Journal of Agricultural and Veterinary Sciences

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The Effects of Farm Yard Manure (FYM) on Sodic Soil in Gezira-Sudan (*Triticum aestivum L.*) Production in Gezira-Sudan

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Article history: Received: 16 April 2013
Accepted: 23 June 2013

Abstract: On farm experiment was conducted at Istrihna block in the Gezira Scheme for two seasons (2003-04 and 2005-06) in a heavy sodic clay Vertisol to study the effect of farmyard manure, (FYM) and planting methods to improve water infiltration aeration, and yield of wheat. The experimental design used was a split plot design with three replicates. The sowing methods treatments (Flat and Ridge) were assigned to the main plots and the levels of FYM (0, 5, 10, 20 tonsha^{-1}) to the sub plots. The infiltration test was measured using double ring infiltrometer method. Data on number of head per m^2, thousand seed weight, plant height, biomass and grain yield were collected at harvest. The addition of the farmyard manure (FYM) improved the physical properties of the soil; it increased the depth of wetting front, cumulative infiltration and infiltration rate. Results of the study indicated no significance differences for planting methods on yield and yield components although the ridge sowing gave higher grain yield as compared to the flat sowing. The use of different levels of the FYM significantly increased biomass, grain yield, thousand seed weight, number of head per m^2 and a plant height. The interactions of the planting methods and the manures showed significance differences for the grain yield. The highest grain yield (4.3 t ha^{-1}) was obtained from the combination of 20 t ha^{-1} FYM with ridge planting method and the lowest grain yield (3.8 t ha^{-1}) from the combination of 20 t ha^{-1} FYM with flat planting method.

Keywords: Wheat; Infiltration; Farm Yard Manure; Planting Method; Sodic; Vertisols Gezira; Sudan.

Introduction:

Wheat (*Triticum aestivum L.*) is an important food crop world wide. It is considered as the most important cereal crop in Sudan after sorghum. Wheat consumption in Sudan has been increasing due to urbanization and arising population. During the mid seventies of the last century, Gezira Scheme adopted the policy of diversification of crops and intensifying the rotation. Wheat was introduced in Gezira Scheme as a winter crop in the irrigated sector although the prevailing climate lies in arid zone and the heavy cracking clays are not favorable for wheat production. Vertisols of the central clay plain are inherently low in organic dry matter (0.3-0.5%) and the cropping system adopted in the irrigated sector do not allow for the build up of high level of organic matter since all crop residues are either removed or burned (Salih *et al*., 1994). Farm yard manure (FYM) significantly influenced the soil organic matter concentration (%) in soil as

compared to application of recommended NPK (Rasoul zeh and Yaghoubi, 2010). Generally, it can be combined application of organic manure and chemical fertilizer to improve soil fertility, soil physical and chemical properties and increased crop yields (Ezekiel, 2010).

Organic matter affects crops growth and yield either directly by supplying nutrients or indirectly by modifying soil physical properties such as stability of aggregates, porosity and available water capacity that can improve the root environment and stimulate plant growth (Rasoulzadeh and Yaghoubi, 2010).

Soil organic matter affects infiltration through its positive affect on the development of stable soil aggregates, or crumbs. Highly aggregated soil has increased pore space and infiltration. Soils high in organic matter also provide good habitat for soil biota, such as earthworms, that through their burrowing activities, increase pore space and create continuous pores linking surface to subsurface soil layers (Anonymous. 2008).

Organic matters not only increase the water holding capacity of the soil but also the portion of water available for plant growth and improve physical properties of soil (Sial *et al*., 2007).

Many reports have shown that growing wheat on flat created some problems in depressional sites such as surface crust due to sodicty and partial pending due to irregular micro-topography. These problems have direct influence on root penetration and its establishment as well as water management. These adverse effects have resulted in reduction of plant emergence, wheat establishment and yield. (Abdullah *et al*., 2008) reported that ridge planting significantly increased yield of maize when compared with flat planting method. Conventional flat planting for winter maize has some disadvantages; it can cause crusting of the soil surface following flood irrigation and can contribute to the degradation of some soil properties, which can result in higher crop lodging and inefficient use of nutrients. Therefore, the main objective of the study is to investigate the effect of FYM and methods of land preparation on grain yield of wheat grown in heavy sodic clay Vertisols under Gezira conditions.

