INTRODUCTION

With the rapid increase in population and limited resources (land and water), it is necessary to search for new methods of agriculture that enhance the production of more food without wasting the available resources.

Tomato is very sensitive to water stress; it, therefore, requires the availability of irrigation water throughout its life cycle for high productivity, and clear response to different levels of fertilization and it is one of the most important crops in the world belonging to the family *Solanaceae* (*Lycopersicum esculentum* Mill.) Deficit irrigation, for horticultural crops, has been studied worldwide for saving water and, hence, improving water use efficiency. Although drip irrigation has a high initial cost, it is considered the best technique to provide water to vegetables, it is a warm-season crop but is generally grown throughout the year. It contains lycopene and is mostly grown in the home gardens for fresh consumption. It is grown under open and protected conditions throughout the world. Generally, its cultivation under open conditions is less under cold conditions due to frost injury during winter and high temperatures in summer. The intensive agricultural practices using chemical fertilizers have helped in increasing crop yields; however, more and more negative effects on soil quality and environmental pollution have been found in areas where chemical fertilizers were overused and/or used for the long-term (Mupambwa. *et all*. 2018, Ayilara. *et all* 2020). Therefore, organic amendments such as crop residues, animal manures, or compost have been widely recognized as a vital agricultural fertilizer resource to improve the soil health and grain yield in an agro Eco system (Yang. *et all*. 2019)

The uses of synthetic chemical fertilizers such as microorganisms in agriculture have been associated with improving the quantity and quality of crops. Many agricultural soils in the world are impoverished in one or more of the essential nutrients required for plant growth and yield so fertilizer additions are essential to ensure maximum yields. However, harmful quantities of fertilizers are applied annually in terrestrial agro-systems because they are not absorbed effectively. The addition of organic residues to the soil increases the organic matter and increases the number of microorganisms and their activity, as well as working to add nutrients to the soil continuously, which rebalances the level of nutrients. Mahmoud *et al*., 2019 found that the addition of organic fertilizer to the soil increased the concentration of nitrogen, phosphorus, and potassium in cauliflower leaves. Bio-fertilizers consist of artificial multiplied cultures of microorganisms that as cyanobacteria, acetobacter, pseudomonas, and rhizobium. The continued use of organic fertilizers increases soil organic matter, better water infiltration and aeration, higher soil biological activity as the materials decompose in soil and increases yields after the year of application (Ceglarek et al., 2002).

Among the sources of available organic manures, vermicompost contains a higher percentage of nutrients necessary for plant growth in readily available forms (Theunissen et al., 2010; Bhat and Limaye,2012).

Vermicompost treatment plots displayed better results with regard to growth and fruit yield of tomato plant as compared to control (Arancon et al., 2003, Abduli et al., 2013) Chemical fertilizers may be used more efficiently by crops growing on soils with adequate amounts of soil organic matter supplied by organic fertilizers (Chadha et al., 2006).

Many research mentioned the positive effect of the combination of organo-mineral fertilizers on tomato productivity (Ayeni and Ezeh, 2017; Islam et al., 2017; Wu et al., 2020).

There are a number of factors affecting the addition of fertilizers, especially the method of application, soil type and crop. Accordingly, this study was conducted to measure the effect of fertilization method in clay soil, and application of effective microorganisms on growth and production of tomato

MATERIAL and METHODS

Study area

The experiment was conducted in a greenhouse in the Northern Elselait Scheme, Khartoum State, Sudan (longitude 32^{0} $32^{\backslash}$ E, Latitude 15^{0} $40^{\backslash}$ N and altitude 382 m above mean sea level), during the winter and summer seasons. The area of the greenhouse was 2000 square meters.

Silt soil

The original soil of the greenhouse was replaced by silt soil.

Effective microorganisms (EM):

Effective Microorganisms or EM is a mixed culture of beneficial microorganisms that can be applied as inoculants to shift the microbial diversity of soils and plants in ways that can improve soil quality, and the growth, yield and quality of crops.

