



Research Article

Effect of Organic Fertilizers Application on Growth, Yield and Quality of Tomatoes in North Kordofan (sandy soil) western Sudan

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ABSTRACT

The Study was conducted in Bara locality of North Kordofan state, for two consecutive winter seasons (2009/2010). The objective of the study was to investigate the effect of different types of organic fertilizers on soil chemical and physical properties, and on growth, yield and quality of tomatoes fruits. The experiment consisted of five treatments. The treatments were laid in a randomized complete block designed (RCBD) with three replications. Soil analysis showed that the experimental area is dominated by sandy soil texture. Tomato seeds were planted in the nursery and then transplanted into the field after five weeks. Data collected Soil sampling and analysis, Results of soil samples analysis showed significant ($p \leq 0.05$) change in the soil chemical and physical properties and increase in the amount of organic matter content especially. The production indicators showed that the tomatoes Agronomic parameters were significantly ($P \leq 0.05$), affected by the addition of different sources of organic fertilizers.

Keywords:

sandy soil, organic fertilizers,
compost, chicken manure, cattle
manure, tomatoes

INTRODUCTION

Low soil fertility is one of the main factors responsible for low productivity of vegetable crops in North Kordofan State. Soil fertility can be presumably enhanced by organic and inorganic fertilizers application. However, the use of any type of fertilizer depends on several factors such as soil type, nature of crop and socio-economic conditions of the area. Use of organic fertilizers is highly encouraged in the area because it is available due to the presence of high livestock population while in-organic fertilizers are less available and costly, and cannot be afforded by the small holder and traditional vegetable producers in the area (Babiker, Mustafa (2005).

Soils in North Kordofan are predominantly sandy. These soils are characterized by low nutrient and water holding capacity, especially during hot summer. This often results in stunted plant growth, poor bloom or fruit production. However, sandy soil also offers benefits, including excellent drainage, good air circulation and less pest incidence. By properly preparing and maintaining sandy soils, farmers enjoy these advantages while improving possible negative factors. This creates a healthy soil in which many plants thrive (Ismail,- 2005).

Soil fertility in smallholder farms is almost entirely dependent on locally available resources. Cattle manure, cereal and legume Stover, and woodland litter are commonly used as sources of organic fertilizers, but they are rarely applied in sufficient quantities to impact crop yields. The use of high quality organic fertilizers is rarely practised, although through research and extension activities in Africa, some farmers now include legume green manures or legume-based fallows in their crop sequences.

Composting is a biological process by which micro-organisms convert organic materials into a dark humus-rich soil-like material called compost. It is the same natural process that produces the dark humus

1. Ten tons per hectare compost (T1).
2. Ten tons per hectare fresh cattle manure (T2).
3. Ten tons per hectare fresh chicken manure (T3).
4. Ten tons per hectare fresh (chicken manure 30% + cattle manure 70%) (T4).
5. Untreated Control (T5).

The organic fertilizers dose of (ten t/ha), were point-applied into the planting plots three days before transplanting.

Data were collected on plot basis. Six tomato stands were selected from the middle of each plot for this purpose. Harvesting was carried out at seven days interval. Soil samples were taken using auger from a depth of (0–40) cm at the start and end of season. Two weeks after transplanting plant height\cm, number of branches, root length \cm fresh and dry weight of shoot and root were measured at two weeks intervals. Fifty percent flowering were measured. Sixty five days after transplanting tomatoes yield parameters were

layer on the forest floor. Composting differs only in the intentional creation of conditions that result in more rapid decomposition of organic material than what would normally occur in nature. Composting is a simple, rewarding way to recycle yard trimmings and food scraps at home while creating compost, a valuable soil amendment for gardens and lawns (Park,- et al., 2002).

The main objective of this study is to determine the effect of organic fertilizers on soil fertility growth, yield and quality of tomato in the sandy soils of Bara locality at North Kordofan State.

