International Journal of Environmental Studies and Researches (2022), 1 (2):250-261

Effect of Compost on Root Rot Disease Management to Increase Tomato Plants Productivity

Arafa.M.M[1]; Shaheen, S.I.[1]; Mansour, A.M.K[1] and Ahmed, M.F.A.[2]

[1]Environmental Studies & Research Institute, University of Sadat City, Egypt.
[2]Central Lab. Of Organic Agriculture, ARC, Giza, Egypt.

Abstract

The present work was carried out during 2020 and 2021 successive growing seasons at Sadat City farms, Cairo, Alexandria Desert Road, Menoufia Governorate, Egypt, to study the Effect of Compost on Root Rot Disease Management to Increase Tomato Plants Productivity. Whereas, chemical pesticides might have injury on the environment and human health because it highly toxic substances produced in agricultural led to, great disturbance in biological balance. *Rhizoctonia solani* and *Sclerotium rolfsii* were isolated from rotted samples of tomato plants as the main causal pathogens of root rot and damping off diseases. In addition, causing losses on the yield. Adding the different organic matters, *i.e.* plant residue, cow manure and compost "plant residue + cow manure" to the soil before transplanting tomato at the rate of 1.2 Kg/m^2 significantly reduced disease incidence and also, increased the percentage of the survived plants compared to control treatment during 2020 and 2021 growing seasons.

Compost, as tomato rich organic fertilizer at the rate of 1.2 Kg/m^2 caused the highest decrease in disease incidence and recorded also, the highest increase in vegetative growth (plant height, no. of brunches/plant and No. of leaves/brunch); yield parameters; flavonoid and total phenol during the two growing seasons. No clear significant differences were noticed between both plant residues and cow manure in respect to plant growth characteristics.

Keywords: Tomato, Compost, Cow manure, Plany residue and root rot diseases.

Introduction

Tomato (*Lycopersi conesculentum*, Mill.) is considered as one of the most important crops as well as popular vegetables all over the world as well as in Egypt. It is a crop extensively grown worldwide, rich in potassium, antioxidants, ascorbic acid, vitamin A, lycopene, and tocopherols for nourishing human health (**Capobianco *et al*., 2021**). In addition, tomato represents one of the important vegetable crops grown for local, consumption and export purposes. Tomato is one of the most important vegetables consumed in the world.

In Egypt, tomato ranked as the first vegetable cash crop with total planting area 185211 , which yielded about 3268740 ton of fruits (**Ministry of Agriculture and Land Reclamation, February 2021**). This area represented about 31.5 % of the total vegetable cultivated area in

Egypt. Globally, Egypt is ranked in the fifth position in growing tomato crop (**FAO, 2017**). Egyptian climate is favorable for tomato production as well as incidence of several diseases most of the year. Tomato is subjected to several diseases caused by fungi, bacteria, viruses, nematodes and abiotic factors (**Balanchard, 1991**).

Some investigators dealt with the effect of organic manure on vegetative growth, yield and chemical constituents. They stated that application of organic manure increased dry weight/plant; N, P and K contents, number of fruits/plant, average fruit weight and yield/plant and feddan (**Mohsen 2006**, **Olaniyi and Ajibola 2008**; **Agyeman *et al.* 2014**, **Ilupeju *et al.* 2015** and **Yousafzai *et al*. 2016**) on tomato.

The most widely grown tomato cultivars were susceptible to soilborne infections and especially to disease caused by *Rhizoctonia solani* (Kühn). This pathogen is mostly known as a damping-off agent but is also responsible for collar and root rots and eventual death of severely diseased plants leading to significant crop yield loss [**Arora *et al.,* 2008 and Ahmed, 2013**].

Tomato is one of the most important vegetable crops all over the world. In Egypt, tomato can be cultivated in different seasons such as winter, summer and Nile; but it is subjected to the attack by many soil borne pathogens causing damping-off, root rot and wilt diseases (**Nguyen *et al*., 2011**). *Fusarium* spp., *Rhizoctonia solani* and *Pythium* spp. are the most popular pathogens causing severe yield losses of tomato all over the world and disease control is difficult (**Bokhari and Perveen, 2012**).

The root rot of tomato, in particular, is commonly caused by soil-borne fungal pathogens such as *Rhizoctonia solani*, *Fusarium solani*, *Phytophora* species, and *Sclerotium rolfii* that delays growth, reduce harvest yield and quality, and subsequent death of severely infected plants (**Ajilogba *et al*., ; Hamza *et al*., 2016; Kashyap *et al*., 2020**). This disease is favored by environmental factors such as temperature for pathogen growth, moderate to high soil moisture content, soil compaction, poor drainage, and other factors that contribute to plant stress (**Sharath Chandran *et al*., 2021**).

