INFLUENCE OF POTASSIUM FERTILIZATION AND IRRIGATION NUMBER ON POTASSIUM UPTAKE AND YIELD OF TWO WHEAT CULTIVARS

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ABSTRACT

Two field experiments were conducted in the experimental Farm of Sids Agricultural Research Station, Agricultural Research Center during two successiv seasons 2004/2005 and 2005/2006. Objective of this work was to investigate the response of two what cultivars namely Sids 1 (bread wheat) and Beni Suef 1 (durm wheat) to potassium fertilization at the rates zero, 24, 48 and 72 kg K2O/fed and irrigation treatments includ six irrigations, five irrigations (withholding one irrigation at heading stage) and four irrigations (withholding two irrigations at boating and milking stages).

Data obtained showed that Beni Suef 1 surpassed Sids 1 varieties in grains and straw yields by about 5.3 and 6.2% in both seasons, while both K concentration and uptake were not affected by wheat varieties.

Increasing irrigation numbers and potassium fertilization levels up to 72 kg K_2O/fed significantly increased both grains and straw yields as well as K total uptake by grains and straw, however K-concentration was not affected by irrigation treatments

When one irrigation was omitted, wheat plants fertilized 72 kg K_2O/fed gave grains and straw yields very closed to those that watered six irrigations and received 48 kg K_2O/fed.

Key words: Irrigation numbers, Potassium fertilization, Wheat cultivars, Grain and Straw yields, Potassium uptake.

INTRODUCTION

The food gap, caused by the over growing population will ever exist and widen unless efforts are made to overcome it. In Egypt, wheat is the most contributing crop to this food gap, where imports amounted to more than 4 million tons in the season 2005 which satisfied about 30% of consumption. The strategy of the ministry of agriculture nowadays aimed to reach a 100% self sufficiency from wheat after adding 20% from corn flour.

The use of the yielding wheat cultivars is the most important way to increase the per unit area productivity. Wheat cultivars differs in yield (**Mahmoud and Ismail, 1997; Morsy *et al*, 1999; El-Aggory, Eglal *et al;* 2000; Hassan and Gaballa, 2000 and Shahin *et al*, 2002).**

The provision of irrigation water and its economic use is considered of importance in semi arid and arid regions for increasing agricultural production by means of intensification where more than one crop can be raised on the same land every year, in addition to the horizontal expansion of cultivated land. On the other hand, plants vary in the timing of their need for water, as timing depends on how much moisture stress they are able to tolerate at any particular stage of growth. If water supply is acutely inadequate, care should be taken at least to provide water at the critical stages of growth. Therefore, the knowledge of the sensitive stages to water deficit by plants is very important for judicious water management. Literature dealing with irrigation of wheat crop in Egypt are numerous such as **Seif El-Yazal *et al.*, (1984), Haggy *et al*. (1993), Khattab (1994), Dhanda and Sethi (2002), Shahin *et al.* (2002) and Morgan (2005).**

Potassium fertilization is gaining progressive consideration in Egypt particularly after construction of the High Dam in 1964 and the deposition of Nile silt (the main source of K enrichment in soil) in the upstream of the formed lake. The favourable effects of K fertilization on wheat production and nutrient contents were reported by **Kamh *et al* (1991), Shehate *et al* (1991), Yu-Zhenwen *et al* (1996), El-Sherbieny *et al* (1999), El-Aggory, Eglal *et al* (2000) and Gebraiel *et al* (2005).** Moreover, the main important role of K in plant growth is its influence on water use efficiency. The process of opening and closing of stomata is regulated by K concentration in cells which surround the stomata. A shortage of K cause the stomata to open only partially and to be slower in closing. This increases the stress from drought.Severl investigators observed the influence of K fertilization on water use efficiency (**Shehata *et al.*, 1990 and Ahmed, Salwa *et al.*, 1997).**

The objective of this study was to find out the effect of K fertilization rate and irrigation numbers on the grain and straw yields of two wheat cultivars and their uptake of potassium.