There are two treatments:

(EM) = Applied of effective microorganisms

(EM0) = non-applied effective microorganisms

Fertilization units

Fertilizer and chemical injectors were incorporated with the drip system to supply fertilizers, herbicides, insecticides, fungicides, trace elements, nutrient solutions, and acids at frequent or nearly continuous application with the irrigation water

Methods

The treatments and layout

The experimental design was laid out in a split block design (SBD) with three replicates. The treatments applied were silt soil (S), two different units of fertilization By-pass(passing of fertilizers with irrigation water without passing through the fertilization system) and injector (F1 and F2 respectively), and two levels of effective microorganisms (EM12L/ha and EM0L/ha), these amendments were applied to plots o.7 m x 39 m in the size. Tomato cv Hytec 36 was used as a test crop. The seeds were soaked for 30 min in distilled water prior to sowing. The treatments were arranged on the following order:

SF1EM0	CF1EM0
SF1EM	CF1EM
SF2EM0	CF2EM0
SF2EM	CF2EM

Where: S= Silt soil, C = Control soil (clay), F1= Injector fertilizer, F2= By-pass fertilizer. EM= Applied effective microorganisms, EM0= non-applied effective microorganisms. EM= Applied effective microorganisms, EM0= non-applied effective microorganisms.

Lab Analyze

The chemical and microbiological composition of microorganisms was determined by lab analysis. Twelve samples of the plants were taken from each treatment to determine the content of the main elements as N, P, K, Ca, and Mg (table 10)

Data collection from tomato crop

Plant growth parameters measured were plant height, number of leaves per plant, stem diameter, number of flowers per plant, and number of fruits per plant (all readings were taken weekly). Yield parameters taken were mean fruit weight (g), yield/plant (g,) and yield (ton/hectare). Plant height was determined by measuring the length of the plant from the soil surface to the growing tip for a group of 5 plants labeled in the middle of the plots. The number of leaves was recorded for 5 plants labeled in the middle of the plots. Stem diameter was determined from mark points at the same place of the third inter node for every 5 plants labeled at the middle of the plots. The number of flowers per plant was determined for every 5 plants labeled. Fruit numbers were recorded for 5 plants labeled in the middle of the plots. This was measured starting from mid-April giving 8 readings.

$$\text{Yield (ton/ha)} = (\text{yield/plant (g)} \times \text{population} \times 10^4) / 1.1\text{m}^2 \times 10^6$$

Data analysis

The data obtained was subjected to analysis of variance (ANOVA) using the SAS statistical package and means separated using least significance differences (LSD) at the 0.05 level of significance.

RESULT and DISCUSSION

Plant height (cm)

Table 1 shows the analysis of variance for plant height weekly from day 45 to 122 of growth. From planting indicated that there was a significant difference in plant height due to the effective microorganisms (EM), and there was a significant difference in soils/fertilizers but there was no significant difference in the interaction (EM×soils/fertilizers). Mean plant height of 267 cm and 285 cm was obtained from a plant grown on control soil and silt soil respectively, fertigated by injector fertilizer unit with applied effective microorganisms (EM), while with control soil and silt soil were 269 cm and 246 cm respectively, fertigated by a by-pass fertilizer unit with applied effective microorganisms (EM). The mean height plant was 289 cm and 279 for a plant grown on control soil and silt soil respectively, fertigated by a by-pass fertilizer unit with non-applied effective microorganisms (EM0). While control soil and silt soils were 224 cm and 259 cm respectively, fertigated by injector fertilizer unit with non-applied effective microorganisms (EM0).

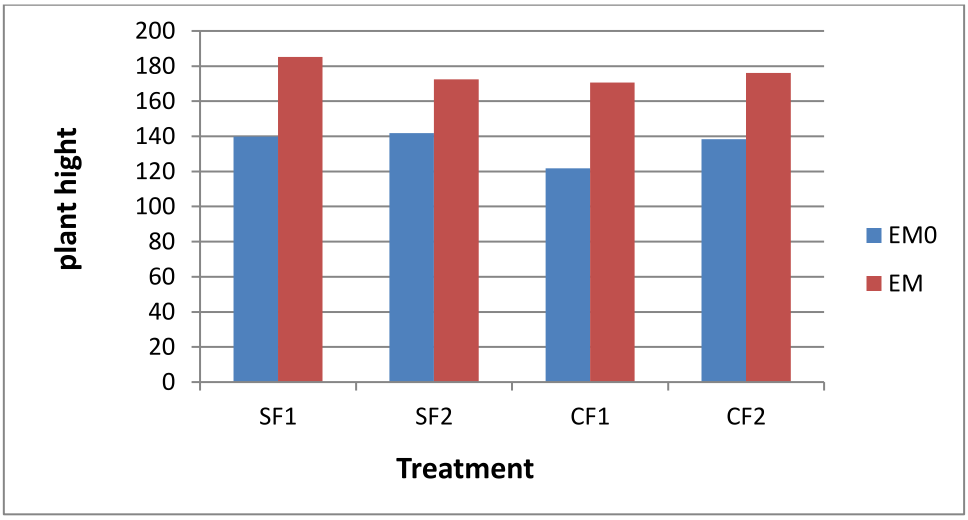

Figure 1. Effect of fertilizing method, soil types and application of effective microorganisms on plant height

