How to Cite:
Ibrahim, H. A., El-Batran, H. S., & Hassan, N. M. K. (2022). Impact on growth, yield and nutritional status of tomato plants grown in saline soil by vermicompost and ascorbic acid. *International Journal of Health Sciences*, *6*(S1), 10134–10143. https://doi.org/10.53730/ijhs.v6nS1.7171

Impact on growth, yield and nutritional status of tomato plants grown in saline soil by vermicompost and ascorbic acid

Huda A. Ibrahim
Vegetable Research Dept., National Research Center, Dokki, Giza, Egypt

Heba S. El-Batran
Vegetable Research Dept., National Research Center, Dokki, Giza, Egypt

Nagwa M. K. Hassan
Vegetable Research Dept., National Research Center, Dokki, Giza, Egypt

***Abstract*---**The experiment was designed to investigate the effect of vermicompost rates (0, 6, 8 and 10 ton fed^{-1}) and ascorbic acid levels (0, 100 and 200 ppm) on growth, yield and nutritional status of tomato plants (*Lycopersicum esculentum* L. cv Kasel rock) grown in saline soil of Tamia District, El-Fayoum Governorate at two seasons 2018 and 2019. The results indicated that the addition of vermicompost supplemented by spraying with concentrations of ascorbic acid has a significant and clear effect on the growth characteristics and quality and quantity of the tomato plants grown in saline soil at two seasons 2018 and 2019. The highest values of the various components of the tomato plants growth and yield were obtained by adding the high rate of vermicompost (10 ton fed^{-1}) and spraying the high concentration of ascorbic acid (200 ppm). Increasing the addition of vermicompost followed by spraying with ascorbic acid increased the content of the nutrients that benefit tomato plants (nitrogen, phosphorous and potassium), while the sodium content of the leaves decreased. It can be concluded that adding vermicompost with spraying tomato plants grown in saline ground with ascorbic acid is one of the important and simple strategies in tomato plants' resistance to soil salinity.

***Keywords*---**Saline soil, Vermicompost, Ascorbic acid, Tomato plants, Growth, Yield, Nutritional state.

Introduction

Salinity of arable land is a problem that is becoming more and more important in many areas where irrigation is a regular agro-technical measure, and in semi-arid and arid regions in the world where atmospheric precipitations are not sufficient to flush the salts from the root zone (Kaya *et al.*, 2001). Stress caused by increased concentrations of salts effect the metabolism of plants and the final outcome of crop production in many ways (Mittler, 2002). Increased salt concentrations can lead to disturbances in mineral nutrition of plants, the plant hormone imbalances, and to the formation of reactive compounds such as different types of oxygen and other free radicals that damage cell membranes (Gehad, 2003).

The production process of the vermicompost is faster than production of traditional compost; as vermicompost is formed as a result of the material rushing into earthworm gut, which soon turns into organic materials that are more decomposed and richer in microbes and growth regulators (Adhikary, 2012). The implementation of vermicompost in the field enhances the goodness of soils by superior in influencing the soil physical, chemical and biological properties such as bulk density, organic matter, available nutrients, beneficial bacterial and fungal population. Vermicompost plays an important role in improving the growth and productivity of all kinds of different crops (Singh *et al.*, 2020).

Application of ascorbic acid on plants as exogenously can produce various metabolic changes under salt stress conditions, which are very effective in reducing the effect of salinity in different crops (Raza *et al.*, 2006). Among the different techniques, exogenous application of antioxidants such as ascorbic acid are very basic and cheap techniques in agricultural field and used as a shotgun approach to ameliorate the effect of salinity in some of the important crop cultivars (Waseem *et al.*, 2006 and Raafat *et al.*, 2011). The paper aimed to study the effect of vermicompost and ascorbic acid on growth, yield and nutritional status of tomato plants grown in saline soil.

Materials and Methods

The experiment was designed to investigate the effect of vermicompost and ascorbic acid rates on growth, yield and nutritional status of tomato plants (*Lycopersicum esculentum* L. cv Kasel rock) grown in saline soil of Tamia District, El-Fayoum Governorate at two seasons 2018 and 2019. Each plot was planned to include 20 rows, and the interplant spacing was 50 cm within each row. Some chemical characteristics of the soil are given in Table (1) using the standard procedures outlined by Cottenie (1980).

