Effect of Drought and Potassium Fertilization Levels on Yield and its Components in some Wheat Cultivars

Gomaa , M.A*; M.N. ElBanna*; H.A. Ashoosh; and Gawhara .A.E. El-Sorady***

*Plant Production Department- Faculty of Agriculture(Saba Basha)- Alexandria Univ.

** Etay Elbaroud Station- Field Crop Institute- Agricultural Research Center.

ABSTRACT

Two field experimental were conducted in 2008/09 and 2009/10 seasons at Etay El-Barod Agricultural research station. El-Behira Governorate, Egypt. To study the effect of drought and potassium fertilization levels on yield and its components in some wheat cultivars i.e Sakha 94, Sids 12 and Gemmiza9. Split split plot design with three replications was used. Results indicated that the irrigation treatments had significant effect on number of spikes/m2, number of grains/spike, 1000-grain weight, grain and straw yield. The highest grain yield was obtained from the control irrigation treatments. The wheat cultivars differed significantly in the same characters. The highest grain yield was obtained from Gemmiza9 application with the K-frtilization levels increasing. The productivity of wheat crops from grain yield/fed increased as s result of increasing number of spikes/m2 and number of grains/spike.

INTRODUCTION

Wheat (*Triticum aestivum*, L) is consider one of the most important grain crop in the world, also it has been considered the first strategic food crop for more than 7000 years ago in Egypt. Wheat production in Egypt had been increased from 2.06 million tons in 1983 to 7.97 million tons in 2008. This high increase in grain yield during the last years was achieved not only by increases in cultivated area, but also by increases in grain yield per feddan18.21 ardab/fed. In 2007/20** . As a result of planting high yield cultivars. Irrigation could be considered the limiting factor affecting crop production and agricultural expansion. Exposing wheat plants to drought condition depressed its yield and yield attributes, (EL-Sabbagh, 1998). for plants growing in drought conditions, accumulating abundant K+ in their tissues may play an important role in water uptake. The objectives of this study aimed to light scope on the effect of water stress on wheat, the influence of water stress on ability of three Egyptian bread wheat varities

and the amount of K fertilization and its effect with water stress on yield and its component in wheat.

MATERIALS AND METHODS

Two field Expriments were carried out at Etay El-Baroud Agricultural Research Station in El-Behira through 2008/09 and 2009/10 growing seasons to study the effect of water stress and poutassium fertilization levels on yield and its components of some wheat cultivars.

A split split-plot design with three replications was used in both seasons of experimentation. Each experiment included 108 treatments.The four irrigation treatments distributed at random in the main plots, whereas the three cultivars distributed randomly in the sub-plot and three levels of poutassium fertilization is located randomly in the sub sub-plot.The area of sub sub-plot was 3.6 m2 (0.086 fed.).(3m long x 1.2m width). The sowing dates were done on 27 and 22 of November in the first and second season, respectively.

A- Main plots (irrigation): Irrigation treatment

I_1: Holding an irrigation on vegetative growth period (the second irrigation).

I_2: Holding an irrigation on fruit growth period (the third irrigation).

Control treatment: take full irrigation (four irrigations).

B- Sub-plots (Wheat varities):

- K_1 = Zero Kg/fed.
- K_2 = 24 Kg/fed.
- K_3 = 48 Kg/fed.

C- Sub sub-plots (K- fertilization):

- V_1 = Sids 12
- V_2 = Gemiza 9
- V_3 = Sakha 94

Studied characters:

1- **Grain yield (ton/fed):** Determined from the harvested area of each sub sub-plot in terms of kg/plot and converted to ton/fed.

2- **Straw yield (ton/fed):** Determined as the difference between biological and grain yield of sub sub-plot in terms of kg/plot and converted to ton/fed.

3- **Biological yield (ton/fed):** Was estimated as the weight of biomass (grain+ straw) for each sub sub-plot.

4- **Harvest index:** Estimated from the following formula:

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

5- **Number of spikes/m2:** Number of fertile tillers/m2 were calculated by counting all spikes per square meter.

