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Effect of some Bio-organic fertilizers on morphological and physiological traits of tomato plants.

Ahmed Mohamed Abd El All
***Corresponding author:** PhD Plant Physiology. Lecturer, Botany Department, Agriculture Faculty, Menoufia University, Shebeen El-Kom, P.O. Box 32514, Menoufia, Egypt.
Phone: 00201112189018. **E- mail:** *ahmed.abdelall@agr.menofia.edu.eg*

Abstract

Two pot experiments were carried out during 2014 and 2015 seasons under green house conditions, Faculty of Agriculture, Menoufia University, to study the effect of different concentrations (0, 1, 3 and 5 % / pot soil weight) of different bio-organic fertilizers (animal, plant and mixture) on some physiological characters of tomato plants (*Lycopersicon esculentum* Mill.) as, growth characters, water relations, and chemical compositions. The first and the second concentrations of all organic fertilizers increased significantly plant height, leaf area fresh and dry weight of tomato plants. All organic fertilizers treatments recorded a significant positive effect on water relations and chemical constituents of tomato plants leaves. The treatments of mixture organic fertilizer 1 and 2 flowed by treatments of animal organic fertilizer 1 were recorded a highest increased in TWC, bound water, free water, RWC, transpiration rate and plasma membrane permeability, also, the same treatments sequence caused a highest increase in chlorophyll A, chlorophyll B, carotenoids, total carbohydrates, total sugars and total protein in treated tomato leaves. Meanwhile, the proline concentration was decreased under all used treatments.

Keywords: Tomato, Bio-organic fertilizer, Growth, Water relations, Chemical compositions.

1. Introduction

Tomato (*Solanum lycopersicum*) is an important plant of the solanales species. Tomato is grown in hot and warm regions. Tomato originated in South America and has spread all over the world, It is widely cultivated in Egypt in different periods throughout the year, both in the open fields and in the greenhouses and tomatoes are now grown widely and are often grown in greenhouses to maintain temperature. Tomato is consumed in many different ways. It can be used as a raw fruit without additives. It is an ingredient in many dishes, sauces, and beverages. The area planted with tomatoes in Egypt reached about 440,000 feddans in 2015/2016 (Egyptian National Statistical Center).

The organic fertilizer is one of the most important safely agriculture practices in the world, that's friendly and safely on the environment, plants, animals and humans. Organic fertilizer is very important for organic farming, which gives plants and fruits free from the accumulation of chemicals. These chemicals accumulate in plants or plant fruits because of the excessive use of chemical fertilizers and pesticides. Over the last five decades, these chemicals, whether pesticides or chemical fertilizers have been found to be dangerous to human and animal health as well as water and wind pollution. Organic fertilizer, increase the microbial activity in soil, anion and cation exchange capacity, organic matter and carbon-content of soil. And, they increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers ([15], [7], [6], [3], [12], [13], [14], [19], [23]).

Research Significance

The aim of this study is to create the best environment for the growth of tomato plants using bio-organic fertilizers ideal for the growth of these plants. This is reflected in the vegetative, physiological and biological characteristics during the period of growth of tomato plants, thus increasing the yield in terms of quantity and quality.

2. Method

Two pot experiments were carried out during 2014 and 2015 seasons under green house conditions, at Faculty of Agriculture, Menoufia University. This experiment was conducted to study the effect of different types and concentrations of bio-organic fertilizers as animal, plant and mixture (Animal + plant) on growth, water relations and chemical constituents of tomato plants. All pots were filled with clay sandy soil (3 kg/pot) fertilized at four rates of 0 (control), 1, 3 and 5 % / pot soil weight. The control pots were fertilized at the agriculture ministry recommended rates of N, P and K fertilizers. Weeds and best control as well as other agriculture practices were used whenever necessary.

Sampling: Plant sample was taken after 40 days (during vegetative growth stage) from transplanting, to determine the following data:

1. Vegetative growth characters: Root volume (cm^3), plant height (cm), leaf area per plant (cm^2 / plant). [9], fresh and dry weight of whole plant (g) (Plant materials were dried in an electric oven at 70°C for 72 hours).

2. Water relations: Total water content (TWC, %), free and bound water ([11] and [18]), relative water content (RWC, %) [5], osmotic pressure [11], transpiration rate [18] and plasma membrane integrity [25].

3. Photosynthetic pigments: The photosynthetic pigments were extracted from fresh leaf sample (fourth upper leaf) by 85 % acetone according to the method described by Wettestein's formula in [2].

4. Chemical analysis: Total carbohydrates and total sugars were determinate using the phenol sulfuric acid method as described by [2]**.** Proline concentration was measured according the ninhydrin method of [4]**.** N, P and K were determined as a described by [2].

