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INTERACTIVE EFFECTS OF ANIMAL MANURES AND CHEMICAL AMENDMENTS ON THE GROWTH ATTRIBUTES AND YIELD OF SUNFLOWER GROWN ON A CALCAREOUS SOIL

[43]

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ABSTRACT

Two field experiments were conducted on a calcareous soil to study the effect of farmyard manure (FYM), chicken manure (CHM), chemical amendments and inorganic fertilizers on the production of sunflower *(Helianthus annus* L.). The experiments were executed for two successive seasons (1999 and 2000) in the Experimental farm, Faculty of Agriculture, Shambat (Latitude 15°40 N and Longitude 32° 32 E), Sudan. The manures were added at the rate of 11.9 tons/ha; the inorganic amendments and fertilizers were applied at the rates of 95.2 kg N/ha, 52.4 kg P_2O_5/ha, 95.2 kg K_2O/ha, and 119 kg S/ha. The design adopted was completely randomized block design with 3 replicates. Measured growth and yield parameters included, number of leaves/plant, plant height, head diameter and seed yield. The results indicated that, the number of leaves/plant, plant heights, and head diameter was significantly different due to CHM+S, CHM+N and FYM+CHM, as compared to other treatments. The seed yield was significantly affected by using FYM+CHM+N FYM+N, CHM+N and CHM+S as compared to other treatments.

INTRODUCTION

It has been thought that chemical fertilizers were the most important input for boosting crop yield, but soon people realized that intensive mineral fertilization has adverse, long-term environmental hazards (**Halliday and Wolfe, 1991, Kuipers *et al* 1999**). Moreover, the cost of production of chemical fertilizers and the need for the conservation of resources forced the developing and the under developed countries, including Sudan, to look for alternatives. Therefore, organic fertilizers assumed great importance compared to synthetic fertilizer although they contain relatively low concentrations of nutrients. They establish a healthy soil ecosystem, enhance beneficial soil micro-flora and breathe life into lifeless soils by enhancing water and nutrient holding capacity of the soil. Organically bound nutrients increase the use efficiency of fertilizers; therefore, less chemical fertilizers are needed to supply the same amount of nutrition, because nutrient loss is reduced. In general, they elicit physical, chemical and biological changes in the soil by performing important functions, which the synthetic formulations do not (**Tester, 1990; Mokolobate and Haynes, 2002**). In addition, the use of organic fertilizer should result in a substantial cut in the farmer's fertilizer bill by providing cheaper soil amendments. Moreover, collection of organic materials and their con-

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servation keep villages clean and promote a healthy life, reducing trash and retaining soil moisture and consequently saving on water bills **(FAO, 1992)**. Using organic fertilizers on large scale can make a significant shift in successful and stable agriculture.

The soils of Sudan are low in organic matter and nitrogen (**Abdelmagid *et al* 1982**). In spite of this fact, there is a remarkable lag in the use of organic manures due to a variety of reasons. These include: the unilateral development of crop and animal systems of production, lack of appreciation of the value of organic manures in the maintenance of soil fertility and paucity of information on the scientific methods of their preservation and storage. Organic fertilizers are so far restricted to traditional horticultural sites with mineral fertilizers are coming into common use in nearly all integrated areas of crop production **(FAO, 1992)**.

Based on the above manure merits, this study was meant to investigate the influence of farmyard manure (FYM), chicken manure (CHM) and their interaction with chemical fertilizers on the growth attributes and seed yield of sunflower crop grown on non-saline calcareous soil.

MATERIALS AND METHODS

Two field experiments were conducted for two successive seasons in a non-saline calcareous soil classified as fine montmorillonite, isohyperthermic, Entic Chromusterts **(Soil Survey Staff, 1975)** in the experimental farm of the Faculty of Agriculture Shambat (latitude 15° 40' N and longitude 32° 32'E), Sudan. Some physical and chemical properties of the soil were presented in **Table (1)**. The climate is semi-desert characterized by very hot to hot summers and mild dry winters. The average annual rainfall is about 150-180 mm. The mean maximum temperature during summer is 48C° and mean minimum temperature during winter is 15°C. The soil was deeply ploughed, harrowed, leveled and finally ridged at 70-cm spacing. The total number of plots was 48 and the plot size was 4x4 m containing 4 ridges.

