YIELD OF SOME CEREAL CROPS AS AFFECTED BY IRRIGATION INTERVAL AND FERTILIZATION IN FAYOUM CALCAREOUS SOIL

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(Manuscript received 22 March 2006)

Abstract

The present investigation was carried out at Kom Oshim Farm, Agric. Res. Station, Fayoum governorate during the two successive seasons 2002 and 2003 to evaluate the effect of two irrigation intervals (2 and 3 weeks), farmyard manure, (0, 10 and 20 FYM ton/fed) and nitrogen fertilizer (0, 50 and 100 kg N/fed) added to the soil in a split-split plot design on grain yield, protein and carbohydrate contents of sorghum (cv. Giza 15) and wheat (cv. Sakha 69). The obtained results could be summarized in the following:

- The irrigation intervals had a positive significant effect on wheat grain yield, but it was insignificant concerning sorghum. Protein and carbohydrate % in grains for both the two crops were markedly decreased using 3 weeks interval.
- Applying FYM up to 20 ton/fed or nitrogen fertilizer up to 100 kg N/fed had a positive effect on grain yield, also the increase of protein % or total carbohydrate % was found in these fertilization levels for the two crops.
- The present study showed that the second and the third interactions (irrigation interval, FYM and N application) were significant in the case of grain yield in both the two crops and the treatment of 20 FYM ton/fed, 100 kg N/fed and two weeks irrigation interval was the highest in grain yield and yield components of protein and carbohydrate for the two crops.

INTRODUCTION

Cereals constitute the most important group of field crops in Egyptian agriculture, where wheat, maize and sorghum are used for bread making. According to the relationship between production and consumption, the volume of wheat imports has tremendously increased especially with the rise in population. On this basis, many studies were directed to tackle the issue of raising cereal productivity by improving the agricultural practices such as irrigation intervals and fertilization.

Olufayo *et al.* (1997) reported that number of sorghum panicles/unit area at booting stage and grain weight at maturity were greatly influenced by water regime.

Irrigating sorghum at two weeks interval increased significantly its plant growth and grain yield as found by Abdel Rehim *et al.* (1991). However, increasing irrigation interval resulted in lowering sorghum grain yield (Khade *et al.*, 1989). In case of wheat, the findings of Metwally *et al.* (1984) revealed that applying irrigation at 50% depletion of available soil moisture was a suitable regime for wheat.

With respect to fertilization, nitrogen application increased sorghum yield (Ferri *et al.*, 1997). However, the application of both farmyard manure and nitrogen increased significantly sorghum yield as found by Goudreddy *et al.* (1989). Also, Makawi (1982), Vidyorthy and Nisra (1982) and Mahmoud *et al.* (1984) reported that the addition of organic manures encourages proliferation of soil microorganisms, also dehydrogenase and urease activity, organic carbon and availability of macro and micronutrients as well as increasing dry matter and grain yields of wheat crop.

The aim of this study is to quantify the effect of irrigating wheat and sorghum plants at different intervals in a calcareous soil of Fayoum governorate to find out the promising irrigation treatment that fit the prevailing conditions. Also, application of nitrogen and farmyard manure were considered in this study as suitable agricultural practices in encountering water shortage effect on cereal production.

MATERIALS AND METHODS

Two field experiments were conducted at Kom Oshim Res. Farm, ARC, Fayoum governorate during 2002 and 2003 seasons to evaluate the effect of applying different levels of nitrogen and farmyard manure in conjunction with irrigation at different intervals on the yield, total carbohydrate and crude protein of wheat and sorghum. Surface irrigation system was used in this, where equal amounts of water were applied per each irrigation to every plot. A split-split plot design with four replicates was used. The following were the treatments:

1- The main treatments comprise two irrigation intervals,

a- Two weeks interval (common use).

b- Three weeks interval (water regime)

2- The sub-treatments: three levels of farmyard manure, (0, 10 and 20 ton/fed).

3- The sub-sub treatments: three levels of nitrogen,(0, 50 and 100 kg N/fed) added as ammonium nitrate 33.5% N.

Sorghum (*Sorghum bicolor* L. *Moench*) cv. Giza 15 followed by wheat (*Triticum vulgare*) cv. Sakha 69 were used in this study, 15 kg P_2O_5 and 24 kg K_2O/fed were applied to every plot and mixed with soil surface before planting. Leveled plots of 3 x 3.5 m each was used.