Table 1. Effect of fertilizing method, soil types and application of effective microorganisms on plant height

Days	45		52		59		66		73		80		87		94		101		108		115		122	
Treatments	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM
SF_1	37.5	39.8	68	69.1	96.8	86	129	133	146	152	180	184	205	208	223	229	244	247	247	256	254.7	270.5	259	285
SF_2	40	37.3	72.6	66.2	85.3	81.6	134	126	154	147	179	176	208	200	226	218	242	231	246	236	258.8	244.3	279	246
CF1	40.2	34.3	64.3	57.1	95.1	96	122	117	137	136	164	163	187	187	196	209	206	232	217	238	225.2	251.7	224	267
CF2	41.1	36.9	69.7	62.2	96.6	87	131	123	150	141	178	168	200	200	216	221	233	239	240	247	249.2	258.6	289	269
Overall mean		39.7		65		92.5		127.5		145.8		174.4		198.8		216.5		233.8		241		251.7		263.7
LSD of EM		1.8		11		7.2		11.6		10.3		5.9		2.9		8.1		11		18.1		20.9		36.2
CV% of EM		4.5		16		8		9		7		3		1		4		5		7		8		13
LSD of soil/fertilizers		7		18		13.7		24		23		33		32		62		10.3		11.9		14.7		24.8
CV% of soil /fertilizer		11.5		11		7		7		6		6		5		6		7		8		8		10

Number of leaves per plant

Table 2 shows the analysis of variance for a number of leaves measured weekly from day 45 to 122, from planting indicating that there was a significant difference due to the effective microorganisms (EM), and there was a significant in soils/fertilizers but there was no significant difference for the interaction (EM × soils/fertilizers). The mean number of leaves per plant was 41 and 48 for plants grown on control and silt soil respectively, fertigated by injector fertilizer unit with applying effective microorganisms (EM), while it was 46 and 43 with control soil and silt soil respectively, fertigated by a by-pass fertilizer unit with applying effective microorganisms (EM). the mean number of leaves per plant was 42 and 49 for a plant grown on control soil and silt soil respectively, fertigated by injector fertilizer unit with non-applied effective microorganisms (EM0), while it was 54 and 48 with control and silt soil respectively, fertigated by a by-pass fertilizer unit with non-applied effective microorganisms (EM0).

Table 2. Effect of fertilizing method, soil types and application of effective microorganisms' on number of leaves

Days	45		52		59		66		73		80		87		94		101		108		115		122	
Treatments	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM
SF_1	8.1	7.6	13.6	12.9	16.6	15.9	17.5	17.9	18.6	18	22	21	26.7	27	29.7	29	31	30	36	33	37	37	49	48
SF_2	8.1	7.5	12.8	12.3	16.1	16.6	17.6	18.3	18.1	19	21.8	21	25.6	26	30.7	28	31	26	33	32	38	37	48	43
CF1	8.5	7.2	13.5	11.2	16.1	14	17.1	15.6	17.7	16	20.9	19	26.3	23	28.3	25	29	27	32	32	38	31	42	41
CF2	8.3	7.5	13.1	12	16.8	14.6	17.7	16.9	20.1	18	22.9	19	26.5	25	32.7	29	31	31	37	33	41	37	51	46
Overall mean		7.9		12.8		15.9		17.4		18.2		21.2		25.7		29		29.7		33.3		36.8		46.3
LSD of EM		0.36		1.6		1.2		11.6		0.94		1.4		2.6		3.2		4.4		1.1		53.1		9.4
CV % of EM		4.5		12		7		9		5		6		10		11		14		3		114		20
LSD of soils/fertilizers		0.25		0.5		1.2		24		1		1.1		1.2		1.3		1.7		1.7		9.2		8.2
CV % of soils/fertilizers		10.8		9		11		7		9		8		7		7		7		7		11.1		10

Stem diameter (mm)

