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EFFECT OF SPRAYING PUTRESCINE AND HUMIC ACID SPRAYING ON CHEMICAL PARAMETERS OF TOMATO PLANT *LYCOPERSICON ESCULENTUM*

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Abstract

Field experiment was conducted in An-Najaf governorate during spring of 2016. The aim of this experiment was to study the effect of different concentrations of putrescine 0, 50, 100 mg·L^{-1}. and humic acid 0, 500 and 1000 mg·L^{-1} spraying on chemical parameters of tomato plant. The experiment included nine treatments, i.e. the interactions of three concentrations of putrescine (0, 50, 100 mg·L^{-1}) and three concentrations of humic acid (0, 500 and 1000 mg·L^{-1}). Sprays were applied twice during season at fifteen days interval that was done on forty-five days from cultivation. Factorial experiment within Randomized Complete Block Design (R. C. B. D.) was used with three replications. Means were compared according to Duncan's Multiple Range Test (D.M.R.T.) at probability of 0.05. Results can be summarized as follows: the use of different concentrations of putrescine with conc. 100 mg·L^{-1} and humic acid with conc. 1000 mg·L^{-1} had significant effects on most of the chemical parameters such as: N, P, K, total soluble carbohydrate and total Chlorophyll in Leaves and N, P, K, T.S.S and amount of vitamin C in fruit compared with control treatment which gave the least values for the above-mentioned parameters. The interactions between two factors (putrescine and humic acid) showed the presence of significant effects on most of the studied chemical parameters.

Key words: *putrescine, humic acid, tomato plant, Lycopersicon esculentum.*

INTRODUCTION

Tomato*, Lycopersicon esculentum* Mill., is in the family Solanaceae and is a widely distributed annual vegetable crop. Tomato was high nutritional quality. It is rich in vitamin C, lycopene and different phenolic compounds (Scalfi et al., 2000). Tomatoes are important not only because of the large amount consumed, but also because of their high health and nutritional contributions to humans. Most important, tomato consumption has been shown to reduce the risks of cardiovascular disease and certain types of cancer, such as cancers of prostate, lung, and stomach (Canene-Adams et al., 2005). United Nations FAO reports that the world production of tomato in 2019 was 180766329.00 tons and in IRAQ was 619543.00 tons (FAO, 2021).

Polyamines (PAs) are organic polycations found in all living organisms. In higher plants putrescine (Put), spermidine (Spd) and spermine (Spm) are the most abundant PAs and are involved in the various developmental processes (Tonon et al., 2004).

Putrescine which having a role in the regulation of plant developmental and physiological processes. (Kusano et al., 2007). A variety of roles have been proposed for PAs, including cell division, root growth, flower and fruit development and apoptosis (Paschalidis & Roubelakis-Angelakis, 2005). PAs were reported to be involved in stabilization of membrane and scavenging of free radicals (Velikova et al., 1998), osmotic adjustment (Aziz et al., 1999), mineral nutrition (Prakash & Prathapasenan, 1988).

Humic substances are a heterogeneous mixture of naturally occurring organic materials those arise from the decay of plant and animal residues. These organic materials contain carbon, which serves as a food source for soil organisms such as bacteria, algae, fungi and earthworms. These soil organisms break the chemical bonds in the residues as they digest the carbon. The remaining by-products serve as building blocks of humic substances, which are not easily decomposed by soil organisms (Hopkins & Stark, 2003) and this will decrease nutrients leaching with irrigation water, and so increase fertilizers use efficiency (Mikkelsen, 2005). In this concern, Selim et al. (2009) found that application of humic substances through drip irrigation enhanced tubers yield quantity, starch content and total soluble solids and this application associated with the decrease of nutrients leaching, which was reflected on increasing macro- and micronutrients concentration in potato tubers, as well as increasing concentration of these nutrients in soil after tubers harvesting.

The objective of this study was to investigate the effect of foliar application of putrescine and humic acid as well as their interaction on growth improvement, chemical parameters, and determining the best application level of both factors.