MATERIALS AND METHODS

Two field experiments were conducted during the two successive seasons (2004/2005 and 2005/2006) at Sids Agricultural Research Station to study the effect of K fertilization on different wheat cultivars. Some physical and chemical properties of the experimental soils under study are given in **Table (1).** Soil analysis were carried out according to **Jackson (1962),** except particle size distribution which determind according to **Klute (1982).**

Two wheat cultivars, i.e. Beni Suef 1 and Sids 1 were planted in rows on November 22th and 25th in the first ad second seasons, respectively and harvested in May. Potassium applications were added prior to sowing as K_2SO_4 48% K_2O (0, 24, 48 and 72 K_2O/fed.).

Irrigation treatments were as follows:

1. Six irrigations, the first at planting, the second at tillering, the third at shooting, the fourth at booting, the fifth at heading and the sixth at milk stage.
2. Five irrigations, the same as one, except withholding irrigation at heading stage.
3. Four irrigations, the same as one, except withholding irrigation at booting and milking stages.

Treatments were arranged in spilt–spilt design, where irrigation treatments were allocated in the main plots and wheat varieties were arranged in sub plots. Potassium applications were randomly distributed in the sub-sub plots. All other cultural practices were applied as recommended for wheat production in the area. Samples of grains and straw were taken for K analysis as described by **Chapman and Pratt (1961).** All collected data were statistically analyzed according to the procedure described by **Snedcor and Cochran (1980).**

Table 1. Some physical and chemical properties of the experimental Soil.

Soil properties	First season	Second season
Particle size distribution		
Sand%	23.9	20.8
Silt%	24.9	26.9
Clay%	51.2	52.3
Texture grade	Clay	Clay
pH(1:2.5 soil water suspension)	8.1	8.1
EC (dSm^{-1} at 25 ^{O}C in soil paste)	0.61	0.73
$CaCO_3$%	0.65	0.83
Organic matter%	1.4	1.2
Available N ugg^{-1} (extracted by 2 N KCl)	31	35
Available P ugg^{-1} (extracted by0.5 N $NaHCO_3$ at $_{P}H$ 8.5)	18	20
Available K ugg^{-1} (extracted by NH_4OAc	120	106

RESULTS AND DISCUSSION

Grain and straw yields

Table (2) shows the averages of grain yield in ardab/fed and straw yield in ton/fed as affected by irrigation numbers, K fertilization and wheat varieties for the two seasons. Data show that the highest values of both grains and straw yield were obtained when wheat plants received six irrigations in two growing seasons. The 5 and 4 irrigations treatment resulted in decreases in grain yield by about 7.4 and 22.3%, respectively as compared with plants receivied six irrigation in the first season. The same trend was obtained for grain yield in the second season and for straw yield in the two seasons. This decrease in grains and straw yield caused by decreasing irrigation numbers is most probably due to the role of water in physiological processes in plant. These results are in line with those obtained by **Seif El-Yazal *et al,* (1984), Shahin *et al* (2002) and Morgan (2005).**

As for potassium fertilization, it is appeared from data given in Table (2) that both grains and straw yields were significantly affected by potassium fertilization, where increasing the application rate from 0 up to 72kg K_2O/fed tended to increase grains and straw yields. The increasing percentage for grains yield in the first season reached about 6.7, 13.1 and 18.1% due to the application of 24, 48 and 72kg K_2O/fed as compared with the control, respectively. The same trend was obtained in the second season, the corresponding increases were 8.1, 14.8 and 19.9%. Also, straw yield had the same trend, thus it could be concluded that the increase of both grains and straw yields were positively assisted with increasing potassium fertilization levels. This increase was probably due to the role of potassium in several important metabolic activities associated with photosynthesis, respiration, chlorophyll development and water content of leaves. It promotes also protein development which is very important in all cereal plants **(Roy *et al,* 1981)**. These results are in accordance with those of **El-Sherbieny and Shahin *et al*. (2002).**

Table 2

Concerning wheat varieties, the obtained data reveal that wheat varieties significantly differ in grains yield, where Beni Suef 1 surpassed Sids 1 by about 5.3 and 6.2% in both seasons, respectively. These results are in line with those obtained by **Mahmoud and Ismail (1997), Hassan and Gaballa (2002) and Shahin *et al,* (2002).** On the other hand straw yield did not affect by wheat variety in the two seasons.

