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Response of Two Wheat Cultivars to Nitrogen and Phosphorus Fertilizer Rates

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ABSTRACT

Two field experiments was carried out at the Experimental Farm of Faculty of Agriculture, Kafrelsheikh University - North Nile Delta, Egypt, during the two successive winter seasons of 2014/2015 and 2015/2016, to investigate the effect of different nitrogen rates (60, 120, 180 and 240 kg N/ha) and phosphorus rates (0, 36 and 72 kg P_2O_5/ha) on yield and yield attributes of two bread wheat cultivars (Misr 2 and Giza 168) grown on clay soil conditions. Misr 2 was higher than Giza168 in values of number of days to heading, plant height, number of fertile tillers in both seasons and number of grain /spike, biological yield, grain yield and straw yield in the first season. Giza 168 recorded the highest values for 1000 grain weight and harvest index in the first season. Fertilizing with 240 kg N/ha resulted the highest values of yield attributes and significantly exceeded other studied levels (60, 120 and 180 kg N/ha). Application of 240 kg N/ha recorded the highest values of grain and straw yields (7.430 and 6.514 t/ha) and straw (12.071 and 10.119 t/ha) in the first and second seasons, respectively. P_2O_5had significant effect on most characters under this study. Increases P_2O_5 rates increased all traits except heading date and harvest index, where the inverse was true P_2O_5. Fertilizing with 72 kg P_2O_5/ha resulted the highest values of grain yield (6.564 and 6.749 t/ha) and straw yield (10.110 and 11.062 t/ha) in both seasons. Respectively. Fertilizer with 240kg N/ha and 72 kg P2O5/ha recorded the highest values for all traits in both seasons.

Keywords: wheat cultivars, varieties, nitrogen fertilizer, phosphorus fertilizer.

INTRODUCTION

Wheat is the main winter cereal crop in Egypt. The production not sufficient to meet the consumption. In Egypt, the total cultivated area of wheat reached about 3.1 million feddan and the total production exceeded 8.463 million tons with an average of 2.730 t/ha (FAO, 2017). Therefore, developing high yielding cultivars as well as improving cultural practices is necessary to solve this problem. Management practices such as fertilization, herbicides, fungicides, irrigation, time of sowing, and seeding rate played a greater role for any crop production. Cultivars and fertilization significantly influenced grain yield and quality of wheat grain production. The differences among wheat cultivars were recorded by Seadh (2014), EL- Hawary and Shahein (2015), Anwar *et al.,* (2016), El-hag (2016), Kandil *et al.,* (2016), El-hag (2017) and El -Hag and El Mantawy (2017). These differences due to genetic back ground or the interaction with environmental condition. Nitrogen (N) is main factor limiting yield of wheat (Andrews *et al.* 2004). Optimum N management to wheat is important for maximum yield. Application the highest level of nitrogen fertilizer produced the highest values of number of spikes/m^2, spike length, number of spikelet's/spike, number of grains/spike, grains weight/spike and thousand grains weight(Khan *et al*., 2008;Amjed *et al*., 2011;Memon*et al.,* 2011;Mojid*et al*., 2012;Haileselassie *et al.*, 2014;EL-Hawary and Shahein2015;Ishaq *et al*., 2015; Anwar *et al*., 2016 ;Kandil *et al.,* 2016 and EL- Hag and Shahein 2017).

Phosphorus is essential for enhancing seed maturity and seed development (Ziadi et al. 2008) found 28.5 kg $P_2o_5ha^{-1}$ as optimum for growth, plant height, tillers, grains/ spike, 1000 grain weight, grain and straw yields. Khalid *et al.* (2004) applied 45 kg $P_2o_5ha^{-1}$ in wheat and obtained maximum spikes/m^2, grain yield and biological yield.

