITIONS

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ABSTRACT

Two field experiments were carried out during 2005/2006 and 2006/2007 seasons in three locations i.e., El-Khattara and El-Salhya, Sharkia Governorate and El-Areish, North Sinai Governorate, Egypt to study the effect of four PK-fertilizer levels (15.5 kg P_2O_5 + 24 kg K_2O, 15.5 kg P_2O_5 + 48 kg K_2O, 31.0 kg P_2O_5 + 24 kg K_2O and 31.0 kg P_2O_5 + 48 kg K_2O/fad.) and six N-fertilizer levels (40, 60, 80, 100, 120 and 140 kg N/fad.) on yield, yield components and yield analysis of wheat. The obtained results could be summarized as follows :

Increasing PK-fertilizer levels up to 31.0 kg P_2O_5 + 48 kg K_2O/fad. at El-Khattara and up to 31.0 kg P_2O_5 + 24 kg K_2O/fed. at both El-Salhya and El-Areish caused a significant increase in number of spikes/m^2. Number of grains/spike, 1000-grain weight and straw, grains and biological yields/fad. were significantly increased by adding 31.0 kg P_2O_5 + 48 kg K_2O/fad. at the three locations. However, the effect of PK-fertilizers on grain weight/spike at the three locations was not significant, except at El-Khattara and El-Salhya locations in the 1st season which was significant.

Increasing N-levels up to 140 kg N/fad. resulted in a significant increase in number of spikes/m^2 at the three locations, while increasing N-levels up to 120 kg N/fad. was accompanied by a significant increase in number of grains/spike at the three locations, 1000-grain weight at El-Salhya and El-Areish and biological yield/fad. at El-Ariesh. However, grain weight/spike at the three locations, 1000-grain weight at El-khattara, straw and grain yields/fad. at the three locations and biological yield/fad. at El-Khattara and El-Salhya were significantly increased when 100 kg N/fad. was applied.

The significant interaction effect between the studied factors indicated that wheat plants grown at El-Salhya and fertilized with 31.0 kg P_2O_5 + 48 kg K_2O and 140 kg N/fad. gave the highest values of number of spikes/m^2. Also, the highest values of 1000-grain weight, grain yield and biological yield were attained when wheat plants were fertilized with 31.0 kg P_2O_5 + 48 kg K_2O and 100 kg N/fad. and this was true at El-Ariesh location. Plants grown at El-Khattara and fertilized with 31.0 kg P_2O_5 + 24 or 48 kg K_2O gave the highest straw yield/fad. when 140 kg N/fad. was applied. However, wheat plants grown at El-Khattara location surpassed those grown at El-Salhya and El-Ariesh locations in most of studied characters.

Positive and highly significant correlation coefficients were detected between grain yield/fad. and all studied characters.

The path analysis revealed that the direct effect of number of spikes/m^2 was 63.98% being higher than that of number of grains/spike and 1000-grain weight which were 11.85 and 4.71% of grain yield variation, respectively.

INTRODUCTION

Wheat (*Triticum aestivum*, L) is the most important among all cereals used as a food grain in the world. It ranks first in the world cereal production and is a staple food of about one third of the world population. In Egypt, it is

grew on an area of 2,200,000 faddan with annual production of 6,600,000 ton which covered about 53.7% of the total consumption (12,300,000 ton) •. The Egyptian government seeks to increase the total wheat production either by cultivation of new high yielding cultivars or by expanding the cultivated area in newly lands with using the suitable agronomic practices. Fertilizers play an important role in increasing yield of wheat in newly lands. El-Bana (2000) found that increasing P rates up to 45 kg P_2O_5/fad. and K rates up to 50 kg K_2O/fad. significantly increased wheat grain yield/fad. Ali *et al.* (1997) reported that adding phosphorus with nitrogen resulted in a significant increase in number of grains/spike, 1000-grain weight and grain yield/ha. Khan *et al.* (1997) concluded that the highest grain weight and grain yield were recorded when N and P were added in the rate of 50 + 40 kg/ha. Maqsood *et al.* (1999), Ali *et al.* (2000) and Iftikhar M. Hussain *et al.* (2002) found significant increases in 1000-grain weight and grain yield with higher NPK levels. Guo *et al.* (2000) revealed that adding PK in the rate of 150 + 112.5 kg/ha under N-levels significantly increased number of grains as well as grain yield/ha. However, Wang *et al.* (2008) reported that N, P and K fertilizers adding resulted in a significant increase in wheat grain yield. The combined application of N, P and K has proved to be more effective in increasing yield of wheat as compared to sole application of either N or P or K. Nitrogen is still the most important plant nutrient needed to obtain high yield of wheat. Most of workers reported a beneficial effect of nitrogen application to wheat. El-Bana (1999), Nareshktaria and Kataria (1999), Patil *et al.* (2000), Alam *et al.* (2003) and Mowafy (2008) indicated that grain yield per unit area was increased by increasing nitrogen fertilization levels. Gomma (1997), Sharaan and Abd El-Samie (1999), Abd El-Hameed (2002), Abd El-Maksoud (2002), Mowafy (2002) and Ali *et al.* (2004) found that number of grains/spike, 1000-grain weight, number of spikes/^{2} and straw and grain yields/fad. were significantly increased with nitrogen applications up to 120 kg N/fad. Brye *et al.* (2007) found different response to N-fertilizer between locations due to the combination of P and K fertility differences.

Thus, the present study was executed to evaluate the productivity of wheat under different rates of P, K and N at three locations.

MATERIALS AND METHODS

Two field experiments were carried out during two successive seasons (2003/2004 and 2004/2005) in three locations i.e., El-khattara, El-Salhya (Sharkia Governorate) and El-Areish (North Sinai Governorate) to study the effect of PK and N-fertilization levels on wheat under newly cultivated sandy soils.

Each experiment included 24 treatments which were the combinations of 4 PK-fertilizer levels i.e., 15.5kg P_2O_5 + 24 kgK_2o, 15.5kgP_2O_5 + 48 kgK_2O, 31.0 kg P_2O + 24 kgK_2O and 31.0 kgP_2O_5 + 48kg K_2O/fad. and six levels of nitrogen fertilization (40, 60, 80, 100, 120 and 140 kg N/fad.).

