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RESPONSE OF THREE HARD WHEAT CULTIVARS TO DIFFERENT LEVELS OF PHOSPHORUS FERTILIZER AT AL-GABAL AL-AKHDAR, LIBYA.

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ABSTRACT

Two field experiments were performed at Gamal Abd El-Nasser Experimental Farm during 2003/2004 and 2004/2005 seasons to study the response of three local hard wheat (*Triticum durum*) cultivars, ie. (Maragwi, Zarda and $IB_{49}F_3$) to five P levels (0, 15, 25, 35 and 45 kg P/ha.) at Al-Gabal Al-Akhdar, Libya situated at latitude 21° 43' North and 32° 26' East and latitude 590 m above sea level. A split plot design with three replications was used.

The obtained results indicated that cultivars had a significant effect on spike length in both seasons and grain width and 1000-grain weight in 2nd season. This effect was not true on other studied traits. Zarda cultivar tended to produce the highest values compared with other two cultivars in both seasons. The same cultivar out yielded Margawi as well as $IB_{49}F_3$ cultivar in grain yield by 0.17 and 0.48 t/ha. as well as 0.83 and 0.78 t/ha. in both seasons, respectively.

Difference in grain yield and most of its related variables due to changing P levels were significant in both seasons. Application of the highest P level (45 kg P/ha.) produced 1.44 and 0.91 t/ha. more than unfertilized treatments. With regarding to protein, glutein and P content, the highest values results from application of the highest P level (45 kg P/ha.). Cultivars x P levels interaction had a significant effect on numbers of tillers and spikes/m^2, spike weight, grain length and 1000-grain weight in one season.

INTRODUCTION

Wheat is the most important food crop in Libya. The total consumption of wheat amounted to about 1.05 million tons, whereas the total production amount to 0.9 million tons. Thus, gap in wheat production is about 0.96 million tons and the reduction of that gap should regarded as a national goal. The most promising way to attain this goal is to improve productivity of wheat cultivars in terms of yield per hectare. This could be achieved by using high yielding cultivars and improving the agronomic practices such as phosphorus fertilization which is important factor affecting the yield of wheat crop.

Variation between wheat cultivars is expected in many cases when there is a marked variability in genetic bases between these cultivars. Therefore many investigators found marked differences in grain and straw yield and same yield components of wheat cultivars (Dubetz 1977; Sofield *et al.*, 1977; Davidson and Cheavalier, 1990; Abdul-Galil *et al.*, 1977).

Most of research work either in Libya and/or abroad indicated that P fertilization increased grain and straw yields of wheat. However, P levels which produces the best yield differed from site to another depending on soil type and fertility, irrigation system, sources and response of the used cultivars. Many workers found that application of 20-40 kg P/ha. increased

grain and straw yield Fayed, 1992; Bassiony *et al.*, 1993; El-Nagar *et al.*, 1989; Aly, 1998; Atia and Aly, 1998; El-Morsy, 1998; Manske *et al.*, 2001). Moreover, Swati *et al.* (1990) and Sharma and Vayas (2001) stated that wheat yield could respond to more than 90 kg P/ha. Consequently, the present investigations aimed to study the response of three hard wheat cultivars to various phosphorus levels at Al-Gabal Al-Akhdar, Libya.

MATERIALS AND METHODS

Two field experiments were performed at Gamal Abd El-Nasser Experimental Farm during 2003/2004 and 2004/2005 seasons to study the response of three local hard wheat (*Triticum durum*) cultivars, ie. (Maragwi, Zarda and $IB_{49}F_3$) to five P levels (0, 15, 25, 35 and 45 kg P/ha.) under Al-Gabal Al-Akhdar district, Libya.

A split plot design with three replications was used. The main plots were devoted to cultivars and sub- plots were occupied by phosphorus levels. Each experimental basic unit was 2x3m occupy an area of $6m^2$.

In the two seasons, soil samples for the over 25cm of soil depth were taken before sowing to estimating the important chemical and physical soil properties as presented in Table (1).