At harvest, sorghum and wheat grain yields were recorded, grain samples were taken for determining crude protein and total carbohydrate contents as described by AOAC (1970) and Magnetski *et al.* (1959).

Some soil properties of the two experiments in addition to some farmyard manure properties are presented in Table 1 (a & b) (Page *et al.*, 1982). Analysis of variance was carried out according to Snedecor and Cochran (1980).

Table 1-a. Some properties of the experimental soil.

Crop	Soil particle %			%		Text. class	EC (dS/m)	pH (1:2.5)	me/100 g soil		T.N* %	Avail. (ppm)	
	Clay	Silt	Sand	$CaCO_3$	OM				CEC	ESP		P	K
Sorghum	38.50	16.00	45.50	13.50	1.05	S. clay	6.38	8.01	31.35	8.58	0.10	8.11	401.31
Wheat	41.00	13.15	45.85	11.47	1.22	S. clay	8.70	8.25	33.28	10.95	0.12	6.31	380.50

Table 1-b. Some properties of the used farmyard manure.

Moisture %	OM %	TN %*	C/N ratio	TP %**	TK %***
9.35	30.60	0.53	29.14	0.31	2.04

*TN : Total N. **TP : Total P. ***TK : Total K.

RESULTS AND DISCUSSION

I- Grain yield as affected by water regime and fertilization:

A- Sorghum grain yield:

The obtained data (Table 2) revealed that sorghum grain yield was mostly not affected by irrigation treatments where an insignificant decrease of 4.41% existed as a result of widening irrigation intervals from two up to three weeks (water regime). This slight decrease may be attributed to the tolerance of sorghum to water stress.

On the other hand, a significant increase in sorghum grain yield was observed along with the application of farmyard manure or N fertilizer, also with increasing their levels.

Table 2. Sorghum grain yield as affected by irrigation intervals, FYM and N fertilizer (ardab/fed).

Fertilizer Levels (kg N/fed)	Irrigation intervals					
	Two weeks			Three weeks		
	Farmyard manure levels			Farmyard manure levels		
	None	10 ton/fed	20 ton/fed	None	10 ton/fed	20 ton/fed
None	6.89	7.20	7.63	6.44	7.15	7.27
50	7.04	7.68	8.59	7.16	7.46	7.92
100	7.50	7.90	8.93	7.17	7.61	8.15

LSD at 0.05 for:

1- Irrigation	= NS	Interaction 1X 2	= NS
2- FYM	= 0.19	Interaction 1X 3	= 0.07
3- N fertilizer	= 0.05	Interaction 2X 3	= 0.08
		Interaction 1X 2X 3	= 0.12

The highest value of sorghum grain yield was found in case of 2 weeks irrigation interval + 20 ton FYM/fed + 100 kg N/fed where this significant increase reached 29.61 % over that of plots receiving neither FYM nor N fertilizer using 2 weeks

interval. It can be observed from the previous results that the negative effect of water regime on sorghum grain yield can be compensated by adding FYM and /or N fertilizer. The positive effect of FYM may be due to its impact on increasing soil water retention and improving soil physico-chemical properties and nutritional status. Increasing the distribution of plant root systems as a result of water regime led to increasing the surface area of nutrient uptake which results in better plant growth and grain yield, these minimize the negative effect of widening irrigation interval.

The significant interaction between irrigation intervals and nitrogen applied denotes that nitrogen application counteracts the negative effect of widening irrigation intervals on sorghum grain yield. Moreover, increasing applied nitrogen results in improving the effect of FYM on grain yield. Also, the significant effect of the interaction between all the studied factors on sorghum is so obvious in increasing its yield by increasing applied nitrogen levels and short irrigation interval in addition to nitrogen positive effect on improving FYM effect. These results are in line with those obtained by Abdel Rehim *et al.* (1991), Ferri *et al.* (1997) and Olufayo *et al.* (1997).

Accordingly, using the trend of such results could help in overcoming the prevailing conditions of water shortage in Fayoum governorate.