• **- Newly study of data center of Egyptian Council of Ministers, 2005.**

A split-plot design with four replications was followed, where, main plots were assigned for four PK-levels and the sub-plots were occupied by N-levels. Each sub-plot area was 9 m^2 (3 x 3m) which included 15 rows 20cm apart.

Sowing date taken place on 17th and 20th of November at El-Khattara, 22nd and 24th of November at El-Salhya and 25th and 28th of November at El-Areish in the two growing seasons, respectively, using Sakha 93 cultivar in a seed rate of 70 kg/fad. Calcium super phosphate (15.5%P_2O_5), Potassium sulphate (50% K_2O) and Ammonium sulphate (20.6% N) were used. P and K fertilizers were added before sowing, while N fertilizer was applied in three equal doses in three times at sowing, tillering and just before heading. The other cultural practices for growing wheat were applied. The mechanical and chemical analysis of experimental soils at the three locations in both growing seasons are shown in Table (1).

Table (1): Mechanical and chemical analysis of the experimental soils of the three locations in the two growing seasons.

Variable	El-Khahara		El-Salhya		El-Areish	
	2005/2006	2006/2007	2005/2006	2006/2007	2005/2006	2006/2007
Sand %	65.8	66.7	70.4	71.8	74.5	73.9
Silt %	20.6	18.8	16.8	15.5	17.7	15.5
Clay %	13.6	14.5	12.8	12.7	7.8	10.6
Soil texture	Sandy	Sandy	Sandy	Sandy	Sandy	Sandy
N (ppm)	27.5	28.13	14.85	15.20	11.24	13.60
P (ppm)	11.17	10.50	7.30	8.85	6.60	6.91
K (ppm)	155.00	163.00	116.30	126.50	69.50	75.40
pH	7.90	7.60	7.20	7.85	8.7	8.3
$CaCo_3$	0.65	0.45	1.15	1.25	2.6	3.4

At harvest ten guarded plants were taken at random from each sub-plot to record the following characters:

1- Number of grains/spike.
2- Grain weight/spike (gm).

There after, bulk samples included all wheat plants found in the middle two rows in each sub-plot were used to study :

3- Number of spikes/m^2.
4- 1000-grain weight (gm).
5- Straw yield (t/fad.).
6- Grain yield (t/fad.).
7- Biological yield (t/fad.).

The proper statistical analysis of split-plot design was used. Combined analysis was performed for the characters recorded in both seasons. Differences among treatments were judged according to Duncan's Multiple Range Test (Duncan, 1955). Means followed by different letters were statistically significant. In interaction tables, small letters used to compare means in columns, whereas capital ones were used to compare means in rows. The combined data of yield components and yield were subjected to simple correlation and path coefficients according to Svab (1973).

RESULTS AND DISCUSSION

a) Yield and yield components :

1- Number of spikes/m^2 :

Data presented in Table (2) show the effect of PK and N-fertilizer levels on number of spikes/m^2 at the three locations in the two growing seasons as well as their combined. With respect to PK-fertilization levels, the results indicated that the highest number of spikes/m^2 was attained when 31.0 kg P_2O_5 + 48 kg K_2O/fad. Was applied at El-Khattara, while this character was the highest with 31.0 kg P_2O_5 + 24 kg K_2O/fad. Level under the other two locations compared to the other studied P + K levels. Similar results were reported by El-Bana (2000), Guo *et al.* (2000) and Iftikhar M. Hussain *et al.* (2002).

Increasing N-fertilizer levels up to 140 kg N/ha was accompanied by a significant increase in number of spikes/m^2 and this was the trend in the two growing seasons as well as their combined at the three locations. Therefore, supporting of wheat plants with more nitrogen fertilizer during the active period and thereafter is preferred for increasing number of spikes/m^2. These results are in agreement with those obtained by Abd El-Hameed (2002), Abd El-Maksoud (2002), Ismail (2002), Mowafy (2002), Alam *et al.* (2003), Ali *et al.* (2004), Hussain *et al.* (2006) and Mowafy (2008).

Regardless to the effect of studied factors at the three locations, the general means of number of spikes/m^2 indicate that wheat plants grown under El-Khattara conditions appeared to produce more spikes/m^2 as compared with those grown at El-Salhya or El-Areish with general means of 257.94, 233.68 and 238.58 spikes/m^2 at the three locations, respectively. Such results could be attributed to the influence of environmental conditions, especially the fertility and texture of soil.

The significant interaction effect between PK and N-fertilizer level at El-Salhya (Table 2-a) indicated that the highest number of spikes/m^2 (291.88) was achieved by fertilizing with 31.0 kg P_2O_5 + 48 kg K_2O/fad. When 140 kg N/fad. was applied.

Table (2-a): Effect of interaction between PK-fertilization and N-fertilization on number of spikes/m^2 at El-Salhya location.

N-fertilizer levels / PK- fertilizer levels	N_1	N_2	N_3	N_4	N_5	N_6
PK_1	F 180.00c	E 194.25b	D 210.00d	C 230.63c	B 247.00c	A 265.63d
PK_2	F 201.25a	E 210.63a	D 225.63c	C 241.88b	B 255.63b	A 268.50c
PK_3	F 191.88b	E 211.25a	D 233.75a	C 250.75a	B 266.88a	A 284.13b
PK_4	F 190.63b	E 211.25a	D 226.25b	C 251.25a	B 267.25a	A 291.88a

2- Number of grains/spike :

Table (3) reports the effect of PK and N-fertilization on number of grains/spike at the three locations during the two seasons and their combined. Concerning the PK fertilization, the results indicated that the highest number of grains/spike was observed when 15.5 kgP_2O_5 + 48 kgK_2O/fad. Or 31.0 kgP_2O_5 + 48 kgK_2O/fad. were added at El-Khattara, while this trait was the highest when PK fertilizer was added in the rate of 31.0 kg P_2O_5 + 48 kgK_2O/fad. and this was true at El-Salhya or El-Areish compared to the other studied PK levels. These results are in agreement with those obtained by Ali *et al.* (2000), El-Bana (2000) and Guo *et al.* (2000). However Iftikhar M. Hussain *et al.* (2002) found insignificant differences in grains number per spike, due to PK fertilizers.

