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Original Research Article

Influence of irrigation regime and farmyard manure on faba bean yield productivity at reclaimed high terrace soil in Sudan

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Abstract

A field trial was carried out for three consecutive seasons (2004-2005, 2005-2006 and 2006-2007) to study the increase of faba bean productivity and improve soil properties by using farm yard manure and irrigation regimes on reclaimed high terrace soils (Aridisols). The experiment consists of three irrigation regimes, which are (after 7, 14 and 21 days), and application of 0.0 and 10 ton/ha farmyard manure (FYM). Superphosphate at a rate of {½ P=20 kg P/Fed) was applied to all treatments at sowing. One faba bean variety was used namely SM-L. The experiment was replicate four times in split-plot design with main plot allotted to FYM treatments and subplot to irrigation regime. Data on grain yield and biomass show that there were significant differences in grain yield between the two FYM levels effects. The irrigation regime also significantly affected grain yield. As expected the addition of FYM to the soils improved grain yield in all irrigated periods compare to without manure (0 FYM), and also in 7 days irrigated were higher than in 14 and 21 irrigated periods. The reduction of faba bean grain yield from 14 to 7 days and from 21 to 7 irrigated days ranges about 5% and 35% for 0 ton/ha FYM treatments, and about 19% and 57% for 10 ton/ha FYM treatments, respectively. However, addition of 10 ton/ha FYM (M1) at irrigation every 7 days interval was significantly higher than in 14 and 21 irrigated days regimes. It can be concluded that the highest faba bean yield was observed in to use 10 ton/ha FYM with irrigation period (every 7 days interval) in the soil reclamation of saline soils and to improved crop productivity.

Key Words: Faba bean, Farmyard manure, Grain Yield, Irrigation regimes, Salt-affected Soils

INTRODUCTION

Soil salinity is an important growth limiting factor for most halophytic plants. Salinity is one of the major environmental stresses that drastically affect crop productivity (Epstein et al., 1980), especially in arid and semi-arid regions (Speer et al., 1994). It is usually very difficult to reclaim these soils and to improve crop production. Salt-affected soils are those on which plant growth is limited by excess of salt content, they are of three types: (i) saline soils (ii) sodic soils and (iii) saline-sodic soils. Salt-affected soils are most common in aridic moisture regimes, and secondary salinization (due to anthropogenic activities such as irrigation) may occur by improper management of irrigation. Crop yields are drastically affected due to lack of availability of water, nutrients and oxygen in the root zone. The magnitude of yield reduction depends on the crop, soil type and management.

Soil salinity and sodicity is one of the main abiotic constraints that affects faba bean and other legumes production in the high terrace soils of Northern State (of

Sudan). High terrace soils consist of a number of soil series with different limitations for sustainable agriculture. Other main limiting factors in this sector of land are very poor chemical fertility, sodicity, salinity and some physical limitations. Northern state has favorable climatic environment and consequently high yield. The national need for more faba bean production necessitated the expansion of faba bean production in salt affected soils. The proper use of these soils requires appropriate soil and water management. From the share of the Nile water Sudan is limited because of the large expansion of irrigated agriculture in the arid and semi arid region, thus there is need to economize on water use by increasing it efficiency.

There is great need to increase our production by expansion through reclaimed areas which represent a hope of cultivated lands. The use of natural organic manure and biofertilizers are recommended by several investigators to substitute the chemical fertilizers as they improve physical and chemical properties of soil and they are the way of clean agriculture with minimum pollution effects and reduce agriculture cost (El-Akabawy, 2000).

Dongola Research Station Farm (DRSF) lies on salt affected soils which are targeted site for agricultural expansion in the Northern State. There has never been any soil reclamation program but continued use of the site for field experimentation has resulted into sustainably improved crop performance which could be attributed to soils having been denied excessive salinity. Thus their being describe as reclaimed high terrace soils. The objective of this experiment was to increase the crop productivity and improve soil properties by using farmyard manure and irrigation regimes in reclaimed high terrace soil of Northern State.