Field experiment was arranged as factorial experiment (two ways) based on randomized complete block design with three repetitions. First factor was rates of vermicompost (0, 6, 8 and 10 ton fed^{-1}). The second factor was spraying levels of ascorbic acid (0, 100 and 200 ppm). The vermicompost was thoroughly mixed with surface soil at the depth (0-20 cm). The vermicompost used in this experiment was made of cattle manure, and using one species of earthworm

(*Eisenia fetida*). Vermicompost was determined (Table, 2) using the standard procedures outlined by Cottenie(1980).

Table (1)
Some chemical properties of soil used.

Soil property	Value
pH (1:2.5 soil suspension)	7.50
EC (dS m^{-1}), soil paste extract	7.90
$CaCO_3$ (%)	10.0
Soluble ions (mmol L^{-1})	
Ca^{++}	38.7
Mg^{++}	13.1
Na^{+}	44.2
K^{+}	0.93
CO_3^{--}	nd*
HCO_3^{-}	3.50
Cl^{-}	54.1
SO_4^{--}	39.3

Table (2)
Some chemical properties of vermicompost used:

Analyses	Vermicompost
pH	6.90
EC (dS m^{-1})	2.00
Moisture content (%)	15
Organic matter (%)	50.3
Organic carbon (%)	29.2
Ash (%)	49.7
C/N ratio	1:24.3
N (%)	1.20
P (%)	0.50
K (%)	0.80

Sixty days after transplanting, random samples consisted of eight plants was taken from each experimental plot to determine some growth parameters, *i.e.,* plant height, number of leaves/plant, leaf area and dry weight/plant.Fruit from ten plants were collected from each experimental plot in the ripening stage to determine yield and its components. The total yield was determined as the total weight of the harvested fruit through the whole harvesting period excluding the damaged.Fruit samples were taken from the 3rd harvest at red ripe stage from each experimental plot to determine fruit quality parameters, *i.e.,* firmness using fruit pressure tester with a probe diameter of 0.8 cm and values were expressed in pounds, total soluble solids (TSS) using hand held Brix meter, and total sugar as described by A.O.A.C. (1990).Leaves were taken from the fourth upper of tomato stem of eight randomly collected plants after 90 days from transplanting, washed with distilled water, dried with paper towels, then dried at 70 ^{0}C and wet digested (Van Schouwenberg, 1968) for the determination of N, P, K and Na (A.O.A.C., 1990).
The obtained data of plant parameters were subjected to the statistical analysis, where the least significant difference test (L.S.D.) at 0.05 level was used to verify the differences between treatments according to Snedecore and Cochran (1980).

Results and Discussion

Under saline soil conditions, the use of vermicompost at different rates along with spraying with ascorbic acid affected the growth of tomato plants in the seasons 2018 and 2019 (Table 3). The increase in the rate of application of vermicompost from zero to 10 ton per feddan significantly affected the growth components of tomato plants grown in saline soil during the two consecutive planting seasons. Also, increasing the spraying concentration of ascorbic acid from zero to 200 ppm led to an insignificant increase in the growth components of tomato plants grown in saline soil. However, the addition of vermicompost followed by spraying with concentrations of ascorbic acid has a significant and clear effect on the growth characteristics of tomato plants grown in highly saline soil. The highest values of the various components of the tomato plants growth were obtained by adding the high rate of vermicompost (10 ton fed^{-1}) and spraying the high concentration of ascorbic acid (200 ppm).

