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Effect of Three Types of Organic Manures on the Grain Yield of Wheat in Khashm Elgirba Soil Series, Sudan

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ABSTRACT

This study was conducted during seasons 1998/1999 and 1999/2000 at a farm adjacent to New Halfa town to assess the effect of farm yard manure (FYM), filtermud (FM) and bagasse (B) on yield of wheat. Each manure was applied to soil surface at a rate of 0, 15, 30, 45, 60 and 75 t ha^{-1} in a randomized complete block design (RCBD) with four replications. Each manure was incorporated into the soil using hand tools. The results of nitrogen (N) and phosphorus (P) uptake (kg ha^{-1}) revealed that wheat plants withdrew higher amounts of N from the soil treated with FYM as compared to those treated with either FM of B. The amounts of P withdrawn by the wheat plants from the soil treated by the three sources of organic manures at all levels of application were very low and ranged from 1.85 to 6.67 kg P $ha^{-1.}$ The present study also showed that increasing rates of application of each of the tested manures resulted in highly significant increases in grain yield. These organic manures can be ranked according to their effectiveness in increasing the yield of wheat as follows: FYM > FM>B. The economic evaluation of the study indicated that only the lowest level of application (15 t ha^{-1}) of FYM and FM gave positive net benefits albeit lower than those reported for the control. However, net losses from the higher rates of application of each of F YM and FM and of all rates of the B were obtained. This was presumably due to high cost of both transportation and application of these bulky organic manures.

INTRODUCTION

The northern part of the central clay plain of Sudan, where the present work was undertaken (1 5^0 N and 36^0 E) is part of the semi-

arid region and its soils are inherently low in organic matter (0.2-0.3%) and nitrogen) (%0.03-0.02)(Blokhuis, 1993). These low values are attributed to the combined effect of low production of organic matter and its high rate of decomposition. Therefore, it is deemed as imperative that irrigated agriculture in this part of the clay plain be supplied with nitrogen fertilizers. Khashm Elgirba soil lies within this part of the Sudan and is characterized by relatively high bulk density and low infiltration rate, which presumably affects soil productivity. The general cultural practice to ameliorate the insufficiency of soil nitrogen necessary for the production of cotton and wheat in this soil is to apply about 80 kg N ha^{-1} in the form of urea. The relatively poor responses of the applied fertilizers make it justifiable to think of the addition of organic manures in order to improve the physical and chemical properties of this soil, and thus probably increase its productivity (Ali, 1998).

The present study was carried out to assess the effect of FYM, FM and B on the grain yield of wheat in Khashm Elgirba soil series under the prevailing climatic conditions at New Halfa.

MATERIALS AND METHODS

The experiment was carried out in a farm adjacent to New Halfa town (15^0 N and 36^0E) during November 1998-April 1999 and November 1999-April 2000. The soil of Khashm Elgirba series is calcareous، alkaline in reaction (pH ≅ ⋯8.3), nonsaline, nonsodic, and moderately fertile. It comprises about 75% of the total area under the rotation of the scheme of New Halfa Agricultural Corporation. The soil is classified as Typic Haplusterts, very fine, smectitic, isohyperthermic (Soil Survey Staff 1999). The organic manures that were applied included FYM, FM and B (Table l), each of which was surface applied at a rate of 0, 15, 30، ،45,60 and 75 t ha^{-l} two weeks before sowing of wheat (*Triticum aestivum* variety Condor) as a test crop. These applied manures were incorporated into the soil using hand tools. Land preparation and all other cultural practices followed were those adopted for wheat in the scheme of New Halfa Agricultural Corporation. The experimental units were plots of 6x7m.

A randomized complete block design (RCBD) with four replications was used in the study.

Table 1. Chemical composition of the studied organic manures.

Organic manure	Total potassium	Organic carbon	Total nitrogen	Total phosphorus
	----------%		----------	
FYM	0.35	23.2	2.1	0.48
FM	0.47	18.9	1.4	.0.94A
B	0.52	25.7	1.2	0.20

Sources: Ali (2001). In addition, the FM has the following composition : 2.1% Ca; 0.3% Mg; 1800 mg Mn kg^{-1}, 50 mg Cu kg^{-l}; 3500 mg Fe kg^{-l} and 350 mg Zn kg^{-l} (Cooper and Abuidris, 1980).

Plant uptake of N and P were determined from plant samples at booting stage, following the procedure of plant analysis by Jackson (1958) Excluding the marginal 50 cm from each side of any experimental unit, the remaining areas (5 x 6m) were harvested to obtain the grain yield (kg ha^{-l}) of wheat for the different treatments.