MATERIALS AND METHODS

The experiment was carried out on a high terrace soils (Aridisols) at Dongola Research Station Farm, Dongola, Sudan (19^{o} 10, N and 30^{o} 29, E) during 2004-2005, 2005-2006 and 2006-2007 cropping seasons. Although the research farm soils were salt affected and no soil reclamation program was undertaken, continued use of the farm fields for experimentation has resulted into improved crop performance and decrease in salinity levels over time. Currently, these farm soils are considered as reclaimed or partly reclaimed high terrace soils.

The experiment was conducted on these soils. Sirelkhatim (2001) reported that the initial average EC was 7.5 dS/m for the upper depth (30 cm) and 8.5 dS/m for the lower two depths (30-60 and 60-90 cm). Mean SAR values were 14.2, 14.7 and 15.4 for the three respective depths. Some selected physio-chemical characteristics of the reclaimed soil are represented in Table 1.

The experiment consists of three irrigation regimes, which are (after 7, 14 and 21 days), and application of 10 and 0.0 ton/ha farmyard manure (FYM). Superphosphate at a rate of {½ P=20 kg P/Fed) was applied to all treatments at sowing. One faba bean variety was used namely SM-L. The experiment was replicate four times in split-plot design with main plot allotted to FYM treatments and subplot to irrigation regime. Size of subplot was 7 rows, 60 cm width and 7 meters long. Data were recorded for grain yield, biomass, 100 seed weight, number of pods/plant and plant height.

The data were analyzed using the MSTAT statistical package. Combined analyses of variance were carried for the all data and means were tested for significant difference by Duncan's new multiple range test.

RESULT AND DISCUSSION

Table 2 show that there were significant differences in plant height between the two FYM levels. The irrigation regime also significantly affected plant height. Interaction was non-significant among the two FYM levels and the three irrigation regimes. In general, FYM treatment observed higher plant height than in treatments without manure. Plant height decreased, with increasing irrigation days from 7 days to 21 days. Maximum plant height (78.1 cm) was recorded when FYM level was 10 ton/ha, while minimum plant height (72.2 cm) was recorded in the control (0 FYM ton/ha). The plant height for SM-L variety of the irrigation periods showed that irrigation every 7 days had maximum plant height (81.3 cm) while irrigation every 21 days had the minimum plant height (71.6 cm). The interaction between FYM and the irrigation regimes was found to be non-significant. However, maximum plant height (85.3 cm) was recorded for 10 ton/ha FYM when irrigated every 7 days, while 0 ton/ha also had minimum plant height (69.5 cm) with 21days irrigated period was applied.

Hundred grain weights is an important yield parameter. Table 3 data show that there were no significant differences in 100 seed weight between 0 FYM and 10 FYM under a same irrigation regime. The irrigation regime also non-significantly affected 100 seed weight. Interaction was non-significant among the two FYM levels and the three irrigation regimes. In general Plants irrigated every 7 days observed higher results compare to 14 and 21 irrigated days. This might be due to crop water requirements or to the decreased of salinity by leaching due to irrigation every 7 days than irrigating every 14 days or 21 days.

The total dry matter produced by a plant as the result of photosynthesis and nutrients uptake, minus that lost by respiration is called biological yield (Shah, 1994). Table 4 shows the biological yield of faba bean as affected by FYM and irrigation regimes. The combined data show that there were significant differences in biological yield

Table 1. Some physio-chemical properties of the soil in the Dongola research station farm.