MATERIALS AND METHODS

A field experiment was conducted during 2014/2015 and 2015/2016 growing seasons at the experiment farm of Faculty of Agricultura ,Kafrel sheikh University, to study the effect of four nitrogen fertilizer rates (60, 120. 180 and 240 kg N/ha), three phosphorus fertilizer rates (0, 36 and 72 kg P_2O_5 /ha) and their interaction on two bread wheat cultivars (Giza 168 and Misr2).The site is located at 30.94 North Latitude 30.11 East Longitude with an elevation of about 6 m above sea level. The mechanical and chemical analyses of the experimental soil are presented in Table 1.

The field was prepared with standard production practices. Each-year the experiments were conducted as a RCBD with three replications using a split split plot treatment arrangement. The cultivars were randomized in the main plots and nitrogen fertilizer rate were in the sub-plots. Phosphorus fertilizer rate was allocated in sub sub plot. The sub sub–plot area was 4.2 m^2 (6 rows x 20 cm apart x 3.5 m long). Soil of the experimental sit is classified as clay textured. The sowing pattern was drilling in rows, 20 cm apart of rows. Sowing was done at 26th November 2014 and 5th December, 2015.

Table 1. Mechanical and chemical properties of the experimental soil at the experimental site during 2014/2015 and 2015/2016 seasons.

Seasons	Mechanical characters			Soil texture	Chemical analysis				
	Sand (%)	Silt (%)	Clay (%)		N Available (ppm)	P Available (ppm)	K Exchangeable (ppm)	PH	Organic matter (%)
2014/15	18.1	37.3	44.6.	clay	21.5	7.5	280.8	8.3	2.2
2015/16	17.1	402	42.7	clay	17.3	7.9	265.2	8.1	2.1

The data collected were: days to heading, plant height in cm, number of spikes/m^2, 1000 grain weight (g), number of grain /spike, biological yield (t/ha), grain yield (t/ ha), straw yield (t/ ha) and harvest index %.

Statistical analysis:

Data collected for the two seasons were subjected to

analysis of variance technique by "MSTAT-C" computer software package. And means of treatment effects were compared using Duncan's Multiple Range Test (Duncun,1955).

RESULTS AND DISCUSSION

1- Varietal difference:

Data in table 2,3 and 4 : show varietal difference in heading date (days to 50% heading),plant height and fertile tillers (spikes number) m^{-2}in both seasons and number of grains spike-,1000-grain weigh , biological yield, grain yield , straw yield and harvest index in the first season, only .Giza was superior to Misr 2 in early heading . 1000- grain weight and harvest index . In the contrary , Misr 2exceeded Giza 168 in plant height , number of spikes m^{-2},number of grains $spike^{-1}$, biological, grain yield and straw yield. The superiority of Misr 2 in grain yield might have been greater number of spikes $^{-2}$and number of grains $spike^{-1}$.The differences between cultivars might be attributed to their variation in genetic makeup and to the unsteady environmental condition. EL- Hawary and Shahein (2015) found varietal differences in grain yield and its components.

2-Effect of nitrogen rates (N):

Nitrogen fertilizer rates had significant effect on all studied characters in both seasons (table 2,3 and 4) .Increasing nitrogen rate from 60 to 240 kg ha^{-1} gradually delayed heading date and decreased 1000-grain weight and harvest index in the two seasons. However plant height , number of spikes m^{-2} , number of grains $spike^{-1}$,biological yield ,grain yield and straw yield were significant increased by each increment of applied nitrogen in both seasons. The reduction in 1000-grain weight may be due to excessive content of nitrogen in plant may really be due to a shortage of carbohydrate supplied per grain which is directly caused by an excessive number of grains produced by heavy N fertilization. Such effect of nitrogen could be attributed mainly to its role in the stimulation of various physiological processes including cell division elongation of internodes resulting in more tillers formation, leaf numbers and photosynthetic area (leaf area), which resulted in more photosynthetic production and consequently increased plant height, number of spikes $^{-2}$,number of grains $spike^{-1}$, biological yield and in turn grain yield. This results are agreementwith Khan *et al*., (2008), Amjed *et al*. (2011), Memon *et al.,* (2011), Mojid *et al*., (2012), Haileselassie *et al.* (2014), EL- Hawary, and Alaa-Shahein (2015), Ishaq *et al*., (2015), Anwar *et al*. (2016) and Kandil *et al.,* (2016) and EL- Hag and Shahein (2017).