Nitrogen fertilization results revealed highly significant whereas increasing nitrogen level from 40 to 60, 80, 100 and then to 120kg N/fad. appeared to be gradually increased grains number/spike and the increase in this character due to increasing N-level from 120 to 140 kg N/fad. was not significant, regarding the combined data at the three locations. These results are in agreement with those obtained by Sharaan and Abd El-Samie (1999), Abd el-Hameed (2002), Abd El-Maksoud (2002), Mowafy (2002), Ali *et al.* (2004) Hussain *et al.* (2006) and Mowafy (2008).

The general means of number of grains/spike at the three locations, regardless of the studied factors indicate that plants grown at El-Khattara or El-Salhya conditions appeared to be highest in number of grains/spike than those grown at El-Areish with general means of 42.34, 42.47 and 40.56 for the three locations, respectively. The interaction effect between the studied factors on number of grains/spike at the three locations was not significant.

3- Grain weight/spike (gm) :

Data presented in Table (4) revealed that the differences among PK fertilization levels in grain weight/spike did not reach the 5% level of significance under the three locations.

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Regarding the influence of nitrogen, the results revealed highly significant differences through the two seasons and combined at the three locations. Meanwhile, increasing N-levels from 40 to 60, 80 and 100 kg N/fad. appeared to be gradually increased grain weight/spike. Adding N-fertilizer more than 100 kg N insignificantly increased grain weight/spike. Similar results were reported by Sharaan and Abd El-Samie (1999), Ismail (2002), Mowafy (2002), Ali *et al.* (2004), Hussain *et al.* (2006) and Mowafy (2008). However, El-Bana (1999) reported that nitrogen fertilization had no significant effect on weight of grains/spike of wheat.

Looking over the three locations regardless the effect of studied factors, El-Khattara location appeared to produce heavier grains/spike as compared with the other two locations, since general means of grain weight/spike amounted to 3.03, 2.84 and 2.80 gm for El-Khattara, El-Salhya and El-Areish locations, respectively.

The interaction effect between the studied factors on grain weight/spike under the three locations was not significant.

4- 1000-grain weight (gm) :

Data concerning the effect of PK and N-fertilization on 1000-grain weight are given in Table (5). PK-fertilization revealed significant differences where fertilizing with 31.0 kgP_2O_5 + 48 kg K_2O/fad. appeared to produce the heaviest grains throughout the seasons and the combined at the three locations compared with the other studied PK levels. This result almost followed the same patterns of number of spikes/m^2 as well as number of grains/spike indicating the role of PK fertilization in increasing most of yield attributes. Maqsood *et al.* (1999), Ali *et al.* (2000) and Iftikhar M. Hussain *et al.* (2002) found similar results.

Nitrogen fertilization results revealed highly significant effect, whereas increasing nitrogen level up to 100 kg N/fad. At El-Khattara or up to 120kg N/fad. at both El-Salhya and El-Areish appeared to be gradually increased 1000-grain weight. These results followed the same patterns of the most yield attributes former discussed indicating the promotion effect of nitrogen on growth in turn favored yield attributes. Similar results were found by Sharaan and Abd El-Samie (1999), Abd El-Maksoud (2002), Mowafy (2002), Ali *et al.* (2004), Hussain *et al.* (2006) and Mowafy (2008). In comparison between locations regardless to the studied factors, El-Khattara location appeared to produce heavier 1000-grain weight as compared to El-Salhya and El-Areish locations, since the general means of 1000-grain weight were amounted to 50.24, 48.48 and 46.01gm for El-Khattara, El-Salhya and El-Areish locations, respectively.

The significant interaction effect between studied factors on 1000-grain weight at El-Areish location (Table 5-a) indicated that wheat plants fertilized with 31.0 kgP_2O_5 + 24 kg K_2O/fad. Plus 120 or 140 kg N/fad. And those fertilized with 31.0 kgP_2O_5 + 48 kg K_2O/fad. Plus 100, 120 or 140 kg N/fad. gave the heaviest 1000-grain weight.

Table (5-a): Effect of interaction between PK-fertilization and N-fertilization on 1000-grain weight (gm) at El-Areish location.

N-fertilizer levels PK- fertilizer levels	N_1	N_2	N_3	N_4	N_5	N_6
PK_1	D 42.76a	CD 43.39A	C 44.58b	B 46.36c	AB 47.99b	A 48.38b
PK_2	C 41.94ab	B 43.58a	B 44.32b	A 46.38c	A 47.94b	A 48.40b
PK_3	D 40.64b	D 41.93b	C 44.73b	B 47.14b	A 49.60a	A 50.35a
PK_4	D 42.46a	C 43.76a	B 47.88a	A 49.45a	A 50.02a	A 50.00a

5- Straw yield (ton/fad.) :

Data presented in Table (6) show the influence of PK and N-fertilization on straw yield through the two seasons and the combined at the three locations.

Combined data revealed that increasing PK fertilizer-levels up to 31.0 kgP_2O_5 + 48 kg K_2O/fad. significantly increased straw yield/fad. and this was true at the three locations. These results are in accordance with those reported by El-Bana (2000).

Regarding the effect of nitrogen fertilization on straw yield, the results indicate highly significant differences through both seasons and the combined at the three locations. Generally, increasing nitrogen level up to 100kg N/fad. was accompanied by a significant increase in straw yield during the two seasons and their combined at the three locations. These results are in a complete accordance with those reported by Mowafy (2002), Ali *et al.* (2004) and Mowafy (2008). However, Abd El-Hameed (2002) reported that nitrogen fertilization had no significant effect on straw yield of wheat.

Looking over locations regardless to the effect of studied factors, El-Khattara location outyields El-Salhyia location by around 1.06 ton straw/fad. (17.47%) and El-Areish location by 1.507 ton straw/fad. (25.22%) since general means of straw yield/fad. at the three locations amounted to 5.975, 4.915 and 4.468 ton/fad.

The only significant interaction between the two studied factors at El-Khattara (Table 6-a) indicated that wheat plants received 31.0 kgP_2O_5 + 24 or 48 kg K_2O/fad. and 140 kg N/fad. gave the highest straw yield.

Table (6-a): Effect of interaction between PK-fertilization and N-fertilization on straw yield (t/fad.) at El-Khattara location.