Table 1: Mechanical and chemical analysis of soil characteristics in the experimental sites during the time 2003/2004 and 2004/2005 seasons.

Properties	2003/2004 season	2004/2005 season
Fine sand (%)	23.80	23.91
Silt (%)	44.28	50.18
Clay (%)	31.92	25.91
Texture	Clay loam	Clay loam
PH	7.90	7.30
Electrical conductivity	0.536	0.426
Ca carbonate (%)	21.00	13.00
O.M (%)	2.72	5.46
Total N (%)	0.25	0.31
Aval. P (ppm)	2.00	4.00
EC.(gm/cm^3)	1.71	1.86
C.E.C (m eq/L)	4.69	4.80

Wheat grains (80 kg/ha.) were drilled in rows 15 cm apart on 15th and 22nd November in the first and second seasons, respectively. Diammonium phosphate (18-46) was added before sowing after the equivalent of N levels which applied to all treatments through application of N as urea (46%N) at the rate of 32.29, 51.04, 69.70, 88.54 and 116.6 kg/ha. (Gabel, 1982). The normal cultural practices of growing wheat at Al Gabel Al-Akhader were followed.

Table 2: Meteorological records of Al-Baida in 2003/2004 and 2004/2005 seasons.

Month	2003/2004 season					2004/2005 season				
	Temperature			Rain	R.H.	Temperature			Rain	R.H.
	Max.	Min.	Aver	(mm)	(%)	Max.	Min.	Aver	(mm)	(%)
Oct.	28.5	16.6	22.5	—	51	29.9	17.7	23.8	—	57
Nov.	20.2	11.6	15.9	58.6	70	21.3	14.3	17.8	128.5	69
Dec.	14.9	8.3	11.6	122.4	78	13.5	17.0	15.3	89.9	77
Jan.	13.3	7.5	10.4	266.9	77	13.6	7.5	10.6	209.9	80
Feb.	15.3	7.6	11.5	55.7	70	12.3	5.9	9.1	53.4	67
March	19.1	9.7	14.4	15.8	64	17.2	8.3	12.8	91.9	64
April	21.5	11.7	16.6	23.9	55	20.1	9.9	15.0	10.0	56
May	25.5	13.6	19.6	—	48	26.2	14.8	20.5	—	47

At harvest time, 0.25m^2 was taken randomly from each sub plots to record number of tillers and spikes/m^2. Also, ten graduated plants where chosen randomly to record plant height, spike length and weight, number of spikelets /spike, number and weight of grain /spike, grain length and width and 1000-grain weight. Biological, grain and straw yields (t/ha.) were computed on the basis of whole plot on the basic of 14.5 % moisture. Moreover, grain protein glutein and phosphorus (%) were determined according to Hesse (1992), A.A.C.C. (1972), respectively.

All data were subjected to statistical analysis by the technique of analysis of variance for the split plot design using SAS program and the treatments means were compared using the least significant differences at the level of 0.05 (LSD_{05}) method as mentioned by Snedecor and Cochoran (1967).

RESULTS AND DISCUSSION

1.Effect of cultivars:

a- Yield attributes:

Results in Table (3) indicated that cultivars had a significant effect on spike length in both seasons and grain width and 1000-grain weight in the first season, while this effect was not true on other studied traits in both seasons. Generally, Zararda cultivar ranked the first position among studied cultivars since it had the highest values in each season regarding plant height (104.5 and 126.6 cm), number of tillers/m^2 (305 and 388), number of spikes/m^2 (288 and 355), spike weight (2.97 and 2.59 gm), number of spikelets/spike (20.73 and 19.10), number of grains/spike (49.45 and 48.49), grain weight/spike (2.59 and 1.86 gm), grain length (0.75 and 0.79cm) and grain width (0.34 and 0.30cm) in both seasons, respectively.