The economic evaluation comprised the data on the effect of organic manures on the grain yield of wheat under the climatic conditions of New Halfa in the two seasons. Net benefits resulting from applying each of the tested organic manures at different rates were compared. Partial budgets were constructed for wheat in the two seasons. Costs of different treatments were calculated from prevailing prices of these organic manures in addition to costs of their transportation to the field and application.

Analysis of variance (ANOVA) and test of significance were done and the means were separated according to Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1960; Ott, 1977).

RESULTS AND DISCUSSION

a) The uptake of N and P by wheat plant

The results of N and P uptake by wheat were expressed in kilograms of nutrient per hectare (kg ha-l). They indicated a general trend of increase of N uptake by wheat plants with increasing rates of application of each of the three tested organic manures for season

1999/2000 (Table 2) These results revealed that the amount of N absorbed by wheat from F YM at different rates was higher than that of the corresponding rates of' either FM or B treatments. This was presumably so because the FYM contained slightly higher percentage (2.1%) of N compared to those of either FM (l .4%) or B (1.2%) (Table 1). This result suggested the superior The superiority of FYM over FM or B in supplying N to the soil. The uptake of P by the wheat from each of the three tested manures at all rates of application were relatively very low and ranged from 1.85 to 6.67kg P ha^{-l}. In this connection, Campbell (1978) stated that high yields of wheat were obtained when the crop absorbed about 95 kg N ha^{-l}; 30 kg P ha^{-l}; and 65 kg K ha^{-l}. Based on this information, it can be stated that Khashm Elgirba soil seriessuffers a serious deficiency in phosphorus. This is substantiated by calcareousness and alkalinity of the soil (pH 8.3). The present data generally showed the inconsistency of increments in the amounts of P uptake by wheat with increasing rates of application of each of the organic manures. It was also observed that P uptake at any specific rate of application, FM treatments were superior followed by those of the FYM and finally those of the B. This result suggests that both FM and FYM are similar in their ability to supply P to growing wheat. The relatively high values of uptake of P for the FM treatments were presumably understandable because the FM contained the highest amounts of P (9400 mg P kg^{-l}) compared to that of either F YM (4800 mg P kg^{-l}) or that of B (2000 mg P kg^{-l}). It is pertinent to mention that this high value of P in the FM was a result of the addition of phosphoric acid to the sugar juice to facilitate precipitation of mud cane ash and salts.

b) Grain yield of wheat

The results showed a noticeable increase in the grain yield of wheat (kg ha^{-l}) with increasing rates of application of each of the tested manures up to 45 t ha^{-l}, thereafter the yield invariably declined (Table 3). This result suggests that the 45 t ha-l dose was probably the adequate dose for each of the studied manures. This observed increase in grain yield could be attributed to either that the manures improved

the availability or added some of the essential plant nutrients and/or substantially improved thee physical conditions of the soil. The results showed a highly significant difference (P≤0.0I) between the grain yields of each of the two seasons, those of the sources of manures, those of the levels of application, and that of the interaction between the source and the level of application. The results also showed that at any specific rate of application of each of the manures the average grain yields for season 1999/2000 were higher than those of their corresponding counterparts for season 1998/1999. The differences in grain yield between the seasons might be attributed to differences of the prevalent environmental conditions of the two seasons (Table 4).

Table 2. N and P uptake (kg ha^{-l}) by the wheat at the booting stage (season 1999/2000).

	%		(kg/ha-l)	
Treatment	Plant N	Plant P	N plant uptake	P plant uptake
Control	0.42	0.067	12.04	1.92
15t ha^{-l} FYM	O. 84	0.092	32.48	3.56
30 " "	I .40	0.097	60.78	4.21
" "	I .40	0.130	71.79	6.67
" "	I .96	0.135	70.25	4.84
" "	2.10	0.115	70.54	3.86
15t ha^{-1} B	0.42	0.070	11.12	1.85
30	0.70	0.076	21.20	2.30
45	0.70	0.092	27.33	3.59
60	0.84	0.084	28.67	2.87
75	0.70	0.070	22.79	2.28
15t ha^{-l} FYM	0.42	0.118	14.92	4.19
30	0.70	0.125	17.94	5.34
45	0.84	o. 123	27.94	4.85
60	0.70	0.150	34.47	6.16
75	0.42	0.148	27.62	5.84

Each figure was an average of four readings.

Table 3. Grain yield (kg/ha) of wheat as influenced by FYM،FM and B.