Table 3 shows the analysis of variance for stem diameter measured weekly from day 45 to 122 of planting indicating that there was a significant difference due to the effective microorganisms (EM), there was no significant difference in soils/fertilizers, and also there was no significant difference in the interaction (EM×soils/fertilizers). Mean stem diameter was 12 mm of plant grown on both control soil and silt fertigated by injector fertilizer unit with applied effective microorganisms (EM), while control soil and silt soil fertigated by a by-pass fertilizer unit with applied effective microorganisms (EM) was 12 mm for both soils with nothing increasing. Mean stem diameter was 13 mm of plant grown on both control and silt soil fertigated by injector fertilizer unit with non-applied effective microorganisms (EM0), while with control and silt soil fertigated by a by-pass fertilizer unit with non-applied effective microorganisms (EM0) was 13 and 12 mm respectively.

Table 3. Effect of fertilizing method, soil types and application of effective microorganisms onstem diameter (mm)

Days	45		52		59		66		73		80		87		94		101		108		115		122	
Treatments	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM
SF_1	5.5	5.6	7.6	6.9	8.5	8.1	9.3	8.5	10	9.4	10.2	9.9	10.5	10.1	11.5	10.3	11.7	10.7	12.1	11	12	12	13	12
SF_2	5.8	5.5	7.7	7.6	8.8	8.2	9.7	8.9	10.1	9.4	10.6	9.5	11	10.1	11.1	10.7	11.3	10.9	11.8	11	12	12	12	12
CF_1	5.7	5.1	7.4	6.5	8.2	7.2	8.7	7.6	9.3	8.4	9.6	9.2	9.8	9.9	10.9	10.2	12	10.8	12.2	11	13	11	13	12
CF_2	6.1	5.5	7.8	7.1	9.1	7.6	9.5	8.3	10.7	8.7	11	9.4	11.2	9.8	11.6	10.6	11.8	11.1	12	11	13	12	13	12
Overall mean		5.6		7.3		8.2		8.8		9.5		9.9		10.4		10.9		11.2		11.5		11.8		12.2
LSD of EM		0.5		1.3		0.5		1.1		1.1		1		0.9		1		1.3		1.4		1.2		1.3
CV % of EM		9.4		18		6		12		11		10		9		9		12		12		10		10
LSD of soils/fertilizers		0.1		0.1		0.2		0.2		0.3		0.3		0.2		0.2		0.2		0.2		0.3		0.3
CV % of soils/fertilizers		6.8		7		8		8		10		9		8		7		7		7		8		8

Number of flowers per plant

Table 4 shows the analysis of variance for the number of flowers per plant measured weekly from day 45 to 122 of planting indicating that there was a significant difference due to the effective microorganisms (EM), and there was no significant difference in soils/fertilizers and also there was no significant difference in the interaction (EM×soils/fertilizers). The mean number of flowers per plant was 18.1 and 16.3 for a plant grown on control and silt soil respectively, fertigated by an injector fertilizer unit with applied effective microorganisms (EM), while with control and silt soil fertigated by a by-pass fertilizer unit with applied effective microorganisms (EM) was 17.8 17.3 respectively. The mean number of flowers per plant was 17 and 20.7 for a plant grown on control and silt soil respectively. fertigated by injector fertilizer unit with non-applied effective microorganisms (EM0), while with control and silt soil fertigated by a by-pass fertilizer unit with non-applied effective microorganisms (EM0) was 20.5 and 18.4 respectively.

Table 4. Effect of fertilizing method, soil types and application of effective microorganisms on number of flowers

Days	52		59		66		73		80		87		94		101		108		115		122	
Treatments	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM
SF_1	0.8	0.8	2.5	3.1	8	7.5	10	11.3	14	14.2	15.4	17	16.9	18.1	20.7	15.2	18.5	17.5	13.9	12.7	10	10.9
SF_2	1.7	0.5	4.3	2.2	6.9	5.9	11.4	9.7	13.4	11.6	13.6	13.9	15.6	15.2	18.2	14.5	18.4	17.3	11	9.7	7.6	8.2
CF_1	1.9	0.2	3.2	1.5	6.5	5.4	10.2	9.2	12.5	9.5	13.9	11.5	15	12.8	17	16.3	13.6	14.5	9.9	12.1	5.9	10.1
CF_2	1.9	0.5	4.1	1.5	7.1	5	11.8	9.1	14.3	10.7	16	11.6	18.5	14.6	20.5	17.8	18.3	15.6	10.4	12.4	8.9	8.4
Overall mean		1.2		2.7		6.3		10.4		12.6		14		15.9		17.3		16.3		11.8		9
LSD of EM		1		0.4		0.8		0.7		1.7		1		2		8.4		11.6		5.3		6.5
CV % of EM		8		14		11		7		13		6		12		48		70		44		71
LSD of soils/fertilizers sosoils/fertilizers		0.3		0.3		0.6		1.4		2.1		1.9		2.2		4.3		6.9		2.3		1.9
CV % of soils/fertilizers		8		33		19		19		19		16		16		20		27		22		26