Zarda cultivar followed by Margawi cultivar which ranked the second position. Whereas, $IB_{49}F_3$ cultivar had the greatest values respecting of spike length (9.83 and 8.65cm) during both seasons, successively. The differences in the yield attributed traits of the concerned cultivars are ascribed to the potential productivity of these cultivars which is genetically controlled. Moreover, these results indicated that the superiority of Zarda cultivar may be

due to low sensitivity to stress conditions at Al-Gabal Al-Akhder. These results are in agreement with those obtained by Bibliographic citation (1976), Dubetz (1977), Sofield *et al.* (1977), Davidson and Cheavalier (1990), and Abd El-Moneim (1999), who found that marked differences among wheat cultivars in some yield components. Moreover, these results are not in harmony with those obtained by Swati *et al.* (1990) and Coa and Moss (1991).

Table 3: Effect of cultivars on yield attributes in 2003/2004 and 2004/2005 seasons.

Yield attributes	2003/2004 season				2004/2005 season			
	Margawi	Zarda	$IB_{49}F_3$	LSD_{os}	Margawi	Zarda	$IB_{49}F_3$	LSD_{os}
Plant height (cm)	98.3	104.5	100.3	NS	124.4	126.6	118.1	NS
Number of tillers/m^2	288	305	273	NS	368	388	380	NS
Number of spikes/m^2	269	288	261	NS	351	355	350	NS
Spike length (cm)	7.21	7.93	98.3	1.33	7.23	7.38	8.65	0.52
Number of spikelets/spike	20.42	20.73	20.62	NS	18.46	19.10	18.24	NS
Spike weight (gm)	2.92	2.97	2.60	NS	2.51	2.59	2.59	NS
Number of grains/spike	48.88	49.45	46.26	NS	41.69	48.49	42.95	NS
Grain weight/spike (cm)	2.60	2.59	2.16	NS	1.79	1.86	1.76	NS
Grain length (cm)	0.74	0.75	0.69	NS	0.77	0.79	0.73	NS
Grain width (cm)	0.32	0.34	0.32	0.01	0.29	0.30	0.30	NS
1000-grain weight (gm)	46.07	57.00	46.73	6.36	43.67	46.33	42.91	NS

b. Yields and chemical composition:

Results presented in Table (4) revealed clearly that no significant differences in biological, straw and grain yield as well as harvest index due to cultivars were obtained in the two seasons. Generally, Zarda cultivar tended to produce the highest values in both seasons. It could be concluded that varietals differences among wheat cultivars may be due to genital make up. The superiority of Zarda in these traits may be due to producing higher spike length, number of grains/spike and 1000 grain weight. These results are in general agreement with those abtained by Loffer *et al.* (1985), Swati *et al.* (1990) and Rogasits *et al.* (2000).

Concerning chemical composition, differences in protein, glutein and phosphorus content in grain were not significant among the effect of cultivars in both seasons. However, Zarda cultivar tended to produce more protein, glutien and phosphorus in grains than $IB_{49}F_3$ and Margawi and the later produced the lowest value in both season. These results are not agreement with those obtained by Mockel *et al.* (1998)and Manske *et al.* (2000).

Table 4: Effect of cultivars on biological, straw and grain yield as well as chemical composition in 2003/2004 and 2004/2005 seasons.

Yields and chemicals composition	2003/2004 season				2004/2005 season			
	Cultivars				Cultivars			
	Margawi	Zarda	$IB_{49}F_3$	LSD_{05}	Margawi	Zarda	$IB_{49}F_3$	LSD_{05}
Biological yield (t/ha.)	16.20	18.43	16.07	NS	19.80	20.73	19.63	NS
Straw yield (t/ha.)	11.45	13.51	11.96	NS	15.84	16.29	19.87	NS
Grain yield (t/ha.)	4.75	4.92	4.09	NS	3.96	4.44	3.76	NS
Harvest index (%)	26.91	29.66	25.89	NS	19.19	21.96	18.85	NS
Protein (%)	13.04	13.58	14.57	NS	9.77	10.98	10.72	NS
Glutein (%)	4.14	4.63	4.61	NS	5.64	6.41	6.29	NS
Phosphorus (%)	0.80	0.90	0.90	NS	1.98	2.22	1.82	NS

2. Effect of phosphorus levels:

a. Yield attributes:

