EDITORIAL

Direct and residual effects of green and farmyard manures on wheat (*Triticum aestivum* L) yield in a desert plain soil, Northern State, Sudan

Imran A. Ahmed[1], Muawia E. Hamad[2] and Habiballa A. Mohamed[1]

[1] National Institute of Desert Studies(NIDS), University of Gezira, Wad Medani, Sudan.
[2] Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan.

ABSTRACT

This study was conducted for four successive seasons during 2007 to 2011 in a desert plain soil to assess the direct and residual effects of green and farmyard manures on wheat yield components and total yield. Treatments consisted of green manure produced from green gram (*Vigna radiate*) with two seed rates (0 kg ha^{-1} and 12 kg ha^{-1}), and farmyard manure with two levels (0 ton ha^{-1} and 10 ton ha^{-1}) arranged in a split plot design with three replicates. For the study of the residual effects of green and farmyard manures the treatments were fixed in the same plots of the first application of the manures, and land preparation was done manually lest to disturb the soil. The results showed that each of the investigated manures and their residuals significantly increased number of seeds per spike, 1000-seed weight, biological yield, and grain yield. According to their effectiveness in improving the yield components and increasing the yield of wheat and considering the direct effects, the interaction of green and farmyard manures came first followed by the farmyard manure and lastly the green manure treatment. The residues of the green manure treatment on the other hand produced higher yield than that of the residues of the farmyard manure. The results also showed that the grain yield of wheat resulting from residual effects in the first year was higher than that resulting from the primary application of manures. The residual effects in the second year resulted in lower grain yield than that of the first application of manures. It is recommended to apply organic manure every two years to enhance the soil properties and productivity of the desert plain soil in northern Sudan.

EDITORIAL

INTRODUCTION

Soil properties play an important role in crop production and water use efficiency especially in light textured soils of the arid regions. Enhancing physical and fertility properties of sandy soils will contribute to addition of new reclaimed soils to cultivated areas and hence increase crop production that will prevent famine. Plant nutrients are depleted as crops are continuously cultivated and ultimately soil productivity decreases. This problem is minimized by the use of fertilizers like chicken manure, compost, green manuring…*etc*. (Sajjad *et al*., 2018). Regular addition of organic manures is very important in maintaining soil tilth, fertility and productivity of agricultural lands, protecting them from wind and water erosion and preventing nutrient losses through runoff and leaching (Hornik and Parr, 1987).

Long term effect of organic manures is a primary means of replenishing soil organic matter. The total benefits of organic matter are sometimes not reflected in crop yield during the first or even second or third year following application of the manure. Although a portion of the nutrients of decomposed manure is released during the first year or the second year, some is still held in humus like compounds which is subject to very slow release. The effect of the manure is long standing, not only on future nutrient supplies but also on the physical conditions of the soil. When manure or crop residues are added to the soil, a portion of organic carbon, nitrogen, sulfur, and probably other elements are converted to humus. In this form, the elements are released only very slowly where rates of 2% to 4% per year are common. Thus, the components of the manure which are converted to humus will have continuing effects on soils years after its application. The first crop following the application of manure recovers only about 20 % to 50 % of the nutrients supplied by organic manure, much of the remainder is held in humus like compounds and will have continuing effects on soils, years after application(Brady,1990).

The soils of the Sudan are low in organic matter and so they have inadequate supplies of many essential nutrients (Ageeb *et al.*, 1995). Awad Elkarim and Babiker (2005) found that farmyard manure significantly increased length of spikes, number of seeds per spike and grain yield. Khan and Khalil (2014) evaluated the use of organic and inorganic fertilizers on wheat productivity. They found that poultry and farm yard manures significantly increased number of spikes m^{-2}, grain yield and harvest index of wheat. Rasul *et al*.(2015) found that organic manure had significantly increased plant height, length of spike, number of grains per spike, number of tillers per plant, 1000- grains weight, biological yield ,grain yield and harvest index.

Ahmed (2017) evaluated the direct and residual effects of green and chicken manures on the properties of a desert plain soil and wheat yield in northern Sudan and found that tested manures and their residues were effective in increasing yield components and total yield of wheat. Awad Elkarim and Younis (2008) reported that farmyard manure and nitrogen significantly increased the yield components and total yield of wheat.