MATERIALS AND METHODS

A Field experiment was conducted during the growing season in spring of 2016 at desert region between An Najaf and Karbala provinces. Seeds were sown in agriculture plate on 15/12/2015 and then after 25 days seedlings (3-5 true leafs and 10-15 cm height) were planted in the field.

Then, the experimental plot was divided in to 27 furrows at 4 m length. The distance between each furrow is two, and each furrow was bedding the animal fertilizer as width 35 cm to each furrow about 3 tons·d^{-1}. Seedlings were cultivated at 40 cm apart on furrow. The experiment design was factorial with two factors adopted with Randomized Complete Block Design R.C.B.D. in three replicates with two factors i. e.: 1 - Putrescine with two concentrations 50 and 100 mg·L^{-1} spraying on vegetative part, besides control treatment (spraying with Distilled water only); 2 -Humic acid 500 and 1000 mg·L^{-1} spraying on vegetative parts, besides control treatment (spraying with Distilled water only). Agricultural practices were done equally and when it is considered necessary (cultivation, weeding, etc.) as mentioned in (Matlob et al., 1989). Period between spraying putrescine treatments and humic acid was one weak.

Irrigation was done from well water with E.C. of 5.6 dS·m^{-1} by dripping system. Duncan's Multiple Range Test was used to compare means when it is considered significant at probability of 0.05 (Al-Rawi & Khalaf-Allah, 2000).

Parameters:

Determination of N, P, K in Leaves and Fruits.

Nitrogen Determination in Leaves and Fruits: by using Micro-Kjeldahl according to Jackson (1958).

Phosphorous Determinations in Leaves and Fruits: by using Ammonium molybdenum and Spectrophotometer methods on 882 nm according to Olsen and Sommers (1982).

Potassium Determination in Leaves and Fruits: by using Flame photometer.

Total soluble carbohydrates in Leaves (mg·g^{1}): according to Duboies et al. (1956). Total Chlorophyll in Leaves (mg·100 g^{-1}): By using acetone to extract chlorophyll pigment according to Mackinney (1941), by using the following equation: Ascorbic Acid Determination in Fruits mg·100 g^{-1}: Titration with 2, 6-dichlorophenol indophenol according to (A.O.A.C, 1980).

Total Soluble Solids in fruits (T.S.S.) by using Handel Refractometer according to Al-Ani (1985).

Table 1. Chemical and Physical Characteristics for Field Soil in the Beginning of the Experiment

Characters	Value	Unit
pH	7.1	--
EC	1.4	dS·m^{-1}
Ca^{+2}	16.6	mM·L^{-1}
Mg^{+2}	5.8	
Na^{+}	2.9	
K^{+}	0.6	
SO_4^{-2}	10.8	
Cl^{-}	15.9	
HCO_3^{-}	1.0	
Soluble P	0.16	mg·L^{-1}
O.M.	5.0	g·kg^{-1}
$CaCO_3$	285.5	g·kg^{-1}
Clay	20	g·kg^{-1}
Silt	65	
Sand	915	
Texture	Sandy	