B- Wheat grain yield

The impact of irrigation treatments in case of wheat is more pronounced compared with sorghum. As shown in Table 3, it is obvious that increasing irrigation intervals from two up to three weeks had resulted in a significant decrease in wheat grain yield which amounted to 13.75 %. On the other hand, a significant increase in wheat grain yield was observed as a result of applying either FYM or N fertilizer up to 20 ton FYM/fed or 100 kg N/fed.

The positive effect of FYM or N fertilizer was noticed in case of either long or short irrigation interval. From the same table, it can be observed that the reduction in wheat grain yield as a result of widening irrigation intervals can be compensated by adding 20 ton FYM/fed or 100 kg N/fed.

Table 3. Wheat grain yield as affected by irrigation intervals, FYM and N fertilizer (ardab/fed).

Fertilizer Levels (kg N/fed)	Irrigation intervals					
	Two weeks			Three weeks		
	Farmyard manure levels			Farmyard manure levels		
	None	10 ton/fed	20 ton/fed	None	10 ton/fed	20 ton/fed
None	6.02	6.62	7.83	4.70	6.14	6.40
50	6.87	8.58	9.62	5.90	7.17	8.54
100	7.53	9.47	11.42	6.75	8.46	9.72

LSD at 0.05 for:

1- Irrigation	= 0.73	Interaction 1X 2	= NS
2- FYM	= 0.61	Interaction 1X 3	= 0.75
3- N fertilizer	= 0.53	Interaction 2X 3	= 0.91
		Interaction 1X 2X 3	= 1.29

The statistical analysis of wheat yield values as affected by the interactions between the studied factors reveal that all the calculated interactions follow the same trend existing in case of sorghum such as the effectiveness of nitrogen application on wheat yield irrigation at wide interval. Also, the improving effect of applied FYM using nitrogen, and finally the significant impact of all the studied factors on grain yield was decided.

As mentioned in the case of sorghum grain yield, the highest values of wheat grain yield existed from the plots receiving 20 ton FYM + 100 kg N/fed using 2 weeks irrigation interval where the increase reached 89.70 % over the control. These results are in agreement with those found by Makawi (1982), Vidyorthy and Nisra (1982), Mahmoud *et al.* (1984) and Metwally *et al.* (1984).

II- Grain content of protein and carbohydrate as affected by irrigation intervals and fertilization:

A- Protein content:

Data of sorghum grain content of protein shown in Table 4 (A) revealed that widening irrigation intervals from two up to three weeks ended with an obvious decrease in protein values. These values tended to increase along with increasing levels of farmyard manure. The increase in protein values was more clear in case of adding and increasing N fertilizer levels. The improving effect of farmyard manure and N fertilizer was more in case of water regime than in recommended irrigation interval comparing with the control in each case.

Table 4. Protein content of sorghum and wheat grains (%).

A. Sorghum

Fertilizer levels (kg N/fed)	Irrigation intervals					
	Two weeks			Three weeks		
	Farmyard manure levels			Farmyard manure levels		
	None	10 ton/fed	20 ton/fed	None	10 ton/fed	20 ton/fed
None	8.10	8.25	8.25	7.39	7.49	7.54
50	8.05	8.41	8.25	7.23	7.95	8.35
100	8.66	8.66	8.76	7.59	8.00	8.35

B. Wheat

Fertilizer levels (kg N/fed)	Irrigation intervals					
	Two weeks			Three weeks		
	Farmyard manure levels			Farmyard manure levels		
	None	10 ton/fed	20 ton/fed	None	10 ton/fed	20 ton/fed
None	10.44	10.81	10.88	9.94	10.44	11.13
50	10.50	10.75	11.31	9.75	10.50	11.00
100	11.06	11.31	11.81	10.50	10.88	11.50

The protein values of wheat grains Table 4 (B) followed the same trend of sorghum grains as affected by water regime, farmyard manure and N fertilization.

B- Carbohydrate content

Data of Table 5 (A) revealed that using water regime was accompanied by an obvious reduction in carbohydrate content of sorghum grains. A trend of increase in carbohydrate values was observed as a result of applying and increasing the levels of FYM. The increase in carbohydrate values was more clear by adding and increasing the levels of N fertilizer. As for carbohydrate content of wheat grains (Table 5 (B), the effect of water regime, FYM and N fertilizer was similar to that of the carbohydrate content of sorghum grains. The positive effect of FYM may be due to increasing soil water retention and also the contribution of organic matter in improving physico-chemical properties and nutritional status of soil (Hesham *et al.*, 1997).