MATERIAL AND METHODS

Bara Locality (study area) is situated in North of Kordofan State between (Longitude 30.35° E and latitudes 13.70 °N), with a semi-arid climate having rainfall between 200 and 300 mm (Fadel-El Moul, (2005). The inhabitants main economic activity is livestock rasing, mainly camels and sheep. Some millet, watermelon (both rain fed) and horticultural production (irrigated) take place. The soils vary from sandy interspaced by silt depression in the northern parts, where the topography is characterized by stabilized and disturbed sand dunes locally known as "goz". The silt depression or clay pockets are locally known as "gardud". The dominant soil type (sandy soil) sustains more cropping pressure by virtue of its good water relations and easy cultivation. Sandy soils were much degraded and set in motion by moving dunes to invade other areas of low contours.

Field experiment were conducted for two consecutive seasons (2009-2010 and 2010-2011), to study the effect of organic fertilizers application on tomatoes. The trial consisted five treatments arranged in a randomized complete block design (RCBD) with three replications and Plot size per treatment was 3 m × 2 m.

The treatments i.e. the organic fertilizers types were: estimated. These parameters included marketable fruit size (Kg), weight of 10 fruits (Kg), mean number of fruits\plant, and total yield\ ha. Measurement of tomato fruits quality like total soluble solids, total soluble sugars, L-Ascorbic acid (vitamin C), total protein and water content were determined. Samples of the harvested plant material (stems and leaves) per treatment were taken at the end of each season, oven-dried at a temperature of 75°C for 3 days and analyzed for its N, P, K, Mg, Ca contents, organic carbon, and C\N. Data collected was subject to analyses using MSTAT-C software (Freed and Eisnsmith, 1986).The data were subject to analysis of variance (ANOVA-2). The computer package "Excel" was used to prepare graphs.

RESULTS AND DISCUSSIONS

Soil analysis before planting

The data in Table (1) shows the composition of the soil before planting and the addition of organic fertilizers. In

two depth (0-20, 20-40cm), showed the effect of organic fertilizers on soil chemical and physical properties. Bulk density (1.46 g/cm³), pH (7.59), saturation percentage (31.7%), the electrical conductivity, cation exchange capacity, organic carbon and nitrogen percentage all these parameters increase with depth.

Soil analysis in the end of experiment

Soil chemical properties

Table (2), revealed no significant differences in nitrogen parentage which ranged between (0.01-0.03). Highest value of nitrogen parentage was recorded when adding compost (0.03%), and the lowest value of nitrogen was observed in the untreated control (0.01%). They were an increase in phosphors and potassium contents with depth. The highest value of Phosphors and potassium were recorded in the compost (3.45ppm, 12.78 mg/100g soil) respectively. Compost increased Phosphors and potassium percentage (97.14%, 39.67%). The organic carbon decreased with depth in all treatments except untreated control. Organic carbon range between (0.44%) in the compost treatment and (0.01%) in the untreated Control. The added organic fertilizers increase the proportion of organic carbon in the soil surface, this indicated increase of organic matter, which have a significant impact in plant nutrition (Nelson et al., 1996). Cation exchange capacity (C.E.C) also increased with depth in all treatments except the untreated control decreased with depth, compost, cattle manure; chicken manure, chicken + cattle manure increased (C.E.C) by (54.97, 28.64, 32.10; and 51.04% respectively). The compost treatment gave the highest value of (C.E.C (6.71 mg\100g soil) ; and the lowest value was recorded in the untreated control (4.33 mg\100g soil). No significant differences ($p>0.05$) in pH values was recorded in all treatments. The highest value of electrical conductivity (ECe) was recorded in the untreated control (1.52 ds/m) in (20-40) depth; and lowest value was recorded in the compost treatment (0.62 ds/m) in (0 – 20) depth.

Soil physical properties

Tables (3) show the effect of organic fertilizers on soil physical properties.

Soil moisture content: percentage increased with depth, the highest value of moisture content given by compost treatment (9.57%) an increase of (88.39%) compared to the untreated control.

Bulk density (B.D): The highest value of bulk density was recorded in the compost treatment (1.62 g/cm³) while untreated control treatment gave the lowest value (1.46 g/cm³).