6- **Spike length (cm).**
7- **Number of grains/spike:** Average number of grains of five randomly chosen spikes.
8- **1000-grain weight (g):** Random samples of 1000-grain were taken from each plot, hand counted and weighted.

Statistical analysis:

The obtained data of the two investigated seasons were statistically analyzed according to Snedecor and Cochran (1967). The treatments means were compared using the least significant differenrce (L.S.D) test (Waller and Duncan, 1969).

RESULTS AND DISCUSSION

Results in (Table 1) showed the effect of irrigation treatments, wheat cultivars and potassium fertilization on grain yield, straw yield, biological yield and harvest index during both seasons 2008/09 and 2009/10. It is clear the influence of irrigation treatments were significant on grain yield, straw yield and biological yield of both seasons. The control treatment gave the highest grain yield, straw yield and biological yield during both seasons. However the lowest grain, straw, biological yield were obtained with the second irrigation treatment (I_2) in the first season and with the first irrigation treatment (I_1) in the second season. Irrigation treatment wasn't significant on harvest index of first season, but it was significant on harvest index of second season, the first irrigation treatment (I_1) gave the highest harvest index but the lowest one was with control irrigation treatment. Similar results were reported by El-Barbary(1998) , El-sabbagh (1998), Kandil (2001), Hassan (2003), Hefnawy and wahba (2003) and kassab et al. (2004) that skipping one irrigation at any of growth stages significantly reduce and grain yield straw yield compared with the control which received full irrigation.

The result showed that the differences among cultivars for the studied characters were significant. For grain yield Gemmiza9 gave the highest value on both seasons. Sakha 94 and Sids 12 gave the lowest values in the first and second seasons, respectively. The results indicated that in the first season Sakha 94 gave the highest straw yield while the lowest one was produced by Gemmiza9 which gave the highest straw yield in the second season. The highest value for the harvest index was obtained by Sakha 94 and Sids 12 in the first season and the second season respectively, while the opposite was true for Gemmiza9. These results are in harmony with those obtained by elsayed et al (2000) who found that

tested wheat cultivars Gemmiza5, 7 and Gemmiza9 showed a significant variation in studied traits. Also, Awad et al (2000), Alderfasi&Moustafa (2001), Moussa and Abd El-Maksoud (2004) who found that wheat cultivars differed significantly for straw, grain yield and harvest index.

Results of (Table 1) showed that potassium fertilization levels had a significant effect on grain yield, in the first season only. Increasing potassium fertilization rates up to 48 Kg /fed increased grain yield.

For straw yield application of 24 kg K_2O/fed significantly produced the highest value in both seasons. Table 1 showed that potassium fertilization hadn't significant effect on harvest index of the second season. But it had a significant effect in the first season. The highest harvest index was with 48 kg K_2O/fed. But the lowest one was with 24 kg K_2O on both seasons. This result was accordance with Mohamedin et al (2003) and Bakry M.A.A (2006) who found that yield and its components were increase with increasing potassium fertilization levels. But this result was in contrast with Elsayed et al (2007). The high level of potash fertilizer encourages wheat plants to absorb more water and increase the water use efficiency.

Effect of interactions:

1- On grain yield:

No significant interaction among all factors were obtained in the second season for grain yield, while in the first season all interactions among all factors were highly significant. **Figure (1)** show that the highest value was obtained from Gemmiza 9 with the control irrigation treatment (take full irrigation) while, the smallest grain yield was obtained from Sakha

94 with holding irrigation in fruit growth period. **Figure (2)** show that the highest value was obtained from 24 kg K_2O/fed with the control irrigation treatment (take full irrigation) while, the smallest grain yield was obtained from zero kg K_2O/fed with holding irrigation in fruit growth period. **Figure (3)** show that the highest value was obtained from Gemmiza9 with zero kg K_2O/fed while, the smallest grain yield was obtained from Sakha 94 with zero kg K_2O/fed.

(Table 1): Grain yield, Straw yield and Harvest index as influenced by holding irrigation, wheat cultivars and potassium fertilization during 2008/2009 and 2009/2010 seasons.