Sullivan (2004) recorded that bean sizes from the compost treatment, were larger and yields 25% higher than those from areas receiving no organic amendment. Ashy stem blight was severe in areas with no compost applied. *R. solani* root rot disease was reduced under the sludge treatment but almost eliminated where compost had been applied. Compost is effective because it fosters a more diverse soil environment in which a myriad of soil organisms exist. Compost acts as a food source and shelter for the antagonists that compete with plant pathogens, for those organisms that prey on and parasitize pathogens, and for those beneficial that produce antibiotics.

Raviv (2009) mentioned that compost is a term describing organic matter that has undergone long, thermophilic, aerobic decomposition a.k.a. composting suppress a wide variety of soil-borne pathogens.

Martina and Brathwaite (2012) reported that the major impediment to the use of compost as substrates or biocontrol agents has variation in physical and chemical characteristics and disease suppression levels across and within compost types, sources, and batches. Compost tea, a product of compost, has also been shown to suppress soil-borne fungi including the causes of damping-off and root rots (*Pythium ultimum*, *Rhizoctonia solani*, *Phytophthora* spp.) and wilts (*Fusarium oxysporum* and *Verticillium dahliae*).

Ahmed (2013) stated that treating soils before cultivation with 15 days with different organic matters, *i.e.* Plant residue, cow manure and compost "plant residue + cow manure" at the certain dose (/m^2) under field conditions during growing two seasons 2008 and 2009, significantly reduced disease incidence and also, increased the percentage of healthy plants compared to control treatment during the two growing seasons. Compost as bean rich organic fertilizer caused the highest significant increase in the percentage of fresh and dry weight of shoots and roots as well as, yield component in the two growing seasons 2008 and 2009, respectively.

Ahmed *et al.* (2022) reported that, Adding the different organic matters, *i.e.*, plant residue, cow manure and compost “plant residue + cow manure” at the rate of 1.2 kg/m^2 to the soil before transplanting Super Strain B hybrid tomato cv., as well as dipping tomato seedlings in diluted (1:50), as recommended dose of vermicompost or humic acid separately significantly reduced disease incidence *in vivo*. Also, assessment the highest increase in the survived plants in comparison with control treatment during both growing seasons. Compost, as rich organic fertilizer at the rate of 1.2 kg/m^2 caused the highest decrease in disease incidence and recorded also, the highest increase in vegetative growth "plant height, No. of brunches/plant and No. of leaves/brunch"; yield parameters; fruit quality "total soluble solid (TSS), vitamin C, protein and total carbohydrate"; chemical components of flavonoid, total phenol and the enzyme activities of peroxidase (PO), polyphenol oxidase (PPO), chitinase and β-1,3 glucanase during both growing seasons. On the contrary, the plant residue showed the least effect treatment.

Materials and Methods

1. Isolation, purification and identification of fungi associated with rotted roots of tomato:-

Samples of root-rotted tomato plants were collected from Sadat City , Cairo, Alexandria Desert Road, Menoufia Governorate, Egypt. The infected roots were washed in tap water, air dried, surface sterilized by dipping in 5% chlorine solution for 3 minutes, washed several times with sterilized distilled water and dried between two sterilized filter papers. The surface sterilized roots were cut into small pieces with sterilized scalpel and aseptically transferred to ready GFA plates; each contained 15 ml of Gliotoxin fermentation agar (GFA) medium (Brian and Hemming, 1945). Plates were incubated at 25±1°C and examined periodically. The developed mycelial growth(s) was transferred to other plates or slops contained the GFA medium using the technique of hyphal tip (Brown, 1924 and Hawker, 1960) and incubated at 28±1°C. for seven days. Pure obtained cultures were stored at 5°C. for further use. Identification of the isolated fungi was carried out at the Central Lab. Of Organic Agriculture (CLOA); Agricultural Research Center (ARC); Egypt, according to their cultural, morphological and microscopic characteristics as described by Gilman (1957); Barnett and Hunter (1987) and Singh (1982). Identification was confirmed through the Dept. of Taxonomy, Plant Pathology Institute, Agriculture Research Center "ARC", Egypt.

Tomato variety:

Seedlings of tomato (*Lycopersicon esculentum* Mill.) cultivar marmand were kindly provided by the Vegetable Research Institute, Agricultural Research Center, Giza, Egypt were used in this study.

Pathogenicity tests

Pathogenicity tests were carried out in potted soils under greenhouse conditions at the Central Lab. Of Organic Agriculture (CLOA); Agricultural Research Center (ARCEgypt. Plastic pots 20 cm, each containing 2.7 kg of light clay soil infested by *S. rolfsii* isolate “A and B” and/or *R. solani* isolate “A and B” (isolated from infected roots of tomato) were prepared. Seedlings of marmand tomato cv. obtained from Field Crop Institute, ARC, Giza , Egypt, were used in this experiment.