Table (3)
Effect of vermicompost and ascorbic acid rates on growth parameters of tomato plants

Vermicompost ton fed^{-1}	Ascorbic acid ppm	Plant height cm	No. leaves	Leaf area cm^2	Plant dry weight g
Season (1)					
0	0	34.8	50.5	32.0	44.6
	100	36.0	51.0	33.1	44.8
	200	36.4	51.3	33.5	45.1
6	0	38.5	58.5	35.8	51.9
	100	40.0	59.1	37.4	52.7
	200	40.4	59.5	37.6	52.8

8	0	44.9	67.6	40.9	61.9
	100	46.8	68.3	42.6	63.8
	200	47.1	69.0	42.9	64.1
10	0	53.0	72.2	44.1	72.8
	100	55.1	73.1	46.2	73.7
	200	55.4	74.1	46.5	74.1
Season (2)					
0	0	35.0	50.0	32.2	45.6
	100	36.2	51.2	33.4	46.8
	200	36.7	51.6	33.6	47.1
6	0	37.9	56.5	34.6	51.7
	100	40.1	58.4	36.4	52.5
	200	40.6	59.6	38.8	52.8
8	0	43.7	65.6	40.1	61.4
	100	45.8	67.3	42.4	63.7
	200	47.2	69.2	42.8	64.5
10	0	50.0	70.4	43.1	70.8
	100	52.1	74.1	45.2	73.2
	200	55.3	76.2	46.7	74.2
$LSD_{0.05}$		2.92	0.09	3.66	0.10

Soil chemical properties improved due to the addition of vermicompost. Where the elevated pH and soil salinity declined with the vermicompost addition as a result of the release of organic acids from vermicompost, as well as vermicompost is characterized by the high contents of nutrients such as nitrogen, phosphorous, potassium and micronutrients, which lead to enhance soil fertility (Tharmaraj *et al.*, 2011).On the other hand, the implementation of different types of vermicompost assists in increasing quantitatively and qualitatively the content of beneficial microorganisms for plants (Lazcano and Dominguez, 2011).Parthasarathi *et al.*, (2007) showed that the vermicompost includes nutrients in available forms for the plants. Ndegwa and Thompson (2001) stated that worm-compost contains sites are rich in available nitrogen, phosphorus and potassium, which encourages better crop growth.

Ascorbic acid is a water soluble compound and important antioxidant, which can scavenge the free radicals produced due to salinity stress in plants. In the present study, the growth of tomato was improved by the exogenous application of ascorbic acid, these results are similar to those in which it has already been described that exogenous application of ascorbic acid counteracted the salt induced growth inhibition in plants (Al-Hakimi, and Hamada, 2001 and El Hariri *et al.*, 2011). Ascorbic acid is a paramount antioxidant in plants which accumulates implants' as an adaptive mechanism to soil salinity (Khan *et al.*, 2011). Growth promoting effect of ascorbic acid under salinity or control conditions may have been due to enhanced antioxidant capacity, and increase in cell division and cell enlargement (Chen and Gallie, 2004).

As was the positive effect of adding vermicompost and ascorbic acid to the growth of tomato plants, this clearly affected the quality and quantity of the tomato crop

produced, as shown in Table (4), during the two planting seasons.Where the spraying with ascorbic acid on tomato plants, in the presence of appropriate additives of vermicompost, encouraged a large production of tomato yield and quality of fruits grown in saline soil.Spraying with a higher concentration of ascorbic acid (200 ppm) with the addition of a higher rate of vermicompost (10 ton fed^{-1}) was the best experimental treatment that gave the highest value for each of fruit yield per plant (2.34 kg), fruit yield (17.4 to fed^{-1}), fruit firmness (6.37 Ibs), total soluble solids (3.42 %) and total sugar (1.4 %) at first season (2018), as well as, fruit yield per plant (2.33 kg), fruit yield (16.5 ton fed^{-1}), fruit firmness (6.38 Ibs), total soluble solids (3.31 %) and total sugar (1.39 %) at second season (2019).