Regarding the interactions between treatments, data clearly show that, only grain yield was affected by all possible interactions between the three studied variables. It is worthy to mention that wheat plants received the highest potassium level, i.e. 72 kg K_2O/fed and irrigated five times produced grain yield somewhat equal to plants irrigated with six irrigations and fertilized with 48 or 72 kg K_2O/fed. The enhancement of potassium application on the water use efficiency may be due to its role in regulating the opening and closing plant stomata as mentioned before. In general, the highest grain yield was obtained by Beni-Suef variety plants which were received 6 irrigations and fertilized with 48 kgK_2O/fed, or those received 5 irrigation and supplied with 72 kg K_2O/fed. Similar results were obtained by **Shehate *et al* (1990)** who reported that the high rate of K application has positive effect on the efficiecny of water use for different crops.

Potassium concentration in wheat grains and straw:

The influence of irrigation numbers, potassium fertilization levels and wheat varieties on K concentrations in both grains and straw is presented in **Table (3).** The obtained data clearly show that only potassium fertilization levels had significant effect on K contents of both wheat grains and straw, while no definite trends were observed for irrigation treatments or wheat varieties with respect to potassium contents in both grains and straw.

Apparently, K in grains or straw increased with increasing K fertilizer level in both growing seasons. Increments in K percentage in grains in the first season were 8.1, 21 and 33.9 due to the applcation of 24, 48 and 72 kgK_2O/fed, respectively. The same trends were obtained for grain contents in the second season as well as in straw in the two seasons. These increases due to increasing K level may be explained by luxury absorption phenomena of potassium by plant. Similar results were obtained by **Kamh *et al* (1991).** On the other hand, data reveal that K content in grains or straw were not significantly affected by the interactions between the three studied variables in both seasons.

Potassium total uptake by wheat plants:

Tables (4 and 5) show the effect of irrigation treatments, potassium fertilization and wheat varieties on potassium uptake by grains and straw as well as the total uptake (grains + straw uptake) for wheat plant. As for irrigation numbers, it could be noticed that increasing irrigation numbers up to six increased grains and/or straw uptake in both seasons, but the difference between K uptake by grains and/or straw due to irrigation with six and five irrigations was not significant in both growing seasons. Results showed that withholding one irrigation (at heading stage) or two irrigations (at booting and milking stages) decreased total potassium uptake by 3.5 and 23.8%, respectively as compared with the treatment (six irrigations) in the first season. The corresponding values for the second season were 6.8 and 22.2%, respectively. The same trends were obtained for both potassium uptake in grains and straw in the two growing seasons. The increment of potassium

Table 3

Table 4

uptake caused by increasing irrigation numbers could be attributed to its effect on both grains and straw yields, since potassium uptake was calculated as the product of multiplying potassium concentration by grain or straw yields.

Table (5): Total K uptake as affected by irrigation number and Potassium fertilization for two wheat varieties.

Number of irrigation	K2O (kg/fed)	Wheat					
		First season			Second season		
		Beni –Suef 1	Sids1	Mean	Beni –Suef 1	Sids1	Mean
6	0	130.6	120.6	125.6	116.3	109.6	113.0
	24	151.7	143.2	147.5	142.3	142.1	142.2
	48	172.6	166.2	169.4	156.6	166.3	161.5
	72	188.3	201.5	194.5	174.1	188.0	181.1
Mean		**160.8**	**157.9**	**159.4**	**147.3**	**151.5**	**149.4**
5	0	119.6	113.6	116.6	101.6	99.5	100.6
	24	146.2	153.6	149.9	117.2	130.3	123.8
	48	143.6	167.7	155.7	147.7	157.6	152.7
	72	185.2	200.1	192.7	181.2	178.8	180.0
Mean		**148.7**	**158.8**	**153.8**	**136.9**	**141.6**	**139.3**
4	0	81.6	85.8	83.7	74.6	77.6	76.1
	24	105.2	114.4	109.8	94.1	100.1	97.1
	48	123.1	132.6	127.9	118.3	133.2	125.8
	72	156.7	171.7	164.2	166.1	165.5	165.8
Mean		**116.7**	**126.1**	**121.4**	**113.3**	**119.1**	**116.2**
Mean of K2O	0	110.6	106.7	108.7	97.5	95.6	96.6
	24	134.4	137.1	135.8	117.9	124.2	121.1
	48	146.4	155.5	151.0	140.9	152.4	146.7
	72	176.7	191.1	183.9	173.8	177.4	175.6
Mean of varieties		**142.0**	**147.6**	**144.8**	**132.5**	**137.4**	**135.0**
L.S.D at 0.05							
A (Irrigation)		**13.315**			**11.907**		
B (K2O)		**12.088**			**8.643**		
C (Varieties)		**N.S**			**N.S**		
AXB		**23.193**			**14.971**		
AXC		**N.S**			**N.S**		
BXC		**N.S**			**N.S**		
AXBXC		**NS**			**N.S**		

