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IMPORTANCE OF COMPOST FERTILIZATION AND SPRAYING WITH MORINGA LEAF EXTRACT ON YIELD AND QUALITY OF CHERRY TOMATO UNDER ORGANIC SOILLESS SYSTEM

M. Nour El-Din[(1)], H.M. El-Koumy[(2)] and M.H. El-Bagory[(1)]

[(1)] **Soil, Water and Environmental Research Institute, ARC, Egypt.**

[(2)] **Vegetable Research Department, Hort. Res. Inst., Agric. Res. Center, Giza, Egypt.**

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ABSTRACT: ***Soilless agriculture is one of the most promising systems because its advantages like saving irrigation water, benefiting from unsuitable land for agriculture or agriculture of building roofs for production of food as well as decreasing pesticide application or mineral fertilizers. Organic fertilization contributes also in decreasing hazardous side effects of using chemical fertilizers.***

The aiming of this investigation was to study of using organic fertilization system by adding compost as a source of fertilizer, irrigate the plants with fish extract at rate of 1:100 and spraying the plants with moringa leaf extract and the influence of that on cherry tomato plant growth, fruit yield and its quality.

The results of the present investigation showed that compost application in vermiculite improved yield and quality of cherry tomato fruits (Guindo F_1), especially at 400 and 500 g/plant levels, which increased plant length, number of leaves and leaf area/plant, total fruit yield, average fruit weight, fruit diameter, vitamin C, TSS, N, P and K percentages. While decreased the stem thickness, and titratable acidity percentage in tomato fruits.

Foliar application with moringa leaf extract exhibited a positive influence on the previous studied parameters. The interactions between organic fertilization and moringa leaf extract highly increased these parameters. The highest total fruit yield was obtained from 400 g compost/plant as well as fertigation with fish extract and sprayed with moringa leaf extract, it gave 5.436 and 5.054 fruits kg/plant compared to the control treatment (chemical fertilization, without moringa leaf extract spray) which obtained 3.765 and 4.201 kg/plant for the first and the second season, respectively.

Key words: ***Soilless agriculture, organic fertilization, compost, fish extract, moringa extract, cherry tomato.***

INTRODUCTION

Cherry tomato is an important vegetable crop characterized with their sweet taste and nutrient value, whereas, it contains lycopene, vitamins C, A, B and nutrient elements (Pinho *et al*., 2011). Cherry tomato planted in large scale environmental conditions in open field and protected agriculture systems (Abd El-Razzak *et al*., 2016).

Vermiculite sometimes used in agriculture of tomato under greenhouse or top roofs. Vermiculite characterized with light weight, high water capacity, sterilized, free from soil porn diseases and nematodes (Olle *et al*., 2012). Therefore, this planting media is suitable for top roof agriculture. In Egypt, about 4 million building, possessed if it is used for producing vegetable, they will improve the natural income. Organic nutrition of plants grown in soilless system is more acceptable especially for top roof agriculture as well as for exporting. Most of important organic nutrient solution is the fish extract synthesis from residues of home fish and the residues of fish industrialization, it contains high amount of macro and micro elements, in addition

to amino acids (Zahi, 2009). Compost used also in organic fertilization, it contains a high levels of macro and micro elements. Compost characterized with low density, high water capacity and free from nematodes and soil porn diseases.

Vegetable plants usually sprayed with plant phytohormones like gebrilline and cytokinen to increase plant growth and enhancing yield and its quality. The moringa extract is considered a natural plant growth regulator, where, it is a source of zeatin which is a natural derivative of cytokinin, proteins, vitamin E, phenols, ascorbates and essential amino acids as well as several mineral elements, which is potentially stimulate plant growth and yield (Howladar, 2014 and Rady *et al*., 2015).

The aim of the present study is to investigate the influence of organic fertilization fish residues extract and foliar application of moringa leaves extract on growth, yield and fruit quality of cherry tomato plants.

MATERIALS AND METHODS

Vermiculite:

Vermiculite is a mineral of soil originated from mined rocks that is heated to produce the final product.

Moringa extract were prepared by crushed 10 kg of fresh moringa leaves in 1 liter water, then filtered, the liquid extract was to concentration of 3% (Muhamman and Mohamed, 2014).

Fish extract:

The fish extract was made by weighing 10 kg of fish residues in 100 L closed container, about 40 L of water, 250 g of compost and 200 ml molasses. Air pump operated for aerating the mixture. The aerobic fermentation process was continued for 20 days. One liter of the liquid hydrosates was mixed with 20 L of water for irrigation the tomato plants. The chemical analysis of fish extract was shown in (Table 1).

Compost:

Compost was prepared by mixing of rice straw with farmyard manure, the characteristics of applied compost was found in Table (2).

Nutrient solution:

Composed of different macro and micro-nutrients as formulated by Tzertzakis and Economakis (2008).