5. Statistical analysis: The experimental pots were arranged in a factorial experiment in completely randomized block design with six replicates. All data collected were subjected to the standard statistical analysis following the proceeding described by [10] using the computer program of Costat Software (1985). The analyzed data then presented in tables.

3. Results

In the beginning: the results cleared that, the third level of mixture organic fertilizer caused a deaths of tomato seedlings after 23 days from transplanting.

Table 1: The characteristics of Organic Fertilizers:

		Organic fertilizer		
		Animal	**Plant**	**Mixture**
Total N	**%**	1,40	1.65	1.70
P		0.72	2.36	0.59
K		0.68	0.74	1.97
Ca		0.43	0.51	0.43
Mg		0.35	0.39	0.35
Fe	**ppm**	57.89	56.97	57.89
Zn		36.72	29.33	36.72
Mn		163.59	188.12	163.59
Cu		20.33	32.10	20.33
PH D,W		7.90	8.79	8.02
EC dS/m		32.00	3.83	35.70
SP	**%**	100	105	190
O.C		17.50	22.72	21.98
OM		30.17	39.17	37.89
C:N ratio		12.50	13.77	12.92
W.cont. % (w/w)		21.21	33	16.96

Growth characters

The presented data in table (2) showed that, the first and the second levels of all organic fertilizers (Animal, plant and mixture) increased significantly plant height, leaf area fresh and dry weight of tomato plants. Meanwhile, the third level of all organic fertilizers caused a significant decrease in all growth characters of tomato plants, also, there's uncorrupted results in root volume at all treatments of organic fertilizers. The highest increase in all growth characters was recorded at the first level of mixture organic fertilizer followed by the second level of mixture organic fertilizer treatments as compared with the control plants. The same data were recorded in second season.

Table (2): Effect of' some organic fertilizers on growth characters of tomato plants at two growing seasons 2014 and 2015.

Characters / Treatments		Root volume (cm^3)	Plant height (cm)	Leaf area (cm^2)	Fresh weight (g)	Dry weight (g)
Season 2014						
Control		**2.50**	**41.85**	**122.97**	**17.71**	**1.86**
Animal	**1**	**1.50**	**53.25**	**177.13**	**35.20**	**3.60**
	2	**0.90**	**51.95**	**115.67**	**28.30**	**2.82**
	3	**0.80**	**44.05**	**116.04**	**24.25**	**2.41**
Plant	**1**	**0.80**	**56.65**	**184.83**	**35.15**	**3.70**
	2	**0.90**	**41.85**	**129.69**	**18.37**	**1.82**
	3	**1.40**	**31.45**	**70.78**	**10.11**	**1.00**
Mixture	**1**	**1.50**	**57.77**	**191.82**	**22.02**	**2.12**
	2	**1.50**	**53.25**	**177.13**	**35.20**	**3.60**
LSD at 5%		0.0006	1.090	0.127	0.046	0.038
Season 2015						
Control		**2.20**	**10.76**	**118.97**	**22.16**	**2.29**
Animal	**1**	**1.40**	**46.15**	**175.94**	**33.06**	**3.45**
	2	**0.90**	**51.45**	**85.10**	**27.73**	**2.54**
	3	**0.85**	**49.56**	**107.87**	**29.79**	**2.99**
Plant	**1**	**0.70**	**42.49**	**113.40**	**27.54**	**2.82**
	2	**0.85**	**37.20**	**101.52**	**27.97**	**2.73**
	3	**1.30**	**26.96**	**91.75**	**29.24**	**2.90**
Mixture	**1**	**1.45**	**53.92**	**222.39**	**33.21**	**3.20**
	2	**1.40**	**46.15**	**144.47**	**33.24**	**3.11**
LSD at 5%		0.0009	1.082	0.133	0.039	0.027

Water relations:

Data in table (3) cleared that, TWC, free water, bound water, RWC, OP, transpiration rate and MP were increased at the levels of mixture two, animal one and mixture one respectively. Meanwhile, the other levels of different organic fertilizers caused a significant decrease in all water relations characters. The highest increase was recorded at mixture two organic fertilizers level by about. When compared with the control plants. Similar results registered in the second season.

Table (3): Effect of some organic fertilizers on water relations of tomato plants at two growing seasons 2014 and 2015.