	Grain yield(ton/fed)		Straw yield(ton/fed)		Harvest index	
	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
Irrigation tr'ts(I)						
I_1	2.75889	1.6567	5.1663	3.2237	35.6311	34.0344
I_2	2.1452	2.3833	4.48703	4.8981	34.0019	32.84
Control	2.8515	2.3807	5.3841	5.0596	35.2963	32.3374
L.S.D $_{0.05}$	0.08678	0.25788	0.5513	0.2599	n.s	n.s
Varities (V)						
V_1	2.47185	2.0563	5.16	3.8893	33.8467	34.5604
V_2	2.9081	2.2922	4.4922	5.0915	40.2729	31.2307
V_3	2.3756	2.0722	5.3852	4.2007	6 30.8096	33.3307
L.S.D $_{0.05}$	0.06862	0.11969	0.3656	0.1837	2.28873	1.36268
K-fertilization (K)						
K_1	2.5533	2.10185	4.4404	4.1537	36.843	33.8585
K_2	2.5615	2.1685	6.4556	4.6148	28.651	32.3393
K_3	2.6407	2.15037	4.1415	4.413	39.436	33.0141
L.S.D $_{0.05}$	0.05079	n.s	0.3298	0.15631	1.735	1.20165
Interaction effect						
I x V	**	n.s	n.s	**	**	*
I x K	**	n.s	**	**	**	n.s
V x K	**	n.s	**	*	**	n.s

*Significant at the 5% level. ** Significant at 1% level . n.s not significant.

I_1, Holding an irrigation in vegetative growth period (the second irrigation)

I_2, Holding an irrigation in fruit growth period (the third irrigation)

Control, full irrigation (four irrigations).

Figure (1) interaction irrigation x wheat cultivars on grain yield

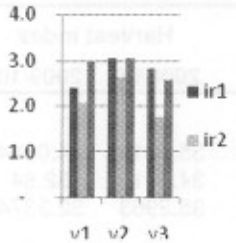


Figure (2) interaction irrigation x K-fertilization on grain yield

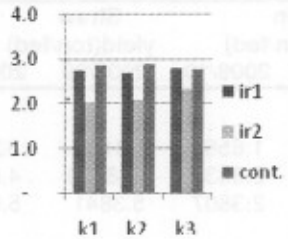
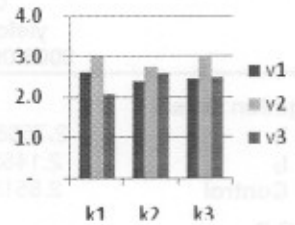


Figure (3) interaction wheat cultivars x K- fert. on grain yield



2- On straw yield:

The interaction between irrigation and varieties wasn't significant in the first season -each factor of them act independently on straw yield- but it was significant on the second season. **Figure (4)** show that The highest value was obtained from Gemmiza9 with the control irrigation treatment (take full irrigation) while, the smallest grain yield was obtained from Sakha 94 with holing irrigation in vegetative growth period. As shown on **figure (5)** 24 kg K_2O/fed with control irrigation treatment gave highest straw yield in both seasons. 48 kg K_2O/fed gave the lowest straw yield with holding irrigation on fruit growth period in the first season. **figure (6)** show The interaction between varieties and K-fertilization was significant on straw yield of both seasons.

3- On harvest index:

The interactions irrigation x wheat cultivars, irrigation x K-fertilization and wheat cultivars x K-fertilization were significant for harvest index of first season, but they weren't significant on harvest index in the second season except for irrigation and wheat cultivars interaction. **Figure (7)** show that the highest harvest index was obtained from holding irrigation on vegetative growth period with Sakha 94, but the lowest one was obtained from the control irrigation treatment With Gemmiza9. **Figure (8)** show that the highest harvest index was obtained from holding irrigation on vegetative growth period with 48 kg K_2O/fed. **Figure (9)** show that the highest harvest index was obtained from Sids 12 With zero kg K_2O/fed, but the lowest one was obtained from Gemmiza9 with 24 kg K_2O/fed.