METHODS:

Two pots experiments were carried out at Sakha Agriculture Research Station during the winter season of 2015/2016 and 2016/2017. To investigate the effect of organic fertilization (compost irrigated with fish extract), foliar spraying with moringa leaf extact and their interactions on growth, yield and fruit quality of cherry tomato Guindo F_1. The seedlings were transplanted on 25 and 20 October in the first and the second seasons, respectively. Split plot design with four replicates was used. The main plots were allocated for two moringa treatments (sprayed with moringa extract and sprayed with water only), the sub plots were assigned to six treatments, chemical fertilization (control) and five treatments of organic fertilization (fish extract with different levels of compost i.e. 100, 200, 300, 400 or 500 g/plant), these rates were mixed with vermiculite.

Table (1): Chemical analysis of fish extract

Characters	Value (ppm)
Total N	2068.8
Total P	562.0
Total K	432.9

Table (2): Characteristics of applied compost

Parameters	FYM 4%Rs
pH	8.26
EC	4.80
Organic carbon (%)	30.08
Bulk density (kg/m^3)	632
Moisture content	32
C/N ratio	16.53
N %	1.82 + 0.14
P %	0.79+0.0
K %	1.44+0.39
Germination %	86.8+0.5
TCB at 30^{o}C	31 x 10^5
TCB at 50^{o}C	48 x 10^3
TCA at 30^{o}C	47 x 10^3
TCA at 50^{o}C	55 x 10
TCF at 30^{o}C	33 x 10^3
TCF at 50^{o}C	17 x 10
E. coli	0.0
Salmonella sp	0.0
Shigella sp.	0.0

TCB: Total content of bacteria

TCA: Total content of actinomycetes

TCF: Total content of fungi

Planting:

The vermiculite media was backing in polyethylene bags, about 2.5 kg vermiculite per bag. This media was washed with tap water several times, then the tomato seedlings were planted as one seedling in each bag. Plants were arranged in rows at a distance of 50 cm between plants to give 2.5 plants/m^2 after that, seedlings were irrigated with tap water for three days. The irrigation with fish extract solution started after three days of planting.

The control plants were irrigated with chemical nutrient solution as formulated by (Tzertzakis and Economakis, 2008). The plant inflated buds were brunning periodically till 60 cm tall. After that, plants were grown vertically on two branches. The nutrition dose was changed after each planting phase (seedling, flowering, fruiting and aging). The pests and plant diseases were controlled by the spray with micronic sulfur (2.5 g/liter), two times weekly. The pest worm and eggs were handling collected when they watched on the plant leaves.

The plant samples:

Three plants were taken from each sub plot at 85 days after transplanting for measurement, number of leaves/plant, leaf area/plant (cm^2) was determined according to the formula:

leaf area (cm^2) =

$$\frac{fresh\ weight\ of\ leaves}{fresh\ weight\ of\ discs}\ x\ area\ of\ discs,$$

stem thickness (mm) and stem length (cm), i.e. vegetative growth parameters.

Fruit yield:

Ripening tomato fruits were collected two times every week and weighed. The early fruit yield was determined for the first five pickings, but the total yield was estimated for the total pickings till the end of the fruiting season.

Fruit characters and quality:

Ten fruits from each sub-plot were taken randomly to determine fruit diameter, average fruit weight, total soluble solids (TSS%) by a hand refractometer according to A.O.A.C., vitamin C content (ascorbic acid) by titration with 2, 6-Di-chlorophenol endophenol according to A.O.A.C., N,P and K contents of fresh tomato fruits. Total N was determined using the micro-kjeldahl method (Pregel, 1945). Total phosphorus was determined colorimetrically using a spectrophotometer at 650 mm (King, 1951). Total potassium was determined using flame photometer as described by Jackson and Strelec (1967).

RESULTS

Vegetative growth:

Data of Table (3) indicated that spraying the plants with moringa leaf extract significantly increased leaves number of the plant. This effect was similar for both studying seasons. Moringa extract exhibited 38.22 and 38.93 leaves/plant compared to 37.28 and 36.20 for control without moringa extract at the first and the second seasons, respectively. The results showed also that, organic fertilization with fish extract (dilution 1:100) with compost levels added to vermiculite soilless culture variably affected on leaves numbers of cherry tomato plants, where, 300 g/plant compost gave the highest number of leaves per plant (39.5) which was similar to chemical fertilized control (without compost, and fish extract which gave 39.5). However, the data of the second season (2016/2017) showed non significant differences between the levels of compost addition. Data of interaction between moringa extract and compost levels did not show significant effect, regarding number of leaves/plant.

Results in Table (3) illustrated the leaf area of plant as affected by moringa extract spray. The spraying with moringa extract gave slight increase in leaf area, no significant difference with non sprayed control plants. The data of the second season followed the same trend of the first one.

