COMPARATIVE STUDY ON ORGANIC AND INORGANIC FERTILIZERS AND THEIR EFFECTS ON GROWTH AND YIELD OF TOMATO AND CUCUMBER UNDER GREENHOUSE CONDITIONS

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ABSTRACT: Organic fertilizers are derived mainly from animal matter, human excreta or crop residues, while chemical fertilizers are defined as any inorganic material of wholly or partially synthetic origin, that is added to the soil to sustain plant growth. This study was designed to compare between a commercial organic fertilizer and chemical fertilizers and their effects on growth and yield of tomato and cucumber under greenhouse conditions. The experiment was conducted in the cropping season of 2016/2017 at the University of Gezira. The experiment consist of four treatments viz. control, inorganic fertilizers, organic fertilizers (commercial organic fertilizer, Elkhaseeb ,of only cow manure) and a combination between organic and inorganic fertilizers. The soil of the experimental site is a riverain silt loam soil. The experiment for the two vegetable crops was arranged in a split plot design with three replications, and two factors, commercial organic fertilizer (OM) and chemical fertilizers (MN) which include nitrogen in the form of urea and phosphorus in the form of triple superphosphate. Foliar fertilization of micronutrients with Ca and B, was used for all treatments. Commercial organic fertilizer: OM was added at the rate of 15 tons /ha and nitrogen was added as urea at 86 kg/ha (2N). Phosphorus was applied as triple superphosphate at 43 kg P_2O_5/ha (1P). Tomato seedlings of cultivar Termis were transplanted on the ninth of February,2017 whereas cucumber seeds, variety Leader were planted on the first of February,2017.The results showed that the effect of combination of inorganic fertilizers and organic fertilizers is significantly higher than application of either fertilizer alone. The combination resulted in 417.65 kg /ha of tomatoes and 823.53 kg / ha of cucumber. Application of the commercial organic fertilizer alone gave 261.4kg / ha in tomatoes, while in cucumber it gave 732.03 kg /ha. Inorganic fertilizers alone gave 256.84 kg/ha in tomatoes and 447.7kg/ha in cucumber. This lead to a recommendation that application of combined fertilizers (organic+ inorganic) is the best practice for tomato and cucumber under greenhouse conditions, than any of the two fertilizers alone.

KEY WORDS: *Tomato, Organic Fertilizers, Inorganic Fertilizers, Growth, Yield Cucumber, Greenhouse*

1. INTRODUCTION

Organic fertilizers are derived mainly from animal matter, human excreta, or crop residues. For example, green manure, animal manure, compost, and others. Cow manure, a product of bovine animal species, which is usually dark brown in color, is often used as

manure. Conventional FYM contains about 0.73% N, 0.18% P and 0.71% K [1]. Organic fertilizers improve soil physical properties, such as water holding capacity, erosion stability and gas exchange [2] as well as chemical and biological properties and nutritional status of the soil. Disadvantages of organic fertilizers are their bulkiness with high cost of transportation and labor, high risk of infection with diseases, insects and the risk of weed seeds. Organic manure, although used for thousands of years in agricultural soils, has only recently been on the spot due to its positive effects on physical, chemical, and biological soil properties [3]. The use of organic sources has a role in the management of plant diseases and soil fertility in the field and greenhouse. Chemical fertilizers are rich in all essential nutrients that are needed by crops and always ready for immediate supply of nutrients to plants. They make plants grow more rapidly and appear greener in comparison with organic fertilizers. Chemical fertilizers can expedite plant growth and provide economic benefits to farmers. Disadvantages of chemical fertilizers are that they are harmful to soil life, acidify the soil, pollute groundwater, and may cause other hazards such as nitrate pollution in vegetables. The chemical fertilizers used for crop production are still at inadequate rates [4]. Nitrogen is an essential part of proteins and nucleic acids, as well as of the chlorophyll molecule [5]. Phosphorus and potassium are critical for tomato growth and development [6]. Phosphorus is essential to seed and root development, it is associated with early root development and architecture, especially when P levels are low.