Table (4)
Effect of vermicompost and ascorbic acid rates on quantity and quality of tomato yield

Vermicompost ton fed^{-1}	Ascorbic acid ppm	Fruit yield /plant (Kg)	Fruit yield ton fed^{-1}	Fruit firmness (Ibs)	Total soluble solids (%)	Total Sugar (%)
Season (1)						
0	0	1.16	7.23	4.71	5.86	0.87
	100	1.17	7.87	5.00	5.58	0.88
	200	1.18	8.17	5.05	5.43	0.98
6	0	2.10	9.52	4.83	5.74	1.11
	100	2.14	10.0	5.04	5.45	1.13
	200	2.16	10.5	5.17	5.30	1.14
8	0	2.18	11.0	5.41	5.04	1.18
	100	2.21	11.6	5.63	4.63	1.23
	200	2.23	12.2	5.81	4.44	1.25
10	0	2.32	15.7	6.01	4.08	1.31
	100	2.33	16.5	6.20	3.63	1.34
	200	2.34	17.4	6.37	3.42	1.40
Season (2)						
0	0	1.14	7.22	4.70	5.75	0.88
	100	1.16	7.80	5.00	5.47	0.90
	200	1.18	8.11	5.04	5.32	0.97
6	0	1.90	9.22	4.82	5.63	1.10
	100	1.99	10.0	5.06	5.34	1.12
	200	2.12	10.6	5.18	5.31	1.13
8	0	2.14	11.0	5.42	5.02	1.17
	100	2.20	11.4	5.64	4.51	1.22
	200	2.23	12.0	5.82	4.43	1.24
10	0	2.28	14.8	6.00	4.06	1.30
	100	2.30	15.9	6.22	3.52	1.33
	200	2.33	16.5	6.38	3.31	1.39
$LSD_{0.05}$		0.83	2.02	0.01	0.28	0.01

The effect of vermicomposts on plants are not merely attributed to the quality of nutritionalcontent but to its other important components such as hormones and humic acids. Eswaran and Mariselvi (2016) studied performance of vermicompost on yield components of tomato plants. The results indicated that by increasing the addition of vermicompost to the soil, this improved fruit quality and increased tomato yield.

vermicompost not only makes plants healthy, but it also regulates plant development with hormones. More importantly, it contributes in soil fertility and quality by increasing microbial activity and also prevents destruction of soil borne pests and diseases (Dintcheva and Tringovska, 2016). Ascorbic acid is regarded as one of the most effective compounds able to ameliorate abiotic stresses (Agami, 2014). Ascorbic acid regulates stress response as a result of a complex sequence of biochemical reactions such as activation or suppression of key enzymatic reactions, induction of stress responsive proteins synthesis, and the production of various chemical defense compounds (Abd El-Rheem *et al.*, 2018).

It has been used to counteract the adverse effects of salinity in many crop plants (Sajid and Aftab 2009 and Bybordi 2012).Vermicompost-amended soils have better physical anf chemical properties such as aeration,porosity pH, organic matter and nutrientscontent enhancedconsiderably and led to improved crop growth andyield (Lim *et al.*, 2015 and Zhu *et al.*, 2017).There is also presence of nitrogen fixing and phosphorus-solubilizing bacteria (Yatoo *et al.*, 2020), substances like gibberellins, auxins, cytokinins and vitamins (Ravindran *et al.*, 2016&Amooaghaie and Golmohammadi 2017) in worm-compost which encourage theoverall productivity of crops.

Table (5) showed the effect of adding vermicompost at its different rates and spraying with ascorbic acid in various concentrations on the content of nitrogen, phosphorus, potassium and sodium inside tomato leaves at two seasons. The results showed that increasing the addition of vermicompost followed by spraying with ascorbic acid increased the content of the nutrients that benefit tomato plants (nitrogen, phosphorous and potassium), while the sodium content of the leaves decreased. Potassium concentration increased significantly when 50 and 100 mg L^{-1} of ascorbic acid were applied as foliar spray on plants under saline conditions.Spraying ascorbic acid by 100 mg L^{-1} applied as foliar spray decreased significantly sodium content of plant under saline conditions (Khan *et al.*, 2013). Parthasarathi *et al.*, (2007) showed that the vermicompost includes nutrients in available forms for the plants. Bhattacharjee *et al.*, (2001) indicated that the loss of important nutrients due to the leaching process is greatly reduced with the addition of worm-compost to the soil, due to the improvement of the worm-compost of the soil's physical and chemical properties. Ndegwa and Thompson (2001) stated that worm-compost contains sites are rich in available nitrogen, phosphorus and potassium, which encourages better crop growth.