Note that upon the addition of organic fertilizer; there was a significant change in the soil physical and

chemical properties. There is a clear increase in the percentage of organic carbon and this is an indication of increased soil organic matter. There is also an increase in the amount of (NPK). There has been improvement in the soil water capacity.

Growth parameters: Results in Table (4) showed that tomato growth parameters in the first season (2009) were significantly ($P\leq 0.01$), influenced by different organic fertilizers. Organic fertilizers have a clear impact on the different stages of plant growth. Compost, cattle manure, chicken manure, Cattle manure + chicken manure increased plant height, number of branches, fresh and dry weight of roots and shoots by 48.8%, 63.6%, 71.0%, 88.4%, 32.4%, 60.0% for compost, cattle manure an increase of 22.0%, 27.3%, 44.1%, 48.5%, 23.1%, 40.4%, chicken manure 26.82%, 36.4%, 47.8%, 51.7%, 23.4%, 44.2%, Cattle manure + chicken manure gave 39.0%, 63.6%, 59.7%, 69.5%, 28.5%, 50.1% respectively; in contrast to the untreated control. The high significant deferent in plant height, number of branches, days to 50% flowering, root length\ cm, Fresh weight of root and shoot, Dry weight of root and shoot\g were recorded for compost treatment(10.4, 51.8g), while the untreated recorded(5.5, 32.4g), respectively.

Yield quality: The data in Table (5) represent the yield parameters in the first season (2009/10). All measured parameters gave highly significant differences ($P\leq 0.01$) among treatments. Tomato yield was positively affected by organic fertilizers application. Compost and chicken plus cattle manure gave the highest yield parameters compared to other treatments. Compost gave the highest values of number fruits/plant (36 fruits), fruits marketable size (11.2 kg); and fruits yield (21.5 ton\ha). Compost increased fruits yield by (112%) as compared to the untreated control. The lowest values of tomato yield parameters were obtained in the untreated control, which gave fruits number/plant (16 fruits), fruits marketable size (3.7 kg), and fruits yield (10 ton\ha).

Tomatoes Chemical constituents: Data presented in Table (6) shows the effect of organic fertilizers tomatoes chemical constituents. Results indicate the favorable effect of organic fertilizers on total soluble solids, total soluble sugars, Total protein, fruits water content and vitamin as L-Ascorbic acid (vitamin "C") compared to the control. Compost, chicken + cattle manure, chicken manure and cattle manure significantly increased total soluble solids by, 95.12% ,89.3% , 62.0% and 58.5%, total soluble sugars by 41.2%, 28.2%, 15.9% and 12.9%, vitamin "C" by, 56.2%, 50.48%,39.1% and 36.8%, and Total protein by 50.0%, 32.4%, 30.0%, and 27.7%, respectively;. Untreated Control gave the lowest values in all tomatoes chemical constituent. Aforesaid above; the highest value of water content was recorded at the untreated control (93.2%); this trait is undesirable. The lowest water content was recorded in the compost treatments (87.4%).

Table 1: shows the composition of the soil before planting and the addition of fertilizers

| Depth (cm) | BD g/cm ³ | pH | SP | ECe (ds/m) | C.E.C (mg/100gsoil) | O.C % | N (%) | P (ppm) | K (mg/100g soil) | Clay (%) | Slit (%) | Sand (%) | Soil texture |
|------------|----------------------|------|------|------------|---------------------|-------|-------|---------|------------------|----------|----------|----------|--------------|
| 0-20 | 1.41 | 7.42 | 32 | 1.45 | 3.75 | 0.01 | 0.01 | 1.26 | 8.40 | 2.64 | 7.10 | 90.26 | Sand |
| 20-40 | 1.50 | 7.76 | 31.4 | 1.87 | 4.23 | 0.22 | 0.02 | 2.85 | 9.63 | 2.85 | 8.85 | 88.30 | sand |

BD=bulk density, **SP**=saturation percentage, **ECe**=Electronic conductivity, **C.E.C**=cation exchange capacity
O.C=organic carbon, **N%**= total nitrogen, **P**=available phosphors, **K**=potassium exchange

