Effects of land preparation methods, farm yard manure and nitrogen on wheat production on a high terrace soil at Addamar area (Sudan)

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ABSTRACT: This study was executed at the extension of Hudeiba Research Station farm on a high terrace soil of the River Nile in two consecutive seasons (2003/04 and 2004/05) to study the effects of land preparation methods, farm yard manure and nitrogen on wheat production. The soil is Sodic Haplocalcids, fine, mixed, hyperthermic and is correlated to Mukabrab soil series. Two land preparation methods (LPM) were made *viz*: disc ploughing and disc ploughing coupled with chiseling. To each of these land preparation methods 15 tons of farm yard manure per hectare were applied except for the control. Each LPM received three rates of nitrogen (0, 43 and 86 kg N/ha). The total number of treatments was nine. Treatments were arranged in a split plot design with four replicates. The method of land preparation was taken as the main plot whereas the different rates of nitrogen were assigned to the subplots. The results indicated highly significant increase in each of plant height, length of spike, number of seeds per spike, 1000 seed weight and grain yield of wheat when the FYM and/or nitrogen were applied, irrespective of the method of land preparation. The combined analysis gave insignificant differences in wheat grain yield between the two LPM. The treatment disc ploughing + 15 tones FYM/ha + 86 kg N/ha proved to be superior over that of disc ploughing + chiseling + 15 tones FYM/ha + 86 kg N/ha with respect to wheat production in the soil under investigation.

KEYWORDS: *Disc ploughing, chiseling, grain yield, yield components*

INTRODUCTION

Wheat can grow on a range of soil textures ranging from sandy loam to smectitic clays, but the sandy loam to clay loam textures are nevertheless preferred. Wheat is less tolerant to salinity at germination stage but at later stages of growth it becomes somewhat salt tolerant. In this respect Sys *et al.*(1) reported that no yield reduction is observed at electric conductivity (EC_e) of < 6 dS m^{-1}.

There are three major soil types in the northern part of Sudan occupying three physiographic positions: the flood plain, middle terrace and high terrace. They are respectively evaluated as highly suitable lands (S1), moderately suitable lands (S2) and marginally suitable lands (S3) for general agriculture (2). The soils that occupy the high terrace are marginal lands because of their very low fertility and other severe physical and/or chemical limitations. Farmers in the northern part of Sudan prefer to grow wheat in the first and middle terrace soils because favorable soil fertility.

The increasing population and the change of Sudanese eating habit necessitate a vital need to increase the production of wheat to cope with this increasing demand. To achieve this goal farmers tried to increase soil productivity in the first and middle terrace soils and expand horizontally on the high terrace soils which are mostly still virgin and documented

agricultural data on suitable field or tree crops are either lacking or scarce. Therefore, an intensive work on different cultural practices for wheat production on these soils is timely and probably a highly priority. Because of some adverse properties of the high terrace soils, economic wheat production is presumably perceived to be achieved through application of soil amendments.

The main objective of this study was to test the effect of two methods of land preparation (LPM), coupled with addition of farm yard manure (FYM) and three rates of nitrogen in order to furnish data on wheat production on a high terrace soil at Addamar area. Such data, if promising may be extrapolated to similar soils in the region.

MATERIALS and METHODS

The present study was carried out at the extension of Hudeiba Agricultural Research farm on a high terrace soil in two consecutive seasons (2003/04 and 2004/05). The soil is classified as Sodic Haplocalcids, fine, mixed, hyperthermic,[3] and is correlated to Mukabrab soil series. Some physical and chemical soil properties of the studied soil are presented in table 1.

Table 1. physic-chemicals Properties of the studied soil (Mukabrab soil series)

Soil depth (cm)	Mechanical Analysis				pH 1:5	ECe (dS^{-1})	Ca CO_3 (%)	CEC cmol (+)/ kg	ESP
	CS	FS	Si	C					
0-15	17	21	32	30	9.0	1.2	2.8	18	9
15-35	19	19	32	30	9.1	3.8	2.3	28	22
35-60	25	20	29	26	8.5	12.8	4.4	20	31
60-90	17	12	38	33	8.6	13.2	5.2	25	31
90-130	14	12	29	35	8.5	11.8	2.8	26	27

(Source: LWRC, 2003. Soil Survey Report No. 164)

The climate of the area is desert with summer rains and warm winter[4]. The mean air temperatures of the growing season seasons (2003/04 and 2004/05) are given in table 2.