As a continuation of the effort to improve the properties of desert soils for crop production, the present study was undertaken to assess the effects of green and farmyard manures and their residues on yield components and total yield of wheat in a desert plain soil, northern Sudan.

MATERIALS AND METHODS

The experiment was carried out during four consecutive seasons 2007/08 (direct effect, season1), 2008/09 (direct effect, season2 and residual effect 1, season1), 2009/10 (residual effect1, season 2 and residual effect 2, season 1) and 2010/11 (residual effect 2, season 2) at the National Institute of Desert Studies Research Farm, New Hamdab Scheme, Northern

EDITORIAL

State, Sudan. The study area lies at the intersection of latitude 17º 55' N, and longitude 31º 10' E in the desert climate.

The soil of the study area belongs to El Multaga soil series which is classified as typic, haplocambids, coarse loamy, mixed, superactive, hyperthermic. It is non-saline non-sodic (LWRC, 1999). Generally, the soil chemical fertility is low and deficient in nitrogen, phosphorus and organic carbon. The physical and chemical properties of the soil are shown in Table1.

The design was a split plot with three replicates. The main plots were assigned to GM (green gram crop) with two seed rates: 0 kg ha^{-1} and 12 kg ha^{-1}. The sub plots were assigned to FYM with two rates: 0 ton ha^{-1} and 10 ton ha^{-1}.

In the first application of GM and FYM for seasons 2007/2008 and 2008/2009, green gram (mung bean),(*Vigna radiate*), was selected as a green manure crop. It was planted early in the summer season (20th July) on the designated experimental units. After two months and before flowering phase, the crop (the average biomass production of 5.4 ton ha^{-1}) was incorporated into the soil six weeks before wheat planting using disk plough. Then the soil was watered and the subsequent watering was carried out at a ten - day interval before the sowing of wheat, as an indicator crop. FYM was hand broadcast six weeks before planting on the designated experimental plots. The manure was mixed with the soil using disk plough. The plots were watered as for the green manure treatments. Land preparation was done manually for the residual effects of GM and FYM lest to disturb the treatments which were fixed in the same plots of the first application of manures.

Table 1. Some soil properties of the experimental site.

Soil properties	Soil depth (cm)				
	0 – 23	3 – 65	65 – 80	80 - 105	105 - 125
CS (%)	37	33	43	42	40
FS (%)	40	23	22	21	24
Silt (%)	15	25	11	19	8
Clay (%)	8	19	24	18	28
Texture	LS	SL	SCL	SCL	SCL
CEC (cmol kg^{-1}soil	6	14	26	24	26
pH (paste)	6	14	26	24	26
ECe (dSm^{-1})	0.35	0.37	0.42	1.1	3.2
ESP	3.0	3.0	4.0	5.0	8.0
$CaCO_3$ (%)	0.8	2.6	10.4	0.2	27.5
O.C (%)	0.05	0.06	0.07	0.06	0.05
C/N ratio	4	4	5	5	5

L S = loamy sand, SL = sandy loam, SCL= sandy clay loam
(Source: LWRC, 1999)

The chemical analysis of the two amendments (GM and FYM) were carried out in the laboratories of LWRC (Table 2).

Wheat variety Wadi Elneel was sown manually for seasons 2007/08, 2008/09, 2008/09 and 2009/10 on 20th November using a seed rate of 120 kg ha^{-1}, at 0.2 m inter-row spacing. Basal doses of nitrogen of 86 kg N ha^{-1} and phosphorus (43 kg P_2 O_5 ha^{-1}) were added to all plots (Ibrahim, 1990). Irrigation was carried out every ten days.

In all seasons, data of number of seeds per spike, 1000-seed weight (g), biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}) were collected. Data were statistically analyzed using MSTAT program.

EDITORIAL

RESULTS AND DISCUSSION

Chemical analysis of the amendments

Table 2 shows the the chemical analysis of the two amendments (green and farmyard manures) applied in this study. As seen, the nitrogen percentage is higher in green manure (3.11%) as compared to that of farmyard manure (0.02%). This is true because legume crops are able to establish relationships with bacteria that transform atmospheric nitrogen into a form that the plant can use. On the other hand, FYM contents of total phosphorus (4.32%), total potassium (5.10%) and to an extent O.C (24.2%) are higher as compared with green manure (0.48% P, 2.1% K and 23.2 % O.C).

Table 2. Results of chemical analysis of the amendments used.