N-fertilizer levels PK- fertilizer levels	N_1	N_2	N_3	N_4	N_5	N_6
PK_1	F 4.419c	E 4.589d	D 5.461c	C 5.921d	B 6.318d	A 6.456c
PK_2	F 4.936b	E 5.103c	D 5.849b	C 6.103c	B 6.403c	A 6.725b
PK_3	F 5.016b	E 5.381b	D 5.948b	C 6.353b	B 6.725b	A 7.121a
PK_4	F 5.258a	E 5.744a	D 6.419a	C 6.878a	B 7.066a	A 7.190a

6- Grain yield (t/fad.) :

Data presented in Table (7) show the effect of PK and N-fertilizer levels on grain yield/fad. in the two growing seasons and their combined at the three locations. Increasing PK-fertilization levels up to 31.0 kgP_2O_5 + 48 kg K_2O/fad. significantly increased grain yield/fad. and this was the same trend at the three locations. These results followed the same patterns of the most yield attributes i.e. number of spikes/m^2, number of grains/spike and 1000-grain weight (Tables 2, 3 and 5). These results are in agreement with those found by Maqsood *et al.* (1999), Ali *et al.* (2000), El-Bana (2000), Iftikhar M. Hussain *et al.* (2002) and Wang *et al.* (2008).

Increasing nitrogen fertilization level up to 100 kg N/fad. appeared to be gradually increased grain yield/fad. The relative increase in grain yield/fad. due to increasing N-level from 40 to 60, 80 and 100kg N/fad. was about 12.8, 26.23 and 35.94% at El-Khattara, 8.66, 22.94 and 35.06% at El-Salhya and 13.40, 29.19 and 46.41% at El-Areish location for the same followed order. Such results could be attributed to the promotion effect of nitrogen and increasing the yield components i.e. number of spikes/m^2, number of grains/spike and 1000-grain weight. The positive response of grain yield of wheat to N application was noticed by several investigators (Abd El-Hameed, 2002; Abd El-Maksoud, 2002; Mowafy, 2002; Alam *et al.* 2003; Ali *et al.* 2004, Hussain *et al.* 2006 and Mowafy (2008).

Looking over the three locations regardless to the effect of studied factors, El-Khattara field outyielded that at El-Salhya and El-Areish by around 0.663 and 0.745 t/fad. (23.47 and 27.16%). Since , general means of 3.488, 2.825 and 2.743 t/fad. were counted for the three locations, respectively.

The only significant interaction between the two studied factors at El-Areish (Table 7-a) indicate that wheat plants fertilized with 31.0 kgP_2O_5 + 24 kg K_2O/fad. and 120kg N/fad. and those fertilized with 31.0 kgP_2O_5 + 48 kg K_2O/fad. either with 100 or 120kg N/fad. produced the highest grain yield/fad. Brye *et al.* (2007) found different response to N due to the different PK levels.

Table (7-a): Effect of interaction between PK-fertilization and N-fertilization on grain yield (t/fad.) at El-Areish location.

N-fertilizer levels PK- fertilizer levels	N_1	N_2	N_3	N_4	N_5	N_6
PK_1	E 1.889d	D 2.120d	C 2.541c	B 2.775d	A 2.877c	B 2.798d
PK_2	F 2.121b	E 2.429b	D 2.701b	C 2.945c	A 3.021b	B 2.979c
PK_3	F 2.065c	E 2.219c	D 2.480d	C 3.158b	A 3.382a	B 3.251a
PK_4	E 2.284a	D 2.691	C 3.071a	A 3.355a	A 3.379a	B 3.185b

7- Biological yield (t/fad.) :

Biological yield of wheat which included both grain and straw yields/fad. as influenced by PK and N-fertilization are given in Table (8).

Concerning the PK differences, the results reveal highly significant differences, where the maximum dose of PK (31.0 kgP_2O_5 + 48kg K_2O/fad.) appeared to produce highest biological yield throughout both seasons and the combined at the three locations. It could be concluded that superiority of (31.0 kgP_2O_5 + 48 kg K_2O/fad.) dose in biological yield is mainly due to straw rather than grain yield components.

Likely, nitrogen fertilization results reveal highly significant during the two seasons and the combined at the three locations, where increasing nitrogen level up to 100kg N/fad. at both El-Khattara and El-Salhya locations and up to 120kg N/fad. at El-Areish was accompanied by a significant increase in biological yield. The obtained results are in a full agreement with those reported by Sharaan and Abd El-Samie (1999), Ismail (2002), Ali *et al.* (2004), Hussain *et al.* (2006) and Mowafy (2008).

Looking over locations regardless to the effect of studied factors, El-Khattara location surpassed El-Salhya and El-Areish locations by around 1.174 t/fad. (22.55%) and 2.247 t/fad. (31.17%), respectively, since the general means amounted to 9.455, 7.715 and 7.208 t/fad. For the three locations, respectively.

The interaction effect between the two studied factors on biological yield at El-Areish location was highly significant as shown in Table (8-a). wheat plants received 31.0 kgP_2O_5 + 48 kg K_2O/fad. with either 100 or 120kg N/fad. produced the highest biological yield.

Table (8-a): Effect of interaction between PK-fertilization and N-fertilization on biological yield (t/fad.) at El-Areish location.

N-fertilizer levels PK- fertilizer levels	N_1	N_2	N_3	N_4	N_5	N_6
PK_1	F 5.256d	E 5.746d	D 6.637c	C 7.215d	A 7.438d	B 7.326d
PK_2	F 5.530c	E 6.299c	D 7.032	C 7.548c	A 8.051c	B 7.886c
PK_3	E 5.619b	D 6.404b	C 6.906b	B 7.990b	A 8.500b	A 8.474b
PK_4	E 5.996a	D 7.065a	C 7.905a	A 8.685a	A 8.792a	B 8.625a

b-Yield analysis :

1- Correlation coefficients :

The association between wheat grain yield in ton per faddan on one hand and each of other characters from 1 to 6 of the combined on the other hand are shown in Table (9).

Data revealed that there were positive and highly significant correlation coefficients between grain yield and all studied characters i.e. number of spikes/m^2, number of grains/spike, weight of grains/spike, 1000-grain weight and straw and biological yields/fad.

Significant positive correlations were observed between number of spikes/m^2, and each of number of grains/spike, weight of grains/spike, 1000-grain weight and straw and biological yields/fad.