3-Effect of Phosphorus rates(P_2O_5):

Data in Table 2, 3 and 4 obtained that phosphorus fertilizer was significant effect on number of days to 50 % heading, plant height, number of fertile tiller, grain yield straw yield in both seasons and 1000- grainweight and harvest index in the second season, on the other hand the deference was significant for number of grain/spike and insignificant for harvest index in first season. Increases phosphorus fertilizer rate increased all these traits under investigation except heading date and harvest index were decreased. The highest numbers of spikes /m^2 were produced by application 72 kg P_2O_5/ha. The highest values of grain yield t/ha were obtained with application 72 kg P_2O_5/ha in the first and second growing season, respectively. Decreases P_2O_5 increased HI which 0 kg P_2O_5 in 2015/16 season compared with application 72 kg P_2O_5/ha, Phosphors' plays an important role in the transfer of energy, which depends on all biological processes directly or indirectly, especially the processes of protein synthesis and nucleic acids. Therefore, plants that do not suffer from the lack of phosphorus are strong growth. Thus increases phosphorus increased all studied traits. These results are agreement with those found by investigators i.e., Hussain *et al.,* (2008), Khan *et al*., (2008),Kaleem *et al.,* (2009), Malghani *et al.,* (2010), Memon *et al.,* (2011), Mojid*et al*., (2012), Haileselassie *et al.* (2014), Mumtaz *et al.,*(2014), Ram *et al.,* (2015) and Anwar *et al.,* (2016).

Table 2. Means of number of days to heading (day), plant height (cm) and number of spikes/m2 as affected by varietal differences of wheat cultivars, nitrogen fertilizer rate, phosphorus fertilizer rate in 2014/15 and 2015/16 growing seasons.

Factor	Heading date(day)		Plant height (cm)		Number of spikes/m^2(No.m^{-2})	
Year	2014/15	2014/15	2014/15	2014/15	2014/15	2014/15
Cultivar						
Misr 2	108.6	97.5	108.9	90.6	355.1	265.5
Giza 168	96.4	90.1	98.8	81.9	324.0	219.7
F test	**	**	**	**	**	**
Nitrogen fertilizer rate (kg/ha) N						
60	100.6d	91.4d	97.0d	84.5d	300.0d	230.4d
120	101.6c	93.4c	101.7c	85.4c	328.1c	238.1c
180	103.1b	94.3b	106.3b	86.7b	351.6b	244.3b
240	104.8a	95.9a	110.6a	88.6a	380.9a	257.5a
F test	**	**	**	**	**	**
Phosphorus fertilizer rates (kg P_2O_5/ha).						
0	102.9a	97.8a	101.8c	80.3c	335.5c	207.6c
36	102.6b	92.9b	104.0b	87.3b	340.7b	242.9b
72	102.0c	90.6c	105.9a	91.3a	344.1a	277.2a
F test	**	**	**	**	**	**

***, ** and NS indicate that $p<0.05$,$p<0.01$ respectively. In each factor, mean designated by the same latter are not statistically different at $p<0.05$ level according to Duncan's Multiple Range Test.**

Table 3. Means of 1000 grain weight (g), number grain/spike and biological yield as affected by wheat cultivars, nitrogen fertilizer rate phosphorus fertilizer rate and their interaction in 2014/15 and 2015/16 growing seasons.