Results presented in Table (5) showed that phosphorus fertilizer had a significant effect on all characters in the first season except number of spikelets and grains/spike, grains weight/spike and 1000-grain weight, while this effect was true among plant height, number of spikelets/spikes and grain length and width in the second one. Increasing phosphorus levels up to 45 kgP/ha. gradually increased all characters in both seasons. Maximum values of the aforementioned characters were recorded from treatment having 45 kgP/ha. in both seasons. These increase might be due to the effect of phosphorus on plant growth and consequently to the efficiency of roots in absorbing various nutrients as well as phosphorus is important for cell division activity, leading to increase of plant height, number of fertile tillers/m^2 and spikes characters. These results are in good agreement with those obtained by Fayed et al(1992), Abdul-Galil *et al.*(1997), they found that phosphorus exhibited its results through increasing number of spikes/m^2, number of grains/spike and 1000-grain weight. Moreover, Aly (1998) and Atia and Aly (1998) showed no response in productive tillers percentage, spike length, number of spikelets and grains/spike of wheat due to P application.

b. Yield and chemical composition:

Results in Table (6) showed that phosphorus levels had a significant effect on grain yield per unit area in both seasons. This effect was not true on biological and straw yields and harvest index in both seasons. It is quite clear from these results that biological and straw yields tented to increase with increasing P levels up to 45 kg P/ha. in both seasons.

Significant differences were registered in grain yield per unit area among the various levels of phosphorus as compared with the unfertilized treatments (control) in both seasons. Increasing P levels up to 45 kg P/ha. caused an obvious increase in grain yield/ha. by 37%, 22%, 10% and 17% in the first season and by 24%, 9%, 1% and 0.2% in the second one over the control, 15, 25 and 35 P/ha. respectively.

Table 5: Effect of phosphorus fertilizer levels, on wheat yield attributes in two Seasons.

P levels (kg/ha.)	Plant height (cm)	Number of tillers/m^2	Number of spikes/ m^2	Spike length (cm)	Number of spikelets/spike	Spike weight (gm)	Number of grains /spike	Grain weight/spike (gm)	Grain Length (cm)	Grain width (cm)	1000-grain weight (gm)
	The first season (2003/2004)										
0.0	89.9	257	212	7.18	19.52	2.17	40.64	2.18	0.66	0.30	52.00
15	101.6	273	238	7.29	20.74	2.97	44.48	2.56	0.70	0.32	55.11
25	102.9	294	252	8.18	20.70	2.75	47.38	2.39	0.73	0.33	57.11
35	107.2	298	352	8.26	21.00	3.05	47.60	2.39	0.75	0.34	58.67
45	108.8	318	309	9.22	21.00	3.20	47.66	2.72	0.76	0.34	59.78
L.S.D	5.9	36.6	36.4	0.75	NS	0.28	NS	NS	0.06	0.01	NS
	The Second season (2004/2005)										
0.0	104.7	323	312	7.59	17.86	2.45	38.86	1.67	0.73	0.28	43.87
15	120.2	386	361	7.65	18.24	2.52	40.39	1.75	0.74	0.29	43.24
25	123.3	402	366	7.69	18.22	2.47	40.69	1.75	0.74	0.30	43.93
35	131.6	381	349	7.76	19.01	2.64	41.98	1.84	0.79	0.31	44.44
45	135.6	403	361	7.77	19.68	2.73	43.29	1.95	0.80	0.31	46.70
L.S.D	7.6	NS	NS	NS	4.79	NS	NS	NS	0.02	0.02	NS

Table 6: Effect of phosphorus fertilizer levels on biological, straw and grain yield as well as chemical composition in 2003/2004 and 2004/2005 seasons.