Number of grains/spike had highly significant positive correlations with weight of grains/spike, 1000-grain weight and straw and biological yields/fad.

Weight of grains/spike had a significant positive correlations with 100-grain weight and straw and biological yields/fad.

Significant positive correlations were detected between 1000-grain weight and both straw and biological yields/fad.

Straw yield/fad. had a highly significant positive correlation with biological yield/fad. Similar results were obtained by Darwich (1994), Moselhy (1995), El-Bana (2000), Mowafy (2002) and Nadia El-Wakil and Maha Abd-Alla (2004).

Table (9): Simple correlation between grain yield (ton/fad) and its components of wheat :

Character	1	2	3	4	5	6
Y- Grain yield (ton/fad.)	0.896**	0.754**	0.609**	0.724**	0.559**	0.817**
1- No. of spikes/m^2		0.488**	0.463**	0.626**	0.691**	0.650**
2- No. of grains/spike			0.260*	0.356**	0.601**	0.570**
3- Weight of grains/spike (gm)				0.392**	0.547**	0.513**
4- 1000-grain weight (gm)					0.594**	0.509**
5- Straw yield (ton/fad.)						0.935**
6- Biological yield (ton/fad.)						—

2- Path analysis :

The method of path coefficient included the yield components i.e. number of spikes/m^2, number of grains/spike and 1000-grain weight. Path analysis was practiced in order to find out the relative importance of these characters in contributing wheat grain yield.

The effect of direct and indirect path coefficients of number of spikes/m^2, number of grains/spike and 1000-grain weight on wheat grain yield are shown in Table (10).

Table (10): Partitioning of simple correlation coefficients between grain yield (ton/fad.) and its components of wheat

Sources	Values
Number of spikes /m^2 :	
Direct effect	0.5974
Indirect effect via number of grains/spike	0.1863
Indirect effect via 1000-grain weight	0.1124
Total (ry1)	0.8961
Number of grains/spike:	
Direct effect	0.1535
Indirect effect via 1000-grain weight	0.4642
Indirect effect via number of spikes/m^2	0.1363
Total (ry_2)	0.7540
1000-gain-weight:	
Direct effect	0.3462
Indirect effect via number of spikes/m^2	0.2704
Indirect effect via number of grains/spike	0.1074
Total (ry3)	0.7240

These effects were computed by partitioning the total correlation coefficient into its components. Number of spikes/m^2 proved to have a high direct effect on grain yield compared with that of number of grains/spike or 1000-grain weight. Again, as mentioned before (Table 9), total correlation coefficient was most pronounced in number of spikes/m^2 (r = 0.8961) than in number of grains/spike (r = 0.7540) or in 1000-grain weight (r = 0.7240).

The relative importance in contributing wheat grain yield as recorded in percentage of variation for number of spikes/m^2, number of grains/spike, 1000-grain weight and their interactions is presented in Table (11). The path analysis revealed that the direct effect for number of spikes/m^2 was 63.98% being higher than that of number of grains/spike and 1000-grain weight which were 11.85 and 4.71 of the variation, respectively. The joint effect of number of spikes/m^2 with number of grains/spike and with 1000-grain weight; number of grains/spike with 1000-grain weight as 3.65, 6.51 and 2.72% of the variation, respectively. Here, it is worthy to note that those characters i.e. number of spikes/m^2, number of grains/spike and 1000-grain weight could contributed much in wheat grain yield since R^2 was 93.42% of the total variation in yield. Also, it is interesting to observe that the residual effects contributing to grain yield in this investigation was low in magnitude being 6.58%. These results are in agreement with those reported by El-Bana (2000).

Table (11): Direct and joint effects of yield components as a percentage of grain yield variation of wheat.

Sources	C.D.	%
Number of spikes/m^2	0.6398	63.98
Number of grains/spike	0.1185	11.85
1000-grain weight	0.0471	4.71
Number of spikes/m^2 x Number of grains/spike	0.0365	3.65
Number of spikes/m^2 x 1000-grains weight	0.0651	6.51
Number of grains/spike x 1000-grains weight	0.0272	2.72
R^2	0.9342	93.42
Residual	0.0658	6.58
Total	1.0000	100.00

*** C.D. = Coefficient of determination**
*** % = Percentage contributed**

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تأثير معدلات مختلفة من التسميد النيتروجينى والفوسفاتى والبوتاسى على القمح تحت ظروف الأراضى الرملية المستزرعة حديثاً

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أقيمت تجربتان حقليتان بمناطق الخطارة والصالحية بمحافظة الشرقية والعريش بمحافظة شمال سيناء خلال الموسمين الزراعيين ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ لدراسة تأثير مستويات مختلفة من التسميد الفوسفاتى والبوتاسى (١٥,٥كجم فو٢أ٥ + ٢٤كجم بو٢أ ، ١٥,٥كجم فو٢أ٥ + ٤٨كجم بو٢أ، ٣١,٠ كجم فو٢أ٥ + ٢٤كجم بو٢أ و ٣١,٠كجم فو٢أ٥ + ٤٨كجم بو٢أ/فدان) وكذلك مستويات مختلفة من التسميد النيتروجينى (٤٠ ، ٦٠ ، ٨٠ ، ١٠٠ ، ١٢٠ ، ١٤٠ كجم ن/فدان) على المحصول ومكوناته للقمح صنف سخا ٩٣. استخدم تصميم القطع المنشقة مرة واحدة فى أربعة مكررات حيث احتوت القطع الرئيسية على مستويات التسميد الفوسفاتى والبوتاسى بينما احتوت القطع المنشقة على مستويات التسميد النيتروجينى.

ويمكن تلخيص أهم النتائج فيما يلى :-

أدت إضافة السماد الفوسفاتى والبوتاسى بمعدل ٣١,٠كجم فو٢أ٥ + ٤٨كجم بو٢أ/فدان بمنطقة الخطارة وبمعدل ٣١,٠كجم فو٢أ٥ + ٢٤كجم بو٢أ/فدان بمنطقتى الصالحية والعريش إلى زيادة معنوية فى عدد السنابل/م٢. وكذلك أمكن الحصول على أعلى عدد للحبوب/السنبلة ، وزن الـ١٠٠٠ حبة ، محصول القش ، محصول الحبوب والمحصول البيولوجى/فدان بإضافة ٣١,٠كجم فو٢أ٥ + ٤٨كجم بو٢أ/فدان بالثلاث مناطق. لم يكن للتسميد الفوسفاتى تأثير معنوى على وزن الحبوب/السنبلة فى الثلاث مناطق التى أقيمت بها هذه الدراسة.