Number of fruits per plant

Table 5 shows the analysis of variance for the number of fruits per plant measured weekly from day 45 to 122 of planting indicating that there was a significant difference due to the effective microorganisms (EM), and there was no significant difference in soils/fertilizers and also there was no significant difference in the interaction (EM×soils/fertilizers). The mean number of fruits per plant was 7.5 and 11.4 for plants grown on control and silt soil fertigated by injector fertilizer unit with applied effective microorganisms (EM), while with control and silt soil fertigated by a by-pass fertilizer unit with applied effective microorganisms (EM) was 10.6 and 10 respectively. The mean number of fruits per plant was 15.6 and 14.2 for plants grown on control and silt soil respectively, fertigated by a by-pass fertilizer with non-applied effective microorganisms (EM0), while with control and silt soil fertigated by injector fertilizer unit with non-applied effective microorganisms (EM0) was 15 and 12.7 respectively.

Table 5. Effect of fertilizing method, soil types and application of effective microorganisms' on number of fruits

Days	59		66		73		80		87		94		101		108		115		122	
Treatments	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM
SF_1	0.2	0.1	1.9	1	2.9	1.7	4.4	3.1	10.1	8.8	11.9	10.5	12.3	11.4	12.7	11.4	10.6	10.1	8.6	8.5
SF_2	0.3	0.3	2.9	2	3.9	3	5.5	4.1	10.8	7.7	11.5	9.5	14	9.5	13.5	9.5	14.2	9.5	10.9	10
CF_1	0.1	0.1	1.5	0.4	3.1	0.8	5.9	2.4	9.7	5.1	11.8	5.8	12.9	7.3	15	7.5	12.9	7.4	10.8	5.2
CF_2	0	0	1.5	0.5	3.9	1.1	5.8	2.6	10.7	8	13.2	9	14.6	10.4	15.6	10.6	11.7	9.9	15.5	10.2
Overall mean		1.1		1.6		2.6		4.4		8.8		10.3		11.4		11		10.8		9.6
LSD of EM		0.4		0.4		0.7		1.1		4.2		4.5		5.9		5.5		6.7		5.4
CV % of EM		158		27		27		24		47		43		51		46		61		55
LSD of soils/fertilizers		0.1		0.7		0.9		1.4		2.3		3.4		3.2		4.5		5.5		10
CV % of soils/fertilizers		200		86		62		46		29		30		27		30		38		57

Mean fruit weight (g)

Table 6 shows the analysis of variance for yield per plant (g) for eight picks indicating that there was a significant difference due to the effective microorganisms (EM), there was a significant difference in soils/fertilizers and also there was a significant difference for the interaction (EM× soils/fertilizers). Mean fruit weight was 82.1 and 100 g for a plant grown on control and silt soil respectively, fertigated by a by-pass fertilizer unit with applied effective microorganisms (EM), while with control and silt soil fertigated by injector fertilizer unit with applied effective microorganisms (EM) was 95.7 and 76.5g respectively. Mean fruit weight was 66.7 and 100 g for a plant grown on control and silt soil respectively. fertigated by injector fertilizer unit with non-applied effective microorganisms (EM0), while control and silt soil fertigated by a by-pass fertilizer unit with non-applied effective microorganisms (EM0) was 66.7 and 100g respectively.

Table 6. Effect of fertilizing method, soil types and application of effective microorganisms onmean fruits weight (gm.)