Yields and chemical composition	2003/2004 season						2004/2005 season					
	P levels (kg/ha.)					LSD_{05}	P levels (kg/ha.)					LSD_{05}
	0	15	25	35	45		0	15	25	35	45	
Biological yield (t/ha.)	14.16	16.89	17.42	17.55	17.39	NS	17.93	20.52	20.63	20.14	21.69	NS
Straw yield (t/ha.)	10.74	12.53	13.01	13.02	12.08	NS	14.59	16.71	16.25	15.98	16.45	NS
Grain yield (t/ha.)	3.87	4.36	4.41	4.52	5.31	0.86	3.33	3.81	4.11	4.16	4.24	0.72
Harvest index (%)	26.38	25.81	28.83	29.79	30.53	NS	18.75	18.24	20.22	20.66	19.74	NS
Protein (%)	9.97	9.82	13.37	17.04	18.40	3.37	7.95	8.92	9.90	11.84	13.35	1.77
Glutein (%)	4.22	4.29	4.39	4.67	4.60	NS	5.69	6.22	5.91	6.33	6.41	NS
Phosphorus (%)	0.60	0.80	0.90	1.00	1.01	0.22	1.72	1.77	1.98	2.20	2.36	NS

It is quit clear that grain yield production per P unit (one kg) of the 1st, 2nd, 3rd, 4th and 5th 15 kg P/ha. was 36.7, 24.7, 36.7 and 52 kg grains/1.0 kg P in the first season and 32.0, 20.0, 3.3 and 5.3 kg grains/1.0 kg P in the second one, respectively. (Table 7). Such effect of phosphorus fertilization on grain yield per unit area was a result of its effect on fertile spikes/m^2, fertile spikelets/spike, spike length, number of grains/spike, grain yield/spike and 1000-grain weight. Moreover, the positive response to P levels may be due to

the assumepiton that P had the most profound effect on the development of the vegetative parts of plants. Results of various studies showed a positive effect with different responses by wheat fertilization (El-Nagar *et al.*, 1989; Fayed *et al.*, 1992; Bassiouny *et al.*, 1993; Abdul-Galil *et al.*, 1997; Atia and Aly,1998). In the present work sustain these reported by Aly (1998) and Atia and Aly (1998).

Table 7: Phosphorus use efficiency in 2003/2004 and 2004/2005 seasons.

P increase (kg/ha.)	2003/2004 season		2004/2005 season	
	Grain yiled increase(kg/ha.)	Grain (kg/kgP)	Grain yiled increase(kg/ha.)	Grain (kg/kgP)
0 - 15	490	36.7	480	32.0
15 -25	470	24.7	300	20.0
23- 35	490	36.7	50	3.3
35-45	790	52.7	80	5.3

It is evident from these results that P levels had a significant effect on protein and phosphorus percent in both seasons and the first season, respectively, while this effect was not true for glutein content in both seasons. The highest values from protein, glutein and phosphorus were obtained with application of 45 kg P/ha., while the lowest values were produced from the unfertilized plants (control) in both seasons. These results were in agreement with those obtained by Fayed (1992), Sharma and Gupta (1994), Atia and Aly (1998) and El-Moursy (1998).

3. Effect of interaction:

The following discussion will be concerned on the characters that significantly affected by the interaction between cultivars and phosphorus level.

Wheat plants markedly differed in their response to cultivars and phosphorus as shown in Table (8). With respect to number of tillers/m^2, number of spikes/m^2 and spike weight in the first season as well as grain length and 1000-grain weight in the second one, results indicated that the previously mentioned characters were significantly increased with increasing phosphorus levels under different cultivars. The highest values of number of spikes/m^2 (346 and 290), number of tillers/m^2 (295.99 and 296.89) and spike weight (3.70 and 3.02gm) was realized when Margawi and $IB_{49}F_3$ cultivars were treated with 45 kg P/ha. While, the lowest value of the aforementioned characters was recorded with planting the both cultivars under control treatments. On the other hand, grain length and 1000-grainweight recorded their highest values when Zarda cultivar received 45 kg P/ha., while the lowest values of both traits produced from the same cultivar under unfertilized treatment (control).

Table 8: Effect of interaction between cultivars and P levels on number of spikes/m^2 spike length in 2003/2004 season as well as number of tillers/m^2, grain length and 1000-grain weight in 2004/2005 season.