أمكن الحصول على أعلى عدد للسنابل/م٢ بالثلاث مناطق بزيادة السماد النيتروجين حتى ١٤٠كجم ن/فدان. كذلك أدت إضافة السماد النيتروجينى حتى معدل ١٢٠كجم ن/فدان إلى زيادة معنوية فى عدد الحبوب/السنبلة بالثلاث مناطق ، وزن الـ ١٠٠٠حبة بالصالحية والعريش والمحصول البيولوجى بالعريش. كما أدى استخدام السماد النيتروجينى حتى معدل ١٠٠كجم ن/فدان إلى زيادة معنوية فى وزن الحبوب/السنبلة بالثلاث مناطق ، وزن الـ١٠٠٠ حبة بالخطارة ومحصول القش والحبوب/فدان بالثلاث مناطق والمحصول البيولوجى/فدان بمنطقتى الخطارة والصالحية.

كان للتفاعل بين عاملى الدراسة تأثير معنوى ، ففى منطقة الصالحية أمكن الحصول على أعلى عدد للسنابل/م٢ باستخدام ٣١,٠كجم فو٢أ٥ + ٤٨كجم بو٢أ/فدان وإضافة ١٤٠ كجم ن/فدان ، أما أعلى قيم لوزن الـ١٠٠٠ حبة ومحصول الحبوب/فدان والمحصول البيولوجى بمنطقة العريش فقد أمكن الحصول عليها عند التسميد بمعدل ٣١,٠كجم فو٢أ٥ + ٤٨كجم بو٢أ/فدان وإضافة ١٠٠كجم ن/فدان. أعطت نباتات القمح النامية بمنطقة الخطارة والمسمدة بمعدل ٣١,٠كجم فو٢أ٥ + ٢٤ أو ٤٨ كجم بو٢أ/فدان مع إضافة ١٤٠ كجم ن/فدان أعلى محصول قش/فدان. بوجه عام ، كانت النباتات المنزرعة بمنطقة الخطارة متفوقة عن تلك المنزرعة بمنطقتى الصالحية والعريش فى جميع الصفات المدروسة.

لوحظ ارتباط موجب ومعنوى جداً بين محصول الحبوب/فدان وجميع الصفات المدروسة. يشير تحليل معامل المرور إلى أن التأثير المباشر لعدد السنابل/م٢ كان ٦٣,٩٨% ومرتفعاً عن ذلك التأثير بالنسبة لعدد الحبوب/السنبلة ووزن الـ١٠٠٠ حبة حيث بلغ ١١,٨٥ و ٤,٧١% من تباين محصول الحبوب على التوالى. وقد ساهمت التأثيرات المباشرة وغير المباشرة بمقدار ٩٣,٤٢% من تباين المحصول.

توصى الدراسة من خلال النتائج المتحصل عليها باستخدام معدل ٣١,٠كجم فو٢أ٥ + ٤٨كجم بو٢أ/فدان من التسميد الفوسفاتى وكذلك معدل ١٠٠كجم ن/فدان من التسميد النيتروجينى وذلك للحصول على أعلى محصول حبوب/فدان بمناطق الخطارة والصالحية بمحافظة الشرقية ومنطقة العريش بمحافظة شمال سيناء.

Table (2): Number of spikes/m^2 as affected by PK and N-fertilizer levels at different locations during the two growing seasons and their combined.

Main effects and interaction	2005/2006 season			2006/2007 season			Combined		
	Khattara	Salhya	Areish	Khattara	Salhya	Areish	Khattara	Salhya	Areish
P + K-fertilizer levels (PK):									
15.5 kg P_2O_5 + 24 kg K_2O/fad.	264.08c	240.79b	243.04b	241.88c	201.71d	215.29c	252.98c	221.25c	229.16c
15.5 kg P_2O_5 + 48 kg K_2O/fad.	264.75c	250.75ab	253.54a	246.46b	217.08c	224.08b	255.61bc	233.92b	238.81b
31 kg P_2O_5 + 24 kg K_2O/fad.	269.63c	258.88a	255.29a	246.63b	220.67b	238.08a	258.23b	239.78a	246.69a
31 kg P_2O_5 + 48 kg K_2O/fad.	272.92a	247.92ab	253.42a	256.96a	231.58a	225.92b	264.94a	239.75a	239.67b
F- test	*	*	*	*	**	*	*	*	
						Location mean	257.94	233.68	238.58
N-fertilizer levels (N):									
40 Kg N/fad.	234.25f	205.19f	209.63f	193.19f	176.67f	185.44f	213.72f	190.93f	197.54f
60 Kg N/fad.	245.25e	221.31e	225.00e	224.06e	192.38e	198.13e	234.66e	206.85e	211.57e
80 Kg N/fad.	256.13d	235.94d	243.13d	239.38d	211.88d	214.38d	247.76d	223.91d	228.76d
100 Kg N/fad.	271.69c	260.31c	259.06c	257.19c	226.94c	230.25c	264.44c	243.63c	244.66c
120 Kg N/fad.	294.19b	280.00	277.31b	277.81b	238.38b	254.38b	286.00b	259.19b	265.85b
140 Kg N/fad.	305.56a	294.75a	293.81a	296.56a	260.31a	272.50a	301.06a	277.53a	283.16a
F- test	**	**	**	**	**	**	**	**	**
Interaction :									
PK X N	N.S	*	N.S	*	*	**	N.S	*	N.S

Table (3): Number of grains/spike as affected by PK and N-fertilizer levels at different locations during the two growing seasons and their combined.