Application of compost levels with fish extract, otherwise, had a noticeable effect on leaf area/plants. The leaf area of cherry tomato plants increased with increasing of the compost levels. The highest values in the first season showed that 400 and 500 gm compost per plant, which gave 6778.65 and 7079.5 compared to 5613.28 cm^2/plant for the chemical treatment (without compost). The differences were significant. In the second season, the treatment of 500 gm compost gave the highest values of the leaf area, it attained 6955.33 cm^2/plant compared to 5419.93 for the control (without organic fertilization), and the difference was significant.

Nevertheless, the interactions between the moringa foliar spraying and compost levels with fish extract had no significant variations, the highest values (7216.6 and 7183.6) at the first and the second seasons which obtained with moringa spray and 500 gm compost addition.

Concerning to stem thickness, it was found that spraying with moringa extract significantly increased stem thickness of tomato (Table 4). The mean value of plant thickness for moringa extract spray was 11.36 compared to 11.09 mm for control plants. At the second season, there was a similar trend as the first one.

The type of fertilization clearly affect of the stem thickness, where, fertilization with fish extract in combination with different levels of compost gave low records than chemical fertilized plants. On the other hand, increasing the levels of compost caused noticeable in the stem thickness. The level of 100 g/plant gave 9.72 mm, while 500 g compost/plant gave 10.93 mm. The differences due to compost levels were significant. At the second season, the treatments gave the same trend on stem thickness as the first one.

The combined effect between moringa extract spray and organic fertilization had no significant effect through the two growing seasons.

Regarding to stem length, data in Table (4) sowed that, moringa extract spraying significantly increased stem length of tomato plants over not sprayed plants. The mean length of sprayed plants at the first season was 213.83 cm compared to 210 cm for not sprayed one. This treatment similarly affected on the plant length at the second season, whereas, sprayed plants with moringa significantly increased to reach (214.17) than not sprayed plants (209.78 cm).

Table (3): Effect of foliar application of the moringa leaves extract and organic fertilization on number of leaves/plant and leaf area cm^2/plant of cherry tomato plants.

Organic fert. / Moringa	Ch.1	Fish extract + compost (g/plant)					
		100	200	300	400	500	Mean
	Number of leaves						
	First season (2015/2016)						
Moringa	40.33	37.33	35.00	40.00	37.33	39.33	38.22 a
Without	38.67	36.33	34.33	39.00	36.67	38.67	37.28 b
Means	39.50 a	36.83 b	34.67 c	39.50 a	37.00 b	39.00 ab	
F. test	M = *, C = **, M x C = NS						
	Second season (2016/2017)						
Moringa	39.40	37.10	36.50	38.57	39.03	42.97	38.93 a
Without	37.63	37.30	33.57	37.77	35.93	35.00	36.20 b
Means	38.52	37.20	35.03	38.17	37.48	38.98	
F. test	M = *, C = NS, M x C = NS						
	Leaf area/plant (cm^2)						
	First season (2015/2016)						
Moringa	5665.00	4337.47	5042.23	5457.53	6914.77	7216.60	5772.27
Without	5561.57	4576.57	4967.77	5331.43	6642.53	6942.40	5670.40
Means	5613.28 b	4457.02 d	5005.00 cd	5394.48 bc	6778.65 a	7079.50 a	
F. test	M = NS, C = **, M x C = NS						
	Second season (2016/2017)						
Moringa	5519.57	4562.67	5096.27	5383.50	6691.67	7183.60	5739.54
Without	5320.30	4200.63	4935.20	5235.03	6516.93	6727.07	5489.19
Means	5419.93 b	4381.65 c	5015.73 b	5309.27 b	6604.30 b	6955.33 a	
F. test	M = NS, C = **, M x C = NS						

****, * and NS indicate significant differences at P<0.01, P <0.05 and Not significant, respectively according to F-test.**

In the same column, means followed by same letter are not significantly different at 5% level according to Duncan's test.

Table (4): Effect of foliar application moringa leaves extract and organic fertilization on stem thickness (mm) and stem length (cm) of cherry tomato plants.

Organic fert. / Moringa	Ch.1	Fish extract + compost (g/plant)					
		100	200	300	400	500	Mean
	Stem thickness (mm)						
	First season (2015/2016)						
Moringa	13.53	9.83	10.67	11.03	12.03	11.03	11.36 a
Without	13.10	9.60	10.40	10.80	11.80	10.83	11.09 b
Means	13.32 a	9.72 d	10.53 c	10.92 c	11.92 b	10.93 c	
F. test	M = **, C = **, M x C = NS						
	Second season (2016/2017)						
Moringa	12.40	9.70	10.50	10.77	11.57	11.23	11.03
Without	11.77	9.43	10.10	10.53	11.37	11.20	10.73
Means	12.08 a	9.57 d	10.30 c	10.65 c	11.46 b	11.22 b	
F. test	M = NS, C = **, M x C = NS						
	Stem length (cm)						
	First season (2015/2016)						
Moringa	208.03	215.90	211.37	209.93	217.13	220.60	213.83 a
Without	206.70	210.77	208.30	208.27	214.93	214.70	210.00 b
Means	207.37	213.33	209.83	209.10	216.03	217.65	
F. test	M = *, C = NS, M x C = NS						
	Second season (2016/2017)						
Moringa	206.67	215.00	214.67	211.33	216.00	221.33	214.17 a
Without	202.67	210.33	211.00	208.00	212.00	214.67	209.78 b
Means	204.67 c	212.67 ab	212.83 ab	209.67 b	214.00 ab	218.00 a	
F. test	M = *, C = **, M x C = NS						