Table 2. Mean temperature (°C) of wheat growing season for the seasons 2003/04 and 2004/05

Season	November	December	January	February	March
2003/04	28	24	21	22	23
2004/05	28	23	20	26	27

The investigated parameters were disc ploughing; disc ploughing + chiseling; FYM and nitrogen on the grain yield of wheat. It is pertinent to state that the performed disc ploughing did not result in large soil clods and hence it did not need harrowing, only leveling was done prior to chiseling. The two land preparation methods were disc ploughing alone and disc ploughing coupled with chiseling. Each of these land preparation methods received 15 tons of FYM per hectare except for the control. The three rates of nitrogen (as

urea) were 0, 43 and 86 kg N/ha. The land preparation methods, the FYM and the rates of nitrogen were combined as described below:

- Disc ploughing + 0 k N/ha.
- Disc ploughing + 43 kg N/ha.
- Disc ploughing + 86 kg N/ha.
- Disc ploughing + 15 tons FYM/ha + 0 kg N/ha.
- Disc ploughing + 15 tons FYM/ha + 43 kg N/ha.
- Disc ploughing + 15 tons FYM/ha + 86 kg N/ha.
- Disc ploughing + chiseling + 15 tons FYM/ha + 0 kg N/ha.
- Disc ploughing + chiseling + 15 tons FYM/ha + 43 kg N/ha.
- Disc ploughing + chiseling + 15 tons FYM/ha + 86 kg N/ha.

The FYM was broadcasted just before sowing, and then incorporated into the soil when ridging was performed, whereas the urea was applied three weeks after sowing at a single dose. The employed experimental design was split plot with four replications. Each of the two methods of land preparation was taken as the main plot and the rates of nitrogen were assigned to the subplots. Seeds of wheat, variety Wadi Elneil, were sown on the 30th of November each season at a rate of 120 Kg seeds/ha. The sowing method was broadcasting and then ridging. The size of the main plot was 320 m^2 (32 m X 10 m) whereas that of the subplot was 102 m^2 (10.2 m X 10 m). Each subplot consisted of 17 rows. Wheat was irrigated every ten days, i.e. receiving a total of nine irrigation rounds per season. The collected plant data included plant height (cm) at maturity, length of spike (cm), number of seeds per spike, 1000-seed weight (g) and grain yield (kg ha^{-1}). The statistical analysis of the data was carried out using MSTAT system and the ranking of the means of the different treatments of the measured plant characters was achieved using Duncan's Multiple Range Test (DMRT).

RESULTS and DISCUSSION

The results in table 3 indicated that each of the nitrogen and the LPM ± FYM had a highly significant ($P \leq 0.001$) increase in each of plant height, length of spike, number of seeds per spike, 1000 seed weight and grain yield in season 2003/04. In season (2004/05), nitrogen also had a highly significant ($p \leq 0.001$) increase in each of the measured parameters of wheat except the 1000 seed weight which was only significant ($P \leq 0.05$) when nitrogen was added. On the other hand, the LPM ± FYM in season 2004/05 significantly ($P \leq 0.05$) increased plant height length of spike and number of seeds per spike and the grain yield ($P \leq 0.001$) but did not increase the 1000 seed weight. These results are in agreement with those reported by Ibrahim[5], Elmobarak[6] and Ali[7]. This is because nitrogen is often the most deficient mineral nutrient in this soil compared to other plant nutrients, in addition to the fact that wheat is highly responsive to nitrogen fertilization. Furthermore, it has been reported that nitrogen plays a vital role in the structure of protein and it is the most important building substance from which the living material or protoplasm of every cell is made[8]. As expected the addition of the FYM resulted in a highly significant increase in the measured yield components and consequently yield of wheat. The positive impact of addition of the organic matter with respect to wheat production, in this study is an added support to the similar results obtained by Ali[9], Elaagib[10,11], and Elaagib and Dawi [12]. This is so because the addition of organic manures to the soil increases the reservoir of organic nitrogen and many other essential plant nutrients [8].

Statistical analyses of the data of the two seasons indicated highly significant ($p \leq 0.001$) differences in wheat grain yield between the control and each of the land preparation methods without nitrogen. However the differences in grain yield between the two land preparation methods were not significant (Table 4). This may be largely attributed to the beneficial effect of FYM and that shallow chiseling (28 cm) was ineffective. Similar results of the effect of land preparation method on wheat production in Sudan were reported by ICARDA[13]; and in Morocco by Marbet[14] who reported that grain yields of wheat obtained under no-tillage were equal to those obtained using a chisel plough or deep tillage. In this regard Fischer *et al.*[15] indicated that the overall yield of wheat was unaffected by tillage, although the yield of minimal tillage was significantly higher.

Table 3. Effects of cultural practices on wheat growth and yield components (2003/04 and 2004/05)

Treatment	Season 2003 / 04				Season 2004 / 05			
	PH	LS	NSS	1000-SWT	PH	LS	NSS	1000-SWT
LPM± FYM	**	***	***	***	*	*	***	NS
N	***	***	***	***	***	***	***	*

FYM = Farm yard manure, LPM± FYM = Land preparation method with or without FYM
N = Nitrogen, PH = Plant height,LS = Length of spike, NSS = # seeds/spike, 1000-SWT = 1000- seed weight
*, **, *** and NS indicate significance at 0.05, 0.01, 0.001 and not significant, respectively

Table 4. Effects of cultural practices on wheat grain yield (kg ha^{-1}), season 2003/04