Characters / Treatments		TWC (%)	Free water (%)	Bound water (%)	RWC (%)	O.P. (bar)	Transpi. rate (mg/g fw.h)	Plasa. Memb. Perm. I. (%)
Season 2014								
Control		**86.42**	**12.96**	**73.46**	**77.18**	**9.15**	**0.027**	**39.08**
Animal	**1**	**88.02**	**13.32**	**74.79**	**78.61**	**9.39**	**0.027**	**40.67**
	2	**85.83**	**13.17**	**72.68**	**76.65**	**9.28**	**0.027**	**39.17**
	3	**86.40**	**13.05**	**73.39**	**77.20**	**9.21**	**0.027**	**38.23**
Plant	**1**	**83.97**	**12.71**	**71.23**	**75.00**	**8.97**	**0.026**	**36.28**
	2	**83.16**	**12.45**	**70.58**	**74.28**	**8.78**	**0.026**	**34.11**
	3	**86.44**	**13.03**	**73.39**	**77.20**	**9.18**	**0.027**	**36.75**
Mixture	**1**	**87.90**	**12.99**	**74.83**	**78.50**	**9.17**	**0.027**	**39.94**
	2	**88.32**	**13.01**	**75.18**	**78.88**	**9.18**	**0.029**	**43.56**
LSD at 5%		0.016	0.011	0.035	0.038	0.009	0.0003	1.013
Season 2015								
Control		**84.59**	**11.97**	**72.62**	**70.78**	**8.81**	**0.026**	**37.21**
Animal	**1**	**85.91**	**12.21**	**73.70**	**71.96**	**8.93**	**0.026**	**38.44**
	2	**83.56**	**11.91**	**71.65**	**69.86**	**8.71**	**0.026**	**37.36**
	3	**84.23**	**11.99**	**72.24**	**70.46**	**8.78**	**0.026**	**37.25**
Plant	**1**	**81.88**	**11.69**	**70.19**	**68.36**	**8.56**	**0.025**	**36.88**
	2	**81.12**	**11.59**	**69.53**	**67.68**	**8.49**	**0.025**	**35.96**
	3	**84.20**	**11.99**	**72.21**	**70.43**	**8.77**	**0.026**	**37.30**
Mixture	**1**	**85.96**	**12.22**	**73.74**	**72.00**	**8.94**	**0.026**	**38.65**
	2	**86.26**	**12.26**	**74.00**	**72.27**	**8.96**	**0.027**	**38.89**
LSD at 5%		0.026	0.009	0.033	0.039	0.009	0.0004	1.008

Photosynthetic pigments:

Data in table (4) confirmed that, the tomato plants fertilized by all different levels of aforementioned organic fertilizers increased the values of leaves chlorophyll a, b and carotenoids contents in both seasons. Meanwhile, the second and the third levels of plant organic fertilizers caused a decrease in leaves photosynthetic pigments. Whereas, at the first level of mixture organic fertilizer produced the highest values of leaves plant pigments contents.

Chemical composition:

Data in table (4) indicated that, in leaves of plants fertilized by all levels of used organic fertilizers, there was a remarkable gradual increase in total carbohydrates, total soluble sugars, total protein, N, P and K concentrations. Meanwhile, there was a significant decrease in proline content at the same levels. In this regard, the highest increase in chemical measures was recorded at mixture 1 organic fertilizer.

Table (4): Effect of some different organic fertilizers on chemical compositions of tomato leaves at two growing seasons 2014 and 2015.