****, * and NS indicate significant differences at P<0.01, P <0.05 and Not significant, respectively according to F-test.**

In the same column, means followed by same letter are not significantly different at 5% level according to Duncan's test.

Otherwise, organic fertilization with fish extract and compost levels affect differently than chemical fertilization. The chemical fertilization gave lower the records than those of organic fertilization. For example, at the first season, the mean record of stem length was 207.38 cm for chemical fertilization compared to 217.65 cm for fish extract at 500 g compost. The data of the second season followed the same trend, where, chemical fertilization exhibited 204.67 cm compared to 218.0 cm for fish extract with 500 g compost. The differences exhibited significant results. The interaction between moringa extract spray and organic fertilization levels had no significant effect at the two studying seasons.

Fruit yield, data in Table (5) represented early and total yield of cherry tomato plants as affected by foliar application of moringa leaves extract and/or compost levels with fish extract fertilization, compared to chemical fertilization without moringa or compost addition. Moringa leaves extract increased early fruit yield, at season of 2015/2016, there was no significant variation in early fruit yield compared to the non-sprayed plants. However, there was a significant increase in early fruit yield for season 2016/2017 due to moringa extract spraying compared to non sprayed treatment. Moringa extract gave 1.209 kg/m^2 for moringa spray in relation to 1.011 kg/m^2 for non sprayed plants.

Table (5): Effect of foliar application moringa leaves extract and organic fertilization on early yield (kg/plant) and total yield (kg/plant) of cherry tomato plants.

Organic fert. / Moringa	Ch.1	Fish extract + compost (g/plant)					
		100	200	300	400	500	Mean
	Early yield (kg/m^2)						
	First season (2015/2016)						
Moringa	0.991	1.347	1.297	1.179	0.962	1.159	1.156
Without	0.876	0.861	1.007	0.888	0.923	1.045	0.933
Means	0.933	1.104	1.152	1.034	0.942	1.102	
F. test	M = NS, C = NS, M x C = NS						
	Second season (2016/2017)						
Moringa	1.055	1.317	1.332	1.253	1.070	1.227	1.209 a
Without	0.960	0.963	1.042	1.044	1.046	1.013	1.011 b
Means	1.007	1.140	1.187	1.149	1.058	1.120	
F. test	M = *, C = NS, M x C = NS						
	Total yield (kg/m^2)						
	First season (2015/2016)						
Moringa	4.670	4.379	4.651	4.188	5.436	4.671	4.666
Without	3.765	3.437	4.222	4.112	4.697	4.714	4.158
Means	4.218 bc	3.908 c	4.437 bc	4.150 bc	5.047 a	4.692 ab	
F. test	M = NS, C = **, M x C = NS						
	Second season (2016/2017)						
Moringa	4.714	4.389	4.513	4.688	5.054	5.321	4.785 a
Without	4.201	3.691	3.997	4.185	4.422	5.020	4.253 b
Means	4.458 c	4.040 e	4.255 d	4.437 c	4.753 b	5.171 a	
F. test	M = **, C = **, M x C = NS						

****, * and NS indicate significant differences at P<0.01, P <0.05 and Not significant, respectively according to F-test.**
In the same column, means followed by same letter are not significantly different at 5% level according to Duncan's test.

The fertilization type clearly affected on early yield of cherry tomato. Organic fertilization (fish extract + different levels of compost) obviously increased early yield over chemical fertilization (without compost). At season of 2015/2016 chemical fertilization (control) produced 0.933 kg/m^2 compared to 1.104, 1.152, 1.034, 0.942 and 1.102 for compost levels, i.e. 100, 200, 300, 400 and 500 g/plant, respectively. The trend at second season was similar trend to the first one.

Total yield of cherry tomato fruits obviously responded to spraying of moringa leaves extract early yield. The data showed 4.666 compared 4.158 kg/m^2 at the first season and 4.785 to 4.253 kg/m^2 at the second season for moringa and not sprayed treatments, respectively. The differences between moringa extract and not sprayed treatment showed significant value at the second season.