Table (5)
Effect of vermicompost and ascorbic acid rates on nutrients content in tomato leaves

Vermicompost ton fed^{-1}	Ascorbic acid ppm	Nutrientscontent (%)							
		N	P	K	Na	N	P	K	Na
		Season (1)				Season (2)			
0	0	2.47	0.25	1.74	2.53	2.46	0.25	1.72	2.55
	100	2.48	0.26	1.76	1.92	2.47	0.26	1.77	1.98
	200	2.50	0.28	1.77	1.98	2.50	0.27	1.78	1.99
6	0	2.84	0.33	2.00	2.41	2.84	0.29	1.99	2.40
	100	2.87	0.34	2.04	1.88	2.86	0.31	2.01	1.90
	200	2.99	0.38	2.07	1.75	2.97	0.35	2.05	1.81
8	0	3.24	0.37	2.03	2.22	3.20	0.32	2.00	2.14
	100	3.31	0.39	2.01	1.50	3.31	0.37	2.02	1.45
	200	3.35	0.40	2.14	1.44	3.33	0.38	2.14	1.42
10	0	3.23	0.41	2.31	1.98	3.22	0.39	2.31	1.97
	100	3.34	0.42	2.41	1.45	3.30	0.40	2.39	1.46
	200	3.37	0.45	2.54	1.44	3.36	0.41	2.45	1.44
LSD 0.05		0.06	0.01	0.02	0.06	0.06	0.01	0.02	0.06

References

Abd El-Rheem Kh. M., Hayam A. A. Mahdy, Entsar M. Essa and Yasser A. El-Damarawy (2018). Improving growth,yield,physiological characteristics and nutrients uptake of growing sunflower(*helianthus annuus* l.) Plants in saline soil by using ascorbic acid. Bioscience Research, 15: 1757-1762.

Adhikary S. (2012). Vermicompost, the story of organic gold: A review Agricultural Sciences, 3: 905-917.

Agami R.A. (2014). Applications of ascorbic acid or proline increase resistance to salt stress in barley seedlings. Biologia Plantarum, 58, 2: 341-347.

Al-Hakimi, A. M. A., and A. M. Hamada (2001). Counteraction of salinity stress on wheat plants by grain soaking in ascorbic acid, thiamine or sodium salicylate. BiologiaPlantarum 44: 253–261.

Amooaghaie R. and Golmohammadi S (2017). Effect of vermicompost on growth, essential oil, and health of Thymus Vulgaris. Compost Sci. Utili., 25:166–177.

A.O.A.C. (1990). Association of Official Analytical Chemists, Official Methods of Analysis. 17th ed., Washington, D.C., U.S.A.

Bhattacharjee G., P.S. Chaudhuri and M. Datta (2001). Response of paddy crop on amendment of the field with different levels of vermicompost. Asian J. Microbial. Biotech. Environ. Sci., 3: 191-196.

Bybordi A. (2012). Effect of ascorbic acid and silicium on photosynthesis, antioxidant enzyme activity, and fatty acid contents in Canola exposure to salt stress. Journal of Integrative Agriculture, 11, 10: 1610-1620.

Chen, Z., and D. R. Gallie. (2004). The ascorbic acid redox state controls guard cell signaling and stomatal movement. Plant and Cell 16: 1143–1162.

Cottenie, A. (1980). Soil and plant testing as a basis of fertilizer recommendation. F.A.O. Soil Bull.

Dintcheva T. and I. Tringovska (2016). Growth response of tomato transplants to different amounts of vermicompost in the potting media. Acta Horticult., 96: 195–201.

El Hariri, D. S, S. S. Mervat, and H. .M. S. El Bassiouny (2011). Response of flax cultivars to ascorbic acid and A. tocopherol under salinity stress conditions. International Journal of Academic Research 6: 100–109.

Eswaran N. and S. Mariselvi (2016). Efficacy of vermicompost on growth and yield parameters of *Lycopersicum esculentum* (Tomato). International Journal of Scientific and Research Publications, 6: 95-108.

Gehad, a. (2003). Deteriorated soils in Egypt: management and rehabilitation. executive authority for land improvement projects (ealip), ministry of agriculture, Egypt.