		Levels(t/ha)						Mean
Season	Source	0	15	30	45	60	75	
1999/1998	FYM	1105	1282	1372	1457	1200	1235	1275a
	B	1 130	1145	1227	1265	1192	1217	1196c
	FM	1047	1200	1295	1342	1237	1240	1227b
1999/2000	FYM	1202	1355	1465	1557	1365	1392	1389a
	B	1262	1247	1320	1362	1189	1252	1272c
	FM	1175	1287	1395	1450	1272	1310	1315b
	Mean	1153d	1252c	1345b	1405a	1242c	1274c	

Means followed by the same letter(s) within each column are not significantly different According to DMRT.

The studied manures can be ranked according to their effectiveness increasing grain yield of wheat as follows: FYM produced the highest grain yield, followed by the FM and finally the B.

Table .4 Meteorological data of New Halfa Station during the wheat wing seasons 1998/99 and 1999/2000.

		Temperature (˚C)			Relative
Season	Month	Maximum	Minimum	Mean	Humidity%
1998/1999	November	36.1	19.0	27.6	51
	December	35.3	17.5	26.4	47
	January	34.0	16.4	25.2	51
	February	40.0	20.0	30.0	41
	March	38.1	17.3	27.7	30
	November	38.2	20.4	29.3	41
	December	35.8	18.5	27.2	49
	January	34.5	16.2	25.4	46
	February	36.3	17.7	27.0	40
	March	38.5	18.5	28.5	24

Source: Ali, Z.A. (2001).

The present study revealed that wheat yields obtained in both seasons were relatively low and ranged from 1047.5 to 1557.5 kg ha^{-l}. In this regard Ibrahim (1993) reported that grain yield of wheat in

New Halfa as influenced by application of organic manures was as high as 2989 kgha^{-1}. The relatively low yields of wheat recorded in this study were partially attributed to relatively high temperatures registered for New Halfa during two growing seasons. To facilitate comparison, it was perhaps useful to state that wheat yields reported for the scheme of New Halfa Agricultural Corporation were 975.8 and 880.6 kg ha^{-1} for season1998 /1999 and 1999/2000, respectively.

Many workers in Sudan reported an increase in wheat yield in response to organic manure application (Ali, 1992; 1998; Ibrahim, 1995, Mukhtar, 1990). However, Salih *et al*. (1993) reported that application of organic manure on the soil of New Halfa did not result in a significant increase in grain yield of wheat.

c) Economic evaluation

The results of the economic evaluation of the three studied manures for season 1998/1999 indicated that the cost of treatments of each of the investigated organic manures were very high due to the cost of hauling those bulky manures to the field (Table 5). In case of F Y M, the cost of the lowest rate of application (15 t ha^{-1}) was SD49815 ha^{-1} which was approximately triple the cost of urea currently practiced in the scheme The results also showed that only the treatments receiving 15 t ha^{-1} from either FYM or FM gave positive net benefits which were still lower than that of the control, whereas doses greater than 15 t ha^{-1} gave negative net benefits. However, all rates of the B application gave negative net benefits. The results of the economic evaluation for the two seasons were almost similar and, therefore, only results of season 1998/1999 were given in Table (5). However, the economic evaluation showed that the relative increase in wheat yield as a result of increasing the rates of the tested manures did not cover the extra cost incurred in applying those increasing rates.

Table 5. Partial budget of wheat organic manure experiment(season (99/1998).

Treatment	Yield (tha)	Gross benefits (SD/ha)	Cost that vary (SD/ha)	Net benefits (SD/ha)
Control (0 t/ha)	1.105	52568.2	0	5268.2
15t/ha FYM	I .283	61036.2	49815	11221.2
30t/ha	I .373	65317.7	96060	Negative
45t/ha	1.458	69361.4	142305	Negative
60t/ha	I .200	57087.6	188550	Negative
75t/ha	I .235	58752.6	234795	Negative
Control (0 t/ha)	I .048	49856.5	0	49856.5
15t/ha FM	I .200	57087.6	33570	23517.6
30t/ha	I .295	61607.0	63570	Negative
45t/ha	I .343	63890.0	93570	Negative
60t/ha	1.238	58895.4	123570	Negative
75t/ha	I .240	58990.5	153570	Negative
Control (0 t/ha)	1.130	53757.5	0	53757.5
15t/ha B	1.145	54471.1	63570	Negative
30t/ha	I .228	58419.6	123570	Negative
45t/ha	I .265	79.8 601	183570	Negative
60t/ha	1.193	56754.6	243570	Negative
75t/ha	1.218	57943.9	303570	Negative

SD Sudanese Dinar.

In conclusion, the results of the present study generally indicated that each of the studies manures was effective in improving the general performance and yield of wheat. However, only the lower rates (15 t/ha^{-1}) from either FYM or FM gage positive net benefits but were still lower than those of the control.

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