Inoculum preparation

For preparing inoculum of *S. rolfsii*, glass bottles (500 ml), each containing 100 ml of solid GFA-medium were inoculated, each with one agar disc obtained from the periphery of 5-days old culture and incubated for 15 days at 30±1°C. Then *S. rolfsii* - sclerotia were harvested using smooth brush and added to the potted soil at the rate of 50 sclerotia / kg. soil (**Ahmed, 2005 and Ahmed, 2013**).

For preparing inoculum of *R. solani*, the corn sand meal medium supplemented with 0.2% peptone solution (**Ahmed, 2005 and Ahmed, 2013**) was used. The medium was distributed in glass bottles (500 ml), each contained 200 g. corn sand meal peptone medium and autoclaved as usual. Autoclaved bottles were inoculated with 5 mm agar disc obtained from the periphery of *R. solani* culture and incubated for 15 days at 25±1°C. Then the inoculated medium was added to the potted soil at the rate of 10g/kg soil and mixed thoroughly. In all cases, soil infestation was performed 10 days before sowing. Marmand cv. seedlings of the tested tomato crop were transplanted in the potted infested or non-infested (control) soil at the rate of two transplants per pot and each replicate contained twenty plants in ten pots. Three replicates were used for each treatment. Planted pots were kept under normal open greenhouse conditions. Tomatoes plants were examined periodically (every week for seven weeks). Percentages of dead plants show damping off symptoms were recorded to determine virulence of each pathogen under test. Pathogenic transplants fungi were re-isolated from infected plants and Koch's postulates were followed. Data were recorded as percentage of disease incidence in each treatment.

Disease assessment

Percentages of root rot as well as healthy survivals percentages in each treatment were determined every week for seven weeks after transplanting using the next formula according to **El-Helaly *et al*. (1970), Ahmed (2005) and Ahmed (2013)**.

Pathogenic fungi were re-isolated from the infected plants and Koch's postulates were followed.

$$\text{\% Root rotted plants} = \frac{\text{Number of root rotted plants}}{\text{Total sown seeds}} \times 100$$

$$\text{\% Survived plants} = \frac{\text{Number of Survivals}}{\text{Total number of sowing seeds}} \times 100$$

Field experiments:-

All field experiments were carried out at Sadat City farms, Cairo, Alexandria Desert Road, Menoufia Governorate, Egypt, on the two successive seasons on 15th October, 2020 and 15th October, 2021 to estimate the efficiency of different compost for controlling root rot disease of tomato plants. The chosen field test area was naturally infested with root rot. All the experiments were conducted in a complete randomized block design with three replicated plots, the area of the experimental plot was 10.50 m^2 and comprised of 3 rows (3m×25cm) with about 50 cm apart. Each row was planted with 20 seedlings of marmand tomato cv. in naturally infested soil.

Effect of treating soils with different organic matters at the certain dose (/m^2) under field conditions during growing two seasons 2020 and 2021

In this experiments, all composted types were added at the rate of on dry basis/1 m^2) to the naturally infested soil in the field and irrigated daily. After 15 days tomato seedlings of cv. marmand were sown in the field treated soil. Plots without using any organic matter were used to serve as control treatment. Three plots were used as replicates for each treatment. Each one composed of 3 rows prepared as mentioned before (Ahmed, 2013).

Disease assessment

In all field experiments, the disease incidence of root rot and percentage of healthy survived plants were recorded after 45 days from transplanting as mentioned before. Plant height, fresh and dry weights of the plant, number of fruits/plant, yield components, Morphological characters, fruit quality, biochemical components and enzymes activity were determined.

Soil analysis:-

A representative sample of a mixture of clay and sandy soils (1:1 w/w) was collected from Sadat City farms, Cairo, Alexandria Desert Road, Menoufia Governorate, Egypt. The collected soil for pot experiment was air dried, crushed and prepared to physical and chemical properties determinations according to methods described by **Piper (1950).** The physical and chemical analysis of soil used in testing antagonistic activities of efficient yeast isolates against root rot fungi *in vivo* are given in Table 1.

Table 1. Some Physio-Chemical Properties of Sadat City Soil.