Tomato (Solanum lycopersicum MiLL.) is one of the most widely grown vegetables in the world, belonging to the family Solanaceae. It is an excellent source of minerals, fibers, vitamins, and antioxidants, which help in controlling cancer, as well as improving the general health of people. Tomato is considered the main vegetable crop that is being cultivated in several locations in the Sudan. Cucumber (Cucumis sativus L.) is one of the most important members of the Cucurbitaceous family. It contains a fair amount of K, Ca and folate and a small amount of other nutrients, including vitamin C and is very low in calories. The mature fruits are eaten raw, in salad or used as pickles. Cucumber is considered as one of the important vegetables in the Sudan, which can be produced in greenhouses because of its limited cultivation period in open farm and its increasing demand to local consumption and export [7].

Greenhouses are very important growth environment in the Sudan, because most vegetables are with medium thermal requirements such as tomato, pepper, cucumber, melon, watermelon, marrow, green bean, and eggplant. Also, Sudan has a harsh climatic condition with high temperature and low relative humidity. Organic production of greenhouse crops has developed in the Sudan during the last decades. Greenhouse crops in general, have higher nutrient demands than field grown crops and therefore, to optimize production, it is essential to focus on the growing media and fertilization. The number of organic farms has increased from 400 in 1989 to 3500 in 2003 [8].

Tomato and cucumber are very important vegetable crops for human consumption with high economic value, short duration of growth and with other uses. For instance, oils extracted from cucumber seeds are used for medicinal purposes; reduced cholesterol and help in fighting cancers. Also, tomato is one of main ingredients in hundreds of dishes and its products (paste, juice, catchup, etc.) are sold in supermarkets throughout the world. This means that there is an increase in demand for tomatoes and cucumbers. For these reasons expansion of tomato and cucumber production, especially under greenhouse conditions, is necessary. Therefore, the main objective of this research is to carry out a comparison between a commercial organic fertilizer (Elkhaseeb) and chemical fertilizers and their effects on growth and yield of tomato and cucumber under greenhouse conditions. Specific

objectives are to show the effect of the two fertilizers (organic and inorganic) on growth and yield of tomato and cucumber, to develop technologies of organic fertilizers use under greenhouse conditions, and to increase awareness of the importance of organic fertilizers, for production of organically grown vegetables for the local and world markets.

2. MATERIAL AND METHODS

The experiment was conducted in the cropping season of 2016/2017at the Central laboratory Greenhouse, University of Gezira, Wad Medani, Sudan, latitude14° 24' N, longitude 33° E, and altitude 411 m.a.s.l. The experiment consists of four treatments viz. control, inorganic fertilizers, organic fertilizers (commercial organic fertilizer, only of cow manure) and a combination of organic and inorganic fertilizers.

2.1. Soil analyses

The soil of the experimental site is a riverain loamy soil with physical properties such as Particle size distribution determined by pipette method for separation of clay, silt and sand [9]. Bulk density was determined in an air –dry soil, using core method [10], field capacity was determined by small soil core method [11] in which the soil samples were subject to 0.3 bar soil moisture tension. Chemical properties, such as pH were measured using a pH meter with a glass electrode [12], electrical conductivity (ECe)was measured using EC-meter [13]. The soil is non saline, non-sodic. Available P was determined by [14]; total N was determined by micro-Kjeldahl procedure [15] and organic carbon was determined by oxidation -reduction titration with ferrous ammonium sulphate [16]. The cation exchange capacity (CEC) was measured using ammonium saturation [17].

2.2 Organic manure analyses

Organic manure analyses for pH by using a pH meter glass electrode in manure water suspension; the measurements include the following: pH, O.C, total N, total and K [18]. The experiment was arranged in a split plot design with three replications, main plot assigned for chemical fertilizers and subplot for commercial organic fertilizer. The land was prepared manually bringing the soil in leveled beds and plots were constructed, (dimension 30 m × 0.8 m). The sub plot size was 3.0m2 (0.8 m× 3.75m).

