IRRIGATION INTERVALS AND POTASSIUM FERTILIZATION IN RELATION TO SORGHUM PRODUCTION IN FAYOUM CALCAREOUS SOIL

EL-BASIONI, S. M., H. M. HASSAN AND R. A. DRAR

Soils, Water and Environment Res. Inst., ARC, Giza

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Abstract

A field experiment was conducted during the summer season 2008 in the calcareous soil of Kom Oshim Farm, Fayoum Governorate to investigate the effect of irrigation intervals (2- or 3-week) and applied K levels (0, 24, 48 and 72 kg K_2O/fed) in a split plot design on sorghum grain yield (cv. Dorado), 100 grain weight and grain content of N, P and K. Also, available K in soil was determined after harvest. The obtained results could be summarized as follows:

* The 2-week irrigation interval had a significant positive effect on grain yield than that of 3-week one. For K application treatments, there was a significant difference in grain yield compared with control treatment. The irrigation intervals or applied K levels had no significant effect on 100 grain weight. The interaction between irrigation intervals and applied K levels has no significant effect on grain yield and 100 grain weight.

* Increasing applied K increased K content of sorghum grains and available K in soil after harvest while the irrigation intervals being with no effect. The values of N and P % in grains were almost the same for both studied variables.

INTRODUCTION

Grain sorghum (*Sorghum bicolor L. Moench*) is considered as the fourth important cereal crop after wheat, rice and maize; in the world. In Egypt, sorghum is widely cultivated in about 400 thousand feddans. Most of these areas are found in Fayoum, Assiut and Sohag Governortaes. It is one of the most adapted summer cereal crops to adverse conditions of water shortage, salinity and low soil fertility. Ahmed and Salem (2005) pointed out that watering and K fertilization are the important factors affecting sorghum growth, yield and their components. They added that exposing sorghum to stresses of soil moisture and K availability at any phase of its life cycle might lead to detrimental effects on growth, yield and yield components. Moreover, this problem is so clear during summer especially at the tail end of irrigation canals. Consequently, selecting the appropriate hybrids, soils and managing irrigation water for sorghum are the main issues under Egyptian conditions.

Many researchers studied the effect of irrigation regime on grain sorghum. Ahmed (1998) showed that significant reduction in some growth characters and yield of grain sorghum were recorded by skipping one irrigation at the various growth stages, however a sharp decrease was observed by skipping the 4th irrigation, i.e. at tasseling and silking stage. Similar results were obtained by Ahmed and Mekki (2005) on maize and Ahmed and Salem (2005) on grain sorghum.

The role of K in crop production has been documented by several authers as a drought tolerant of crop, which its production can improved with high K levels due to its effect on the morphological, biochemical and biophysical features. Potassium also reduces transpiration losses in crop plants; making its use beneficial particularly under dry weather conditions (Jensen and Taphoj, (1985); Saxena, (1985) and Andersen *et al.*, (1994).

The present study was conducted to evaluate the effect of irrigation intervals and K application on grain sorghum yield, 100 grain weight and some nutrients status in Fayoum calcareous soil.

MATERIALS AND METHODS

A field experiment was carried out in the summer season 2008 in Kom Oshim Farm, Fayoum Governorate, to investigate the effect of irrigation intervals and K levels on grain sorghum (*Sorghum biclor L. Moench*) cv. Dorado. Representative soil samples (0-30 and 30- 60 cm) were taken before cultivation to determine soil physical, chemical and nutritional properties according to Page *et al.* (1982) as shown in Table 1. The plots, 3 X 3.5 m^2 each, were prepared for sorghum planting in a split plot design with 4 replicates which included 8 treatments as follows: Two irrigation interval treatments (2-week and 3-week intervals) for the main plots. Four K levels (0, 24, 48 and 72 kg K_2O/fed as K_2SO_4 48 % K_2O as K_0, K_1, K_2 and K_3) in sub-plots.

After thinning, the main and sub-treatments were applied where K treatments were added in 3 doses; the first after thinning, followed by the second after two weeks, then the third one before flowering. Phosphorus and nitrogen were added at the rates of 15.5 kg P_2O_5/fed as superphosphate (15.5 % P_2O_5) and 100 kg N/fed as ammonium nitrate (33.5 % N). The P fertilizer was added before planting whereas N was added in 2 doses; the first after thinning and the second two weeks later. All agricultural practices were performed as recommended in such location; surface irrigation was used, where equal amounts of water per each irrigation were applied to every plot.