Soil Compositions					
1-Physical Properties		**2-Chemical Compositions**		**3-Exchangeable bases (mol (+) kg)**	
Clay %	7.69	**pH (Kcl)**	7.39	**Zn (ppm)**	1.82
Silt %	19.35	**Total Carbon (g/kg)**	0.22	**Mn (ppm)**	3.01
Sand %	72.79	**Total Nitrogen (g/kg)**	11.10	**K (ppm)**	280
EC (dS. m^{-1})	1.82	**P (ppm)**	6.83	**Cu (ppm)**	1.01
ECE (cmolc-Kg^{-1})	13.9	**$CaCO_3$ %**	5.00	**CEC**	5.80
Textural class	Sandy loamy	---------		**Fe (ppm)**	14.98

Chemical components determination:-

Quantification of total phenolics

The amount of total phenolics in extracts was determined by Folin – Ciocateu method as modified by **Singelton and Rossi (I965).**

Determination of total flavonoids content

The flavonoid content is expressed as milligrams of rutin equivalents per gram of sample (mg RE/g) according to the method of (**Rice-Evans *et al*., 1996).**

Statistical analysis

All the obtained data were subjected to statistical analysis and compared according to the least significant difference (L.S.D.) as mentioned by **Snedecor and Cochran (1989).**

Results and Discussion:

Isolation, purification and identification of the associated microorganisms

a.Frequency of fungi isolated from rotted roots

The isolated fungi of rotted roots of tomato plants collected from Sadat City, Cairo, Alexandria Desert Road, Menoufia Governorate, Egypt, were purified and identified as Fusarium oxysporum, F. solani, Pythium sp., Rhizoctonia solani and Sclerotium rolfsii. Data in Table (2) indicate that R. solani and S. rolfsii showed the highest frequency among those isolated fungi from the rotted samples of tomatoes collected from Menoufia Governorates. Identification was carried out according to their cultural, morphological and microscopic characteristics as described by **Gilman (1957); Barnett and Hunter (1987) and Singh (1982)**.

Table 2. Frequency (%) of fungi isolated from the rotten roots of tomato collected from two locations during 2019 growing season.

Isolated fungi	Frequency of fungi isolated from:	
	No.	(%)
Fusarium oxysporum (Schlecht)	3	11.1
F. solani (Marti "Sacc.")	3	11.1
***Pythium* sp.** (Pringsheim)	2	7.40
Rhizoctonia solani (Kuhn)	9	33.3
Sclerotium rolfsii (Sacc.)	10	37.1
Total	27	----

Pathogenicity tests

Data in Table (3) shows that that the most dangerous effects of *R. solani* and *S. rolfsii* have occurred after 49 days from transplanting. In this respect, *S. rolfsii* (isolate A) caused significantly the highest effect on root rot incidence (100 %) followed by *S. rolfsii* (isolate B) (93.33%), respectively. The opposite trend was recognized for *R. solani* (isolate A) showed the lowest records (73.34%) for root rot diseases and showed the highest percentage 26.66 % on standing plants (7-weeks post transplanting). These results are in agreement with those reported by **Nguyen *et al*., 2011; Bokhari and Perveen, 2012; Ahmed, 2013 and Sharath Chandran *et al*., 2021** who mentioned that the destruction on root caused by soilborne pathogens was due to the synergistic action between polygalacturonase and oxalic acid produced by these pathogens.

Table 3. Pathogenicity of *R. solani* and *S. rolfsii* on tomato plants (marmand cv.) under greenhouse conditions.

Pathogenic fungi	Root rot Diseases (%)	Plant survival (%)
R. solani (isolate **A)**	73.34	26.66
R. solani (isolate **B)**	86.67	13.33
S. rolfsii (isolate **A)**	100	00.00
S. rolfsii (isolate **B)**	93.33	06.67
Control "Untreated"	00.00	100.00
L.S.D at 5%	0.92	1.16

Effect of treating soils with different organic matters at the certain dose (1.2 Kg/m^2) under field conditions during 2020 and 2021 growing seasons

1. Disease control

Data presented in Table (4) indicate that all the added different organic matters, *i.e.* plant residue, cow manure and compost “plant residue + cow manure” to the soil before transplanting tomato at the rate of 1.2 Kg/m^2 significantly reduced disease incidence and also, increased the percentage of the survived plants compared to control treatment during 2020 and 2021 growing seasons. Compost was the most effective one in decreasing the disease incidence by efficacy of 17.01 and 32.21% during 2020 and 2021 the two growing seasons, respectively in comparison with control treatment. On the other hand, cow manure when added to tomato soil during growing season of 2021 was more effective, being 24.28% than when added during season of 2020, being 13.81%. The use of organic soil amendments can result in a better soil quality and greater plant disease suppressiveness (**Sullivan (2004); Raviv (2009); Martina and Brathwaite (2012); Ahmed (2013) and Sharath Chandran *et al*., 2021**); however, in this study it depended on the type of organic fertilizer. These data are in agreement with those obtained by **Abd-El-Moniem (2001); Sullivan (2004); Zmora-Nahum *et al.* (2008); Deeksha *et al.* (2009) and Sang *et al.* (2010).** On the other hand, compost as rich fertilizer contains more antagonistic microorganisms than the other two organic matters either regarding nutrient content or microbial population.