No. of Pick	Pick 1		Pick 2		Pick 3		Pick 4		Pick 5		Pick 6		Pick 7		Pick 8	
Treatments	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM
SF_1	0	0.5	4.5	4.5	11.9	9.7	8.1	7.8	8.7	5	36	36.2	100	41.7	66.7	76.5
SF_2	0.4	5.3	7.1	7.1	3.7	12.8	10	8.9	3.6	7	21.2	21	100	100	91.7	58
CF_1	2	0.2	10.7	10.7	8.7	8.9	6.4	5.2	9.4	14.1	19.5	24.4	62	33.3	66.7	95.7
CF_2	4.9	0	5.4	2.2	9.8	10.8	6.4	5.5	7.2	5	11.5	15.2	66.7	82.1	33.9	75
Overall mean		2		5.6		9		6.9		15.1		22.6		68.8		70.8
LSD of EM		0.9		0.6		8.8		2.5		3.1		15.8		17.3		10.4
CV% of EM		46		11		88		36		38		69		23		14
LSD of soils/fertilizers		2.4		4.5		14.1		4.1		15.8		125		394		659
CV% of soils/fertilizers		65		65		65		50		84		84		46		62

Yield ton per hectare

Table 7 shows the analysis of variance for yield ton per hectare for the eight picks whereas indicated that there was a significant difference due to the effective microorganisms (EM), and there was no significant difference in soils/fertilizers but there was a significant difference for the interaction (EM× soils/fertilizers). Yield ton per hectare for a plant grown on control and silt soil fertigated by injector fertilizer unit with applied effective microorganisms (EM) was 3.2 and 5.4 ton/ha respectively, while with control and silt soil fertigated by a by-pass fertilizer unit with applied effective microorganisms (EM) was 3.6 and 4.6 ton/ha respectively. Yield ton per hectare for a plant grown on control and silt soil fertigated by injector fertilizer unit with non-applied effective microorganisms (EM0) was 4.6 and 7.3 ton/ha respectively, while with control and silt soil fertigated by a by-pass fertilizer unit with non-applied effective microorganisms (EM0) was 4.6 and 5.5 ton/ha respectively.

Table 7. Effect of fertilizing method, soil types and application of effective microorganisms on yield ton per hectare

No. of Pick	Pick 1		Pick 2		Pick 3		Pick 4		Pick 5		Pick 6		Pick 7		Pick 8	
Treatments	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM	EM_0	EM
SF_1	0	0.1	1.6	1.2	3.6	2.7	3.1	2.3	2.6	1.4	7.3	5.4	2.8	2.3	1.8	2.1
SF_2	0.1	1.4	2.3	2.3	1.4	2.8	3.6	2.1	1.4	1.7	5.5	4.6	2.7	2.7	2.5	1.6
CF_1	0.7	0.03	3.1	0.4	3.2	1.8	2.3	1.1	3.2	2.6	4.6	3.2	1.7	0.9	1.8	2.6
CF_2	1.5	0	2	0.7	4.2	2.7	2.7	1.6	2.3	1.4	4.6	3.6	2.3	2.1	0.9	2.1
Overall mean	0.6	0.6	2.1	1.5	3.1	2.9	2.5	2.2	2.2	2.2	5.1	4.6	1	2.1	1.8	2
LSD of EM		0.2		1.4		1		0.4		2.4		0.4		0.3		0.3
CV % of EM		41		91		36		20		109		9		32		14
LSD of soils/fertilizers		0.2		0.3		0.1		0.4		0.9		2.1		0.3		0.5
CV % of soils/fertilizers		65		65		65		50		73		53		94		61

Soil analysis

The results of tables 8, 9, and fig. 1 Showed that the pH increased in all treatments, and ECe reduced in all SF1EM. Ca+Mg reduced in SF1EM. Na reduced in SF1EM. K reduced in SF1EM. P increased in SF2EM. N increased in all treatments except SF2EM.

Table 8. Chemical and Physical composition of soil before planting (depth, 0-30)

Sample	SP	pH	ECe (ds/m)	Ca+Mg (mmol+/l	Na (mmol+/l)	K (mmo+/l)	SAR	CEC (mmol+/l)	$CaCo_3$ (%)	P (ppm)
Silt	43.1	7.17	0.6	3.5	1.9	0.22	1.4	30.5	3.94	4.2

Table 9. Chemical and Physical composition of soil (depth, 0-30): after flushing

Indicators Flushing contents	SP	SAR	pH	ECe (ds/m)	Ca+Mg (mmol+/l)	Na (mmol+/l)	K (mmol+/l)	P (ppm)	N %	Clay %	Silt %	Sand %
SF1EM	37.4	2.8	7.74	0.3	1.0	2.0	0.12	0.28	0.08	26.6	15.0	58.4
SF1EM0	36.9	2.4	7.77	0.9	5.0	3.9	0.15	0.45	0.09	26.2	19.6	54.2
SF2EM	35.9	2.9	7.81	0.5	2.0	2.9	0.15	0.45	0.08	25.5	19.0	55.5
SF2EM0	35.4	2.9	7.71	0.5	2.0	2.9	0.22	0.61	0.1	25.1	25.1	49.8