Khan A., I. Lang, M.Amjid, A. Shah, I. Ahmad, and H. Nawaz (2013).Inducing salt tolerance on growth and yield of sunflower by applying different levels of ascorbic acid.Journal of Plant Nutrition, 36:1180–1190.

Khan T.A., Mazid M. and Mohammad F. (2011). A review of ascorbic acid potentialities against oxidative stress induced in plants. Journal of Agrobiology, 28, 2: 97-111.

Kaya, C., Kirnak, H. and Higgs, D. (2001). Enhancement of growth and normal growth parameters by foliar application of potassium and phosphorus in tomato cultivars grown at high (NaCl) salinity. Journal of Plant Nutrition, 24, 357-367.

Lazcano C. and J. Dominguez (2011).The use of vermicompost in sustainable agriculture: impact on plant growth and soil fertility. In: Miransari M (ed) Soil nutrients. Nova Science, New York, pp 1–23.

Lim SL, Wu TY, Lim PN and Shak KP (2015). The use of vermicompost inorganic farming: overview, effects on soil and economics. J. Sci. Food Agric., 95:1143–1156.

Mittler, R. (2002). Oxidative stress, antioxidants and stress tolerance. Trends in Plant Science, 7: 405 – 410.

Ndegwa, P.M. and S. A. Thompson (2001). Integrating composting and vermicomposting in the treatment and bioconversion of biosolids. Bioresource Technol., 76: 107-112.

Parthasarathi, K., L.S. Ranganathan, V. Anandi and J. Zeyer (2007). Diversity of microflora in the gut and casts of tropical composting earthworms reared on different substrates. J. Environ. Biol., 28, 87-97

Raafat, N., and T. E. E. Radwan (2011). Improving wheat grain yield and its quality under salinity conditions at a newly reclaimed soil by using different organic sources as soil or by foliar applications. Journal of Applied Sciences Research 7: 42–55.

Raza, S. H., H. R., Athar, and M. Ashraf (2006). Influence of exogenously applied glycinebetaine on the photosynthetic capacity of two differently adapted wheat cultivars under salt stress. Pakistan Journal of Botany 38: 341–351.

Ravindran B, Wong JW, Selvam A, Sekaran G (2016). Influence of microbialdiversity and plant growth hormones in compost and vermicompost from fermented tannery waste. Bioresour. Technol.,217:200–204.

Sajid Z.A. and Aftable F. (2009). Amelioration of salinity tolerance in *Solanum tuberosum* L. by exogenous application of ascorbic acid. In Vitro Cellular & Developmental Biology-Plant, 45: 540-549.

Snedecore, G. W. and Cochran, W. G. (1980). St*atistical Methods*.7th ed. Iowa State Univ., Press, Amer., Iowa, U.S.A.

Singh A.; V. Kumar, S. Verma, M. Majumdar and S. Sarkar (2020). Significance of vermicompost on crop and soil productivity: A review. International Journal of Chemical Studies, 8: 1529-1534.

Tharmaraj K., P. Ganesh, K. Kolanjinathan, R. Kumar and A. Anandan (2011). Influence of vermicompost and vermiwash on physico chemical properties of rice cultivated soil. Curr. Bot., 2:18-21.

Yatoo AM, Rasool S, Ali S, Majid S, RehmanMU, AliMN, Eachkoti R,Rasool S, Rashid SM, Farooq S (2020). Vermicomposting: an ecofriendlyapproach for recycling/management of organic wastes. In:Bioremediation and Biotechnology. Springer, Cham, pp 167–187.

Van Schouwenberg, J. Ch. (1968). International Report of Soil and Plant Analysis. Lab. of Soil and Fert. Agric., Wageningen Univ., Netherlands.

Waseem, M., H. R. Athar, and M. Ashraf (2006). Effect of salicylic acid applied through rooting medium on drought tolerance of wheat. Pakistan Journal of Botany 38: 1127–1136.

Zhu F, Jingtao H, Xue S, Chuan W, Qiongli W, Hartley W (2017). Vermicompost and gypsum amendments improve aggregate formationin bauxite residue. Land Degrad. Dev., 28:2109–2120.