Main effects and interaction	2005/2006 season			2006/2007 season			Combined		
	Khattara	Salhya	Areish	Khattara	Salhya	Areish	Khattara	Salhya	Areish
P + K-fertilizer levels (PK):									
15.5 kg P_2O_5 + 24 kg K_2O/fad.	43.50c	43.71c	40.96	39.93	37.50b	39.25b	41.72b	40.61c	40.11b
15.5 kg P_2O_5 + 48 kg K_2O/fad.	47.17a	44.71c	40.17	40.63	39.58a	40.17b	43.90a	42.15b	40.17b
31 kg P_2O_5 + 24 kg K_2O/fad.	44.38bc	46.29b	40.71	40.08	38.50ab	40.08b	42.23b	42.40b	40.40b
31 kg P_2O_5 + 48 kg K_2O/fad.	46.54a	49.50a	40.38	40.75	39.96a	42.75a	43.65a	44.73a	41.57a
F- test	**	**	N.S	N.S	*	**	*	*	*
				Location mean			42.34	42.47	40.56
N-fertilizer levels (N):									
40 Kg N/fad.	41.00d	41.06c	35.81d	36.63f	34.25e	36.63d	38.82f	37.66e	36.22e
60 Kg N/fad.	43.38cd	42.63c	37.63c	37.88e	36.50d	38.38c	40.63e	39.66d	38.01d
80 Kg N/fad.	44.81bc	46.19b	39.81b	39.69d	38.31c	40.13b	42.25d	42.25c	39.97c
100 Kg N/fad.	46.19bc	47.81ab	42.25a	41.06c	40.19b	41.38b	43.63c	44.00b	41.82b
120 Kg N/fad.	47.88ab	48.88a	43.31a	42.69b	41.63a	43.06a	45.29a	45.26a	43.19a
140 Kg N/fad.	49.13a	49.75a	44.50a	44.00a	42.44a	43.81a	46.57a	46.10a	44.16a
F- test	**	**	**	**	**	**	**	**	**
Interaction :									
PK X N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Table (4): Grain weight/spike (gm) as affected by PK and N-fertilizer levels at different locations during the two growing seasons and their combined.

Main effects and interaction	2005/2006 season			2006/2007 season			Combined		
	Khattara	Salhya	Areish	Khattara	Salhya	Areish	Khattara	Salhya	Areish
P + K-fertilizer levels (PK):									
15.5 kg P_2O_5 + 24 kg K_2O/fad.	3.17ab	2.99b	2.92	2.90	2.53	2.68	3.04	2.76	2.80
15.5 kg P_2O_5 + 48 kg K_2O/fad.	3.01b	3.07bc	2.86	2.87	2.62	2.74	2.94	2.85	2.80
31 kg P_2O_5 + 24 kg K_2O/fad.	3.17ab	3.14ab	2.94	2.92	2.56	2.70	3.05	2.85	2.82
31 kg P_2O_5 + 48 kg K_2O/fad.	3.28a	3.23a	2.86	2.92	2.58	2.70	3.10	2.91	2.78
F- test	*	*	N.S	N.S	N.S	N.S	N.S	N.S	N.S
					Location mean		3.03	2.84	2.80
N-fertilizer levels (N):									
40 Kg N/fad.	2.94c	2.82d	2.57d	2.63c	2.23e	2.28e	2.79b	2.53d	2.43d
60 Kg N/fad.	2.98be	2.99c	2.76c	2.77b	2.36d	2.45d	2.88b	2.68c	2.61c
80 Kg N/fad.	3.00be	3.14b	2.91b	2.80b	2.57c	2.64c	2.90b	2.86b	2.78b
100 Kg N/fad.	3.20ab	3.20ab	3.04a	3.00a	2.69b	2.82b	3.10a	2.95ab	2.93a
120 Kg N/fad.	3.38a	3.23a	3.02a	3..1a	2.78a	2.99a	3.25a	3.01a	3.01a
140 Kg N/fad.	3.43a	3.24a	3.06a	3.10a	2.80a	3.05a	3.27a	3.02a	3.06a
F- test	**	**	**	**	**	**	**	**	**
Interaction :									
PK X N	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Table (5): 1000-grain weight (gm) as affected by PK and N-fertilizer levels at different locations during the two growing seasons and their combined.

Main effects and interaction	2005/2006 season			2006/2007 season			Combined		
	Khattara	Salhya	Areish	Khattara	Salhya	Areish	Khattara	Salhya	Areish
P + K-fertilizer levels (PK):									
15.5 kg P_2O_5 + 24 kg K_2O/fad.	55.28c	50.46c	46.79b	41.48b	46.38a	44.36	48.38c	47.98c	45.58b
15.5 kg P_2O_5 + 48 kg K_2O/fad.	56.00bs	50.09c	48.16ab	43.80a	45.49ab	42.69	49.90bc	47.79c	45.43b
31 kg P_2O_5 + 24 kg K_2O/fad.	57.52b	52.42b	47.38b	44.38a	44.12b	44.11	50.95b	48.27b	45.75b
31 kg P_2O_5 + 48 kg K_2O/fad.	60.67a	54.90a	49.66a	42.78ab	44.82b	44.89	51.73a	49.86a	47.28a
F- test	**	**	*	*	*	N.S	*	*	*
						Location mean	50.24	48.48	46.01
N-fertilizer levels (N):									
40 Kg N/fad.	52.57c	48.47d	44.62d	40.52c	42.06c	39.28e	46.55c	45.27e	71.95e
60 Kg N/fad.	53.92c	49.33cd	45.75d	41.01c	44.13b	40.58d	47.47c	46.73d	43.17d
80 Kg N/fad.	56.50b	51.16bc	47.31c	42.53b	45.04b	43.44c	49.52b	48.10c	45.38c
100 Kg N/fad.	59.93a	52.30b	48.59b	44.18a	46.21a	46.07b	52.06a	49.26b	47.33b
120 Kg N/fad.	60.59a	55.63a	50.45a	45.23a	46.84a	47.38a	52.91a	51.24a	48.92a
140 Kg N/fad.	60.70a	54.94a	51.28a	45.19a	46.92a	47.29a	52.95a	50.93a	49.29a
F- test	**	**	**	**	**	**	**	**	**
Interaction :									
PK X N	N.S	N.S	N.S	N.S	*	**	N.S	N.S	*

Table (6): Straw yield (t/fad.) as affected by PK and N-fertilizer levels at different locations during the two growing seasons and their combined.