Cucumber seeds, variety Leader was planted manually on the first of February ,2017 at 40 cm inter row spacing. Transplanting of tomato seedlings of cultivar Termis was done manually on the ninth of February, 2017at 40 cm inter row spacing. Half of the greenhouse(southern) was allotted to cucumber and the other half(northern) was allotted for tomato. Commercial organic fertilizer: OM was added at the rate of 15 tons /ha and nitrogen was added as urea at 86 kg/ha (2N). Phosphorus was applied as triple superphosphate at 43 kg P2O5/ha (1P). Also, foliar fertilizer (Calboro2) which contains Ca and micronutrients is used for all treatments. Drip irrigation is the irrigation system practiced for the experiment.

2.2.1 Growth analyses

Growth analyses data were taken for plant height, number of leaves per plant every two weeks for the first and second reading, then every week. The number of fruits per plant were taken from the first pick on the sixteenth of March,2017 for cucumber, while the first pick for tomato was done on the thirteenth of April,2017 and every week until the end of the experiment for two crops.

2.2.2 Nutrient analysis

Leaves and fruits of tomato and cucumber were dried in an air- forced oven (70°C for 48 hours) grinded, sieved and analyzed for N and P. Nitrogen content in plant tissues was determined by Kjeldahl method according to [19]. Phosphorus of plant leaves and fruits tissues was extracted by hydrochloric acid to determine phosphorus content by using spectrophotometer [19].

2.2.3 Fruit yield

Total yield was calculated from all harvests for the two crops, starting at first production of fruits, until the final harvest after four months from planting date for cucumber and transplanting of tomato. The yield of fruits was calculated on fresh weight basis and dried, grinded, sieved and saved for further analyses.

2.2.4 Statistical analysis

Statistical tables were prepared for all measured and derived parameters and the data was analyzed using the statistical package Statistix 8.0 (ANOVA and Mean separation).

3. RESULTS AND DISCUSSION

3.1 Soil analyses

3.1.1 Physical properties

Table (1) shows the physical properties of the soil which is riverain silt loam soil with 2% sand, 73% silt and 25% clay.

Table1: Physical properties of the soil

CS%	FS%	SI%	C%	Bulk density gcm^{-3}	F.C%
1	1	73	25	1.67	40.6

3.1.2 Chemical properties

Table 2: The chemical properties of the soil

pH	CEC cmol / kg Soil	ECe dS/m	Av.P mg/ kg soil	TN%	O.C%
7.6	49	0.5	10.4	0.043	0.081

3.1.3 Organic manure analyses(Elkhaseeb commercial organic manure)

Table 3: Organic manure analyses

pH	O.C %	TN %	TP%	K%
7.1	31.5	1.4	1.60	1.45

3.2 Growth analysis of tomato and cucumber

3.2.1 Plant height of tomato(cm)

Plant height of tomato was recorded at (15,30,37and44) days after transplanting (DAT) and at the final harvest. Fig (1) shows that plant height increased continuously from

15 DAT to 44 DAT in all the treatments, At 44DAT the tallest plants were observed with the combination (organic+ inorganic) fertilizers(T4), followed by inorganic fertilizers alone (T2), then organic manure alone (T3) and finally the control treatment(T1), which gave the lowest plant height. These results agree with those of [20] who reported that treatments with organic manure in combination with ammonium nitrate resulted in taller plants than other treatments.