Two types of manure were used namely: chicken manure (CHM), farmyard manure (FYM) and their combination (1:1) at the rate of 11.9 tons/ha applied to the soil before seed sowing. The chemical fertilizer and amendments included the following: nitrogen 95.2 kgN/ha, phosphorus 52.4 kgP_2O_5/ha, potassium 95.2 kgK_2O/ha and elemental sulfur 119 kgS/ha. The sources of nitrogen, phosphorus and potassium were urea, triple superphosphate and potassium sulphate, respectively. The chemical fertilizers were broadcast and then, incorporated into plots to which animal manures had been already added.

Certified seeds of new high performance hybrid (Hysun 45) of sunflower *(Helianthus annus* L.) were planted at the rate of 4.8 kg/ha (2-3 seeds/hole) with 10 cm spacing between holes. The plots were irrigated every 10-12 days. Three weeks after sowing, the seedlings were thinned to one plant/hole giving a population of 112 plants/plot. Weeding was practiced by hand hoeing, whenever needed. Heads were covered after pollination by paper and cloth bags to protect them against birds.

Three plants per plot were tagged randomly to measure parameters that include: the number of leaves/plant, plant height and head diameter. Heads were threshed prior to seed counting then seeds were weighed to estimate seed yield (g/plant). The results were statistically analyzed **(Snedecor and Cochran, 1987)**, and mean separation was performed using Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Relatively high values of plant height were recorded when the soil was treated with CHM+N, CHM+S and CHM+P **(Table 2)**. This reflects the efficiency of manures as a valuable source of nutrients compared with the control. It could also be attributed to the effect of manure in increasing water uptake by plant roots which enhance cell elongation, nutrient uptake, and subsequently extensively plant growth **(Buresh and Tian, 1997)**. However CHM treatments stand out as the most effective soil amendment followed by those of FYM in both seasons. This agreed with the findings recorded by **Eltilib, *et al* (1995)** on wheat crop. The increase in plant height was significant over the control in both seasons **(Table 3)**. This was attributed to the beneficial effect of treatments and their interactions on the nutrient uptake, metabolic process, root growth, cell division and elongation (**Soliman *et al* 1994; Bahadur *et al* 2002**) by ensuring appropriate balance of nutrients (**Uyovbisere and Lombim, 1991; Diaz *et al* 1995**).

A significant increase in the number of leaves per plant was observed due to the treatment of FYM+CHM+K in the first season; otherwise the differences were not significant in both seasons.

Significant effects were frequently obtained on the head diameter **(Table 4)** could be explained by

Table 1. Some selected physical and chemical properties of the soil of the experimental site

Properties	Soil depth (0 – 30 cm)	Soil depth (30 – 60 cm)
Saturation percentage	57.3	76.9
Ph	7.9	8.1
ECe (dS/m)	1.02	0.83
Soluble cations		
Calcium ($mmol_c$/l)	2.8	2.2
Magnesium ($mmol_c$/l)	1.6	0.93
Sodium ($mmol_c$/l)	0.32	0.20
Potassium ($mmol_c$/l)	0.02	0.02
SAR $(mmol/l)^{1/2}$	0.21	0.22
Organic Matter (%)	0.56	0.51
Nitrogen (%)	0.028	0.021
Phosphorus (ug/g)	5.3	4.2
Calcium carbonate (%)	6.8	7.0
Sand (%)	33.3	30.7
Silt (%)	25.4	24.1
Clay (%)	41.3	45.2
Bulk Density (Mg/m^3)	1290	1380
Hydraulic conductivity (cm/hr)	1.92	1.66

Table 2. The effect of treatments on the number of leaves/plant of *Helianthus annus* in the first and the second season

Treatments	First Season	Second season
	No. of leaves/plant	No. of leaves/plant
Control	33.33^{ab}	35.67^{a}
FYM	34.33^{ab}	35.67^{a}
CHM	35.33^{ab}	36.00^{a}
FYM+CHM	35.00^{ab}	35.67^{a}
FYM+N	33.33^{ab}	37.00^{a}
FYM+P	32.67^{ab}	37.33^{a}
FYM+K	32.33^{ab}	37.00^{a}
FYM+S	31.33^{b}	35.67^{a}
CHM+N	34.67^{ab}	35.67^{a}
CHM+P	35.67^{a}	37.00^{a}
CHM+K	34.67^{ab}	36.00^{a}
CHM+S	34.00^{ab}	37.67^{a}
FYM+CHM+N	34.33^{ab}	35.67^{a}
FYM+CHM+P	34.33^{ab}	36.67^{a}
FYM+CHM+K	35.67^{a}	37.33^{a}
FYM+CHM+S	34.00^{ab}	36.00^{a}
	$LSD_{0.05}$ = 3.408	$LSD_{0.05}$ = 1.927