Materials and Methods

An experiment was conducted on farm for two seasons (2003-04 and 2005-06) at Istrihna block of the Gezira Scheme. The Gezira soils are characterized by wide cracking, classified as "Vertisols"; low organic matter; slow permeability; high bulk density and with coarse prismatic structure parting to sub angular blocky when dry and massive when moist (Zeinelabdine et al., 1969). The selected soil is classified as Typic Haplusterts, fine, smectitic, isohyperthermic (Soil Survey Staff 1992) and as sodic phase in (Soil Survey Reports of Central and Wad Habouba group) but according to Soil Survey Staff (1999) the soils are classified as Sodic Haplusterts). Some soil characteristics are listed in table 1.

Table 1: Some soil characteristics of the soil under the study.

Depth cm	pH paste	EC mS-1	$CaCO_3$ %	Mechanical analysis %				O.C. %	N %	ESP
				CS	FC	Silt	Clay			
0 - 20	7.8	0.80	3.8	10	8	30	52	0.437	0.040	13
20-50	8.3	0.75	6.4	12	11	32	45	0.390	0.045	20
50-90	8.0	2.50	6.0	11	13	232	53	0.406	0.040	22

The data in Table 1 indicats that this soil is calcareous, sodic, non saline, low in organic carbon and nitrogen content.

The cattle manure was collected from the diary farm of the Gezira Research Station, air dried under the shade and large pieces were crushed. The content of the organic manure was 1.65%, organic carbon was 20% with C: N=12:1 and total phosphorous was 0.6% (Ibrahim *et al*., 2003).

Eight treatments with four levels FYM (0, 5, 10 and 20 tons ha^{-1}) in combination with two types of land preparation (Flat and ridge).were conducted as follows:

1- Flat + 0 manure (control)
2- Flat + 5 t ha^{-1} manure
3- Flat + 10 t ha^{-1} manure
4- Flat + 20 t ha^{-1} manure
5- Ridge (0 manure)
6- Ridge + 5 t ha^{-1} manure
7- Ridge + 10 t ha^{-1} manure
8- Ridge + 20 t ha^{-1} manure

FYM and urea were broadcasted on soil surface and then mixed by using disc harrow. The experiment was a factorial setup in split plot design. The main plots were sowing methods (Flat and ridges). The subplots had different levels of FYM. Each treatment combination was replicated three times. The plot size was 14X20 m^2. Ridges were 0.8 m wide and 0.2m row spacing on flat. The recommended fertilizer was applied at the rate of 86 kg Nha^{-1} and Triple Super Phosphate (TSP) at the rate of 43 kg P O_5ha^{-1}. Other cultural practices were followed as recommended. Wheat variety Debeira was sown on 25th of November and harvested during March. The infiltration rate using (double ring infiltrometer) was measured. Yield and yield components were calculated from an area of 8X14 m^2. Data were analyzed using Statgraf software.

Results and Discussion

1-Effect of FYM on the physical properties

a- Depth of wetting Front

Result of the depth of wetting front for control and treated soils was shown in Figure (1).