The positive effect of N fertilizer in this respect could be attributed to being an important constituent of amino acids, protein and protoplasts which directly influences plant growth and development through better utilization of photosynthesis. Similar results were reported by Fayed *et al.* (1981).

To conclude, it is apparent that applying agricultural practices such as water regime, FYM and nitrogen fertilizer could help in improving cereal productivity in areas suffering from water shortage.

Table 5. Carbohydrate content of sorghum and wheat grains (%).

A. Sorghum

Fertilizer levels (kg N/fed)	Irrigation intervals					
	Two weeks			Three weeks		
	Farmyard manure levels			Farmyard manure levels		
	None	10 ton/fed	20 ton/fed	None	10 ton/fed	20 ton/fed
None	73.71	74.01	74.00	72.71	73.11	72.81
50	74.11	74.50	75.81	72.58	72.81	73.01
100	74.25	75.00	75.00	73.55	72.58	73.17

B. Wheat

Fertilizer levels (kg N/fed)	Irrigation intervals					
	Two weeks			Three weeks		
	Farmyard manure levels			Farmyard manure levels		
	None	10 ton/fed	20 ton/fed	None	10 ton/fed	20 ton/fed
None	69.80	70.30	70.70	67.21	68.71	69.21
50	69.27	72.51	71.37	67.52	68.80	71.51
100	71.81	72.01	72.80	69.72	70.82	70.93

From the abovementioned results, it could be concluded that the treatment having 20 ton/fed FYM+100 kg N/fed under 2 weeks irrigation was the highest in grain yield and yield components of protein and carbohydrate for the two crops.

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تأثير فترات الرى ومعدلات التسميد على إنتاجية بعض المحاصيل النجيلية فى أرض جيرية بالفيوم

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أقيمت تجربتان حقليتان فى قطع منشقة مرتين خلال موسمين متعاقبين (٢٠٠٢-٢٠٠٣) بالمزرعة البحثية بكوم أوشيم بمحطة البحوث الزراعية – الفيوم لدراسة تاثير فترات الرى (كل اسبوعين أو ثلاث لأسابيع) مع التسميد العضوى (صفر، ١٠ ، ٢٠ طن/ف) والنيتروجينى (صفر، ٥٠ ، ١٠٠ كجم ن/ف) على انتاجية محصول حبوب الذرة الرفيعة والقمح ومكوناتها من المحتوى البروتينى والكربوهيدراتى ويمكن تلخيص النتائج كما يلى:

- تأثر إيجابياً ومعنويا محصول حبوب القمح بالزيادة عند الرى كل أسبوعين بالمقارنة بالرى كل ثلاثة أسابيع، ولكن كان التأثير غير معنوى فى حالة محصول الذرة الرفيعة . تقل النسبة المئوية للبروتينات والكربوهيدرات فى حبوب القمح والذرة الرفيعة عند الرى كل ثلاثة أسابيع بالمقارنة بالرى كل أسبوعين.
- إضافة السماد العضوى عند مستوى ٢٠ طن/ف أو التسميد النيتروجينى عند مستوى ١٠٠ كجم/ف كان له اكبر الأثر فى زيادة محصول حبوب القمح والسورجم معنوياً وكانت هناك أيضاً زيادة فى محتوى الحبوب من البروتين والكربوهيدرات لكلا المحصولين عند نفس مستوى التسميد.
- أوضحت الدراسة أن التأثير المتبادل (الثنائى والثلاثى) بين الرى والتسميد العضوى والمعدنى كان له أكبر الأثر معنوياً بالزيادة فى محصول حبوب القمح والذرة الرفيعة وكانت المعاملة ٢٠ طن/ف سماد عضوى + ١٠٠ كجم ن/ف سماد نيتروجينى والرى كل أسبوعين أعلى المعاملات إنتاجاً للحبوب ومكوناتها من البروتين والكربوهيدرات فى كلا المحصولين.
- يوصى باستخدام هذه المعاملة المذكورة سابقا تحت ظروف التجربة، مع عمل دراسة مستقبلية لتحليل التكاليف حتى يمكن الحكم على أفضل المعاملات إقتصاديا.