Values within the column having the same letters are not significantly different using Multiple Range Test.
FYM – farmyard manure; CHM = chicken manure; N = nitrogen; P = phosphorus K = potassium; S = sulphur.

Table 3. The effect of treatments on plant height of *Helianthus annus* in the first and the second season

Treatments	First Season	Second Season
	Plant height (cm)	Plant height (cm)
Control	129.7^{e}	132.0^{defg}
FYM	142.3^{bcde}	131.0^{efg}
CHM	167.3^{ab}	153.1^{ab}
FYM+CHM	160.0^{abc}	136.9^{bcdefg}
FYM+N	149.7^{abcde}	147.4^{abcde}
FYM+P	138.0^{cde}	134.4^{cdefg}
FYM+K	137.0^{cde}	122.1^{g}
FYM+S	133.0^{de}	126.1^{fg}
CHM+N	173.7^{a}	149.2^{abcd}
CHM+P	172.0^{a}	146.7^{abcde}
CHM+K	167.3^{ab}	148.9^{abcd}
CHM+S	172.3^{a}	160.2^{a}
FYM+CHM+N	163.0^{abc}	141.8^{bcdef}
FYM+CHM+P	156.7^{abcd}	143.6^{abcde}
FYM+CHM+K	152.7^{abcde}	143.9^{abcde}
FYM+CHM+S	161.7^{abc}	150.3^{abc}
	$LSD_{0.05} = 22.66$	$LSD_{0.05} = 15.33$

Values within the column having the same letters are not significantly different using Multiple Range Test.
Symbols as defined in **Table (2)**

Table 4. The effect of treatments on the head diameter (cm) of *Helianthus annus* shoot at flowering stage

Treatments	First Season	Second Season
	Head diameter	Head diameter
Control	15.59^{a}	16.91^{bc}
FYM	15.61^{a}	17.28^{bc}
CHM	12.16^{a}	19.29^{ab}
FYM+CHM	19.49^{a}	21.06^{a}
FYM+N	12.47^{a}	20.82^{a}
FYM+P	11.85^{a}	17.34^{bc}
FYM+K	10.91^{a}	16.19^{c}
FYM+S	10.32^{a}	16.40^{c}
CHM+N	12.13^{a}	19.36^{ab}
CHM+P	19.02^{a}	18.49^{abc}
CHM+K	13.12^{a}	20.83^{a}
CHM+S	20.34^{a}	19.49^{ab}
FYM+CHM+N	13.78^{a}	19.52^{ab}
FYM+CHM+P	16.28^{a}	18.73^{abc}
FYM+CHM+K	12.31^{a}	20.77^{a}
FYM+CHM+S	11.98^{a}	18.63^{abc}
	LSD = 8.544	LSD = 2.273

Values within the column having the same letters are not significantly different using Multiple Range Test.
Symbols as defined in **Table (2)**

Table 5. The effect of treatments on the grain yield (g/plant) and grain yield/area (kg/ha) of *Helianthus annus* in the first and second seasons