Factor	1000 grain weight (g)		Number of grain/spike		Biological yield (t/ha)	
year	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16
Cultivar (C)						
Misr 2	38.0b	40.8	60.0a	62.6	17.212	15.570
Giza 168	41.5a	41.5	57.3b	60.9	15.010	12.129
F test	*	NS	*	NS	**	NS
Nitrogen fertilizer rate (kg/ha) N						
60	41.3a	42.0a	54.0c	58.6d	11.595d	14.370c
120	39.8b	41.6b	56.8bc	60.6c	15.693c	14.789c
180	39.5b	40.9c	59.4b	62.9b	17.650b	15.605b
240	38.3c	40.1d	64.5a	65.1a	19.501a	16.631a
F test	**	**	**	**	**	**
Phosphorus fertilizer rates (kg P_2O_5/ha) P						
0	40	39.3c	57.5b	51.0c	15.608c	12.480c
15	39.9	41.2b	58.8ab	63.7b	16.050b	15.758b
30	39.4	43.0a	59.7a	70.7a	16.671a	17.812a
F test	NS	**	*	**	**	**

***, ** and NS indicate that $p<0.05$,$p<0.01$ respectively. In each factor, mean designated by the same latter are not statistically different at $p<0.05$ level according to Duncan"s Multiple Range Test**

Table 4. mean of grain yield (t/ha), straw yield (t/ha), harvest index % as affected by wheat cultivars, nitrogen fertilizer rate, phosphorus fertilizer rate and their interaction in 2014/15 and 2015/16 growing seasons.

Factor	Grain yield (t/ha)		Straw yield (t/ha)		Harvest index %	
year	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16
Cultivar C						
Misr 2	6.716	6.307	10.495	9.263	39.2	40.7
Giza 168	6.004	5.914	9.005	9.215	40.4	39.3
F test	*	NS	**	NS	*	NS
Nitrogen fertilizer rates (kg/ha)N						
60	4.850d	5.821d	6.745d	8.546d	41.9a	40.7a
120	6.326c	5.919bc	9.367c	8.870c	40.4b	40.2ab
180	6.835b	6.188b	10.814b	9.417b	38.7c	39.9bc
240	7.430a	6.514a	12.071a	10.119a	38.1d	39.4c
F test	**	**	**	**	**	**
Phosphorus fertilizer rate s(kg P_2O_5/ha).P						
0	6.171b	5.264c	9.439c	7.216c	39.9	42.1a
36	6.347a	6.318b	9.703b	9.439b	39.9	40.2b
72	6.564a	6.749a	10.110a	11.062a	39.6	37.9c
F test	**	**	**	**	NS	**

***, ** and NS indicate that $p<0.05$,$p<0.01$ respectively. In each factor, mean designated by the same latter are not statistically different at $p<0.05$ level according to Duncans Multiple Range Test**

4- Effect of interaction

1-The interaction of C x N:

Data in Table 5 indicated that there were significant effects for interaction between wheat cultivars and nitrogen fertilizer rate for number of days to heading, number of spikes/m^2, grain yield, straw yield and harvest index. With application 100 kg N/ha Misr 2 had record the highest values for number of days to heading, number of spikes/m^2, grain yield (t/ha) and straw yield (t/ha). Meanwhile Giza 168 recorded the highest values for harvest index with application 60 kg N/ ha.

2-The interaction of CxP:-

Data in Table 6 indicated that there were highly significant effects for interaction between wheat cultivars and phosphorus rate for number of days to heading, number of spikes/m^2, number of grain/spike in 2015/16 and significant effect on harvest index in 2014/15 season. At application of 72 kg P_2O_5/ha Giza 168 recorded the lowest number of days to heading (days) and Misr 2 recorded the highest number of spikes/m^2, while Giza 168 superior in number of grain/spike in 2015/16 and harvest index in 2014/15 season

3-The interaction of NxP:-

Data in Table 7 indicated that there were significant effects for interaction between nitrogen fertilizer rate and phosphorus rate for number of spikes/m^2, grain/spike, biological, grain yield, straw yield and harvest index. Maximum rate for N 240 and P 72 were recorded the highest values for spikes/m^2, and grain/spike in 2015/16 and biological yield (t/ha) and grain yield (t/ha) in both seasons. Also for straw yield (t/ha) in 2014/15. On the other hand 240 kg N/ha with 0 kg P_2O_5/har recorded the highest values for harvest index (%) in 2015/16 season.