With regard to potassium fertilization, the above mentioned results indicated that K uptake by grains and/or straw of wheat plants significantly increased due to increasing potassium fertilizer levels up to 72 kg K_2O/fed. The relative increases in total K uptake by wheat plants received 24, 48 and 72 kg K_2O/fed were 24.9, 38.9 and 69.6% over the control, respectively in the first season. The same trends were obtained for the second season and for K uptake by grains or straw in the two growing seasons. The enhancement of increasing potassium fertilizer levels on K uptake by wheat plants could be explained on basis of its effect on both grains and straw yields (Table, 2) and on K-concentration in grains and straw (Table, 3). These results are in harmony with those obtained by **El-Sherbieny *et al* (1999) and El-Aggory, Eglal *et al* (2000).**

As for the interactions between the three studied variables, the obtained data show that K-uptake by grains and/or straw was affected only by the interaction between irrigation treatments and potassium fertilization levels. It is worthy to mention that the deffirence between K-uptake by grains and/or straw for plants receivad six irrigations and fertilized with 72 kg K_2O/fed, and the plants having 5 irrigations with omitting on irrigation at heading stage was not significant in both seasons. The highest values of of K-uptake by grains and/or straw were obtained for wheat plants watered six or five times and supplied with 72 kg K_2O/fed.

These results togther with those of grain and straw yields (Table, 2) may emphasize the possibility of irrigating wheat crop only 5 irrigations with a rate of 72 kg K_2O/fed, instead of 6 irrigations with 48 kg K_2O/fed. This could save one irrigation / fed under similar conditions of the studied clay soil.

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مصطفى على مرسى ، على احمد عمران ومصطفى محمد فؤاد
معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية

اجريت تجربتان حقليتان بالمزرعة البحثية بمحطة البحوث الزراعية بسدس مركز البحوث الزراعية خلال موسمي الزراعة ٢٠٠٤/٢٠٠٥ و ٢٠٠٥/٢٠٠٦ لدراسة مدي استجابة محصول الحبوب والقش وامتصاص البوتاسيوم في الحبوب والقش لصنفي قمح (سدس ١ ممثل لقمح الخبز وبني سويف ١ ممثل لقمح المكرونة) للتسميد البوتاسي (صفر و ٢٤ و ٤٨ و ٧٢ كجم بو٢أ/فدان) وعدد الريات وهي ست ريات وخمس ريات مع ايقاف رية عند مرحلة طرد السنابل و٤ ريات مع ايقاف ريتين عند مرحلة الحبلان ومرحلة الطور اللبني.

وأوضحت النتائج تفوق صنف القمح بني سويف ١ عن سدس ١ فى المحصول الناتج بحوالي ٥.٣ و٦.٢% في موسمي النمو، بينما لم يتاثر كلا من تركيز وامتصاص البوتاسيوم باختلاف الصنف.

كما آدت زيادة الريات ومستويات التسميد البوتاسي إلي زيادة معنوية في كل من محصول الحبوب والقش والامتصاص الكلى للبوتاسيوم في الحبوب والقش أما تركيز البوتاسيوم في الحبوب والقش فلم يتاثرمعنويا بعدد الريات.

ولقد لوحظ أن نباتات القمح التي رويت خمس ريات فقط مع إيقاف رية عند مرحلة طرد السنابل وسمدت بمعدل ٧٢ كجم بو٢أ/فدان أعطت محصولا مساويا لتلك التي رويت ٦ مرات وسمدت بمعدل ٤٨ كجم بو٢أ//فدان.

وقد استنتج من النتائج انه يمكن بزيادة التسميد البوتاسي إلى ٧٢ كجم بو٢ا توفير رية كاملة لمحصول القمح المنزرع تحت ظروف مشابهة لظروف التربة الطينية المستخدمة في هذه التجربة.