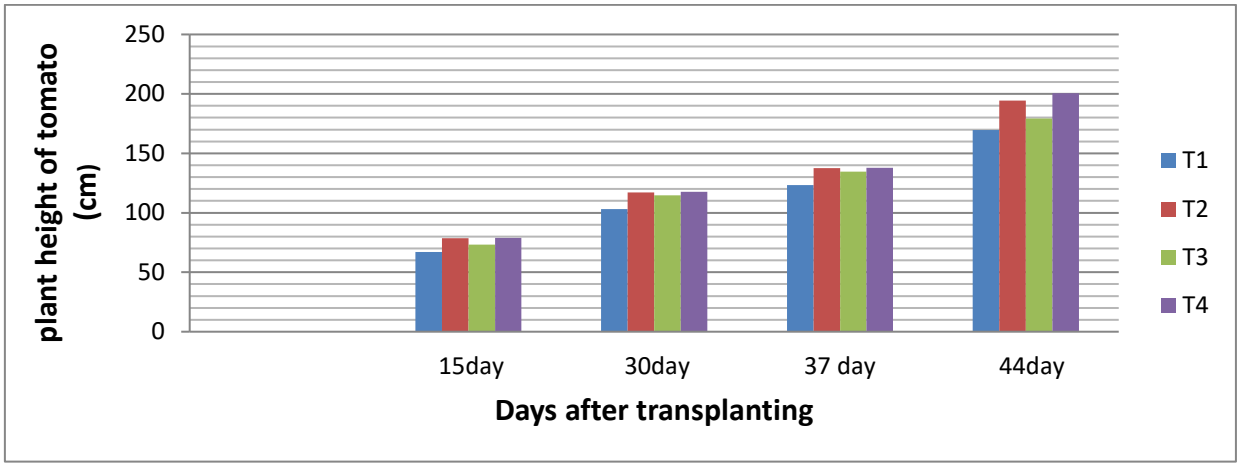

Fig.1: The effect of organic manure and inorganic fertilizers on plant height (cm) of tomato at different days after transplanting.

3.2.2 Vine length of cucumber

The measurements of vine length of cucumber as taken at 15,30, 37and 44 DAT. Fig (2) show that the combination of organic manure and inorganic fertilizers (T4) recorded maximum vine length of cucumber in comparison with other treatments. This was followed by organic manure alone, then chemical fertilizers alone, with control giving the shortest vine length. These results are in agreement with those of [21] who found that combined use of organic and Inorganic fertilizers reduced cost and amount of fertilizer required by crops. It also produced the maximum plant growth [22].

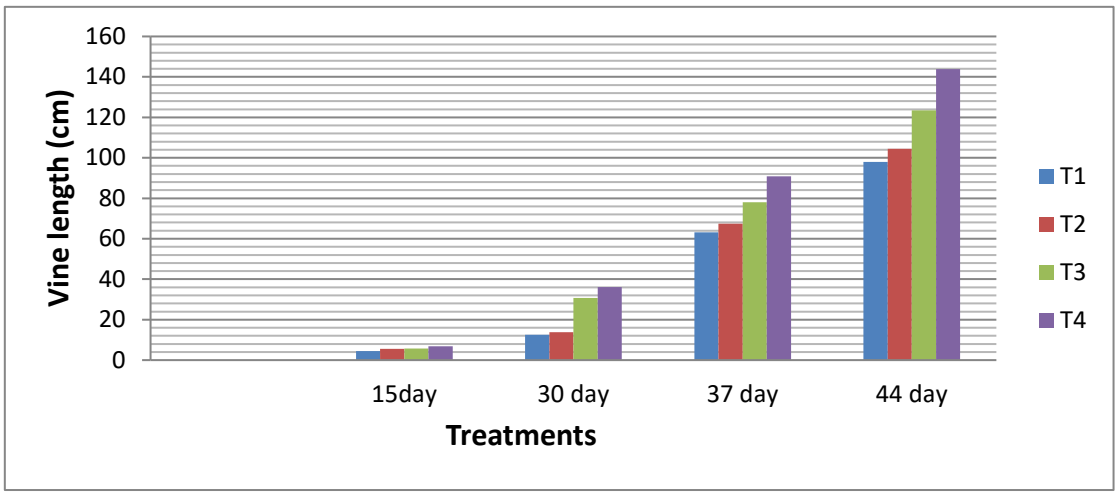

Fig .2: Effect of organic and inorganic fertilizers on vine length (cm)of cucumber.

3.2.3 Number of leaves per plant of tomato

A higher number of leaves indicate better growth and development of the crop. When there is greater number of leaves, the greater will be the photosynthetic area which may result in higher fruit yield. Fig (3) shows that the highest number of leaves per plant was produced by the combination of organic and inorganic fertilizers (T4) at (37)DAT. This is possibly due to the greater plant height and available nutrients. Treatment (T4) was followed by inorganic fertilizers (T2), then organic manure alone (T3), while the control (T1) produced lowest number of leaves per plant. These results agree with those of [23] at Jabalpur, Madhya Pradesh, India ,who found that application of 100 kg N + 50 kg P_2O_5 + 50 kg K_2O + 20 tonnes FYM ha^{-1} gave significantly maximum plant height (50.68 cm) and number of leaves plant-1 (49.50) and number of branches plant-1 (16.83). Number of leaves per plant of tomato was measured but did not give significant differences between treatments because of the lavish growth of the leaves in all treatments.