At harvest, heads of plants in each plot were cut, air dried, then grain yield (ardab/fed) and 100 grain weight (g) were recorded. Oven dried grain samples were

analyzed for N, P and K content. After harvest available K in the soil depth 0 - 30 cm was determined as described by Chapman and Pratt (1961). Data were statistically analyzed according to Snedecor and Cochran (1980).

Table 1. Analyses of the experimental soil samples.

a- Physical analysis (%)

Depth (cm)	Sand		Silt	Clay	$CaCO_3$	OM	TSS	Textural class
	Coarse	Fine						
0 - 30	7.51	42.70	22.85	26.94	12.31	1.08	0.09	Sandy clay loam
30-60	5.01	40.83	25.43	28.73	12.96	0.85	0.11	Clay loam

b- Chemical analysis

Depth (cm)	SP %	EC dS/m	Cmolc/kg soil in saturation extract								pH 1:2.5 soil water susp.	CEC Cmolc / Kg soil
			$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	Ca^{++}	Mg^{++}	Na	K^+		
0 – 30	50.2	2.82	-	0.61	0.77	0.45	0.57	0.42	0.80	0.04	7.74	21.93
30-60	56.1	3.11	-	0.63	0.76	0.81	0.62	0.51	1.01	0.04	7.66	22.01

C – Nutritional status

Depth (cm)	Total N %	Available (mg/kg)	
		P	K
0 – 30	0.04	8.01	220
30-60	0.03	7.78	195

RESULTS AND DISCUSSION

1- Grain yield and 100 grain weight as affected by irrigation intervals and K levels:

a- Effect of irrigation intervals:

Table 2 shows that the mean of sorghum grain yield (12.57 ardab/fed) obtained with the 2-week irrigation interval is significantly higher compared with the mean of the 3-week irrigation interval (11.64 ardab/fed). This result is in agreement with those reported by Abdel-Rehim *et al.* (1991) who stated that amount of sorghum grain yield increased significantly along with the irrigation every two weeks as compared to irrigation every three weeks. Ahmed (1998) pointed out that a significant reduction in growth characters and sorghum grain yield were recorded by skipping some irrigations at various growth stages.

Regarding the 100 grain weight, there is no significant difference between the values of 2-week irrigation interval and that of 3-week irrigation interval (Table 2).

Table 2. Effect of various treatments on sorghum grain yield (ardab/fed) and hundred grain weight (g).

Irrigation treatments / K level treatments	Irrigation interval				Mean	
	2-week		3-week			
	Grain yield	100 grain weight	Grain yield	100 grain weight	Grain yield	100 grain weight
K_0	11.16	2.62	10.16	2.80	10.66	2.71
K_1	12.23	3.22	11.47	3.26	11.85	3.24
K_2	13.14	3.32	12.15	3.20	12.65	3.26
K_3	13.76	3.15	12.78	3.26	13.27	3.21
Mean	12.57	3.08	11.64	3.13		

LSD at 0.05 for:

	Grain yield	100 grain weight
Irrigation	0.30	NS
Potassium	0.24	NS
Interaction	NS	NS

b- Effect of K fertilization:

It is obvious from Table 2 that increasing K levels up to 72 kg K_2O/fed increased sorghum grain yield significantly. The percentage increase reached 11.16, 18.67 and 24.48 compared to control (K_0) as a result of applying K_1, K_2 and K_3 levels, respectively. Furthermore, the percentage increase as compared to the recommended dose (K_1) was 6.75 and 11.98 for K_2 and K_3 levels, respectively. The increase in grain yield may be due to the stimulative effect of potassium on vegetative growth and reproductive organs. Moreover, Bala (1987) mentioned that drought tolerance of crops should be improved with higher K level because of its effect on morphological, biochemical and biophysical features of crop adaptation to water stress.

Regarding the 100 grain weight means, it is observed that it increased slightly due to K fertilizer addition up to 48 kg K_2O/fed (K_2 level). Similar findings were obtained by Ahmed and Mekki (2005) on maize.

c- Interaction effect :

Regarding the interaction between treatments, there are no significant differences in case of grain yield or 100 grain yield (Table 2). The highest value in grain yield was recorded in 2-week irrigation interval and K_3 level followed by 3-week irrigation interval and K_3 level, while in 100 grain weight the highest value was found in 2-week irrigation interval and K_2 level, followed by 3-week irrigation interval with K_1 level treatment.