Amendment	N	O.C	Total P	Total K
		(%)		
GM	3.11	23.2	0.48	2.10
FYM	0.02	24.2	4.32	5.10

Yield components of wheat:

The results showed that GM and FYM and their residues had significant (P≤ 0.05) effects on yield components of wheat in all seasons. The data of the average number of seeds per spike for all seasons are shown in Table 3. There were significant differences (P≤ 0.05) in the number of seeds per spike among each of the direct effect of organic manures and the control and also between each of the residual effect of green and farmyard manures and the control. This result is in conformity with that of Ahmed (2017) and Awad Elkarim and Babiker (2005) who reported that organic manure significantly increased the number of seeds per spike.

Table 4 showed significant differences (P≤ 0.05) in the 1000- seed weight between each of GM and FYM and their respective residues and the control. The direct and residual effects of green and farmyard manures positively increased the 1000- seed weight. This result was in conformity with that of Ahmed (2017) who found that 1000- seed weight increased significantly in response to organic manure application and its residues.

EDITORIAL

Table 3. Number of seeds per spike.

Green manure levels(kg/ha)	FYM Levels (ton/ ha)	Direct effect	Residual effect (first year)	Residual effect (second year)
		2007/08	2008/09	2009/10
		First season		
0	0	16	28	18
	10	45	48	32
12	0	35	51	37
	10	46	47	32
Grand mean		35	43	30
C.V (%)		18.74	3.32	12.41
SE±		3.89	0.833	2.167
		Second season		
0	0	22	24	15
	10	43	43	39
12	0	43	43	36
	10	45	47	46
Grand mean		38	39	34
C.V%		6.25	10.69	11.38
SE±		1.39	1.81	2.261

Table 4. 1000- seed weight (g).

Green manure levels(kg/ha)	FY Levels (ton/ ha)	Direct effect	Residual effect first year	Residual effect second year
		2007/08	2008/09	2009/10
		First season		
0	0	11.5	28.0	19
	10	20.3	36.6	27.5
12	0	20.4	37.3	33.5
	10	21.3	37.3	28.3
Grand mean		18.37	34.7	27.1
C.V%		3.94	4.81	8.76
SE±		0.42	3.97	1.37
		Second season		
0	0	2.6.0	31.5	20.3
	10	36.0	37.3	35.0
12	0	36.0	35.9	30.6
	10	42.0	38.7	36.2
Grand mean		35.0	35.8	30.6
C.V%		4.82	5.48	3.65
SE±		3.96	1.4	0.646

The data of average biological yield for all seasons are shown in Table 5 and showed significant differences (P≤ 0.05) in biological yield between each of GM treatment and FYM treatment and the control . Also, similar results were found in their residual effect. These results are in line with the results shown by Rasul *et al.* (2015) who reported that the value of biological yield increased significantly in response to organic manure application.

EDITORIAL

Table 5. Biological yield (ton ha^{-1}).

Green manure levels(kg/ha)	FYM Levels (ton/ ha)	Direct effect	Residual effect first year	Residual effect second year
		2007/08	2008/09	2009/10
First season				
0	0	3.54	8.95	5.61
	10	11.35	12.52	11.97
12	0	7.61	13.96	8.28
	10	10.54	12.29	13.92
Grand mean		8.26	11.93	9.95
C.V%		19.87	10.91	4.61
SE±		9.48	6.51	0.264
Second season				
0	0	4.77	7.15	4.70
	10	10.37	11.47	7.33
12	0	9.83	11.48	7.33
	10	13.29	11.92	8.19
Grand mean		9.57	10.51	6.81
C.V%		18.88	5.82	9.43
SE±		10.42	3.53	0.371

Grain yield of wheat

Table 6 showed significant differences ($P \leq 0.05$) in grain yield between each of GM, FYM, and their interaction during the first application of manures and that of the control. Also similar results were found due to the residual effects of GM and FYM. In the primary application of manures the interaction of GM and FYM treatments produced the highest grain yield followed by that of FYM treatments and then that of GM treatments. However, regarding the residual effect of both seasons, GM gave higher grain yields than that of FYM. This is probably due to the higher nitrogen percentage (3.11%) of GM as compared to that of FYM (0.02%) (Table 2).The residual effect1 of GM and FYM treatments gave higher grain yield than that of their respective direct effects. However, in the residual effect2 both of GM and FYM recorded lower grain yield than that of their respective direct effect. This result might be due to the higher decomposition of organic matter due to higher soil temperature in the desert plain soil or/ due to the presumable depletion of the soil or both.