Treatments	First Season		Second Season	
	Grain yield (g)/plant	yield/area (kg/ha)	Grain yields g/plant	yield/area (kg/ha)
Control	53.00^{f}	7761^{bcde}	54.33^{bcde}	7572^{f}
FYM	65.01^{cdef}	7481^{cde}	52.37^{cde}	9287^{cdef}
CHM	78.20^{abcd}	10140^{abc}	70.96^{abc}	12460^{abcd}
FYM+CHM	96.30^{ab}	10720^{abc}	75.01^{abc}	13760^{ab}
FYM+N	105.10^{a}	8959^{bcd}	62.71^{abcd}	15020^{a}
FYM+P	63.32^{def}	7951^{cde}	55.66^{bcde}	9045^{def}
FYM+K	51.95^{f}	6155^{de}	43.09^{de}	7421^{f}
FYM+S	56.6^{ef}	5269^{e}	36.88^{e}	8086^{ef}
CHM+N	83.42^{abcd}	10240^{abc}	71.71^{abc}	11920^{abcd}
CHM+P	81.89^{abcde}	11060^{abc}	77.42^{abc}	11700^{abcde}
CHM+K	91.49^{abc}	11500^{ab}	80.47^{ab}	13070^{abc}
CHM+S	84.34^{abcd}	12060^{a}	84.39^{a}	12050^{abcd}
FYM+CHM+N	88.11^{abcd}	11510^{ab}	80.55^{ab}	12590^{abcd}
FYM+CHM+P	74.32^{bcdef}	7387^{de}	51.71^{cde}	10620^{bcdef}
FYM+CHM+K	92.9^{ab}	9398^{abcd}	65.57^{abcd}	13270^{a}
FYM+CHM+S	76.97^{bcdef}	9688^{abcd}	67.81^{abcd}	11000^{bcdef}
	$LSD_{0.05}$=31.92	$LSD_{0.05}$ = 23.3	$LSD_{0.05}$ = 22.35	$LSD_{0.05}$ = 3329

Values within the column having the same letters are not significantly different using Multiple Range Test.
Symbols as defined in **Table (2)**

the fact that, most of the nutrients absorbed by the plants especially nitrogen may be invested in seed filling and head enlargement before maturity, thus confirming the findings of **Coic (1975)**. However, the effect of FYM+CHM and CHM treatments was relatively pronounced on the head diameter in the second season. This indicated that more nutrients were released upon the decomposition of these treatments in the second season to satisfy the nutrient requirements of the sunflower crop.

The high seed yield obtained with CHM+S, FYM+CHM+N **(Table 5)**, agrees with the results of **Peter, *et al* (2002)** who concluded that, seed yield and its components, such as head diameter, number of seed per head and 1000 seed weight, increased significantly by nitrogen application. However the low yield in the first season could be attributed to the effect of low nitrogen level applied on the later stages of growth, and the amount remaining in the soil might not be sufficient to give a marked response.

Finally, it can be concluded that the application of manures generally exerted significant effects on growth and yield of sunflower crop. The efficiency of CHM in promoting sunflower production frequently surpassed that of FYM.

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حوليات العلوم الزراعية
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التأثير التفاعلي لمخلفات الحيوان والمصلحات الكيميائية علي نمو وإنتاج عباد الشمس المزروع في أرض جيرية

[٤٣]

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أجريت تجربتين حقليتين علي أرض جيرية لدراسة تأثير مخلفات الأبقار (FYM)، مخلفات الدواجن (CHM)، المصلحات الكيميائية والأسمدة غير العضوية علي إنتاج عباد الشمس. نفذت التجارب لموسمين متتاليين (١٩٩٤ و ٢٠٠٠) في المزرعة التجريبية بكلية الزراعة - شمبات (خط عرض ٤٠° ١٥ ش وخط طول ٣٢ °٣٢٥ شرق) بالسودان.

أضيفت المخلفات بمعدل ١١,٩ طن/هكتار بينما أضيفت الأسمدة الغير عضوية بمعدل ٩٥,٢ كجم نيتروجين للهكتار، ٥٢,٤ كجم فوسفور للهكتار و٩٥,٢ كجم بوتاسيوم للهكتار و ١١٩,٠ كجم كبريت للهكتار. وأتبع في تنفيذ التجربة التصميم الكامل العشوائي بثلاثة مكررات. مقاييس النمو والإنتاج شملت عدد الأوراق لكل نبات طول النبات، قطر الرأس وإنتاج الحبوب.

أوضحت النتائج أن هناك بعض الاختلافات في عدد الأوراق لكل نبات وأطوال النبات وقطر الرأس في المعاملات (CHM+S) ، (CHM+N) و(FYM+CHM) بالمقارنة بالمعاملات الأخرى . وتأثر إنتاج الحبوب إيجابيا بالمعاملات (FYM+CHM+N) ، (FYM+N) ، (CHM+N) و(CHM+S) مقارنة بالمعاملات الأخرى.

تحكيم: أ.د عادل السيد اللبودى