Organic fertilization highly increased total yield of tomato especially for the

high levels of compost (400 and 500 g/m^2) compared to chemical treatment for both seasons. The chemical fertilization treatment gave average value of 4.218 compared 5.047 and 4.692 kg/m^2 for 400 and 500 g/plant compost, respectively, at season 2015/2016. Similar trend appeared at season 2016/2017, where chemical fertilization treatment attained 4.458 compared to 4.753 and 5.171 kg/m^2 for 400 and 500 g compost/pot, respectively. Although, there was no significant variation for interaction treatment, the highest yield was 5.436 (400 g compost with moringa spray) at season one compared with chemical fertilization and without moringa which gave 3.765 kg/m^2. While, at season two, the highest total yield appeared for organic fertilization (fish extract with 500 g/pot compost) with moringa spray which gave 5.321 compared 4.201 kg/m^2 with chemical fertilization and without moringa treatment.

Data of the fruit quality depended on some morphological parameter as those shown in Table (6). Average fruit weight positively influenced by foliar spray with moringa leaf extract, but no significant differences was observed at the two growing seasons. Organic fertilization, also, did not exhibit significant variations than the control (chemical fertilization). The interactions between foliar spray with moringa extract and fertilization types had no significant effect on the average of fruit weight.

Table (6): Effect of foliar application moringa leaves extract and organic fertilization on average fruit weight (g), fruit diameter (mm) of cherry tomato fruits.

Organic fert / Moringa	Ch.1	Fish extract + compost (g/plant)					
		100	200	300	400	500	Mean
	Average fruit weight (g)						
	First season (2015/2016)						
Moringa	6.49	6.83	7.41	8.47	7.09	6.81	7.18
Without	6.70	6.32	6.66	6.60	7.42	6.63	6.72
Means	6.60	6.57	7.03	7.53	7.25	6.72	
F. test	M = NS, C = NS, M x C = NS						
	Second season (2016/2017)						
Moringa	7.08	7.29	7.17	8.36	7.45	7.03	7.40
Without	6.37	6.33	6.80	6.86	7.22	6.45	6.67
Means	6.73	6.81	6.99	7.61	7.34	6.74	
F. test	M = NS, C = NS, M x C = NS						
	Fruit diameter (mm)						
	First season (2015/2016)						
Moringa	23.6	25.4	26.9	27.2	26.4	26.6	26.0
Without	23.6	24.9	25.8	25.7	25.3	27.5	25.46
Means	23.6 d	25.2 c	26.3 ab	26.4 ab	25.8 bc	27.1 a	
F. test	M = NS, C = **, M x C = NS						
	Second season (2016/2017)						
Moringa	25.8	24.7	25.8	26.4	26.8	27.3	26.1 a
Without	24.2	24.3	24.7	25.5	26.4	26.6	25.3 b
Means	25.0 d	24.5 d	25.3 cd	26.0 bc	26.6 ab	26.9 a	
F. test	M = **, C = **, M x C = NS						

****, * and NS indicate significant differences at P<0.01, P <0.05 and Not significant, respectively according to F-test.**

In the same column, means followed by same letter are not significantly different at 5% level according to Duncan's test.

Data of Table 6 illustrated, the average of fruit diameter (mm). The records indicated that there was no significant variations by foliar spray with moringa leaves extract, at the first season, while, at the second growing season, there were significant variations in fruit diameter, which attained 26.1 mm for moringa extract spray in relation to 25.3 mm for without moringa one. On the other hand, the organic fertilization significantly increased fruit diameter. The highest values i.e. 27.1 and 26.9 mm were obtained from high levels of compost (500 g/pot) compared to 23.6 and 25.0 mm in the first and the second seasons, respectively,. The interactions between moringa spraying and organic fertilization had no significant effect in both seasons.

Moringa leaves extract had a positive effect on total soluble solids of cherry tomato fruits (Table 7), but the differences were not significant at the first season only. At the second season, shown significant increase in total soluble solids control. Moringa extract spray attained an average 6.03% in comparison to 5.79% for not sprayed treatment.

Data of vitamin C were illustrated in Table (7). The moringa extract did not show significant differences than not sprayed treatments in both seasons, although, there were consistent increase for moringa extract spray over not sprayed control, at both seasons, but without significant level.

Otherwise, organic fertilization had a remarkable influence for vitamin C compared to chemical fertilizer (Table 7). A general gradual increase in vitamin C was noted with the increase of compost levels. The chemical fertilization treatment averaged 30.43 compared to average values of compost levels those attained 22.95, 38.45, 38.13, 37.6 and 44.70 mg/100 g fruit (fresh weight) for 100, 200, 300, 400 and 500 g compost/plant, respectively, the differences showed significancy. The trend of the second season was similar to the first one.

The interactions between moringa extract spray and organic fertilization had no significant variations for values of vitamin C. But the moringa spray with the high levels of organic fertilization resulted increase of vitamin C content in tomato fruits compared to no moringa spray and chemical fertilization treatment in both studying seasons.