Parameters	Depth (cm)			
	0-25	**25-50**	**50-75**	**75-100**
pH (paste)	7.94	7.89	7.90	8.0
EC (dS/m)	0.96	0.85	0.96	1.06
$CaCO_3$ %	2.96	2.51	2.90	2.53
SAR	1.19	1.21	2.16	3.18
ESP (%)	0.55	0.40	1.60	3.05
Clay (%)	27	28	35	36
Silt (%)	22	25	24	22
Sand (%)	51	47	41	43

Table 2. Effect of farmyard manure and irrigation regime on plant height (cm) of faba bean (average of three seasons, 2005 to 2007).

Cultivars	Irrigation period (day)			FYM main effect
	7	14	21	
		2005		
0 FYM	63.5	54.5	54.1	57.3
10 FYM	66.4	53.4	53.03	57.6
Irrigation days main effect	64.93	53.93	53.54	57.5
Significance:	FYM: *	ID: NS	FYMxID: NS	
	FYM = 1.98,	ID = 2.67,	FYM x ID = 3.43, CV%= 21.18	
		2006		
0 FYM	97.3	86.5	94.8	92.9
10 FYM	106.4	87.1	90.6	94.7
Irrigation days main effect	101.9	86.8	92.7	93.8
Significance:	FYM: **	ID: NS	FYMxID: NS	
	FYM = 1.52,	ID = 1.38,	FYM x ID = 2.63, CV%= 5.61	
		2007		
0 FYM	71.1	68.2	59.7	66.3
10 FYM	83.0	84.8	77.5	81.8
Irrigation days main effect	77.03	76.48	68.60	74.1
Significance:	FYM: **	ID: **	FYMxID: NS	
	FYM = 2.42,	ID = 1.35,	FYM x ID = 4.19, CV%= 11.32	
		Combined		
0 FYM	77.3	69.7	69.5	**72.2**
10 FYM	85.3	75.1	73.7	**78.1**
Irrigation days main effect	81.3	72.4	71.6	
Significance:	FYM: ***	ID: ***	FYMxID: NS	
	FYM = 1.16,	ID = 1.10,	FYM x ID = 2.01, CV%= 9.25	

FYM=Farmyard manure, ID=Irrigation days, N.S. = non significant at Probability level.
** *, **, * = significant at P < 0.001, 0.01 and 0.05 respectively.

Table 3. Effect of farmyard manure and irrigation regime on 100 seed wt yield (g) of faba bean (average of three seasons, 2005 to 2007).

Cultivars	Irrigation period (day)			FYM main effect
	7	14	21	
		2005		
0 FYM	48.31	47.83	44.58	46.91
10 FYM	50.14	50.39	41.68	47.40
Irrigation days main effect	49.22	49.11	43.13	47.15
Significance:	FYM: * ID: ** FYMxID: NS			
	FYM = 0.48, ID = 0.86, FYM x ID = 0.83, CV%= 3.53			
		2006		
0 FYM	69.25	68.50	70.43	69.39
10 FYM	69.45	70.93	69.53	69.97
Irrigation days main effect	69.35	69.71	69.98	69.70
Significance:	FYM: NS ID: * FYMxID: NS			
	FYM = 0.80, ID = 1.8, FYM x ID = 1.38, CV%= 3.97			
		2007		
0 FYM	53.08	60.63	62.59	58.77
10 FYM	64.77	60.50	59.05	61.44
Irrigation days main effect	58.93	60.57	60.82	60.10
Significance:	FYM: NS ID: NS FYMxID: NS			
	FYM = 2.82, ID = 4.19, FYM x ID = 4.89, CV%= 16.26			
		Combined		
0 FYM	56.88	58.98	59.20	**58.35**
10 FYM	61.45	60.61	56.75	**59.60**
Irrigation days main effect	59.17	59.80	57.80	
Significance:	FYM: NS ID: NS FYMxID: NS			
	FYM = 0.99, ID = 1.55, FYM x ID = 1.72, CV%= 10.08			

FYM=Farmyard manure, ID=Irrigation days, N.S. = non significant at Probability level.
** *, **, * = significant at P < 0.001, 0.01 and 0.05 respectively.