Figure (4) interaction between irrigation and wheat cultivars on straw yield, second season

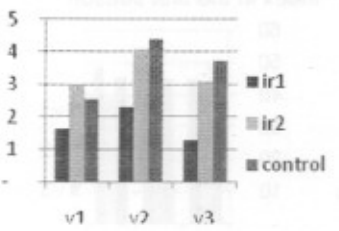


Figure (5) interaction irrigation x K- fertilization on straw yield, both seasons

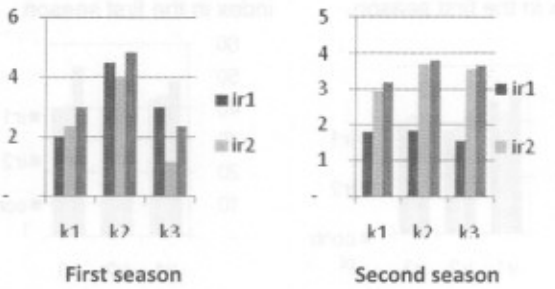


Figure (4) interaction between irrigation and wheat cultivars on straw yield , second season

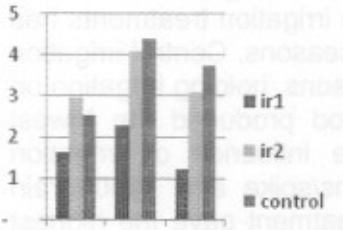


Figure (5) interaction between irrigation and K-fertilization on straw yield, both seasons

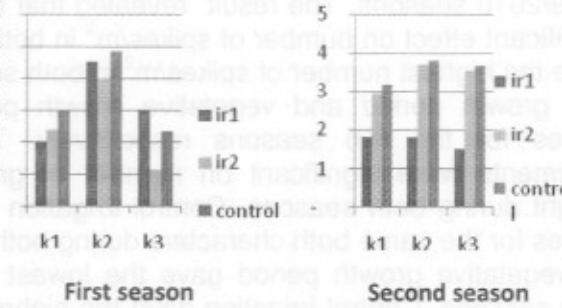


Figure (6) show the interaction between wheat cultivars and potassium fertilization levels on straw yield of both seasons.

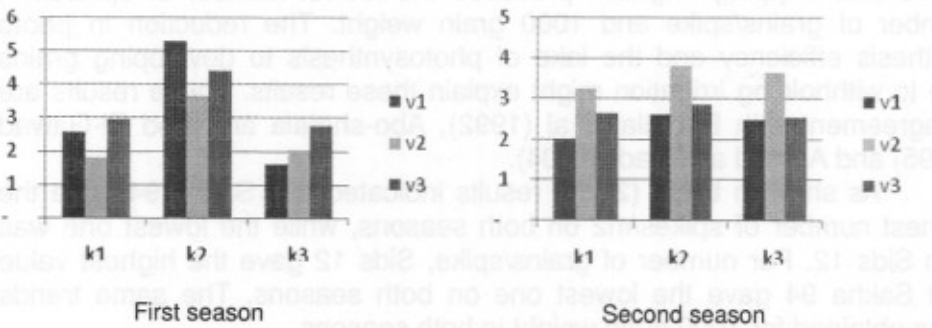


Figure (7) interaction irrigation treatments x wheat cultivars on harvest index in the first season.

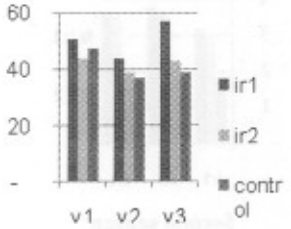


Figure (8) interaction irrigation treatments x K- fertilization on harvest index in the first season

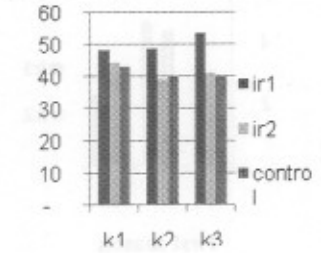
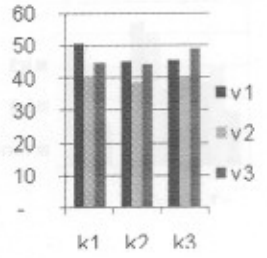