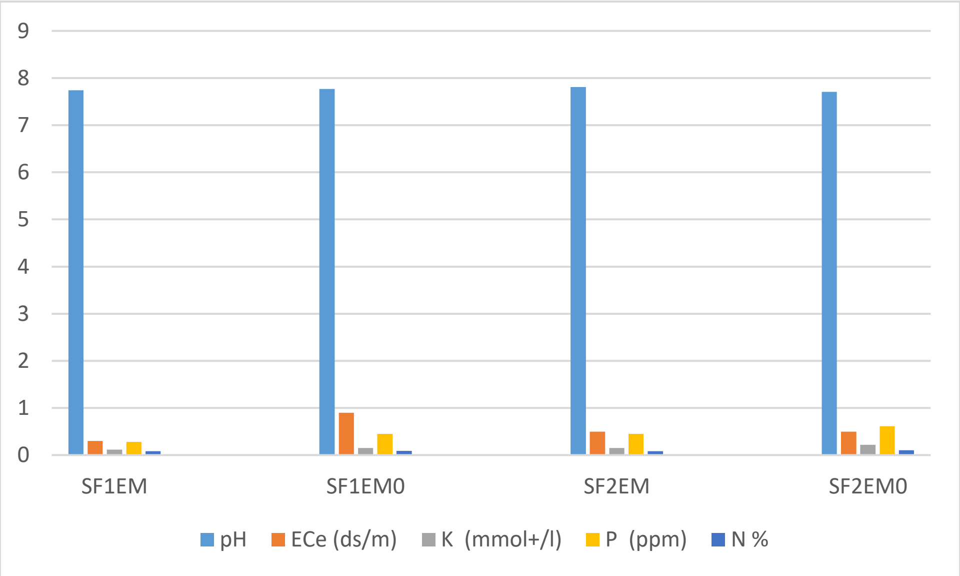

Figure 1. Chemical and Physical composition

Plant analysis

The results of the analysis in table 10 and fig 2 showed increasing in all macro elements except N and Ca due to applied dose NPK and also Ca and Mg, the increase of N, and the reduction of P and K compared with N which gave high plants with a small number of fruits thus lead to a reduction in the productivity.

Table 10. The plant analysis (Macroelements)

Treatment	*N %*	*P %*	*K %*	*Ca %*	*Mg %*
SF1EM	2.2	0.92	1.6	7	3
SF1EM0	2.6	0.98	1.5	9	4
SF2EM	2.2	1.03	1.3	6	2
SF2EM0	2.3	1.01	1.7	6	3

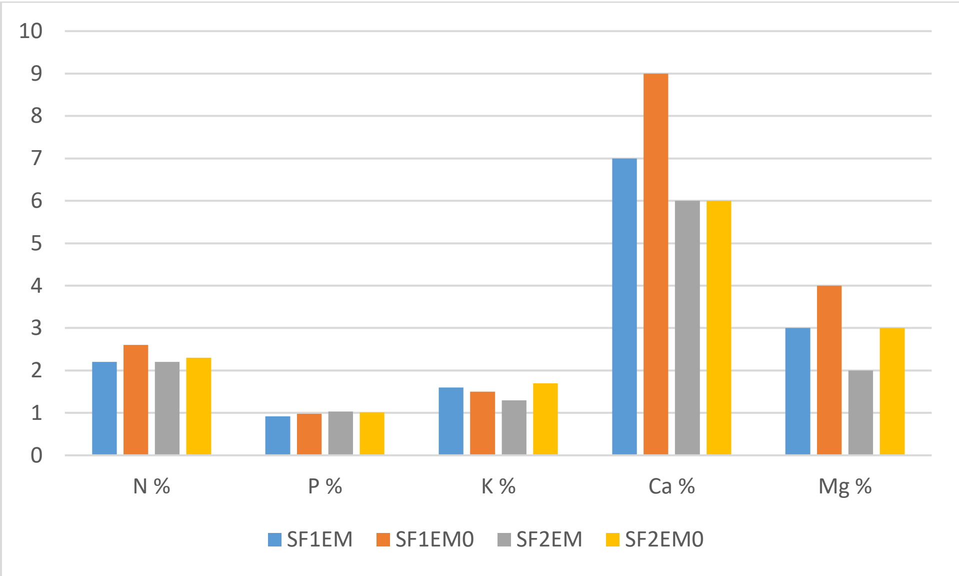

Figure 2. The plant macro elements analysis

Conclusion

From the results of this study the following conclusion can be drawn:

- The by-pass fertilizer unit was considered better than the injector fertilizer unit with respect to cost and performance.
- The silt soil proved to be the most appropriate soil for the greenhouse for the production of tomatoes.
- The effective microorganism showed no significant effect as a fertilizing material for tomato growth and yield.
- Further studies are recommended along similar lines, particularly with the addition of microorganisms as a fertilization material.