Table 4. Effect of farmyard manure and irrigation regime on biological yield (ton/ha) of faba bean (average of three seasons, 2005 to 2007).

Cultivars	Irrigation period (day)			FYM main effect
	7	14	21	
		2005		
0 FYM	2.24	2.14	1.76	2.05
10 FYM	2.99	1.97	2.20	2.38
Irrigation days main effect	2.62	2.06	1.98	2.22
Significance:	FYM: NS ID: NS FYMxID: NS			
	FYM = 0.14, ID = 0.18, FYM x ID = 0.23, CV%= 21.18			
		2006		
0 FYM	4.38	3.57	4.03	3.99

Table 4. Continue

10 FYM	5.38	3.45	3.44	4.09
Irrigation days main effect	4.88	3.51	3.73	4.04
Significance:	FYM: NS	ID: NS	FYMxID: NS	
	FYM = 0.15,	ID = 0.25,	FYM x ID = 0.25, CV%= 15.58	
		2007		
0 FYM	2.87	2.42	1.77	2.36
10 FYM	3.59	3.17	2.37	3.04
Irrigation days main effect	3.23	2.80	2.07	2.70
Significance:	FYM: ***	ID: **	FYMxID: NS	
	FYM = 0.14,	ID = 0.07,	FYM x ID = 0.24, CV%= 26.8	
		Combined		
0 FYM	3.16	2.71	2.52	**2.80**
10 FYM	3.99	2.86	2.67	**3.17**
Irrigation days main effect	3.58	2.79	2.60	
Significance:	FYM: ***	ID: ***	FYMxID: *	
	FYM = 0.11,	ID = 0.08,	FYM x ID = 0.14, CV%= 16.3	

FYM=Farmyard manure, ID=Irrigation days, N.S. = non-significant at Probability level.
* *, **, * = significant at P < 0.001, 0.01 and 0.05 respectively.

Table 5. Effect of farmyard manure and irrigation regime on grain yield (ton/ha) of faba bean (average of three seasons, 2005 to 2007).

Cultivars	**Irrigation period (day)**			FYM main effect
	7	14	21	
		2005		
0 FYM	1.37	1.22	0.85	1.15
10 FYM	2.01	1.19	0.91	1.37
Irrigation days main effect	1.69	1.21	0.88	1.26
Significance:	FYM: NS	ID: NS	FYMxID: NS	
	FYM = 0.09,	ID = 0.11,	FYM x ID = 0.16, CV%= 25.5	
		2006		
0 FYM	0.98	0.96	0.95	0.96
10 FYM	1.15	1.0	0.59	0.91
Irrigation days main effect	1.07	0.98	0.77	0.94
Significance:	FYM: NS	ID: NS	FYMxID: NS	
	FYM = 0.09,	ID = 0.13,	FYM x ID = 0.13, CV%= 28.6	
		2007		
0 FYM	1.80	1.76	1.28	1.61
10 FYM	2.88	2.89	2.35	2.71
Irrigation days main effect	2.34	2.32	1.28	2.16
Significance:	FYM: ***	ID: ***	FYMxID: NS	

Table 5. Continue

	FYM = 0.17, ID = 0.06, FYM x ID = 0.29, CV%= 26.8			
	Combined			
0 FYM	1.38	1.31	1.02	**1.24**
10 FYM	2.01	1.69	1.28	**1.66**
Irrigation days main effect	1.70	1.50	1.15	
Significance:	FYM: ***	ID: ***	FYMxID: NS	
	FYM = 0.07, ID = 0.06, FYM x ID = 0.12, CV%= 28.4			

FYM=Farmyard manure, ID=Irrigation days, N.S. = non significant at Probability level.
** *, **, * = significant at P < 0.001, 0.01 and 0.05 respectively.