LPM ± FYM	Nitrogen (kg/ha)			Mean
	0	43	86	
Disc (control)	370e	551d	699d	540
Disc + 15 tons FYM/ha	1660c	2026b	2651a	2112
Chiseling + disc ploughing +15 tons FYM/ha	1734c	2132b	2567a	2144
Mean	1255	1570	1972	1599

*S.E ± LPM ± FYM = 139.4*** N = 64.3*** % C.V* = 14, **Means followed by the same letters are not significantly different at p≤ 0.05 according to Duncan's Multiple Range Test., *, **, ***, and NS indicate significance at P≤ 0.05, 0.01, 0.001and not significant respectively.*

Table 5. Effects of cultural practices on wheat grain yield (kg ha^{-1}), season 2004/05

LPM ± FYM	Nitrogen (kg/ha)			Mean
	0	43	86	
Disc g (control)	470f	626e	863d	653
Disc + 15 tons FYM/ha	779d	1187c	1382b	1116
Chiseling + disc ploughing +15 tons FYM/ha	818d	1255c	1530a	1201
Mean	689	1023	1258	990

*S.E ± LPM ± FYM = 62.5*** N = 35.0*** % C.V* = 12

The combined analysis of wheat grain yield for the two sequential seasons (2003/04 and 2004/05) indicated that the addition of nitrogen, at the rate 86 kg N/ha without application of FYM caused a highly significant ($P \leq 0.001$) increase in yield from 420 kg ha^{-1} in the control to 781 kg ha^{-1}, and that the noticeable difference in wheat grain yield between the 43 kg N/ha without addition of FYM and that of the control was not statistically significant, (Table 6).

Table 6. Combined analysis of wheat grain yield for the two seasons (kg ha^{-1}) (2003/04 and 2004/05)

LPM ± FYM	Nitrogen (kg/ha)			Mean
	0	43	86	
Disc (control)	420e	589e	781d	596
Disc + 15 tons FYM/ha	1219c	1607b	2017a	1614
Chiseling + disc ploughing +15 tons FYM/ha	1276c	1701b	2048a	1675
Mean	971	1299	615	1295

*S.E ± LPM ± FYM = 77.0*** N = 36.5*** % C.V = 14*

Highly significant ($p \leq 0.001$) differences in wheat grain yield were observed between each of the two rates of nitrogen (43 and 86 kg N/ha) and the control when the FYM was added with disc plough. The increments were from 1219 kg ha^{-1} for the control to 1607 and 2017 kg ha^{-1}, for the 43 kg ha^{-1} and 86 kg ha^{-1} respectively, (Table 6). The same trend of increase was noticed when the FYM was added with chiseling + disc plough in combination with the two rates of nitrogen. Also the data in Table 6 indicated that the FYM alone significantly increased wheat grain yield, irrespective of the land preparation method. This is because the decomposition of the FYM is expected to increase the concentration of most plant nutrients in the soil solution in addition to its physical effect on water holding capacity of the soil which may presumably add to the increasing wheat grain yield.

The combined analysis revealed that disc ploughing + chiseling + 15 tons FYM/ha + 86 kg N/ha gave the highest grain yield of 2048 kg ha^{-1} whereas disc ploughing + 15 tons FYM/ha + 86 kg N/ha gave 2017 kg ha^{-1}. However, the difference in grain yield of wheat between these two treatments was not significant. This was also true when 43 kg N/ha was applied. This might be due to the possibility that the shallow depth of chiseling (28 cm) was ineffective. The results in Table 6 also indicated highly significant increase in wheat grain yield as a result of addition of each of FYM and/or nitrogen.

Generally, the mean wheat grain yield was low in season 2004/05 (990 kg ha^{-1}) (Table 5) compared to that of season 2003/04 (1599 kg ha^{-1}) (Table 4). This difference in yield might be attributed to the high mean temperature in February and March of season 2004/05 (Table 2). The high temperature of season 2004/05 also resulted in low 1000-seed compared to that of 2003/04. Generally, the present results showed the importance of low temperature for wheat production particularly at the grain filling stage. This finding is in agreement with that of Wiegand and Cuellar[16] who reported a 2.8 - 3.1 day shortening of grain filling per

degree Celsius increase in mean daily air temperature during grain filling stage, and a decrease of about 2.8 mg p kernel per degree Celsius increase in temperature.

CONCLUSIONS

Based on the findings of the present study, the following conclusions can be drawn:

- Addition of FYM alone or coupled with nitrogen resulted in a highly significant increase in yield components and grain yield of wheat irrespective of the method of land preparation.
- the high temperature particularly during the grain filling stage of wheat resulted in a low 1000 seed weight and consequently low wheat grain yield. The treatment that included disc ploughing + 15 tons FYM/ha +86 kg N/ha which gave 2017 kg ha^{-1} of grain yield is the best for wheat production in this high terrace soil.

  Based on the results of this study it is seen as a judicious suggestion that addition of FYM coupled with nitrogen is presumably beneficial to high grain yield of wheat on similar high terrace soils in Addamar region.

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