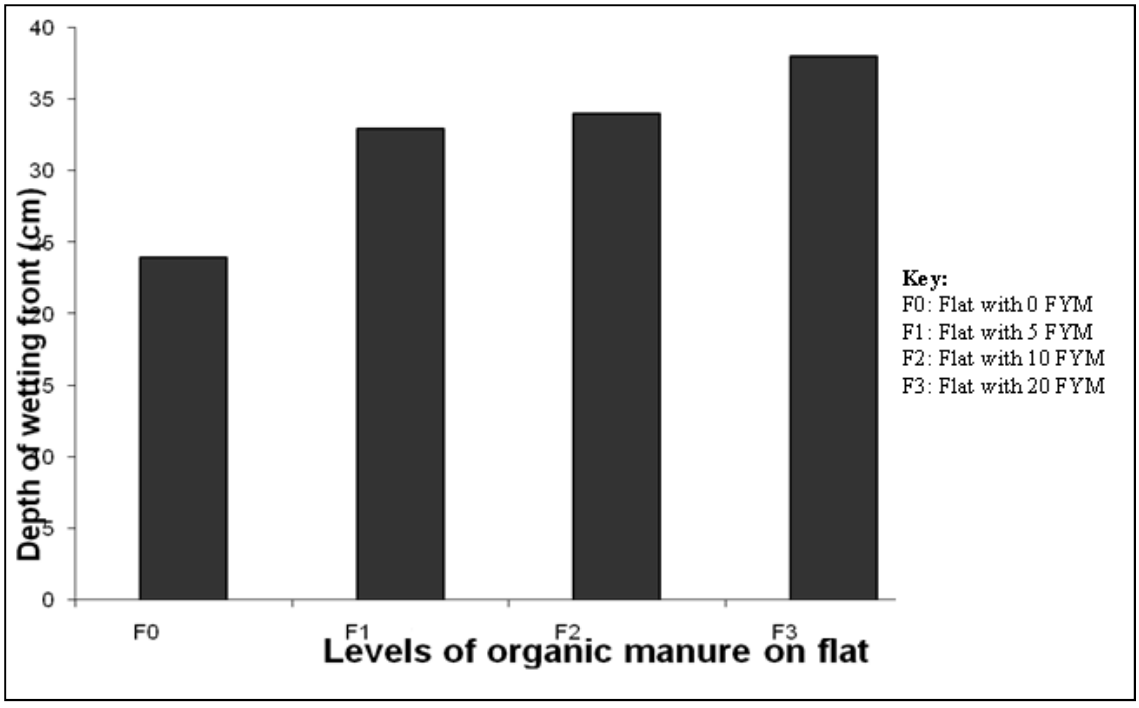

Figure 1: Mean average depth of Wetting Front in (cm) of control and treated soils.

The depth of wetting front increased as the amount of FYM increased. The maximum depth (37ccm) was recorded with the application of FYM at 20 t ha^{-1} as compared with the control (28 cm). This might be due to the aggregation of structural elements creating more voids for water penetration and better aeration. These results are confirmed by (Haynes and Naidu, 1998) who reported that addition of organic manure improved soil aggregation and soil structure.

b-Cumulative Infiltration:

The cumulative infiltration of water for the control and the manure treated soils is shown in Figure (2).

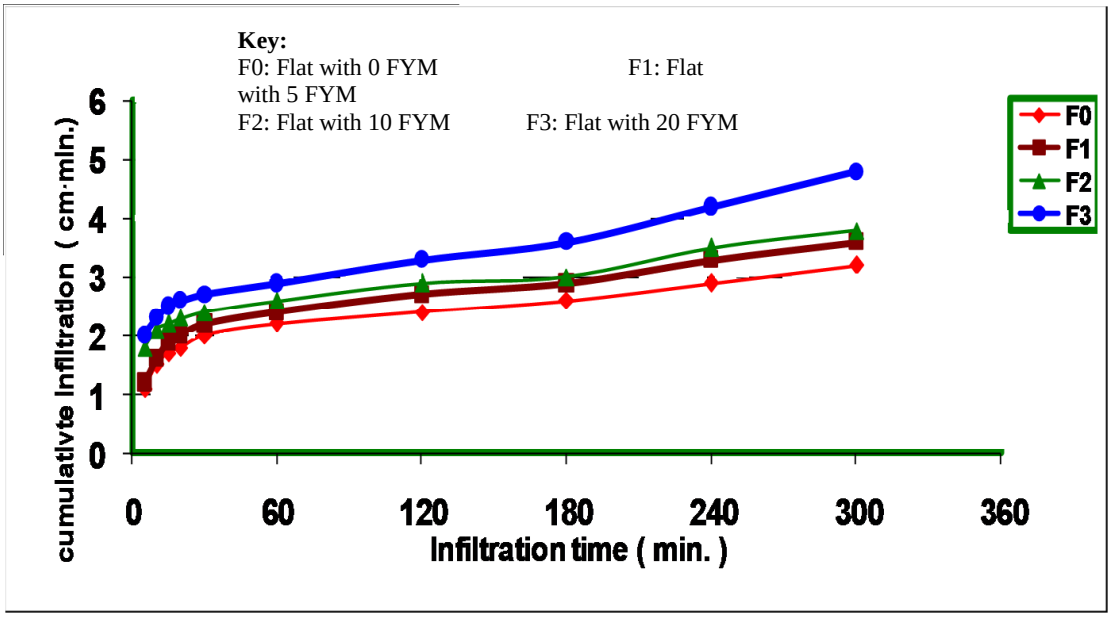

Figure 2: Cumulative infiltration (I) as a function of time (min) for the control and manure treated soils.

result is in agreement with the finding of (Rasoulzadeh and Yaghoubi, 2010) who reported that with the application of cattle manure, the cumulative infiltration showed increasing trend and concluded that cattle manure significantly soil the physical properties.

c- Infiltration Rate

The infiltration rate of water for the control and the manure treated soils is shown in Figure.3.