between the two FYM levels. The irrigation regime also significantly affected biological yield. Interaction was also significantly affected the biological yield among the two FYM levels and the three irrigation regimes. As expected the addition of FYM to the soils improved biological yield in all irrigated periods compare to without manure (0 FYM), and also in 7 days irrigated were higher than in 14 and 21 irrigated periods. Maximum biological yield (3.17 ton/ha) was recorded when FYM level was 10 ton/ha, while minimum biological yield (2.80 ton/ha) was recorded in the control (0 FYM ton/ha). The biological yield for SM-L variety of the irrigation periods showed that irrigation every 7 days had maximum biological yield (3.58 ton/ha) while irrigation every 21 days had the minimum biological yield (2.60 ton/ha). The interaction between FYM and the irrigation regimes was found to be significant. However, maximum biological yield (3.99 ton/ha) was recorded for 10 ton/ha FYM when irrigated every 7 days, while 0 ton/ha also had minimum biological yield (2.52 ton/ha) with 21days irrigated period was applied. The two FYM levels and the three irrigation regimes interacted significantly. To improve the vegetative growth and productivity of crops without pollution of the environment, a number of alternative technologies are needed to apply. Organic fertilization is a very important technique in this respect. Significant attentions have been paid to both growers and agricultural authorities to replace manufactured chemical fertilizers by another naturally organic fertilizer which appear to be safety for environment and correct the soil fertility (David, 2002). The effects of organic fertilizers on vegetative growth, yield and chemical contents of crops were investigated by many authors. Our results agree with those obtained by Tawfiek and Gamal (2000) on Balady mandarin trees and Hammam *et al.,* (2003) on Williams banana plants, found that organic fertilizers (green, farmyard manure (FYM) and cattle manure) produced significant increases in growth characters and leaf mineral contents These results can be explained on the base that FYM contains high amount of available nutrients and may improve physical and chemical properties of the soil which appear to enhance plant growth and hence increases the yield. Table 5 combined analysis data on grain yield show that there were significant differences in grain yield between the two FYM levels effects. The irrigation regime also significantly affected grain yield. Interaction was non-significant affected the grain yield among the two FYM levels and the three irrigation regimes. As expected the addition of FYM to the soils improved grain yield in all irrigated periods compare to without manure (0 FYM), and also in 7 days irrigated were higher than in 14 and 21 irrigated periods. Nadjafi and Rezvani Moghaddam (2002), reported that irrigation interval of 7 days have a significant higher seed yield in compare with 14, 21 and 28 days irrigation intervals, in Plantago ovata. They showed that irrigation intervals of 28 days significantly decreased the number of seeds per spike and number of spike per plant. Research (Ertek et al., 2004), showed that in irrigation intervals of 5 days fruit yield of Cucrbito pepo is higher than 10 days irrigation interval. Fertilizer (FYM) application enhances the grain yield of faba bean cultivar. The results in table 5 reveal that FYM application significantly increased the grain yield over that of the control. Faba bean grain yield resulting from application of 0 to 10 ton/ha FYM differing insignificantly from each other could be attributed to the low soil organic matter content and also due to the improvement of soil physical properties.

The reduction of faba bean grain yield from 14 to 7 days and from 21 to 7 irrigated days ranges about 5% and 35% for 0 ton/ha FYM treatments, and about 19% and 57% for 10 ton/ha FYM treatments, respectively. However, data from Table 5 observed that addition of 10 ton/ha FYM at irrigation every 7 days interval was significantly higher than in 14 and 21 irrigated days interval. So the results showed that the highest faba bean yield was observed in to use 10 ton/ha FYM with irrigation period (every 7 days interval) in the soil reclamation of saline soils and to improved crop productivity.

CONCLUSION

The addition of 10 ton/ha FYM at irrigation every 7 days interval was significantly higher than in 14 and 21 irrigated days interval.

The highest faba bean yield was observed in to use 10 ton/ha FYM with irrigation period every 7 days in the soil reclamation of saline soils.

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