REFERENCES

Abduli, M.A.; Amiri, L.; Madadian, E.; Gitipour, S. and Sedighian, S. 2013. Efficiency of vermicompost on quantitative and qualitative growth of tomato plants. International Journal of Environmental Research,7(2): 467-472.

Arancon, N.Q.; Edwards, C.A.; Bierman, P.; Metzger, J.D.; Lee, S. and Welch, C. 2003. Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries. Pedobiologia, 47: 731-735.

Ayilara, M.S.; Olanrewaju, O.S.; Babalola, O.O.; Odeyemi, O. Waste management through composting: Challenges and potentials. Sustainability 2020, 12, 4456. [Google Scholar] [CrossRef]

Bhat, M.R. and Limaye, S.R. 2012. Nutrient status and plant growth promoting potential of prepared vermicompost. International Journal of Environmental Sciences, 3(1): 312-321.

Ceglarek, R.J.; Rosa, R. and Framczuk, Y. 2002. Successive effect of green manures in the form of gone crops in cultivation of onion. Journal of Plant Nutrition and Soil Science, 14(1): 3-12.

Chadha, S.; Rana, S.S. and Chaudhury, D.R. 2006. Nutrient management in summer onion (Allium cepa) under cold desert conditions of North Wester Himalayas. Indian Journal of Agricultural Science,76(10): 629-631.

Islam, A., Islam, S., Akter, A., Rahman, M. d. H, and Nandwani, D (2017). Effect of Organic and inorganic fertilizers on soil properties and the growth, yield and quality of tomato in mymensingh, Bangladesh M. Agriculture 7, 18. doi: 10.3390/agriculture7030018.

Mahmood, Y.A.; Firas, W.A.; Sinan, S.J.; Al-Arazah, A.A. (2019. Effect of solid and liquid organic fertilizer and spray with humic acid on growth, yield of Cauliflowerand nutrient uptake of nitrogen, phosphorus and potassium. Plant Archives. Special Issue Vol. 19, Supplement (2), July.

Mupambwa, H.A.; Mnkeni, P.N.S. Optimizing the vermicomposting of organic wastes amended with inorganic materials for production of nutrient-rich organic fertilizers: A review. Environ. Sci. Pollut. Res. 2018, 25, 10577–10595. [Google Scholar] [CrossRef] [PubMed]

Seung Kyu Lee 2020 Assessment of improving irrigation efficiency for tomatoes planted in greenhouses in Lam Dong Province, Vietnam.

Theunissen, J.; Ndakidemi, P.A. and Laubscher, C.P. 2010. Potential of vermicompost produced from plant waste on the growth and nutrient status in vegetable production. International Journal of the Physical Sciences, 5(13): 1964-1973.

Wu, Y., Yan, S., Fan, J., Zhang, F., Zheng, J., Guo, J., et al. (2020). Combined application of soluble organic and chemical fertilizers in drip fertigation improves nitrogen use efficiency and enhances tomato yield and quality. J. Sci. Food Agricult. 100, 5422–5433. doi: 10.1002/jsfa.10593.

Yang, W.; Yang, Z.; Guan, Y.; Zhai, C.; Shi, D.; Chen, J.; Wang, T.; Gu, S. Dose-dependent effect of compost amendment on soil bacterial community composition and co-occurrence network patterns in soybean agroecosystem. Arch. Agron. Soil Sci. 2019, 66, 1027–1041. [Google Scholar] [CrossRef]

Yeni, L. S., and Ezeh, O. S. (2017). Comparative Effect of NPK 20:10:10, organic and organo-mineral fertilizers on soil chemical properties, nutrient uptake and yield of tomato (Lycopersicon esculentum). Appl. Tropic. Agricult. 22, 111–116. doi: 10.13140/RG.2.2.18726.63049.