Table 2: shows the effect of organic fertilizers on soil chemical properties in the end of experiment

| Treatments | Depth (cm) | N % | P (ppm) | K (mg/100g soil) | O.C | C.E.C (mg/100gsoil) | pH | ECe (ds/m) |
|------------------|------------|------|---------|------------------|------|---------------------|------|------------|
| Compost | 0 – 20 | 0.02 | 3.4 | 12.34 | 0.44 | 6.20 | 7.14 | 0.62 |
| | 20 – 40 | 0.03 | 4.8 | 13.21 | 0.34 | 7.22 | 7.24 | 0.93 |
| Cattle | 0 – 20 | 0.01 | 1.9 | 10.24 | 0.24 | 5.11 | 7.32 | 0.84 |
| | 20 – 40 | 0.01 | 2.5 | 11.36 | 0.20 | 6.03 | 7.41 | 1.20 |
| Chicken | 0 – 20 | 0.02 | 3.1 | 11.09 | 0.31 | 5.24 | 7.25 | 0.81 |
| | 20 – 40 | 0.03 | 3.6 | 11.75 | 0.21 | 6.19 | 7.40 | 1.19 |
| Chicken + cattle | 0 – 20 | 0.02 | 3.2 | 12.14 | 0.36 | 6.05 | 7.32 | 0.74 |
| | 20 – 40 | 0.03 | 3.8 | 12.86 | 0.27 | 7.02 | 7.72 | 1.02 |
| Control | 0 – 20 | 0.01 | 1.4 | 8.28 | 0.01 | 3.94 | 7.30 | 1.41 |
| | 20 – 40 | 0.01 | 1.8 | 10.02 | 0.02 | 4.72 | 7.17 | 1.52 |

Table 3: shows the effect organic fertilizers on soil physical properties in the end of experiment

| Treatments | Depth (cm) | M% | B.D | Clay (%) | Slit (%) | Sand (%) | Soil texture |
|------------------|------------|------|------|----------|----------|----------|--------------|
| Compost | 0 -20 | 9.29 | 1.56 | 4.50 | 8.30 | 87.20 | Sand |
| | 20 – 40 | 9.85 | 1.67 | 5.65 | 9.70 | 84.65 | Sand |
| Cattle | 0 – 20 | 7.12 | 1.42 | 2.80 | 6.60 | 90.60 | Sand |
| | 20 – 40 | 7.74 | 1.53 | 3.75 | 7.90 | 88.35 | Sand |
| Chicken | 0 – 20 | 7.18 | 1.46 | 3.15 | 7.70 | 89.15 | Sand |
| | 20 – 40 | 7.95 | 1.57 | 4.84 | 8.40 | 86.76 | Sand |
| Chicken + cattle | 0 – 20 | 8.35 | 1.56 | 4.25 | 8.10 | 87.65 | Sand |
| | 20 – 40 | 9.10 | 1.62 | 5.40 | 9.18 | 85.42 | Sand |
| Control | 0 – 20 | 4.81 | 1.40 | 2.65 | 5.55 | 91.80 | Sand |
| | 20 – 40 | 5.35 | 1.51 | 3.97 | 6.22 | 89.81 | Sand |

Table 4: Effect of organic fertilizers application on growth of tomatoes in the first Season (2009/2010).