Organic fertilization with fish extract and different levels of compost, generally, had a positive increase in TSS over chemical fertilization treatment (Table 7). Chemical fertilization at the first season, exhibited an average 5.55% compared to 6.1, 7.02, 6.25, 5.97 and 5.78 for 100, 200, 300, 400 and 500 g/pot compost, respectively. The effect of fertilization type, at the second season, gave the same trend. Total soluble solids for chemical fertilization treatment averaged 5.38% compared to 6.0, 6.9, 6.48, 5.95 and 5.72% for 100, 200, 300, 400 and 500 g compost/pot, respectively. The interaction between moringa extract spray and compost levels showed significant variation at the first season, but did not show significancy at the second one. The treatment of moringa extract spray with 200 g/pot compost exhibited the highest total soluble solids (7.17%) in compared to the lowest value (5.23%) of the chemical fertilization and without moringa spray treatment (control).

Data of Table (7) showed a heavy increase in titratable acidity due to spray with moringa extract over not sprayed one, and the differences were significant at both seasons. Moringa extract spray averaged 0.388% in comparison to 0.341% for not sprayed one. The effect at the second season was similar to first one. Titratable acidity gave 0.380 and 0.338% for spray and not sprayed treatments, respectively, and the difference was significant.

Table (7): Effect of foliar application of moringa leaves extract and organic fertilization on vitamin C, TSS and titratable acidity of cherry tomato fruits.

Organic fert. / Moringa	Ch.1	Fish extract+compost (g/plant)					
		100	200	300	400	500	Mean
	Vitamin C (mg/100 g fruits)						
	First season (2015/2016)						
Moringa	33.20	23.23	40.37	40.00	38.20	42.50	36.62
Without	27.67	22.67	36.53	36.27	37.00	40.90	33.51
Means	30.43 c	22.95 d	38.45 b	38.13 b	37.60 b	44.70 a	
F. test	M = NS, C = **, M x C = NS						
	Second season (2016/2017)						
Moringa	32.20	28.43	38.67	40.59	38.20	39.90	36.33
Without	29.33	26.47	30.90	34.93	35.73	36.83	32.37
Means	30.77 c	27.45 d	34.78 b	37.75 ab	36.97 ab	38.37 a	
F. test	M = NS, C = **, M x C = NS						
	Total soluble solids (TSS %)						
	First season (2015/2016)						
Moringa	5.87 cd	6.33 b	7.17 a	6.17 bc	6.17 bc	5.80 cd	6.25
Without	5.23 e	5.87 cd	6.87 a	6.33 b	5.77 d	5.77 d	5.97
Means	5.55 e	6.10 bc	7.02 a	6.25 b	5.97 cd	5.78 de	
F. test	M = NS, C = **, M x C = *						
	Second season (2016/2017)						
Moringa	5.70	6.40	7.37	6.67	6.23	5.73	6.03 a
Without	5.07	5.60	6.43	6.30	5.67	5.70	5.79 b
Means	5.38 d	6.00 c	6.90 a	6.48 b	5.95 c	5.72 cd	
F. test	M = *, C = **, M x C = NS						
	Titratable acidity (%)						
	First season (2015/2016)						
Moringa	0.607 a	0.373 b	0.350 b	0.327 b	0.320 b	0.350 b	0.388 a
Without	0.367 b	0.350 b	0.333 b	0.320 b	0.337 b	0.337 b	0.341 b
Means	0.487 a	0.362 b	0.342 b	0.323 b	0.328 b	0.343 b	
F. test	M = **, C = **, M x C = **						
	Second season (2016/2017)						
Moringa	0.567 a	0.370 b	0.353 b	0.327 b	0.327 b	0.337 b	0.380 a
Without	0.353 b	0.340 b	0.347 b	0.323 b	0.330 b	0.333 b	0.338 b
Means	0.460 a	0.355 b	0.350 b	0.325 b	0.328 b	0.335 b	
F. test	M = **, C = **, M x C = **						

**, * and NS indicate significant differences at P<0.01, P <0.05 and Not significant, respectively according to F-test.

In the same column, means followed by same letter are not significantly different at 5% level according to Duncan's test.

On the other hand, the chemical fertilization potentially increased titratable acidity over organic fertilization treatments as shown in (Table 7), the chemical fertilization gave 0.487% in relation to 0.362, 0.342, 0.323, 0.328 and 0.343% for compost levels 100, 200, 300, and 500 g compost /pot, at season one. The interaction between moringa spray and compost levels had significant variation through the two studying seasons. The highest value attained for moringa spray with chemical fertilization 0.607 and 0.567% at seasons one and two, respectively.

Concerning to N, P and K concentration in cherry tomato fruits, results presented in Table (8) showed that spray with moringa leaf extract did not significantly affect N, P and K contents of tomato fruits.