A steady increase of cumulative infiltration for all treatments was shown in Fig.2. This may be due to the presence of the cracks. Hoawever with time the rate of increase in the cumulative infiltration slowed down due to the disappearance of cracks and pores upon wetting. The addition of FYM increased the cumulative infiltration as compared to the control. The increase of the amount of water per unit time infiltrated is an indication of the improvement of the physical properties of the heavy clay soil as a result of the application of the FYM. This

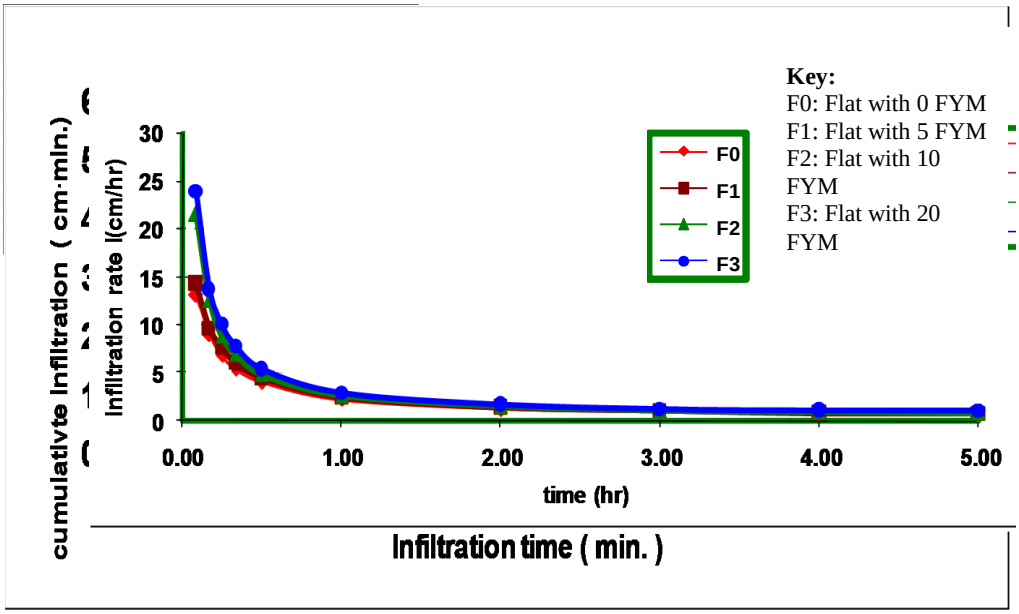

Figure 3: Infiltration rates (i) with time (hr) for control and manure treated soils.

The infiltration rate of organic manure treated soils and the control are shown in Figure (3). Generally, high infiltration rate observed at the beginning of the infiltration and as the time progressed, the intake rate started to decrease after 3 hours to the basic flow. These variations in rate could be attributed to the transmission of water through wetting zones that increased the resistance to the flow which decreased the infiltration rate. A trend of increasing the infiltration rate with the addition of FYM was observed in Figure (3). The highest infiltration rate was found in the manure treatment of 20 t ha^{-1} as compared to the control. This might be due to the improved physical properties of soil as a result from the application of FYM. These results are supported by Singh et al. (2007) who reported that increased organic carbon content of the soil improved its aggregation status, infiltration rate and decreased the bulk density.

2. Effect of FYM and Planting Methods on Yield and Yield Components of Wheat:

Application of FYM significantly increased the yield and increased yield components when compared with the control, while the effect of planting methods was not significant for the tow seasons and the combine seasons as in (Tables 2, 3 and 4). Number of heads m^{-2} increased significantly as the rate of FYM increased. The maximum number was obtained from FYM treatment 20 tons ha^{1} (524,492 and 508) and the minimum from control (425, 429 and 427) as indicated in Tables 2, 3 and 4 respectively. Regarding the planting method the number of head m^{-2} higher on ridge planting method (500,471 and486) relative to sowing in flat (459,458 and 459) as indicated in Tables 2, 3 and 4 respectively. The interaction effect of FYM and planting methods on number of head m^{-2} was not statistically significant different as shown in the combined analysis (Table 4). The highest number of head m^{-2} (537) was obtained from the combination of 20 t ha^{-1} FYM treatment with ridge planting method and the lowest (426) from the combination of FYM at 0 t ha^{-1} with flat planting method. These results agree with the findings of Rehman *et al*., (2008) who reported that levels of FYM significantly increased spikes m^{2} than control plots.