Figure (9) interaction wheat cultivars x K-fertilization on harvest index in the first season



Results of **table (2)** show the significant effect of holding irrigation, wheat cultivars and potassium fertilization on number of spikes/m^2, number of grains/spike,1000 grain weight and spike length during 2008/2009 and 2009/2010 seasons. The result revealed that the irrigation treatments had significant effect on number of spikes/m^2 in both seasons. Control irrigation gave the highest number of spikes/m^2 in both seasons, holding irrigation on fruit growth period and vegetative growth period produced the lowest values for the two seasons respectively. The influence of irrigation treatments were significant on number of grains/spike and 1000 grain weight during both seasons. Control irrigation treatment gave the highest values for the same both characters during both seasons. Holding irrigation on vegetative growth period gave the lowest number of grains/spike on both seasons. Control irrigation gave the highest 1000 grain weight during both seasons, holding irrigation on fruit growth period and vegetative

growth period had the lowest values for the two seasons, respectively. The results are in harmony with those obtained by El-Morshedy (2008) who stated that skipping irrigation produced the lowest number of spikes/m^2, number of grains/spike and 1000 grain weight. The reduction in photo synthesis efficiency and the lake of photosynthesis to developing grains due to withholding irrigation might explain these results. These results are in agreement with El-Kalla et al (1992), Abo-shetaia and Abd El-Gawad (1995) and Ahmed and Badr (2004).

As show in **table (2)** the results indicated that Sakha 94 gave the highest number of spikes/m2 on both seasons, while the lowest one was with Sids 12. For number of grains/spike, Sids 12 gave the highest value and Sakha 94 gave the lowest one on both seasons. The same trends were obtained for 1000 grain weight in both seasons.

As shown in **table (2),** Respecting the number of spikes/m^2 the fertilization had significant effect. The highest value was with 48 kg K_2O/fed on both seasons, but the lowest value was with zero kg K_2O/fed on both seasons. For number of grains/spike, potassium fertilization effect was significant in the first season. But k-fertilization wasn't significant on number of grains/spike in the second season. For 1000 grain weight, K-fertilization had no significant effect in the first season, but it had a significant variation values in the second season.

(Table 2): Number of Spikes/m^2, Number of grains/spike and 1000 grain weight(g) as influenced by holding irrigation, wheat cultivars and potassium fertilization during 2008/09 and 2009/10 seasons.

	Number of Spikes/m2		Number of grains/spike		1000 grain weight	
	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
Irrigation tr'ts(I)						
I_1	297.5556	275	52.837	60.2963	51.1546	47.7363
I_2	268.7037	307.9629	56.03704	61.1852	48.9907	49.2963
Control	335.5555	312.7778	57.837	67.3704	51.9944	49.7359
L.S.D $_{0.05}$	20.7617	22.2022	2.55998	2.8193	1.4988	1.5898
Varities (V)						
V_1	287.6667	257.963	59.1852	72.4074	51.9593	51.9137
V_2	302.778	315.7407	54.8593	59.4074	51.8593	48.5307
V_3	311.3707	322.037	52.667	57.0370	48.3222	46.3241
L.S.D $_{0.05}$	10.3373	11.5517	1.494	1.44355	1.46687	1.0538
K-fertilization (K)						
K_1	280.9259	282.5926	57.733	63.333	51.01297	49.0504
K_2	309.1482	303.1481	52.2074	63.5926	51.02593	49.5626
K_3	311.7074	310	56.7704	61.9259	50.10186	48.156
L.S.D $_{0.05}$	10.7364	13.6418	2.01374	**n.s**	**n.s**	1.0809
Interaction effect						
I x V	**	**n.s**	*	**	**n.s**	**n.s**
I x K	**	**	*	**	**n.s**	**n.s**
V x K	**	**n.s**	**	**	**n.s**	**

*Significant at the 5% level. ** Significant at 1% level . n.s not significant.

I_1, Holding an irrigation in vegetative growth period (the second irrigation)

I_2, Holding an irrigation in fruit growth period (the third irrigation)

Control, full irrigation (four irrigations).