Whilst, the organic fertilization with compost levels plus fish extract fertilization significantly varied than chemical fertilized ones. The highest N, P and K content were 3.98, 6.7 and 5.18 (g/plant) at 400 g compost/plant with fish extract fertilization compared to 2.60, 5.34 and 4.68 (g/plant) for chemical fertilization. The interactions between moringa leaf extract spray and organic fertilization exhibited a significant influences especially for the treatment of 400 g compost with fish extract fertigation + moringa leaf extract spray which gave the values 4.16, 7.72 and 5.68 (g/plant) compared to 2.64, 5.28 and 4.56 (g/plant), respectively, for treatment of chemical fertilization without moringa leaf extract spray.

Table (8): Effect of moringa extract and organic fertilization on N, P and K contents (g/plant) of cherry tomato fruits.

Compost / Moringa	Ch.1	Fish extract compost (g/plant)					
		100	200	300	400	500	Mean
	N content (g/plant)						
	First season (2015/2016)						
Moringa	2.56 d	3.28 c	3.84 ab	2.84 a	4.16 a	3.64 b	3.4
Without	2.64 d	2.64 d	3.24 c	2.96 d	3.80 b	3.52 bc	3.08
Means	2.60 d	2.96 c	3.54 b	2.90 cd	3.98 a	3.58 b	
F. test	M = NS, C = **, M x C = *						
	P content (g/plant)						
	First season (2015/2016)						
Moringa	5.40 bc	6.04 bc	6.20 b	5.08 cd	7.72 a	5.44 bc	5.44
Without	5.28 bc	4.04 d	5.80 bc	4.84 d	5.68 bc	7.88 a	5.60
Means	5.34 bbc	5.04 c	6.00 ab	4.96 c	6.70 a	6.66 a	
F. test	M = NS, C = **, M x C = **						
	K content (g/plant)						
	First season (2015/2016)						
Moringa	4.80 bc	4.48 c	5.32 ab	4.40 c	5.68 a	4.76 bc	4.88
Without	4.56 bc	3.32 d	4.92 abc	4.60 bc	5.60 a	5.60 a	4.80
Means	4.68 bc	3.90 d	5.12 a	4.50 c	5.64 c	5.18 a	
F. test	M = NS, C = **, M x C = *						

****, * and NS indicate significant differences at P<0.01, P <0.05 and Not significant, respectively according to F-test.**

In the same column, means followed by same letter are not significantly different at 5% level according to Duncan's test.

DISCUSSION

Moringa oleifera **is a wide broad cultivated plant, it is easy to be cultivated through wide broad environmental area. Moringa leaves contain a high content of elements and vitamins. It contains 25% protein, 0.5% methionine and it is also an important source of antioxidant (Bashir *et al*., 2014). It is found, also, that contains cytokinins related hormones (Fugil, 2000). Moringa leaves contains zeatin hormone with high values (from 5 to 200 mcg/g moringa leaves) (Culver *et al*., 2012).**

For these characteristics of moringa leaves, the foliar spray with moringa leaves extract had positive influences on tomato growth and yield. Whereas, Culver *et al*. (2012) found that foliar spray with leaves moringa extract increased rates of tomato growth under greenhouse cultivation, it potentially increased fruit yield. Similarly Matthew (2016) found that foliar spray of pepper plants with moringa extract at concentration of 1:20 each two weeks gave the highest fruits yield and the highest fruits number/plant compared to not sprayed plants. Additionally, it improved the other growth like stem thickness number of leaves/plant and stem length.

On the other hand, the present study indicated that organic fertilization with the different compost levels with fertigation with fish extract (1:100) gave a high fruits yield for cherry tomato as well as improving other growth characteristics such as stem length, number of leaves per plant, number of fruits/plant … etc. Therefore, the application of organic fertilization in soilless systems contributes an important feature for production of organic foods, whereas, Treadwell *et al*. (2007) remembered that chemical fertilized plant products are rejected under the NOP (National organic program). But plant nutrients may supplied as plant-animal-based organic fertilizers as well as mind minerals.

Lazcano *et al*. (2009) used additions of compost and vermicompost on peatmoss medium, they found that compost concentrations till 20% added on peatmoss improved tomato growth and fruits yield. They also, found that substitution of peatmoss with vermicompost till 100% improves these characteristics of tomato. Atiyeh *et al*. (2000) indicated a similar results, whereas, they substituted Metro-Mix360 medium with 10% or 20% Vermicompost increased tomato growth, because of the high content of elements present in vermicompost.

Dresbell (2004) reported in his study on alternative media for organic greenhouse production, that compost may be a suitable alternative to natural substrate in case of organic fertilization. But, when compost is used as growing medium in organic greenhouse production, a number of requirements should be fulfilled: first, the compost structure, water retention, air filled porosity and volume weights must be suitable, the particle size distribution must be in the range 30-300 µm. These will retain water, but not bind it tightly, secondly: nutritional quality of compost important parameter (Payne, 1988).