Thousand seed weight was significantly affected by FYM application, while the effect of planting methods and the interaction between FYM and planting methods was not-significant (Table 2, 3 and 4). The weight of thousand seeds increased statistically as the amount of FYM increase. Data on the combined seasons (Table 4) revealed that the heaviest seed weight (34.8g) was produced by application of FYM at 20 t ha^{-1}as compared with the control (32.8 g). These results are confirmed by Rehman *et al*., (2008) who reported that maximum thousand grain weight (34.69 g) was recorded in plots which received 45 t FYM ha^{-1} while minimum thousand grain weight (33.69 g) was recorded in the control plots. They concluded that FYM significantly increased thousand grain weight.

Based on the results shown in Tables 2, 3 and 4, the grain yield was significantly affected by FYM, while the effect of planting methods was not significant. Grain yield increased significantly as the rate of FYM increased. The highest grain yield (4.0 tons ha^{-1}) was produced by applying FYM at 20 tons ha^{-1} as compared to the lowest grain yield (1.6 tons ha^{-1}) of the control (Table 4). The increase in grain yield was observed as 30%, 127% and 160% in case of application of FYM at 5, 10 and 20 tons ha^{-1}, respectively in comparison to the control. These results are in conformity with the finding of (Barzegar *et al*., 2002), who reported that application of organic materials significantly increased wheat yield. Although no significant differences were observed for tested planting methods on grain yield in (Tables 2, 3 and 4), ridging method produced more grain yield (2.9 tons ha^{-1}) when compared to the flat methods of planting (1117 kg fed^{-1}). The percentage of increase in grain yield was calculated as 9% more in ridge planting as compared to the planting on flat (Table 4). This might be due to the fact that ridge planting provided better soil conditions for nutrient uptake and reduced lodging. These results agree with the findings of Rahman *et al*., (2010) concluded that bed planting is better culture method for wheat production. Results of the interaction of FYM application and planting methods on grain yield as shown in Tables 2, 3 and 4 were consistent. The influence of the interaction of FYM application and planting methods on grain yield was significantly different. The combined analysis of the two seasons (Table 4) indicated the significant differences between sowing on flat and ridge for the same levels of FYM. The highest grain yield (1793 kg fed^{-1}) was obtained from the combination of 20 t ha^{-1} FYM with ridge planting method and the lowest grain yield (3.8 tons ha^{-1}) from the combination of 20 t ha^{-1} FYM with flat planting method (Table 4). The percentage of increase in grain yield was calculated as 12.6% more in ridge planting as compared to the planting on flat. This might be due to the fact that ridge planting provided good soil conditions for proper root development and the addition of FYM improved soil fertility. These results are in agreement with that of (Rasoulzadeh and Yaghoubi, 2010) who reported that cattle manure can effectively be used to enhance physical fertility of low organic matter soils which are widely cultivated in semiarid region.