Table 4. Effect of adding different organic matters at the rate 1.2 Kg/ m^2 to the soil of tomato on disease incidence under field conditions during 2020 growing seasons.

Different treatments	2020 growing season			2021 growing season		
	Root rot %	Plant survival %	Efficacy * %	Root rot %	Plant survival %	Efficacy* %
Plant residue	21.70	78.30	13.81	29.50	70.50	18.89
Cow manure	21.70	78.30	13.81	26.30	73.70	24.28
Compost**	19.50	80.50	17.01	21.60	78.40	32.21
Control	31.20	68.80	-------	40.70	59.30	----
LSD at 5%	1.05	0.64		0.82	0.68	

* % Efficacy of plant survival = ((Treatment/Control)×100)-100

****** Compost consists of “plant residue + cow manure”.

Morphological Characteristics:-

Vegetative growth in terms of plant height, no. of brunches/plant and No. of leaves/brunch were clear positive trends in increasing by all tomato seedling treatments as resulted in Tables (5). The best results were recorded in the treatment of compost which consists of plant residue and cow manure followed by cow manure treatment. On the contrary, the plant residue showed the lowest effect in comparison with control treatment during the two successive seasons 2020 and 2021 respectively. These results are in harmony with those obtained by **Sullivan (2004)** and **Ahmed *et al.* (2022)** who reported that soil-borne diseases result from a reduction of biodiversity of soil organisms.

Table 5. Effect of adding different organic matters at the rate 1.2 Kg/ m^2 to the soil of tomato on plant growth parameters and fruit yield under field conditions during 2020 and 2021 growing seasons.

Different treatments	2020 growing season			2021 growing season		
	Plant Height (cm)	Branch No.	No. of leaves/ branch	Plant Height (cm)	Branch No.	No. of leaves/ branch
Plant residue	55.80	10	9	56.00	10	10
Cow manure	60.50	11	10	71.00	11	11
Compost**	65.00	12	11	66.00	12	12
Control	45.00	5	4	45.50	5	4
LSD at 5%	2.30	0.33	0.20	2.44	0.32	0.22

**** Compost consists of “plant residue + cow manure”.

Effect on plant fresh and dry weight

Data presented in Tables (6-a and 6-b) reveal that treatment with compost resulted in significant increase in the percentage of fresh and dry weight of shoots (54.02 and 59.69%) and roots (137.23 and 92.31%), respectively during 2020 growing season and gave the highest increase in fresh and dry weight of shoots (56.95 and 70.97%) and roots (159.84 and 170.69%), respectively during 2021 growing season in comparison with control treatment. On the contrary, plant residue treatment was the lowest effective one during the two growing seasons. In general, all different treatments led to conspicuous improvement in the aforementioned crop parameters during the two growing seasons compared with control treatment. Obtained results are in agreement with those reported by **Sullivan (2004); Ahmed, 2013 and Dawa *et al.* (2013).** All working on tomato. In this respect, **El-Naggar (2004) and Ahmed *et al.* (2022)** reported that under sandy soil conditions Microbein fertilizer at 200g/fed. gave the highest number of both leaves and branches/plant, dry weight of branches, leaves and total dry weight/plant.

Table 6.a. Effect of adding different organic matters at the rate 1.2 Kg/ m^2 to the soil of tomato on fresh, dry weight of shoots and roots in "g"/plant under field conditions during 2020 growing season.

Different treatments	Fresh weight				Dry weight			
	Shoots	Change * %	Roots	Change * %	Shoots	Change * %	Roots	Change * %
Plant residue	167.50	28.16	41.11	29.15	16.70	21.90	6.40	64.10
Cow manure	190..30	45.60	48.83	53.41	31.50	129.93	6.50	66.67
Compost**	201.30	54.02	50.83	59.69	32.50	137.23	7.50	92.31
Control	130.70	------	31.83	------	13.70	------	3.90	------
LSD at 5%	2.05		0.44		0.24		0.12	

*Change % = [(Treatment – Control) / Control] x 100

**** Compost consists of “plant residue + cow manure”.

Table 6.b. Effect of adding different organic matters at the rate 1.2 Kg/ m2 to the soil of tomato on fresh, dry weight of shoots and roots in "g"/plant under field conditions during 2021 growing season.