Effect of interactions:

1- Number of spikes/m^2:

The interaction between irrigation and varieties on number of spikes/m^2 had significant effect in the first season **figure (13)**, the highest value was obtained from Sakha 94 with control irrigation treatment, but the lowest one obtained from Sids 12 with holding irrigation on fruit growth period. As shown in **figure (14)**, In the first season the highest value was obtained from48 kg K_2O/fed with control irrigation where as the lowest one was obtained from zero kg K_2O/fed with holding irrigation on fruit growth period. **Figure (15)** show that The highest value was obtained from 48 kg K_2O/fed with Sakha 94 while the lowest one was obtained from zero kg K_2O/fed with Sids 12.

2- Number of grains/spike:

On both seasons all interaction treatments had significant effect on number of grains/spike. **Figure (16)** showed, In the first season, The highest value was obtained from Sids 12 with holding irrigation on fruit growth period, while the smallest numer of grains/spike was obtained from Sakha 94 with holding irrigation on vegetative growth period. **Figure (17) showed that** In the first season, the highest value was obtained from 48 kg K_2O/fed with control irrigation treatment while, the smallest one was obtained from 24 kg K_2O/fed with holding irrigation on fruit growth period. As shown in **Figure (18)**, In the first season the highest value was obtained from zero kg K_2O/fed with Sids 12, while the smallest value was obtained from 24 kg K_2O/fed with Gemmiza9. In the second season, the highest value was obtained from zero kg K_2O/fed with Sids 12, but the smallest value was obtained from zero kg K_2O/fed with Sakha 94.

Figure (13) interaction Irrigation x varieties on number of spike/m^2 of first season

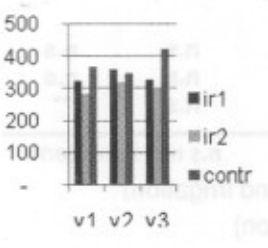
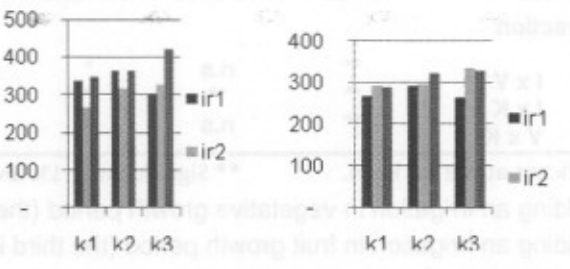


Figure (14) interaction irrigation x k-fertilization on number of spike/m^2 of both seasons



First season Second season

Figure (15) interaction varieties x k-fertilization on number of spikes/m^2,1_{st} season

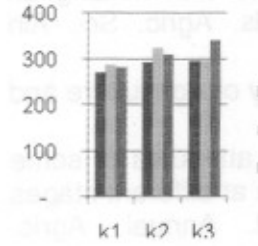


Figure (16) interaction irrigation x varieties on number of grain/spike of both seasons

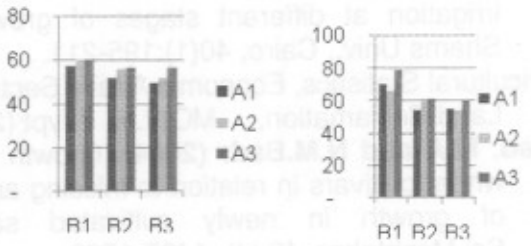


Table (17) interaction between irrigation and k-fertilization on number of grain/spike of both seasons