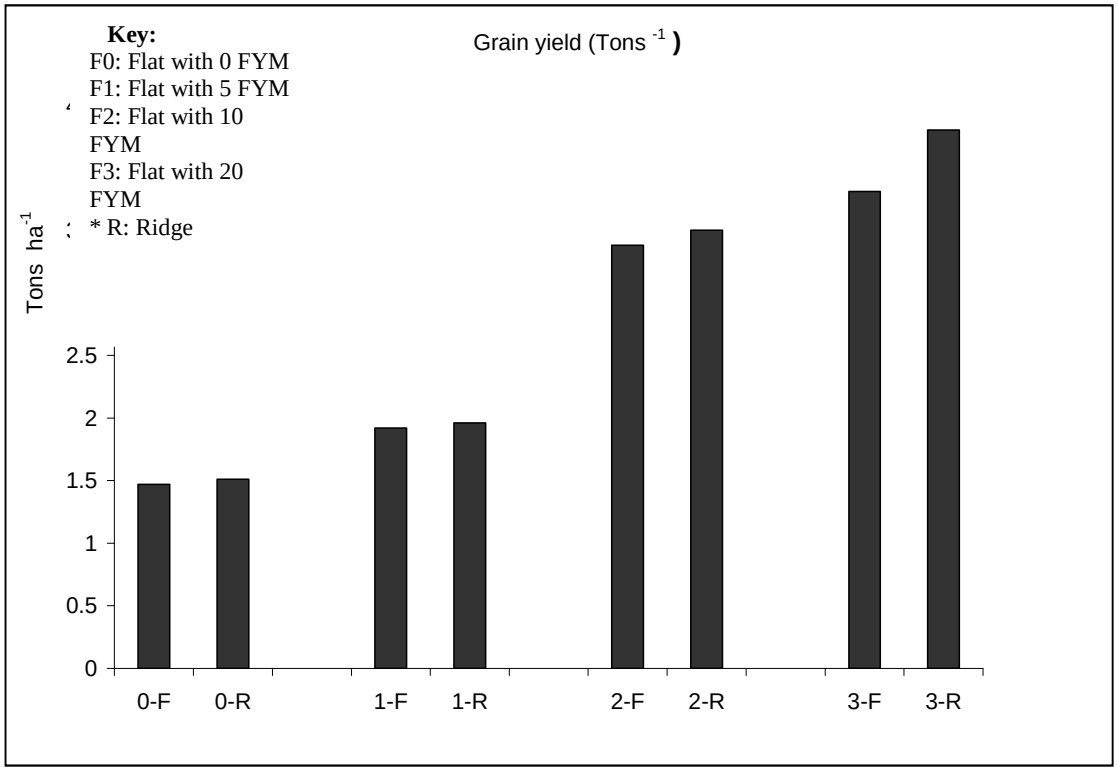

Figure 4:. Effects of planting method and addition of organic manure on grain Yield (kg/fed) (combined analysis).

Biomass yield was significantly affected by application of FYM, while the effect of planting methods was not significant (Tables 2, 3 and 4). Biomass yield increased significantly with the increase in the rate of FYM. The highest biomass yield (4996 kg fed^{-1}) obtained by applying FYM at 20 t ha^{-1} as compared to the lowest grain yield (10.0 tons ha^{-1}) of the control (Table 4), while the percentage increased in biomass yield was calculated as 2.8%, 15.8% and 18.5% in case of application of FYM at 5, 10 and 20 t ha^{-1}, respectively as compared to the control. These results are in line with Matsi *et al., (*2003) who reported that increased biological yield in manure treated plots were attributed to the enhanced soil fertility and improved soil physical conditions. The effect of planting methods on biomass yield was not significant (Tables 2, 3 and 4). Ridge planting produced higher biomass yield (11.3 tons ha^{-1}) as compared with flat method (10.8 tons ha^{-1}) (Table 4). Similar trend was observed in the previous seasons (Table 2 and 3). This might be due to the fact that ridge planting provided better conditions for root development, reduced water lodging and ensured efficient use of irrigation water and nutrients. These results are confirmed by Jehan *et al*., (2011) reported that the maximum biological yield was produced by ridge planting, while minimum in broadcast method. The interaction effect of planting methods and the same level of FYM on biomass yield was not statistically significant (Table 2,3 and 4) although the ridge sowing out yielded the flat sowing. As shown in the combined analysis (Table 4), the highest biomass yield tons ha^{-1} (12.3) was obtained from the

combination of 10 t ha^{-1} FYM treatment with ridge planting method and the lowest (3935) from the combination of FYM at 0 ton ha^{-1} with flat planting method.

Results in Tables 2, 3 and 4 showed that the plant height was significantly affected by FYM and not significantly affected by planting methods. Plant height increased significantly as the rate of FYM is increased. The highest plant height (94 cm) was obtained by applying FYM at 20 t ha^{-1} as compared to the lowest height (71 cm) of the control (Table 4). Similar trend was observed in Table 2 and 3. Although the plant height was not significantly affected by planting methods and the interactions of FYM and planting methods. The taller plants were recorded in the ridge method and the smaller in the flat planting method (Table 2, 3 and 4). This might be due to the fact that ridge planting provided better soil conditions for nutrient uptake and root development reduced lodging. These results are confirmed by Jehan, *et al*., (2011) who reported that taller plants were attained by ridge planting, while smaller plants in flat.

Table 2: Effect of FYM and Planting Methods on Yield and Yield Components of Wheat, sesaon 2003-04.