RESULTS AND DISCUSSIONS

With regards to the spraying putrescine, resultd in Table 2 shows that there was a significant difference between treatments of putrescine, particularly treatment of 100 mg·L^{-1} that gave the highest values for chemical parameters of leaves which included N, P, K concentration, total soluble carbohydrate and total chlorophyll in leaves with 2.11%, 0.24%, 1.96%, 2.82 mg·g^{-1} and 36.88 mg·100 g^{-1}, respectively compared with control treatment (sprayed with distilled water) that gave 1.70%, 0.22%, 1.51%, 2.41 mg·g^{-1} and 32.92 mg·100 g^{-1}, respectively.
Moreover, humic acid with concentration 1000 mg·L^{-1} spraying had a significant effect on chemical parameters of leaves which included N, P, K concentration, total soluble carbohydrate and total chlorophyll in leaves were 2.30%, 0.25%, 2.25%, 2.86 mg·g^{-1} and 37.52 mg·100 g^{-1}, respectively. Meanwhile, control treatment gave the lowest values i.e. 1.53%, 0.20%, 1.41%, 2.39 mg·g^{-1} and 32.19 mg·100 g^{-1}, respectively.
The interaction between factors showed significant differences on chemical parameters of leaves, and the treatment of putrescine 100 mg·L^{-1} × humic acid with concentration 1000 mg·L^{-1} gave the highest values the of chemical parameters of leaves were 2.555%, 0.259%, 2.458%, 3.05 mg·g^{-1} and 39.99 mg·100 g^{-1}, respectively compared putrescine 0 × humic acid 0 presented the lowest value of chemical parameters of leaves were 1.452%, 0.178%, 1.236%, 2.31 mg·g^{1} and 31.60 mg·100 g^{-1}, respectively.
Results in Table 3 reveals that there was a significant difference between the treatments of putrescine, the treatment (100 mg·L^{-1}) gave the highest value of chemical parameters of fruits which included N, P, K concentration, T.S.S and amount of vitamin C in fruits were 2.01%, 0.16%, 1.15%, 5.00 and 27.77 mg·100 g^{-1}, respectively compared with the control treatment which gave the lowest means i.e. (1.62%, 0.21%, 1.44%, 4.20 and 23.44 mg·100g^{-1}) respectively.
Spraying humic acid at a concentration 1000 mg·L^{-1} clearly affected on chemical parameters of fruits which included N, P, K concentration, T.S.S and amount of vitamin C in fruits were 2.21%, 0.23%, 1.51%, 5.03 and 26.66 mg·100 g^{-1}, respectively compared with control treatment (without spraying of humic acid) that gained the least values i.e. (1.41%, 0.15%, 0.98%, 4.27 and 23.55 mg·100 g^{-1}) respectively.
The interaction between factors appeared significant differences on all chemical parameters of fruits and the treatment of putrescine 100 mg·L^{-1} × humic acid with concentration 1000 mg·L^{-1} gave the best values were 2.420%, 0.242%, 1.546%, 5.23 and 29.66 mg·100g^{-1}, respectively. While, the treatment of (0 Putrescine ×0 humic acid) which gave the lowest values 1.260%, 0.120%, 0.690%, 3.83 and 22.00 mg·100 g^{-1}, respectively.

Table 2. Effect of putrescine and foliar application of humic acid on chemical parameters of leaves of tomato plant

Treatments		Concentrations	Nitrogen concentration in leaves (%)	Phosphorus concentration in leaves (%).	Potassium concentration in leaves (%).	Total soluble carbohydrate in leaves ($mg \cdot g^{-1}$).	Total chlorophyll in leaves ($mg \cdot 100\ g^{-1}$)
Putrescine $mg \cdot L^{-1}$		0	1.70c	0.22a	1.51b	2.41b	32.92c
		50	1.92b	0.23a	1.83a	2.75a	34.97b
		100	2.11a	0.24a	1.96a	2.82a	36.88a
Humic acid $mg \cdot L^{-1}$		0	1.53c	0.20b	1.41c	2.39b	32.19c
		500	1.90b	0.24a	1.64b	2.72a	35.05b
		1000	2.30a	0.25a	2.25a	2.86a	37.52a
Putrescine $mg \cdot L^{-1}$ × Humic acid $mg \cdot L^{-1}$	0	0	1.452ef	0.178c	1.236f	2.31d	31.60e
		500	1.645d	0.233b	1.364e	2.36cd	32.49d
		1000	2.005bc	0.239b	1.940b	2.56c	34.66c
	50	0	1.550e	0.211c	1.475d	2.41c	32.08de
		500	1.882c	0.238b	1.654c	.286b	34.90c
		1000	2.325ab	0.255a	2.365a	2.98a	37.92b
	100	0	1.592e	0.223bc	1.522c	2.46c	32.90d
		500	2.180b	0.244ab	1.895b	2.95ab	37.76b
		1000	2.555a	0.259a	2.458a	3.05a	39.99a

Table 3. Effect of putrescine and foliar application of humic acid on chemical parameters of fruits of tomato plant