Characters / Treatments		Chl. A. (mg /g dwt)	Chl. B. (mg /g dwt)	Car-oten-oides (mg /g dwt)	Total Carboh-ydrates (mg /g dwt)	Total sugars (mg /g dwt)	Prot-ein (%)	Proli-ne (µg / /g dwt)	N (%)	P (%)	K (%)
Season 2014											
Control		**3.09**	**1.06**	**1.28**	**0.824**	**0.016**	**25.16**	**287.78**	**2.88**	**0.35**	**2.93**
Animal	**1**	**3.81**	**1.53**	**1.74**	**0.885**	**0.018**	**25.65**	**238.12**	**2.96**	**0.38**	**3.04**
	2	**3.70**	**1.00**	**1.38**	**0.829**	**0.016**	**25.27**	**279.77**	**2.98**	**0.38**	**3.13**
	3	**3.25**	**1.00**	**1.35**	**0.811**	**0.017**	**23.11**	**279.88**	**2.86**	**0.37**	**3.07**
Plant	**1**	**3.64**	**1.39**	**1.44**	**0.825**	**0.017**	**25.22**	**249.93**	**2.96**	**0.36**	**3.03**
	2	**3.09**	**1.12**	**1.23**	**0.830**	**0.016**	**23.42**	**273.71**	**2.90**	**0.36**	**2.94**
	3	**2.32**	**1.06**	**1.13**	**0.774**	**0.015**	**23.33**	**281.28**	**3.11**	**0.38**	**3.17**
Mixture	**1**	**3.97**	**1.65**	**1.59**	**0.945**	**0.018**	**26.12**	**217.32**	**2.99**	**0.43**	**3.65**
	2	**3.93**	**1.53**	**1.94**	**0.912**	**0.018**	**25.87**	**221.48**	**2.99**	**0.42**	**3.08**
LSD at 5%		0.031	0.047	0.022	0.003	0.0008	0.059	1.392	0.066	0.029	0.021
Season 2015											
Control		**3.03**	**1.01**	**1.22**	**0.785**	**0.015**	**23.96**	**295.07**	**2.94**	**0.37**	**3.07**
Animal	**1**	**3.79**	**1.49**	**1.70**	**0.863**	**0.018**	**25.01**	**232.20**	**2.98**	**0.39**	**3.11**
	2	**3.71**	**1.01**	**1.39**	**0.837**	**0.016**	**25.02**	**282.57**	**2.97**	**0.38**	**3.11**
	3	**3.15**	**1.00**	**1.35**	**0.811**	**0.017**	**23.19**	**280.85**	**2.95**	**0.37**	**3.07**
Plant	**1**	**3.66**	**1.37**	**1.42**	**0.812**	**0.017**	**24.81**	**245.91**	**2.94**	**0.37**	**3.07**
	2	**3.02**	**1.06**	**1.17**	**0.789**	**0.015**	**22.26**	**260.18**	**2.97**	**0.38**	**3.09**
	3	**2.46**	**1.09**	**1.17**	**0.799**	**0.015**	**24.08**	**290.29**	**2.93**	**0.37**	**3.06**
Mixture	**1**	**3.95**	**1.61**	**1.85**	**0.923**	**0.018**	**25.51**	**212.27**	**3.01**	**0.44**	**3.14**
	2	**3.93**	**1.50**	**1.90**	**0.894**	**0.018**	**25.36**	**217.14**	**2.99**	**0.43**	**3.14**
LSD at 5%		0.025	0.044	0.017	0.006	0.0009	0.048	1.366	0.087	0.051	0.023

4. Discussion

In reference to the table of the analysis of bio-organic fertilizers, we note that, the containment of fertilizers on a good levels of different minerals and important for the growth of all plants. In addition, it also contains a percentage of organic matter suitable for the growth of plants as well as that improves the rhizosphere area biologically and chemically. All of these factors have shown us an optimal balance in the water content of tomato plants. This balance has resulted in good and very well vegetative characters and increase in photosynthetic pigments, which in turn reflected on the process of photosynthesis and formation of sugars inside plant cells, which also related with all metabolic processes. This has been observed in proline deficiency, which indicates plant growth under good conditions. Proline may be converted into protein. On the basis of these factors, the good growth (vegetative, physiological and chemical) for the tomato plants obtained from grown in soil fertilized by bio-organic fertilizers. This leads to a good harvest in terms of quantity and quality.

All cation balanced treatments (organic, mineral or a combination of both) significantly improved plant growth of tomato plants [23]**.** Organic fertilizers can be helpful to improve the plant height, stem diameter, the aerial parts fresh weight, root fresh weight, and lays a good foundation for the growth of tomatoes [16]. the results on the growth parameters of the studied tomato varieties showed that the chicken manure had a significant effect on plant height and root length of Isabella F1, leaf area of sun cherry, root fresh and dry weight and of Lelord, leaves fresh and dry weight of Sadia F1 [17]. Whereas, shoot fresh

and dry weight of Isabella tomato variety was increased when treated with mixed manure. Compost application alone affected on the shoot fresh and dry weight of tomato plants rather than root fresh and dry weight [20]. Stomatal conductivity of water was in generally correlated with transpiration process and is concerning the state of leaf dehydration. The dependency with the type of technology is linked to rate of decomposition of the nutrient from soil and to the entering into metabolism (photosynthesis and carbon assimilation); in this way the synthetic fertilizers are available quickly, while the organic nutrients are released slowly during vegetation duration [1]. In this concern, microbial inoculants to both bokashi (organic fertilizer) and chicken manure increased photosynthesis in leaves of tomato plants [24]. Organic fertilizers can be helpful to improve the leaf photosynthetic rates and photosynthesis of tomatoes [16]. Concentrations of sugars and organic acids were higher in fruit of tomato plants fertilized with bokashi (organic fertilizer) than in fruit of other treatments [24]. Moreover, [22] showed that, the application of organic fertilizers positively affected the micronutritional element content of tomato fruits compared to the conventional treatment.

5. Conclusion

It can be concluded that, there is more promise to use bio-organic fertilizers to feeding different plants and crops than to use chemical fertilization and increased public interest to reduce the use of chemicals. The results of this study showed that the fertilization of bio-organic fertilizers led to good growth of tomato plants, which is reflected in the production of a good yield in quantity and quality.

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