Treatment	Biomass Tons ha-$^{-1}$	Grain yield Tons ha^{-1}	Straw Tons ha^{-1}	1000 Seed Wt/ g	Head no./m2	Plant Height/ cm
Planting Method						
Flat – F	11.2	2.9 a	8.3 a	33.9 a	459 a	82 a
Ridge – R	11.8 a	3.1 a	8.5 a	33.9 a	500 a	86 a
SE	0.4	0.3	0.3	0.4	19.9	3.1
C.V%	11.9	35.6	12.4	4.0	14.6	12.5
Manure Level						
0 ton/ha	10.4 a	1.8 a	8.6 a	33.1 a	425 a	72 a
5 ton/ha	10.6 a	2.2 b	8.4 a	33.7 ab	480 ab	82 b
10 ton/ha	12.4 b	3.7 c	8.7 a	34.2 ab	491 ab	86 b
20 ton/ha	12.2 b	4.3 d	7.9 a	34.7 b	524 b	98 c
SE	0.4	0.08	0.4	0.5	26.4	1.9
C.V%	11.9	35.6	12.4	4.0	14.6	12.5
Planting Method * Manure Level						
0-F	9.6 a	1.7 a	7.9 a	32.8 a	412 a	69 a
0-R	11.2 abcd	1.8 a	9.3 a	33.7 a	438 a	75 ab
1-F	10.7 abc	2.2 b	8.5 a	34.7 a	476 ab	80 bc
1-R	10.6 ab	2.3 b	8.3 a	34.3 a	484 ab	84 c
2-F	12.3 cd	3.6 c	8.7 a	33.3 a	465 ab	84 c
2-R	12.6 d	3.9 d	8.7 a	33.7 a	517 ab	87 c
3-F	12.1 bcd	4.0 d	8.0 a	33.7 a	485 ab	97 d
3-R	12.3 cd	4.5 e	7.8 a	35.0 a	563 b	100 d
SE	0.6	0.07	0.6	0.8	38.0	2.6
C.V%	11.9	35.6	12.4	4.0	14.6	12.5

Means within a column followed by the same letter are not significantly different according to Multiple Range Test at $P \leq 0.05$ - Statgraphics Plus 3.0 Software.

Table 3: Effect of FYM and Planting Methods on Yield and Yield Components of Wheat, sesaon 2006-06.

Treatment	Biomass Tons ha^{-1}	Grain yield Tons ha^{-1}	Straw Tons ha-1	1000 Seed wt/g	Head no./m2	Plant height cm
Planting Method						
Flat – F	10.4 a	2.5 a	8.0 a	33.8 a	458 a	81 a
Ridge – R	10.9 a	2.7 a	8.2 a	33.9 a	471 a	81 a
SE	0.3	0.3	0.2	0.3	12.0	2.8
C.V%	11.1	41.2	11.7	3.2	8.7	11.9
Manure Level						
0 ton/ha	9.7 a	1,3 a	8.4 a	32.5 a	429 a	70 a
5 ton/ha	10.0 a	1.8 b	8.2 a	33.7 b	450 ab	77 b
10 ton/ha	11.4 b	3.3 c	8.0 a	34.5 c	487 bc	85 c
20 ton/ha	11.6 b	3.8 d	7.8 a	34.8 c	492 c	91 c
SE	0.3	0.07	0.3	0.3	13.5	2.2
C.V%	11.1	41.2	11.7	3.2	8.7	11.9
Planting Method * Manure Level						
0-F	9.2 a	1.3 a	7.9 ab	33.0 a	441 abc	68 ab
0-R	10.2 abc	1.4 a	8.8 b	32.0 b	416 abc	73 ab
1-F	9.8 ab	1.7 b	8.1 ab	33.3 bc	438 ab	76 abc
1-R	10.2 abc	1.9 b	8.4 ab	34.0 cd	462 abcd	79 bc
2-F	10.8 bcd	3.2 c	7.7 ab	34.7 de	477 bcd	85 cd
2-R	11.6 d	3.4 d	8.2 ab	34.3 d	496 cd	86 cd
3-F	11.8 d	3.6 e	8.3 ab	34.3 d	475 bcd	90 d
3-R	11.3 cd	4.0 f	7.3 a	35.3 e	510 d	91 d
SE	0.4	0.05	0.4	0.3	19.2	3.3
C.V%	11.1	41.2	11.7	3.2	8.7	11.9

Means within a column followed by the same letter are not significantly different according to Multiple Range Test at $P \leq 0.05$ - Statgraphics Plus 3.0 Software.

Table 4: Effect of FYM and Planting Methods on Yield and Yield Components of Wheat, sesaon (combined of two seasons)