As for grain yield, it was noticed that the interaction effect of irrigation every 2 weeks with K levels gave a relative increase; equals 7.5 % as a general mean, than that of irrigation every 2 weeks with K levels, taking into consideration that no significance was obtained between interaction treatments as mentioned before.

2- Effect of various treatments on N, P and K contents of sorghum grains and available K in soil after harvest:

Concerning irrigation intervals, all nutrient means were nearly the same indicating no effect of irrigation on N, P and K contents (Table 3). As for K fertilization, the mean values of N and P %, were somehow close, but K mean values rised from 0.51% (K_0) to 0.75 % (K_3). The highest K value of interaction was appeared in 3-week irrigation interval and K_3 level treatment; this could be due to the high K application to such calcareous soil; causing considerable K concentration in soil as shown in Table 3. In this concern, Fernandez and Struchtmeyer (1982), Usherwood (1987). El-Sedfy *et al.* (2003) and El-Sedfy *et al.* (2008) stated that the highest K in plant and available K in soil were associated with higher K fertilizer dose added to the soil.

Table. 3 Effect of various treatments on N, P and K (%) of sorghum grains and available K in soil (mg/Kg) after harvest at 0-30 cm depth.

Irrigation treatments / K level treatments.	Irrigation interval							
	2-week				3-week			
	grains			Soil	grains			Soil
	N	P	K	K	N	P	K	K
K_0	1.88	0.13	0.50	205	1.89	0.11	0.52	213
K_1	1.92	0.14	0.62	210	1.90	0.13	0.62	235
K_2	1.95	0.14	0.68	277	1.93	0.15	0.70	265
K_3	1.97	0.15	0.74	302	1.96	0.15	0.76	310

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علاقة فترات الري والتسميد البوتاسي بإنتاج الذرة الرفيعة في أرض جيرية بالفيوم

صبري محمود البسيوني، حسين مصطفى حسن ، رشاد عبد المنعم درار

معهد بحوث الأراضي والمياه والبيئة، مركز البحوث الزراعية، الجيزة، مصر

أقيمت تجربة حقلية في تصميم قطع منشقة خلال الموسم الصيفي ٢٠٠٨ بمزرعة كوم أوشيم بالفيوم، لدراسة تاثير فترات الري (أسبوعين أو ثلاثة أسابيع) مع التسميد البوتاسي (صفر، ٢٤، ٤٨، ٧٢ كجم بو٢أ/فدان) على إنتاج محصول حبوب الذرة الرفيعة (صنف دورادو)، وزن ١٠٠ حبة ومحتوى الحبوب من ن ، فو ، بو، وكذلك البوتاسيوم الميسر في التربة بعد الحصاد.

هذا ويمكن تلخيص النتائج فيما يلي :

١- تأثر محصول حبوب الذرة الرفيعة إيجابيا ومعنوياً عند الري كل أسبوعين بالمقارنة بالري كل ٣ أسابيع مع نقص المحصول في الفترة الأخيرة. كان تأثير إضافة معاملات البوتاسيوم على المحصول معنوياً قياساً بمعاملة المقارنة، ولم يكن التأثير معنوياً بمقارنة المعاملات ببعضها. لم يوجد فرق معنوي لمعاملات الري أو إضافة السماد البوتاسي بالنسبة لوزن ١٠٠ حبة.

لم يكن للتأثير المتبادل بين عاملي الري والبوتاسيوم أي فروق معنوية على محصول الحبوب أو وزن ١٠٠ حبة.

٢- أوضحت الدراسة أن زيادة التسميد البوتاسي صاحبه زيادة في محتوى الحبوب من البوتاسيوم وكذلك المحتوى المتبقي من البوتاسيوم الميسر في التربة بعد الحصاد.

وفي المقابل لم يكن لفترات الري أي تأثير على البوتاسيوم في الحبوب أو البوتاسيوم الميسر في التربة.

وبينت الدراسة أن النسبة المئوية لأي من النتروجين أو الفوسفور في حبوب الذرة الرفيعة كانت متقاربة في كلا عاملي الري والتسميد.