4-The interaction between CxNxP :

Data Table 8 indicated that the effect of interaction between wheat cultivars, nitrogen fertilizer rate and P_2O_5 fertilizer rate were highly significant for number of spikes/m^2 in 2015/16 season. Misr 2 had recorded the highest values with application 240 kg N and 72 P_2O_5/ha.

Table 5. Means of number of days to heading, number of spikes/m^2, grain and straw yield and harvest index as affected by interaction between wheat cultivars and nitrogen fertilizer rate in 2014/2015 and 2015/2016

Wheat cultivar	Nitrogen rate (Kg/ha)	Heading date 2014/15	Spikes/m^2 2014/15	Grain yield (t/ha) 2014/15	Straw yield (t/ha) 2015/16	Harvest index 2014/15
Misr 2	60	106.9	319	5.143	8.449	41.0
	120	108.2	344	6.609	6.731	39.4
	180	108.9	368	7.235	9.500	38.6
	240	110.7	390	7.877	9.988	37.9
Giza 168	60	94.3	281	4.560	8.644	42.8
	120	95.0	312	6.045	8.632	41.4
	180	97.2	335	6.437	9.334	38.9
	240	98.9	372	6.981	10.253	38.3
F test		*	*	*	*	**
LSD 0.05		0.8	9.3	0.166	0.399	0.4
0.01		-	-			0.6

*** and ** indicate that $p<0.05$ and $p<0.01$.**

Table 6. Means of number of days to heading, number of spikes/m^2, grain/spike in 2015/16 and harvest index in 2014/15 as affected by interaction between wheat cultivars and phosphorus fertilizer rate in 2014/15 and 2015/16.

Treatment	P_2O_5 (kg/ha)	days to heading 2015/16	spikes/m^2 2015/16	grain/spike 2015/16	harvest index 2014/15
Misr 2	O	100.3	232	53.4	39.2
	36	96.0	268	65.5	39.4
	72	96.1	296	69.0	39.1
Giza 168	O	95.2	183	48.6	40.0
	36	89.8	218	61.8	40.4
	72	85.2	258	72.3	40.7
F test		**	**	**	*
LSD0.05		1.0	2.5	3.1	0.3
0.01		1.4	3.3	4.2	

Table 7. Means of grain filling rate, flag leaf area, number of spikes/m^2, grain/spike, biological, grain and straw yield and harvest index as affected by interaction between nitrogenfertilizer rate and phosphorus rate in 2014/15 and 2015/16.

N (kg/ha)	P2O5 (kg/ha)	No. Spikes/m^2 15/16	No. grain/ spike15/16	Biological yield (t/ha)		grain yield t/ha		Straw yield	HI (%)
				14/15	15/16	14/15	15/16	(t/ha) 14/15	15/16
60	0	195	46.3	11.086	10.829	4.643	4.595	6.442	42.0
	36	230	60.3	11.681	14.786	4.902	6.076	6.780	41.1
	72	267	69.0	12.019	17.493	5.005	6.799	7.016	38.9
120	0	202	47.8	14.975	11.859	6.035	4.986	8.939	42.1
	36	237	61.8	15.391	15.451	6.261	6.333	9.129	41.0
	72	276	72.2	16.719	17.057	6.685	6.437	10.034	37.7
180	0	210	50.2	17.178	12.990	6.668	5.471	10.526	42.1
	36	247	65.8	17.773	15.700	6.890	6.254	10.883	39.8
	72	276	68.8	17.981	18.128	6.949	6.837	11.031	37.7
240	0	224	59.7	19.178	14.239	7.335	6.002	11.842	42.2
	36	258	66.7	19.354	17.095	7.337	6.618	12.014	38.8
	72	290	72.7	19.973	18.564	7.613	6.921	12.359	37.3
F test		**	**	**	*	**	**	**	*
LSD 0.05		3.7	4.7	0.395	0.928	0.161	0.380	0.261	1.1
LSD 0.01		4.7	5.9	0.533	-	2.189	0.476	0.352	-