Main effects and interaction	2005/2006 season			2006/2007 season			Combined		
	Khattara	Salhya	Areish	Khattara	Salhya	Areish	Khattara	Salhya	Areish
P + K-fertilizer levels (PK):									
15.5 kg P_2O_5 + 24 kg K_2O/fad.	5.08d	5.09c	4.38d	5.97c	4.00	3.83d	5.53d	4.55c	4.11c
15.5 kg P_2O_5 + 48 kg K_2O/fad.	5.40c	5.49b	4.80c	6.28b	4.10	3.90c	5.84c	4.80b	4.35b
31 kg P_2O_5 + 24 kg K_2O/fad.	5.89b	5.74b	5.14b	6.30b	4.16	3.98b	6.10b	4.95b	4.56b
31 kg P_2O_5 + 48 kg K_2O/fad.	6.16a	6.64a	5.65a	6.69a	4.08	4.05a	6.43a	5.36a	4.85a
F- test	**	**	**	**	N.S	**	**	*	*
						Location mean	5.975	4.917	4.468
N-fertilizer levels (N):									
40 Kg N/fad.	4.69f	4.43e	3.68e	5.12f	3.59d	3.33e	4.91d	4.01d	3.51d
60 Kg N/fad.	5.02e	4.99d	4.29d	5.38e	3.91c	3.74d	5.20c	4.45c	4.02c
80 Kg N/fad.	5.43d	5.58c	4.89c	6.41d	4.29ab	4.02c	5.92b	4.94b	4.43b
100 Kg N/fad.	5.95c	6.13b	5.37b	6.64c	4.47a	4.24a	6.30ab	5.30a	4.81ab
120 Kg N/fad.	6.26b	6.55a	5.87a	6.99b	4.24b	4.19ab	6.63a	5.40a	5.03a
140 Kg N/fad.	6.43a	6.51a	5.91a	7.31a	4.01c	4.11b	6.87a	5.26a	5.01a
F- test	**	**	**	**	**	**	**	**	**
Interaction :									
PK X N	**	N.S	N.S	**	N.S	N.S	**	N.S	N.S

Table (7): Grain yield (t/fad.) as affected by PK and N-fertilizer levels at different locations during the two growing seasons and their combined.

Main effects and interaction	2005/2006 season			2006/2007 season			Combined		
	Khattara	Salhya	Areish	Khattara	Salhya	Areish	Khattara	Salhya	Areish
P + K-fertilizer levels (PK):									
15.5 kg P_2O_5 + 24 kg K_2O/fad.	3.23	3.13c	2.99b	3.44c	2.15b	2.01c	3.34c	2.64c	2.50c
15.5 kg P_2O_5 + 48 kg K_2O/fad.	3.07	3.41ab	3.40a	3.65b	2.30a	2.02c	3.36c	2.86b	2.71b
31 kg P_2O_5 + 24 kg K_2O/fad.	3.15	3.35b	3.38a	4.00a	2.31a	2.14b	3.58b	2.83b	2.76b
31 kg P_2O_5 + 48 kg K_2O/fad.	3.14	3.59a	3.70a	4.19a	2.34a	2.29a	3.67a	2.97a	3.00a
F- test	N.S	**	**	**	**	**	*	**	**
						Location mean	3.488	2.825	2.743
N-fertilizer levels (N):									
40 Kg N/fad.	2.61c	2.72c	2.42d	3.01d	1.90e	1.76e	2.81d	2.31d	2.09d
60 Kg N/fad.	2.96b	2.93c	2.78c	3.37c	2.09d	1.95d	3.17c	2.51c	2.37c
80 Kg N/fad.	3.27a	3.32b	3.26b	3.82b	2.36bc	2.13c	3.55b	2.84b	2.70b
100 Kg N/fad.	3.48a	3.75a	3.88a	4.16a	2.48ab	2.24b	3.82a	3.12a	3.06a
120 Kg N/fad.	3.26a	3.90a	4.04a	4.33a	2.56a	2.29ab	3.80a	3.23a	3.17a
140 Kg N/fad.	3.31a	3.61ab	3.82a	4.22a	2.27c	2.31a	3.77a	2.94ab	3.07a
F- test	**	**	**	**	**	**	**	**	**
Interaction :									
PK X N	N.S	N.S	*	N.S	N.S	**	N.S	N.S	*

Table (8): Biological yield (t/fad.) as affected by PK and N-fertilizer levels at different locations during the two growing seasons and their combined.

Main effects and interaction	2005/2006 season			2006/2007 season			Combined		
	Khattara	Salhya	Areish	Khattara	Salhya	Areish	Khattara	Salhya	Areish
P + K-fertilizer levels (PK):									
15.5 kg P_2O_5 + 24 kg K_2O/fad.	8.21b	8.23c	7.37c	9.41d	6.15	5.84d	8.86d	7.19c	6.61d
15.5 kg P_2O_5 + 48 kg K_2O/fad.	8.47b	8.91b	8.20b	9.92c	6.40	5.91c	9.20c	7.66b	7.06c
31 kg P_2O_5 + 24 kg K_2O/fad.	9.04a	9.08b	8.52b	10.30b	6.47	6.12b	9.67b	7.78b	7.32b
31 kg P_2O_5 + 48 kg K_2O/fad.	9.60a	10.05a	9.34a	10.88a	6.42	6.34a	10.09a	8.23a	7.84a
F- test	**	**	**	**	N.S	**	**	**	**
					Location mean		9.455	7.715	7.208
N-fertilizer levels (N):									
40 Kg N/fad.	7.31e	7.15e	6.10e	8.13e	5.49e	5.09d	7.72d	6.32d	5.60e
60 Kg N/fad.	7.99d	7.92d	7.07d	8.76d	5.99d	5.69c	8.38c	6.96c	6.38d
80 Kg N/fad.	8.70c	8.89c	8.09c	10.24c	6.65b	6.15b	9.47b	7.77b	7.12c
100 Kg N/fad.	9.43b	9.88b	9.24b	10.80b	6.95a	6.47a	10.12a	8.42a	7.86b
120 Kg N/fad.	9.52ab	10.45a	9.91a	11.32a	6.80ab	6.48a	10.42a	8.63a	8.20a
140 Kg N/fad.	9.74a	10.11ab	9.73a	11.53a	6.82c	6.43a	10.64a	8.20a	8.08a
F- test	**	**	**	**	**	**	**	**	**
Interaction :									
PK X N	N.S	N.S	**	N.S	N.S	**	N.S	N.S	**