Different	Fresh weight	Dry weight

treatments	Shoots	Change * %	Roots	Change * %	Shoots	Change * %	Roots	Change * %
Plant residue	167.85	30.42	41.20	38.12	16.90	33.07	6.50	124.14
Cow manure	190..50	48.02	49.00	64.26	31.75	150.00	6.75	132.76
Compost**	202.00	56.95	51.00	70.97	33.00	159.84	7.85	170.69
Control	128.70	------	29.83	------	12.70	------	2.90	------
LSD at 5%	1.88		048		0.26		0.14	

*Change % = [(Treatment – Control) / Control] x 100

** Compost consists of "plant residue + cow manure".

Yield components:-

Results shown in Tables (7) show that applying any of the tested organic matter as solution and used at the rate 1.2 Kg/ m^2 to the soil of tomato seedlings led to significant increase in the assessed yield parameters in 2021 growing season than in 2020 growing season. Compost which consists of cow manure and plant residue caused significant increase in number of fruit/plant, average fruit weight and fruit yield/plant, respectively in the 2021 growing season and gave 42.5, 94.50g and 4016.25 g, respectively in comparison with the control. On the other hand, plant residue was the lowest effective one during the two growing seasons. In most cases there were significant differences in the estimated values in both growing season due to using cow manure. In this connection, **El-Tantawy and Mohamed (2009); Mahila *et al.* (2010); Ahmed, 2013** and **Ahmed *et al.* (2022)** recorded same results. Some investigators dealt with the effect of organic manure on vegetative growth, yield and chemical constituents. They stated that application of organic manure increased dry weight/plant; N, P and K contents, number of fruits/plant, average fruit weight and yield/plant and feddan (**Agyeman *et al.* 2014, Ilupeju *et al.* 2015 and Yousafzai *et al.* 2016**) on tomato.

Table 7. Effect of adding different organic matters at the rate 1.2 Kg/ m^2 to the soil of tomato on yield components under field conditions during 2020 and 2021 growing seasons.

Different treatments	2020 growing season			2021 growing season		
	No. of fruit/ plant	Average fruit weight/ (g/fruit)	Fruit yield (g/plant)	No. of fruit/ plant	Average fruit weight/ (g/fruit)	Fruit yield (g/plant)
Plant residue	39.3	85.5	3360.15	39.8	84.5	3363.10
Cow manure	39.5	90.5	3574.75	40.5	90.3	3657.15
Compost*	41.5	95.5	3963.25	42.5	94.5	4016.25
Control	12.9	45.8	590.82	13.2	45.8	604.56
LSD at 5%	1.14		12.11	1.15		9.44

***** Compost consists of "plant residue + cow manure".

Effect of treating tomato plants with different organic matter treatments on the activity of flavonoids and total phenols under field conditions during 2020 and 2021 growing seasons:-

Data in Table (8) indicate that all tested different organic matter treatments at the rate of 1.2 Kg/ m^2 to the soil of tomato seedlings were affected positively on the activities of flavonoids and total phenols in leaves of tomato plants comparing with control treatment during the two successive seasons 2020 and 2021. In this respect, the highest effective treatment on flavonoids and total phenols was compost where it recorded 43.50, 175.00 and 43.65, 177.50 %, in the two seasons 2020 and 2021, respectively, followed by cow manure. On the contrary plant residue show the least effect in comparison with control treatment. These resulta are harmony with **Mahila *et al.* (2010); Ahmed, 2013 and Abdeljalil et al., 2016** who recorded same results when tomato seedlings dealt with the effect of organic manure on vegetative growth, yield and chemical constituents.

Table 8. Effect of adding different organic matters at the rate 1.2 Kg/ m^2 to the soil of tomato on the activity of flavonoids and total phenols under field conditions during 2020 and 2021 growing seasons.

Different treatments	2020 growing season		2021 growing season	
	Flavonoids	Total phenols	Flavonoids	Total phenols
Plant residue	35.00	160.00	35.53	160.30
Cow manure	42.00	170.50	42.55	172.00
Compost**	43.50	175.00	43.65	177.50
Control	30.00	125.20	32.00	32.50
LSD at 5%	1.33	2.22	1.44	2.20

****** Compost consists of "plant residue + cow manure".

References

Abdeljalil, O.; Vallance, J.; Gerbore, J. and Daami-Remadi, M.(2016). Bio-suppression of Sclerotinia Stem Rot of Tomato and Biostimulation of Plant Growth Using Tomato-associated Rhizobacteria. Journal of Plant Pathology and Microbiology, 7 (2) 1000331.

Agyeman, K.; Osei-Bonsu, I.; Berchie1, J.N.; Osei1, M.K.; Mochiah, M.B.; Lamptey, J. N.; Kingsley, O. and Bolfrey-Arku, G. (2014). Effect of Poultry Manure and Different Combinations of Inorganic Fertilizers on Growth and Yield of Four Tomato Varieties in Ghana. Agricultural Science Volume 2, Issue 4, 27-34 ISSN 2291- 4471.