Treatments		Concentrations	Nitrogen concentration in fruits (%).	Phosphorus concentration in fruits (%).	Potassium concentration in fruits (%)	T.S.S. in fruits	Vitamin C in fruit, mg.100 g⁻
Putrescine, $mg \cdot L^{-1}$		0	1.62c	0.16b	1.15c	4.20c	23.44c
		50	1.84b	0.20a	1.28b	4.64b	24.44b
		100	2.01a	0.21a	1.44a	5.00a	27.77a
Humic acid, $mg \cdot L^{-1}$		0	1.41c	0.15b	0.98c	4.27c	23.55c
		500	1.86b	0.19a	1.39b	4.54b	25.44b
		1000	2.21a	0.23a	1.51a	5.03a	26.66a
Putrescine, $mg \cdot L^{-1}$ × Humic acid, $mg \cdot L^{-1}$	0	0	1.260e	0.120f	0.690c	3.83c	22.00e
		500	1.605c	0.155e	1.288b	4.00bc	24.00d
		1000	1.992b	0.198c	1.482ab	4.76b	24.33cd
	50	0	1.450d	0.157e	0.984cd	4.20bc	22.33de
		500	1.850bc	0.202c	1.366b	4.63b	25.00d
		1000	2.225ab	0.235a	1.500a	5.10a	26.00c
	100	0	1.505c	d0.184	1.260b	4.78b	26.33c
		500	2.110b	0.211b	1.522a	5.00ab	27.33b
		1000	2.420a	0.242a	1.546a	5.23a	29.66a

The results show that spraying with the Putrescine in combination with humic acid had a significant effect on the increases in chemical parameters of leaves which included N, P, K concentration, total soluble carbohydrate and total Chlorophyll in leaves and chemical parameters of fruits which included N, P, K Concentration, T.S.S and amount of vitamin C in fruits (Tables 2 and 3) respectively. That could be attributed to putrescine spraying induction important biological processes such as ionic balance and DNA, RNA and protein stabilization, hence, leading to the enhancement of free amino acids and increasing in leaf sucrose content. Certain PA changes are correlated with changes in the structure and function of the photosynthetic apparatus (Demetriou et al., 2007). Application of Put. lead to improvement in photosynthetic pigment (Zeid, 2004). Ndayiragije and Lutts (2007) reported improvement in net photosynthesis as response to Put treatment in rice, and that Put. induced stomatal closure in wheat which exhibited high water content (Liu et al., 2000) and these all lead to increase all studied chemical parameters which mention above.

Humic acid spraying which promote growth and increased yield and quality in a number of plant species at least partially through increasing nutrient uptake (Karakurt et al., 2009). Humic acid have been reported to enhance mineral nutrient uptake by plants, increasing the permeability of membranes of root cells (Valdrighi et al., 1996). Humic acid is important for chloroplast system through it leads to the increased rate of photosynthesis in plant and consequently, productions of photosynthesis materials have increased in plant when spraying with humic acid also. In general, spraying with humic acid had increased the length of growth period, rate of carbohydrates, amino acids and proteins in plant. In the same direction, rate of retransfer of photosynthesis materials is done to a great extent from growth parts and consequently, weight of plant will be increased (Farnia & Nasrollahi, 2010).

Tahir et al. (2011) pointed that higher leaf chlorophyll associated to humic spraying could be related to increased cell membrane permeability by humic acid and thus promoting greater efficiency in the absorption of nutrients, especially nitrogen a nutrient with direct relation with leaf chlorophyll concentration. Moreover, the effect of humic acid caused good nutritional status in plant and thus, increased the availability of elements such as: N, P, K which had an activation of biotic activity in plant and then conformation of organic acid such vitamin C (Ertan, 2007). David et al. (1994) reported that promoting growth and nutrient uptake of plants due to the addition of humic substances. The plants take more mineral elements due to better-developed root systems. In addition, the stimulation of ions uptake under the applications of humic materials led many investigators to proposing that these materials affect membrane permeability.

CONCLUSIONS

The addition of putrescine and humic acid by spraying on the shoot of tomato had a significant effect in increasing and improving the chemical characteristic. The double interference treatments between putrescine and humic acid had a significant effect on increasing all the studied traits more than single factors.

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