The use of fish extract, in the present investigation, help in supply the tomato plants with their needs from elements, but from organic source. It was noted that the use of fish extract with the dilution of 1:10 in addition to compost amendments contributes for supply the plant with their most needs of elements when compared to the plant fertigated with the recommended dose of chemical nutrients as fertigation (Tzortzakis and Economakis, 2008). Whereas, Fernandez-Salvador *et al*. (2015) used different sources of liquid organic fertilizers for production of organic blackberry like fish waste digestion blend and a corn steep liquor (2.5 N : 1.1 P : 1.2 K) and also

soluble and molasses blend (4 N: 0.0 P : 1.2 K) and they mentioned that these two organic fertilizers supplied sufficient nutrients to meet plant needs except Ca and B.

Plant contents of macro-elements in leaves and fruits varied with type and level of fertilization. Tomato fruit contents of N, P and K were found by Baldantoni *et al*. (2015) which the increase due to application of compost levels, the most effective level was 45 tons/ha. Kochakinezhad *et al*. (2012) remembered that the addition of different types of compost like spent mushroom and manure compost increased fruit contents from P and K. Whilst, the treatment with moringa leaf extract did not give significant increase in these macro-element than control plants (N, P and K contents). These results in confirm with the results of the present investigation (Culver *et al*., 2012 and Bashir *et al*., 2014) on tomato plants.

In conclusion, the soilless agriculture is very important, especially for using bare lands and house roofs in food production. Cherry tomato planted in vermiculite media with compost levels gave grater results. The organic fertilization with compost and fertigation with fish extract at concentration with 1:100 water, increased yield components and improved fruit quality as well as other plant growth parameters.

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أهمية التسميد بالكومبوست والرش بمستخلص المورينجا على إنتاجية ونوعية الطماطم الشيرى تحت نظام الزراعة العضوية بدون تربة

محمد نور الدين السيد[١] ، حسنى محمد الكومى[٢] ، محسن حسن الباجورى[١]

[١] معهد بحوث الاراضى والمياه والبيئة ، مركز البحوث الزراعية ، القاهرة

[٢] قسم بحوث الخضر ، معهد بحوث البساتين ، مركز البحوث الزراعية ، الجيزة ، مصر

الملخص العربى

نظام الزراعة بدون تربة من الأنظمة الواعدة لما لها من مميزات أهمها توفير مياه الرى والاستفادة من الاراضى البور واسطح المنازل لإنتاج الطعام ، والحد من استخدام المبيدات. كما اتجهت أنظار الباحثين إلى التسميد العضوى بدلاً من التسميد الكيماوى لتقليل الأثار الضارة الناتجة عنه. وكان الهدف من هذه التجربة هو دراسة نظام التسميد العضوى وذلك بإضافة الكومبوست كمصدر للتسميد مع رى النباتات بمستخلص مخلفات السمك بنسبة ١ :١٠٠ مع رش النباتات بمستخلص أوراق المورنجا وتأثير ذلك على نمو نباتات الطماطم الشيرى ومحصول الثمار ومواصفاته وقد أثبتت نتائج البحث أن إضافة الكومبوست لبيئة الفيرماكيوليت المستخدمة فى الزراعة أدت إلى تحسين إنتاجية ونوعية الطماطم الشيرى هجين جوايندو وخصوصا مستويات ٤٠٠ ، ٥٠٠ جم/نبات التى حسنت من طول الساق ، الانتاج الكلى للثمار ، متوسط وزن الثمرة وقطر الثمرة. كما حسنت من الخواص الكيماوية للثمار مثل فيتامين C ، TSS ، نسبة النتروجين والبوتاسيوم والكالسيوم ولكن قللت سمك الساق و نسبة الحموضة فى الثمار.

وكان للرش بمستخلص المورينجا أثره الايجابى على كل هذه الصفات المدروسة. كما حسن التفاعل بين التسميد العضوى والرش بالمورينجا من هذه الصفات ، فكانت أعلى إنتاجية ثمار لمعاملة ٤٠٠ جم كمبوست/نبات والرى بمستخلص السمك مع الرش بمستخلص المورينجا الى أعطت ٥,٤٣٦ ، ٥,٠٥٤ كجم/نبات للموسم الأول والثانى على التوالى بالمقارنة بـ ٣,٧٦٥ و٤,٢٠١ كجم/نبات لمعاملة الكنترول (تسميد كيماوى وبدون رش مورينجا).

أسماء السادة المحكمين

أ.د/ عبدالرؤف هويدى معهد بحوث الخضر - الدقى

أ.د/ فتوح أبـو اليزيـــد كلية الزراعة – جامعة المنوفية