| tomatoes Growth parameters | | | | | | | | |
|-----------------------------|--------------------|-----------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Type of organic fertilizers | Plant height(cm) | Days to 50% flowering | Number of branches | Root length(cm) | Fresh root(g) | Dry root(g) | Fresh shoot(g) | Dry shoot(g) |
| Compost | 61.0 ^a | 68.0 | 18.0 ^a | 18.6 ^d | 52.0 ^a | 10.4 ^a | 186.6 ^a | 51.8 ^a |
| Cattle manure | 50.0 ^c | 71.0 | 14.0 ^b | 22.1 ^b | 43.8 ^b | 8.2 ^{bc} | 173.4 ^c | 45.5 ^c |
| Chicken manure | 52.0 ^{bc} | 73.0 | 15.0 ^b | 23.3 ^b | 44.9 ^b | 8.4 ^{bc} | 174.1 ^c | 46.7 ^c |
| Chicken + cattle | 57.0 ^b | 69.0 | 18.0 ^a | 20.8 ^c | 48.5 ^b | 9.3 ^b | 181.1 ^b | 48.6 ^b |
| Control | 41.0 ^d | 82.0 | 11.0 ^c | 26.4 ^a | 30.4 ^c | 5.5 ^d | 140.9 ^d | 32.4 ^d |
| Mean | 52.0 | 73.0 | 15.0 | 22.2 | 43.92 | 8.35 | 171.2 | 45.0 |
| SE± | 0.87 ^{**} | 0.71 ^{**} | 0.49 ^{**} | 0.34 ^{**} | 0.95 ^{**} | 0.25 ^{**} | 2.05 ^{**} | 0.86 ^{**} |
| CV% | 3.53 | - | 7.16 | 5.48 | 2.20 | 3.29 | 1.65 | 2.08 |

^{**} Significant at ($P \leq 0.01$) level. a, b, c, d means in the same column under the same factor with different letters are significantly different according to Duncan Multiple Range Test (DMRT).

Table5 : Effects of organic fertilizers application on tomatoes yield in the first Season (2009/2010).

| Treatments | Fruits (No./plant) | Fruits Marketable yield(Kg) | weight of 10 fruits(Kg) | Fruits yield (ton/ha) |
|------------------|--------------------|-----------------------------|-------------------------|-----------------------|
| Compost | 36.0 ^a | 11.3 ^a | 1.1 ^a | 21.5 ^a |
| Cattle manure | 31.0 ^{bc} | 6.1 ^b | 0.8 ^c | 13.6 ^c |
| Chicken manure | 30.0 ^c | 6.7 ^b | 0.9 ^{bc} | 16.1 ^{bc} |
| Chicken + cattle | 34.0 ^{Ab} | 9.3 ^a | 1.0 ^b | 19.4 ^{ab} |
| Control | 16.0 ^d | 3.7 ^c | 0.5 ^d | 10.0 ^d |
| Mean | 29.5 | 7.4 | 0.9 | 16.1 |
| SE± | 0.92 ^{**} | 0.46 ^{**} | 0.02 ^{**} | 0.27 ^{**} |
| CV% | 6.24 | 14.61 | 7.62 | 15.55 |

^{**} Significant at ($P \leq 0.01$) level, a, b, c, d, e means in the same column under the same factor with different letters are significantly different according to Duncan Multiple Range Test (DMRT).

Table 6: the effect of organic fertilizers in composition of tomato fruits

| Type of organic fertilizers | Total soluble solid | Total soluble sugar | L-Ascorbic acid/1000g fresh weight | Total Protein | Moisture % |
|-----------------------------|---------------------|---------------------|------------------------------------|---------------|------------|
| Compost | 4.00 | 2.40 | 16.4 | 2.55 | 87.4 |
| Cattle manure | 3.25 | 1.92 | 14.2 | 2.17 | 89.6 |
| Chicken manure | 3.32 | 1.97 | 14.6 | 2.21 | 89.1 |
| Chicken+ cattle manure | 3.88 | 2.18 | 15.8 | 2.25 | 88.2 |
| Untreated control | 2.05 | 1.70 | 10.5 | 1.75 | 93.2 |
| L.S.D at 5% | 0.047 | 0.045 | 0.246 | - | - |

CONCLUSIONS

The results of this experiment demonstrated the effects of organic fertilizers in the soil properties growth, and yield quality of tomatoes. The following can be concluded.

- An organic manure fertilizer is a good efficient amendment for improving the physical, chemical and nutritional properties of the soil and increasing crops yield.
- Organic manure fertilizers addition decreased soil pH values and increased the nutrients uptake by the plant.

Depending on the type of organic fertilizer applied, the increase in yield was 112% from compost, 90% from chicken plus cattle manure, 70% from chicken manure and 50% from the cattle manure compared to the untreated control.

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