Table 8. Means of number of spikes/m^2 as affected by interaction between wheat cultivars, nitrogen fertilizer rates and phosphorus rates in 2015/16.

Kg N/ha	P_2O_5 kg/ha					
	Misr 2			Giza 168		
	0	36	72	0	36	72
60	215	257	289	175	203	244
120	223	264	297	180	209	256
180	234	272	297	186	223	255
240	255	281	303	193	236	277
F test				**		
LSD 0.05				4.9		
LSD 0.01				6.6		

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استجابة بعض أصناف القمح لمعدلات السماد النيتروجينى والفوسفاتى

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اجريت تجربة حقلية بمزرعه كلية الزراعة، جامعه كفر الشيخ بشمال الدلتا- مصر خلال موسمي٢٠١٤-٢٠١٥ و ٢٠١٥-٢٠١٦ لدراسة تأثير معدلات مختلفه من السميد بمعدلات مختلفة من السماد النيتروجيني (٦٠، ١٢٠،١٨٠ و٢٤٠ كجم/هكتار) والفوسفاتى (صفر، ٣٦ و٧٢ (P_2O_5)/هكتار) على المحصول ومكوناته لصنفي القمح مصر ٢ و جيزة ١٦٨ فى ارض طينية. وأظهرت النتائج وجود اختلافات معنوية بين الصنفين فى معظم الصفات تحت الدراسة. وسجل الصنف مصر ٢ أعلي القيم فى عدد الايام حتى طرد ٥٠% من السنابل ،ارتفاعالنبات ,عدد السنابل/م٢ فى الموسمين ،عدد الحبوب/سنبلة والمحصول البيولوجى (٧.٢٣٢ طن/فدان) ومحصول الحبوب (٢.٨٢٢ طن/فدان) ومحصول القش فى الموسم الأول. بينما سجل الصنف جيزة ١٦٨ أعلي وزن للألف حبة ومعامل الحصاد فى الموسم الأول. بزيادة التسميد النيتروجيني من ٦٠، ١٢٠ و١٨٠ الى ٢٤٠ كج نتروجين/هكتار زاد معنويا من المحصول ومكونات المحصول. اضافة ٢٤٠ كجم/هكتار نيتروجين ادى الى زيادة في محصول الحبوب الى ٧.٤٣٠ و ٦.٥١٤ طن/هكتار ومحصول القش الى ١٢.٠٧١ و ١٠.١١٩ طن/هكتار فى الموسم الاول والثانى علي التوالى. اثر السماد الفوسفاتى معنويا على كل الصفات تحت الدراسة. زادت قيم كل الصفات بزيادة التسميد الفوسفاتى فيما عدى طرد السنابل ومعامل الحصاد. أدى التسميد بمعدل ٧٢ كجم P_2O_5/هكتار الى زياده معنويه في محصول القمح من الحبوب (٦.٥٦٤ و ٦.٧٤٩ طن/هكتار) ومن القش (١٠.١١ و ١١.٠٦٢ طن/هكتار) فى الموسم الاول والثاني على الترتيب . أدى التسميد بمعدل ٢٤٠ كجم نيتروجين و ٧٢ كجم P_2O_5 كجم /هكتار مع زراعة الصنف مصر ٢ تسجيل اعلي قيم للمحصول ومكوناته.