3.2.4 Number of leaves per plant of cucumber

Data presented in the Fig (3) shows that the combination of organic and inorganic fertilizers (T4) recorded the highest number of leaves per plant for cucumber followed by organic manure alone (T3), then inorganic fertilizers (T2) and the control (T1) which produced the lowest number of leaves per plant. This may be due to the nutrient availability from organic and inorganic fertilizers. This results are similar to those of [24] who observed that the soil + manure (1:1) medium gave better growth in terms of plant height, length of leaf, leaf width, number of leaves, and fresh weight of pineapple seedlings than other treatments.

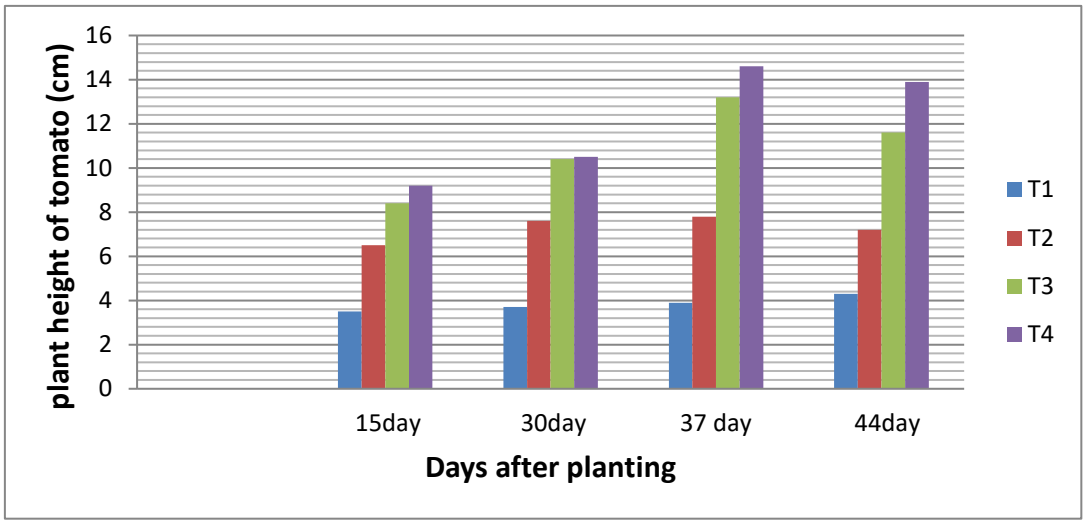

Fig. 3: Number of leaves of cucumber as affected by application of organic manure and inorganic fertilizers at different days after planting.

3.2.5 Yield of tomato

There was a gradual increase in tomato production with time of harvesting until it reached a maximum then declined as time passed until the final harvest. Fig (4) The combination of organic and inorganic fertilizer recorded maximum productivity of tomato, followed by organic manure (T3), which was the same as inorganic fertilizers (T2) and finally the control treatment(T1). This result supports the finding of [25] who found that more number of fruits per plant with the combined application of 10 t ha-1organic manure with inorganic fertilizers. The increase in fruit number per plant might be due to the increased growth attributes which in turn lead to the increased photosynthetic rate and dry matter production.