High wheat grain yield due to application of organic manures has been reported by many workers (Ahmed, 2017; Rasul *et al.* 2015; Awad Elkarim and Yuonis, 2008). The increase in grain yield of wheat could be attributed to either addition or improved availability of some essential plant nutrients or to improved physical conditions of the soil.

EDITORIAL

Table 6 Wheat grain yield (ton ha^{-1}) .

Green manure levels(kg/ha)	FYM Levels (ton/ ha)	Direct effect	Residual effect first year	Residual effect second year
		2007/08	2008/09	2009/10
		First season		
0	0	1.13	2.62	0.92
	10	4.47	4.85	2.41
12	0	3.03	5.04	3.02
	10	4.66	5.08	3.34
Grand mean		3.32	4.39	2.41
C.V%		15.02	8.93	14.67
SE±		2.88	1.96	0.203
		Second season		
0	0	1.51	2.42	0.93
	10	3.85	4.69	2.35
12	0	3.58	5.03	2.52
	10	5.11	5.06	3.20
Grand mean		3.51	4.30	2.24
C.V%		15.16	3.23	14.11
SE±		3.07	0.80	0.18

CONCLUSION

Wheat yield components and total yield were increased due to application of GM and FYM. GM, therefore, may be used in vast areas, as it may give a solution to the problems of the infertility of desert plain soils. GM and FYM had continuing positive effects on the desert plain soil to produce higher grain yield of wheat at least in the second year after application. It is recommended to add organic manure every two years to improve the soil properties and productivity of the desert plain soil in the Northern State of the Sudan.

EDITORIAL

REFERENCES

Ageeb,O.A.A, A.B.Elahmadi, M.B. Solh and M.C. Saxena. 1995. Wheat production and improvement in the Sudan. Proceeding of the National Research Review Workshop, 27 – 30 August 1995, ARC, Wad Madani, Sudan.

Ahmed, I. A. 2017. Direct and Residual Effects of Green and Chicken Manures on Properties of Desert Plain Soils and Wheat (*Triticum aestivum L.*) Yield in the Northern State, Sudan. Ph.D. Thesis, Department of Soil and Water Sciences, Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan.

Awad Elkarim, E. E. and S. Babiker. 2005. Response of wheat to farmyard manure and nitrogen fertilization in high terrace soils. Annual Report of LWRC (2004/2005), ARC, Medani, Sudan.

Awad Elkarim, E. E. and I. D.Younis. 2008. Effects of farmyard manure, nitrogen and phosphorus fertilization on growth and productivity of wheat under New Hamdab conditions. A paper submitted to the Crop Husbandry Committee, December 2008, LWRC,ARC, Wed Medani, Sudan.

Brady, N.C. 1990. The Nature and Properties of Soils (6th Edition). MacMillan Publishing Company, New York.

Hornik,S.B. and J.F. Parr. 1987. Restoring the productivity of marginal soil wit organic amendments. American Journal of Alternative Agriculture. 2(2):64-68.

Ibrahim,H.S. 1990. Effects of different levels of fertilizers N and P application on yield and NP uptake by wheat under high terrace soil of the Northern Region of Sudan. Annual National Coordination Meeting, 27 -31 Sept. 1990, Agricultural Research Corporation, Wad Medani, Sudan.

Khan, S. and S. K. Khalil.2014. Integrated use of organic and inorganic fertilizer in wheat and residual effect on subsequent mung bean. International Journal of Farming and Allied Sciences. 3(8):835-844.

LWRC (Land and Water Research Centre).1999. Detailed soil survey and land suitability classification of Multaga Scheme. ARC, Wad Medani, Sudan.

Rasul,G; A.M. Ahmed and S. T. Ahmed,.2015. Influence of different organic fertilizers on growth and yield of wheat. American-Eurasian Journal of Agriculture and Environmental Science, 15 (6): 1123-1126.

Sajjad,R.M., A. Subhani, R. Rafique, T. Hussain, W. Naseem, R. Bibi and S. N. Malik. 2018. Green manuring for moisture conservation and wheat yield improvement in rainfed agriculture. Journal of Natural Sciences Research 8(9):33-41.