Abd-El-Moniem, M.L. (2001). Evaluation of some non-chemical methods to control some soilborne fungi and foliage diseases of cucumber. Ph.D. Thesis. Faculty of Agriculture, Zagazig Univ., 143 p.

Ahmed, M.F.A. (2005). Effect of adding some biocontrol agents on non-target microorganisms in root diseases infecting soybean and broad bean plants. M.Sc. Thesis. Faculty of Agriculture, Moshtohor, Benha Univ., 137 p.

Ahmed, M.F.A., (2013). Studies on non-chemical methods to control some soil borne fungal diseases of bean plants Phaseolus vulgaris L. Ph.D. Thesis. Faculty of Agriculture, Cairo Univ., pp: 137.

Ahmed, M.F.A.; Ali, A.A.M. and Shahin, S.I. (2022). Efficiency of some Organic Matter on Suppression of Soil-Borne Diseases of Tomato Plants under Organic Agriculture System. Egyptian Journal of Phytopathology, 50, (2): 124-137.

Ajilogba, C.F..; Babalola, O. and Ahmad, F.(2013). Antagonistic Effects of Bacillus Species in Biocontrol of Tomato Fusarium Wilt. Ethno Med, 7(3): 205-216.

Arora NK, Khare E, Oh H, Kang SC, Maheshwari DK (2008) Diverse mechanisms adopted by fluorescent Pseudomonas PGC2 during the inhibition of Rhizoctonia solani and Phytophthora capsici. World J Microbiol Biotechnol 24: 581-585.

Barnett, H.J. and Hunter, B.B. (1987). Illustrated Genera of Imperfect Fungi. Burgess, Publ.Co., Minneapolis, USA, 218 p.

Blanchard, O.J. (1991). Comments [on Barro and Sala-i-Martin, 'Convergence across States and Regions']." BPEA, 1: 159-74.

Bokhari, N.A. and Kahkashan, P. (2012). Antagonistic action of Trichoderma harzianum and Trichoderma viride against Fusarium solani causing root rot of tomato. African Journal of Microbiology Research Vol. 6(44), pp. 7193-7197.

Brian, P.W. and Hemming, H.G. (1945). Gliotoxin a fungistatic metabolic product of *Trichoderma viride.* Ann. Appl. Biol., 32:214-220.

Brown, N. (1924). Two mycological methods. II. A method of isolated single strain fungi by cutting a hyphal tip. Ann. Bot., 38:402–406.

Dawa, Kawsar k. A.; Al-Gazar, T.M. and Abdel-Fatah, A.M. (2013). Effect of chicken manure combined with bio-fertilizers,mineral fertilizer and some foliar applications on vegetative growth and some chemical constituents of tomato leaves.Plant Production, Mansoura Univ. Vol. 4 (10): 1555 – 1570.

Deeksha, J.; Hooda, K.S.,; Bhatt, J.C.,; Mina, B.L. and Gupt, H.S. (2009). Suppressive effects of composts on soil-borne and foliar diseases of French bean in the field in the Western Indian Himalayas. Crop Protection, 28(7):608-615.

EL-Helaly, A.F.; Elarosi, H.M.; Assawah, M.W. and Abol-wafa, M.T. (1970). Studies on damping- off and root- rots of bean in U.A.R. (Egypt). J. Phytopath., 2:41-57.

El-Nagaar, S. A. (2004). Evaluation of tomato productivity under organic agriculture in new reclaimed sandy soil condition. M. Sc. Thesis, Fac. Agric ., Zagazig. Univ., Egypt.

El-Tantawy, M.E. and Mohamed, M.A.N. (2009). Effect of inoculation with phosphate solubilizing bacteria on the tomato rhizosphere colonization process, plant growth and yield under Organic and Inorganic fertilization. J. App. Sci. Res., 5(9): 1117-1131.

Food and Agriculture Organization (FAO) of the United Nations Rome (2017). The future of food and agriculture – Trends and challenges. 180 p.

Gilman, J.C. (1957). A Manual of Soil Fungi. Second Ed., The Iowa State College Press, Ames, Iowa, USA, 450 p.

Hamza A.M.; Mohamed A.A.A. and Hamed S. (2016). New trends for biological and non-biological control of tomato root rot, caused by Fusarium solani, under greenhouse conditions. Egyptian Journal of Biological Pest Control 26 (1): 89–96.

Hawker, L.E. (1960). Physiological of Fungi. Univ. of London Press, LTD War -Wich Square, London, 452 p.