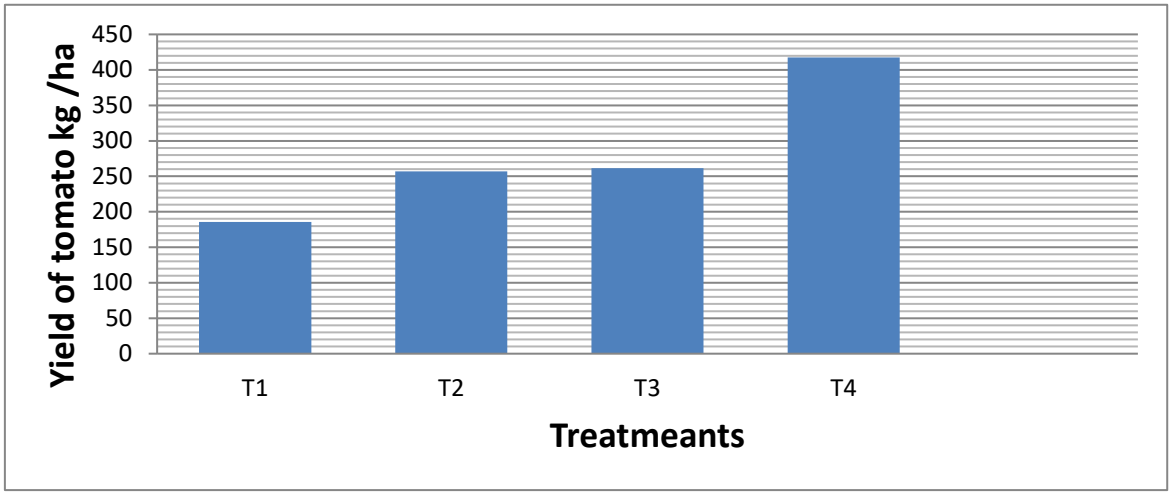

Fig. 4: Average yield kg / ha of tomato as affected by application of organic manure and chemical fertilizers.

3.2.6 Yield of cucumber

Fig (5) shows that the yield of cucumber was highest with the combination of organic and inorganic fertilizes, followed by organic manure , then inorganic fertilizer, and finally the control treatment which gave the lowest yield. These results are in agreement with [26] who state that application of organic manure combined with chemical fertilizers improved the yield of crops. The difference between treatments was more pronounced with cucumber than with tomato.

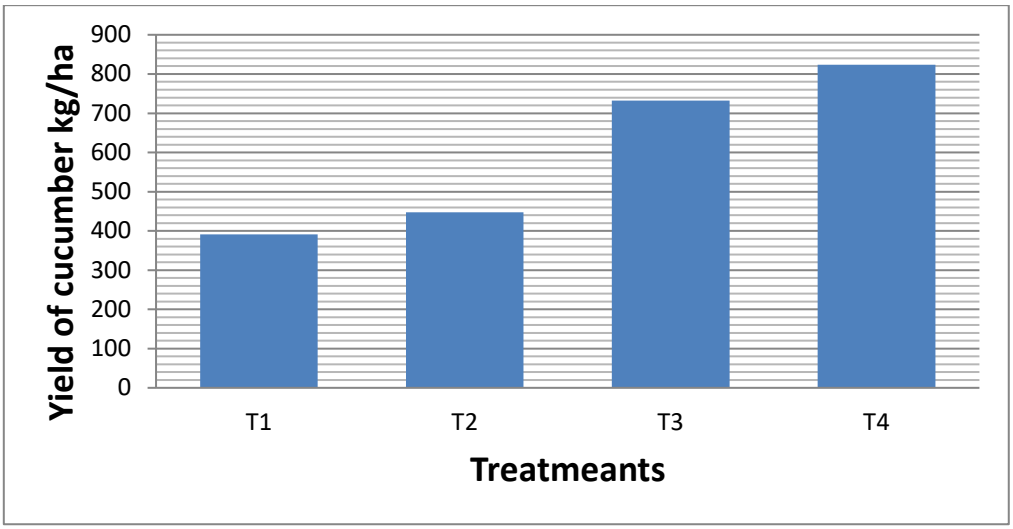

Fig.5: Average yield kg / ha of cucumber as affected by application of organic manure and chemical fertilizers.

3.2.7 Nutrient content in of tomato

Nutrient content of the leaves and fruits of tomato was measured but only that of the fruit was presented.

3.2.8 Nutrient content of cucumber

Nutrient content of the leaves and fruits of cucumber was measured but only that of the fruit was presented.

4. CONCLUSION

Application of organic manure together with inorganic fertilizers improved growth parameters of plant height and number of leaves per plant. This increased the photosynthetic rate of two crops. The combination of inorganic fertilizers and organic manure recorded highest productivity of tomato and cucumber. There for It is recommended that the application of inorganic fertilizers and organic manure is the best practice for tomato and cucumber under greenhouse conditions than either of the two fertilizers alone.

ACKNOWLEDGEMENT

The acknowledgements are to Gezira university, to all the technicians and staff.

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