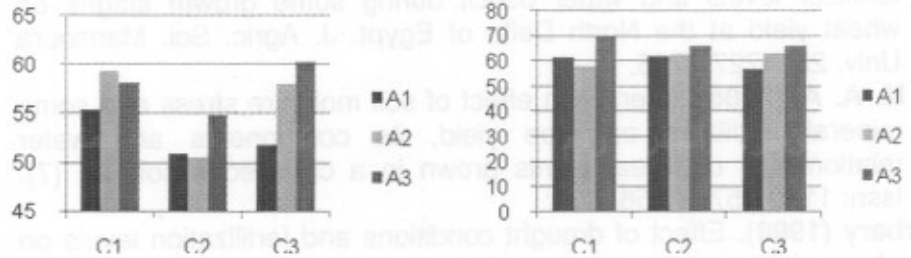
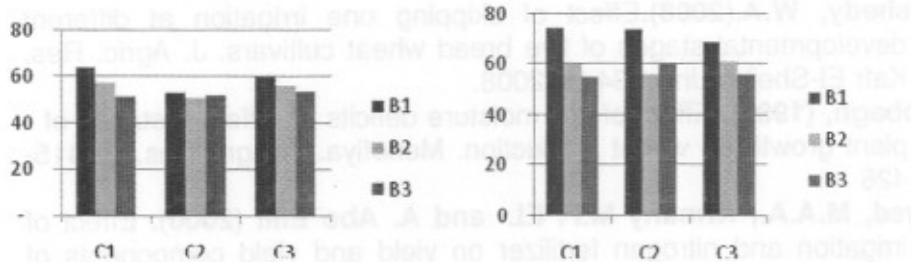


Table (18) interaction between varieties and k-fertilization on number of grain/spike of both seasons



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الملخص العربى

تأثير الجفاف ومستويات التسمد البوتاسى على المحصول ومكوناته فى بعض أصناف القمح.

محمود عبد العزيز جمعة*- محمد نجيب البنا*- حسن عبد اللطيف عشوش- جوهرة عبد السلام الصردى***

*قسم الإنتاج النباتى- كلية الزراعة سابا باشا- جامعة الإسكندرية.

**محطة بحوث إيتاى البارود- معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية.

قيمت ثلاثة أصناف من قمح الخبز (سدس 12 ، جميزة 9 ،سخا 94) تحت ثلاث معاملت رى (رى كامل ،حرمان رية فى مرحلة النمو الخضرى ، حرمان رية فى رحلة المو الثمرى) وذلك تحت ثلاث متويات من التسميد البوتاسى (صفر كجم K2O / فدان ، 24 كجم K2O / فدان ، 48 كجم K2O / فدان) خلال موسمى 2009/2008 ، 2010/2009 فى محطة إيتاى البارود للبحوث الزراعية - مركز البحوث الزراعية.

الرى الكامل أعطى أعلى محصول حبوب ومحصول قش. اما منع الرى فى أى مرحلة من مراحل النمو سبب إنخفاض فى محصول الحبوب والقش خاصة عند منع الرى فى مرحلة النمو الخضرى التى إدى منعها الى إنخفاض كبير فى المحصول. كانت الإختلافات معنوية بين معاملت الرى فى كل الصفات ادروسة عدا دليل الحصاد التى كانت فيها الإختلافات غير معنوية فى الموسمين. كانت الإختلافات بين الأصناف معنوية فى كل الصفات المدروسة فى الموسمين. كان الصنف جميزة 9 الأعلى فى محصول الحبول وأعلى عدد سنابل/م2، بينما أعطى سدس 12 أعلى عد حبوب/السنبلة وأعلى وزن لل 1000 حبة.

كان التأثير المعنوى للتسميد البوتاسى محدو نسبياً وظهر فى بعض الصفات مثل محول الحبوب للفدان، محصول القش للفدان، عدد السنابل/م2، عدد السنابل/م2 .... الخ ولكن الزيادة فى الصفات المدروسة والتى ترجع للتسميد البوتاسى مع منع الرى كانت طفيفة ويمكن إرجاع ذلك لغنى الأرض الطينية والتى أقيمت فيها التجربة بالبوتاسيوم.

مما تقدم فإنه ينصح باتباع الرى العادى وهو خمسة ريات لجميع الأصناف تحت الدراسة وعدم إستخدام التسميد البوتاسى لمساعدة النبات فى تحمل العطش فى الأرض الطينية حيث أنها غنية أساساً بالبوتاسيوم. وعموماً فق إختلفت إستجابة الأصناف لمعاملات منع الريات والتسميد البوتاسى لذلك فإن نتائج هذة الدراسة تؤكد على أهمية إختيار الصنف المناسب للمعاملات والمنطقة المنزرع فيا المحصول.