Cultivars	P levels (kg/ha.)				
	0	15	25	35	45
	Number of spikes/m^2 2003/2004 season				
Margawi	233.33	254.00	274.33	325.67	346.00
Zarda	298.00	289.33	289.00	332.33	319.00
$IB_{49}F_3$	241.67	275.67	321.33	236.67	290.00
$LSD_{0.05}$			63.47		
	Spike weight (gm) in 2003/2004 season				
Margawi	2.13	3.06	2.93	3.01	3.70
Zarda	2.30	3.38	2.91	3.12	2.88
$IB_{49}F_3$	2.06	2.48	2.42	3.00	3.02
$LSD_{0.05}$			0.49		
	Number of tillers/m2 in 2004/2005 season				
Margawi	201.33	236.89	205.89	242.67	295.99
Zarda	243.23	202.23	262.33	235.56	221.78
$IB_{49}F_3$	270.67	242.00	257.78	296.67	208.89
$LSD_{0.05}$			68.20		
	Grain length (cm) in 2004/2005 season				
Margawi	0.77	0.75	0.74	0.79	0.80
Zarda	0.75	0.76	0.79	0.82	0.82
$IB_{49}F_3$	0.68	0.71	0.72	0.75	0.71
$LSD_{0.05}$			0.05		
	1000-grain weight (gm) in 2004/2005 season				
Margawi	47.06	41.06	40.56	46.44	42.44
Zarda	42.33	47.89	48.33	43.11	52.00
$IB_{49}F_3$	41.44	40.78	42.89	43.78	45.67
$LSD_{0.05}$			6.97		

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استجابة ثلاث أصناف من القمح الصلب لمعدلات مختلفة من السماد الفوسفاتي

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تجربتان حقليتان أقيمتا بمزرعة جمال عبد الناصر خلال الموسمين ٢٠٠٣/٢٠٠٤ و ٢٠٠٤/٢٠٠٥ و الواقعة علي خطي العرض ٢٠°، ٣٣° والمرتفعة عن سطح البحر حوالي 590 م لدراسة تأثير استجابة بعض الأصناف المحلية من قمح الديورم (مرجاوي وزاردة و$IB_{49}F_3$) لخمسة معدلات من السماد الفوسفاتي (صفر و١٥و٢٥و٣٥و٤٥ كجم فوسفور/هكتار). وقد استخدم تصميم القطع المنشقة في موسمي الدراسة.

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي:

١- أظهرت النتائج إن كل من طول السنبلة (في موسمي الزراعة) وعرض الحبة ووزن ال١٠٠٠ حبة (في موسم واحد) قد تأثر معنويا نتيجة لتغير الأصناف، إلا أن هذا التأثير لم يكن مؤكدا علي باقي الصفات في موسمي الزراعة. وقد تفوق الصنف زاردة علي الصنف مرجاوي بحوالي ٠,١٧ و٠,٤٨ طن/هكتار وعلي الصنف $IB_{49}F_3$ بحوالي ٠,٨٣ و٠,٧٨ طن/هكتار في موسمي الزراعة علي الترتيب.

٢- اظهر التغير في معدلات التسميد الأزوتي تأثيرا معنويا سوا علي محصول الحبوب أو معظم مكوناته في موسمي الزراعة، كما أن إضافة المعدل العالي من الفوسفور (٤٥ كجم فوسفور/هكتار) قد أعطي ١,٤٤ و٠,٩١ طن/هكتار زيادة عن المحصول الناتج من المعاملات الغير مسمدة (المقارنة).

٣- أدت إضافة المعدل العالي من الفوسفور (٤٥ كجم/هكتار) إلي الحصول علي اعلي محتوي للحبوب من كل من البروتين والجلوتين والفوسفور في موسمي الزراعة.

٤- اظهر التفاعل بين الأصناف والتسميد الفوسفاتي تأثيرا معنويا علي كل من عدد الفروع والسنابل بالمتر المربع ووزن السنبلة وطول الحبة ووزن الألف حبة حيث زادت هذه الصفات بزراعة أي من الأصناف الثلاثة تحت المعدل العالي من التسميد الفوسفاتي (٤٥ كجم/هكتار) في موسمي الزراعة.