Treatment	Biomass Tons ha^{-1}	Grain yield Tons ha^{-1}	Straw Tons ha^{-1}	1000 Seed wt/g	Head no./m2	Plant height/cm
Planting Method						
Flat – F	10.8 a	2.7 a	8.1 a	33.9 a	459 a	82 a
Ridge – R	11.3 a	2.9 a	8.4 a	33.9 a	486 a	84 a
SE	0.2	0.2	0.2	0.25	11.55	2.09
C.V%	11.97	38.59	12.09	3.59	12.08	12.27
Manure Level						
0 ton/ha	10.0 a	1.6 a	8.5 a	32.8 a	427 a	71 a
5 ton/ha	10.3 a	2.0 b	8.3 a	33.7 b	465 ab	80 b
10 ton/ha	11.9 b	3.5 c	8.3 a	34.3 bc	489 bc	85 c
20 ton/ha	11.9 b	4.0 d	7.8 a	34.8 c	508 c	94 d
SE	0.2	0.05	0.2	0.29	14.46	1.48
C.V%	11.97	38.59	12.09	3.59	12.08	12.27
Planting Method * Manure Level						
0-F	9.4 a	1.5 a	7.9 a	32.9 ab	426 a	71 a
0-R	10.7 b	1.6 a	9.1 b	32.7 a	427 a	71 a
1-F	10.2 ab	2.0 b	8.3 ab	33.5 abc	457 ab	78 b
1-R	10.4 b	2.1 c	0.8 ab	33.8 bcd	473 bc	81 bc
2-F	11.6 c	3.4 d	8.2 ab	34.7 de	471 bc	85 c
2-R	12.0 c	3.6 e	8.5 ab	34.0 bcd	507 cd	86 c
3-F	12.0 c	3.8 f	8.2 a	34.3 cde	480 bcd	93 d
3-R	12.0 c	4.3 g	7.6 a	35.2 e	537 d	95 d
SE	0.3	0.04	0.3	0.40	20.00	2.15
C.V%	11.97	38.59	12.09	3.59	12.07	12.27

Means within a column followed by the same letter are not significantly different according to Multiple Range Test at $P \leq 0.05$ - Statgraphics Plus 3.0 Software.

Conclusions

1-The addition of FYM improved the physical properties of the sodic Vertisols soil through increasing the depth of wetting front, the cumulative infiltration and the Infiltration rate.

2- Results of this study showed a trend of increased grain yields with increasing the levels of FYM indicating the positive response of the crop to the FYM as an amendment for heavy sodic clay Vertisols.

3-The results showed no significant differences between the two planting methods for the grain yield and its components, although an increase of 9% for grain yield was observed in case of sowing on ridges as compared to sowing on flat.

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آثار المواد العضوية على أراضي التربة الصودية لإنتاج القمح في مشروع الجزيرة ، السودان .

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المستخلص

تم اجراء تجربه حقليه فى منطقة استرحنا بمشروع الجزيرة خلال موسميين (2003-04 and 2005-06) فى تربة الجزيرة الطينية المتشققة (Vertisols). هدفت الدراسة الى تقييم تأثير السماد العضوى (FYM) و طرق الزراعة. على خاصية تسرب المياه فى التربة و انتاجية محصول القمح. صممت التجربة باستعمال تصميم القطع المنشقة بثلاثة تكرارات. وضعت معاملات طرق الزراعة (الزراعة على سراب 80 سم وعلى ارض مسطحة فى خطوط) فى القطع الرئيسية ووضعت معاملات السماد العضوى (0, 5, 10, 20 tons/ha) فى القطع الفرعية. تم قياس إختبار التسرّبَ باستعمال جهاز (double ring infiltrometer). جمعت معلومات عند الحصاد عن عدد السنابل فى المترالمربع ، ووزن ألف بذرةِ، و طول النباتِ ، والانتاج الكلي (الحبوب+القش) و انتاجية الحبوب. اشارت نتائج الدراسة الى ان اضافة السماد العضوى (FYM) حسنت الخواص الفيزيائية للتربة التى تشمل زيادة العمقَ لرطوبة التسرّبِ ، والتسرّبِ المتراكمِ، و معدل التسرب. اظهر التحليل الأحصائى للدراسة أن طرق الزراعة ليس لها تأثير معنوى على انتاجية البذور بالرغم أن الزراعة على سراب أعطت أعلى انتاجيه للحبوب. أثبت التحليل الأحصائى للدراسة ان استعمال معاملات السماد العضوى المختلفة أدى الى زيادة معنوية فى انتاجية الحبوب، و وزن ألف بذرةِ، وعدد السنابل فى المترالمربع، وكذلك إرتفاع طول النباتِ. دلت الدراسة على ان تفاعل طرق الزراعة و معاملات السماد العضوى أعطى فروقات معنوية لأنتاجية الحبوب. أعلى انتاجية للحبوب ($4.3\ tons\ ha^{-1}$) حُصِلَ عليه مِنِ الزراعة على سراب و استعمال المعاملة ($20\ t\ ha^{-1}$ FYM) بينما نتجت أقل انتاجية للحبوب ($3.8\ tons\ ha^{-1}$) مِنِ الزراعة على ارض مسطحة فى خطوط و استعمال المعاملة ($20\ t\ ha^{-1}$ FYM).