Ilupeju, E. A.O.; Akanbi, W.B.; Olaniyi, J.O., Lawal, B. A.; Ojo, M.. and Akintokun, P.O. (2015). Impact of organic and inorganic fertilizers on growth,fruit yield, nutritional and lycopene contents of three varieties of tomato (*Lycopersiconesculentum (L.) Mill*) in Ogbomoso, Nigeria.Department of Agronomy, LadokeAkintola University of Technology, Ogbomoso, Oyo State, Nigeria. 14(31), pp. 2424-2433

Kashyap, P.L., Solanki, M.K., Kushwaha, P., *et al.*, (2020). Biocontrol potential of salt-tolerant Trichoderma and Hypocrea isolates for the management of tomato root rot under saline environment. J. Soil Sci. Plant Nutr. 20, 160–176.

Mahila, P.; G. Mahavidhyalaya and Jodhpur (2010). Growth and productivity of tomato (*Lycopersiconesculentum*Mill.) grown in greenhouse as affected by organic, mineral and bio-N-fertilizers. Sci. & Cult. 76 (3-4) 128-131.

Martina, C.C.G. and Brathwaite, R.A.I. (2012). Compost and compost tea: Principles and prospects as substrates and soil-borne disease management strategies in soilless vegetable production. Biological Agriculture & Horticulture: An International Journal for Sustainable Production Systems, 28 (1):1-33.

Mohsen, A.A. (2006). Studies on the effect of bio, organic and chemical fertilizers on growth and yield and its quality of tomato under sandy soil conditions. M.Sc. Thesis, Fac . Agric., Zagazig Univ., Egypt. 125p.

Nguyen Giang Kien Truc ; Sen Zhang; Nguyen Ngan Thi Kim ; Nguyen Phuong Quoc Thuc ; Ming Sheau Chiu; Hardjojo, A. ; Tam, J. P.(2011). Discovery and characterization of novel cyclotides originated from chimeric precursors consisting of Albumin-1 chain a and cyclotide domains in the *Fabaceae* family. J. Biol. Chem., 286 (27): 24275–24287.

Olaniyi J. O. and A. T. Ajibola (2008). Effects of inorganic and organic fertilizers application on the growth, fruit yield and quality of tomato (lycopersiconlycopersicun). J. Applied Biosciences, 8 (1): 236-242.

Piper, C.S. (1950). Soil and Plant Analysis, Inter. Science, Publishers. INC, New York, USA.

Raviv, M. (2009). Suppressing soil-borne diseases of container-grown plant using composts. International Symposium on High Technology for Greenhouse Systems. ISHS Acta Horticulturae, 893 p.

Rice-Evans, C.; Miller, N. J. and Paganga, G. (1996). Structure–antioxidant activity relationships of flavonoids and phenolic acids. Free Radical Biology and Medicine, Vol. 20(7), pp.933-956.

Sang, M.K.; Kim, J.G., and Kim, K.D. (2010). Biocontrol activity and induction of systemic resistance in pepper by compost water extracts against *Phytophthora capsici*. Phytopathology, 100(8):774-783.

Sharath Chandran, U.S.; Tarafdar, A.; Mahesha, H.S. and Sharma, M.,(2021). Temperature and soil moisture stress modulate the host defense response in chickpea during dry root rot incidence. Front. Plant Sci. 12, 653265 https://doi.org/10.3389/fpls.2021.653265.

Singh, R.S. (1982). Plant Pathogens "The Fungi". Oxford and IBH Publishing Co.New Delhi, Bombay, Calcuta, 443 p.

Singh, B.N., Singh, A., Singh, S.P., Singh, H.B., 2011. Trichoderma harzianum-mediated reprogramming of oxidative stress response in root apoplast of sunflower enhances defence against Rhizoctonia solani. Eur. J. Plant Pathol. 131, 121–134.

Singleton, V.L. and Rossi, J.A. (I965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Am.J.Enol.Vitic.,16:144-158.

Snedecor, G.W. and Cochran, W.G. (1989). Statistical Methods, 8th ed. Iowa State Univ. Press, Ames, Iowa USA, 503 p.

Sullivan, P. (2004). Sustainable management of soil-borne plant diseases soil systems guide. NCAT Agriculture Specialist, 173 p.

Yousafzai, S. K.; Shah Masaud Khan, Khalil urRehman, Junaid Khan, SherAslam Khan, IjazHussain and Ishrat N. (2016). Response of tomato cultivars to different organicfertilizers under agro-climatic conditions of Mingora, Swat. Pakistan J. Agric. Res. Vol. 29 No.1.

Zmora-Nahum, S.; Danon, M.; Hadar, Y. and Chen, Y. (2008): Compost curing reduces suppression of plant diseases. Compost Science & Utilization. Emmaus, 16(4): 250-256.