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Effect of ascorbic acid, proline and jasmonic acid foliar spraying on fruit set and yield of Manzanillo olive trees under salt stress

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ABSTRACT

A field experiment study was carried out during two successive seasons during 2011 and 2012 in Manzanillo olive orchard about 14 years old grown in sandy soil under drip irrigation system from well at El Maghara Station (Desert Research Center), North Sinai Governorate, Egypt. Treatments of ascorbic acid (2000 and 3000 ppm), proline (75 and 150 ppm) and jasmonic acid (15 and 30 ppm) and tap water control foliar sprayed were carried out at three times a year started at full bloom with 4 weeks intervals.

Briefly, ascorbic acid, proline and jasmonic acid enhanced all studied leaf characters, fruit set, yield and fruit quality traits. Ascorbic acid at 3000 ppm proved to be most efficient treatment in this respect.

1. Introduction

The olive tree (*Olea europeae* L.) is one of the important crops in Egypt. Manzanillo olive is one of the important olive cultivar grown in Egypt. Olive trees face several factors which have a negative effect on its yield, among these factors the depression of olive yield which is caused by the salinity.

Salinity is an environment stress, mainly occurs in arid and semi-arid conditions where rain precipitation is not enough to leach the excess soluble salts from the root zone, as well as, it can occur in irrigated agriculture cultivations particularly when water of poor quality is used for irrigation. Cho and Park (2000) worked on tomato seedling, pointed that the biochemical change occurring in plants subjected to environmental stress conditions is the production of reactive oxygen species, which can damage essential membrane lipids proteins nucleic acid (Inze and Van Montague, 1995; Garratt et al., 2002).

Furthermore, the use of special management practice to minimize and counteract salinity effect appears is very important. Many investigators reported that growth promoters are very effective in increasing salt tolerance of plants.

Antioxidants (such as ascorbic acid) have catch all free radicals produced during plant metabolism, hence increasing plant resistance to stress. Moreover, they provide adequate protection against the deleterious effects of activated oxygen species (Nicholas, 1996; Alscher et al., 1997). Also, ascorbic acid has an auxinic action and synergistic effect on flowering and fruiting of fruit trees as well as, ascorbic acid is a natural and safety used instead of synthetic auxins. Shalata and Peter (2001) and Khan (2006) stated that ascorbic acid as an antioxidant could be used as a potential growth regulator to improve salinity stress resistance in several species.

Ascorbic acid was reported to enhance growth and fruit quality, El Sayed et al. (2000) on flame seedless grapevine; Ahmed (2001) on mangoes; Ragab (2002) on Washington Navel orange; Mostafa (2004) on banana; Wassel et al. (2007) on white banaty seedless grapevines. Moreover, Maksoud et al. (2009) on olive trees stated that spraying ascorbic acid at 1000 and 2000 ppm alone or combined with bio-fertilizer (phosphorine) enhanced yield and fruit quality. Moreover, Yousef et al. (2009) stated that spraying ascorbic acid at 90 ml/L a month before harvest improved fruit chemical properties and gave positive effect on oil characteristic of Picaul olive trees. Also, Fayed (2010) worked on pomegranate trees, found that the interaction of foliar application of compost tea with double combined antioxidant treatment (ascorbic + citric acid) increasing yield and fruit quality. Furthermore, Mansour et al. (2010) indicated that spraying ascorbine (1%) containing 26% ascorbic acid for three times started at the first week of March with monthly intervals improved yield and fruit quality of mango cultivars namely, Zebda, Awase, Alphonso and Taimor.

Proline amino acid has been shown to accumulate in plant tissues under various conditions (Yang et al., 1999; Mansour, 2000). The proposed function of the accumulated proline is osmosis regulation which has an adaptive mechanism to environmental stress and salinity (Aspinall and Paleg, 1981). Also, other proposed function is maintenance of membrane and protein stability, growth,

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Table 1
Analysis of experimental soil of El-Maghara Station, North Sinai Governorate in 2011 and 2012 seasons.

I – Physical analysis of El-Maghara soil

Soil depth (cm)	Particle size distribution				Texture class	Bulk density (g/cm)	Organic mater (%)	Moisture content (%)	
	Coarse sand	Fine sandy	Silt	Clay				Field capacity	Wilting point
0–30	0.00	98.00	1.00	1.00	Sand	1.55	0.24	10.23	4.45
30–60	0.00	98.50	0.80	0.70	Sand	1.58	0.23	9.98	4.51
60–90	0.00	99.00	0.50	0.50	Sand	1.60	0.19	10.35	4.64
90–120	0.00	98.50	0.70	0.80	Sand	1.57	0.28	9.87	4.41
120–150	0.00	99.50	0.30	0.20	Sand	1.56	0.22	10.18	4.39

[0,1-12]II – Chemical analysis of El-Maghara soil

Soil depth cm	$CaCo_3$	pH soil past	E. Ce ($dS\,m^{-1}$)	Soluble cations (meq/l)				Soluble anions (meq/l)			
				Ca^{2+}	K^+	Na^+	Mg^{2+}	Cl^-	$SO_4^=$	Hco_3^-	$Co_3^=$
0–30	5.89	7.70	0.60	2.50	0.05	1.26	1.50	1.40	2.11	1.80	–
30–60	3.80	7.70	0.70	3.00	0.08	1.57	2.00	2.00	2.85	1.80	–
60–90	4.35	7.40	1.10	3.50	0.05	3.04	2.00	6.10	2.09	2.40	–
90–120	5.98	7.60	1.20	3.50	0.03	4.04	2.50	5.10	1.97	3.00	–
120–150	4.44	7.60	0.60	2.50	0.03	1.56	1.50	2.10	1.09	2.40	–

Table 2
Chemical analysis of water used for irrigation at El-Maghara Station, North Sinai Governorate in 2011 and 2012 seasons.

pH	E.C. ($dS\,m^{-1}$)	O.M. (%)	Soluble cations (meq/l)				Soluble anions (meq/l)			
			Ca^{2+}	Mg^{2+}	Na^+	K^+	$CO_3^=$	HCo_3^-	Cl^-	$SO_4^=$
8.36	4.38	1.40	11.40	3.48	24.60	0.69	0	4.40	3.57	32.20

and provisions of a store of carbon, nitrogen and energy (Mansour, 2000). In this respect, Ezz (1999) mentioned that proline foliar application increased fruit juice, ascorbic acid content peel, proline, free amino acids and reducing sugar content of Washington Navel orange and Marsh grape fruit. Furthermore, Takeuchi et al. (2008) demonstrated that L-proline treatments caused an increase in sugar content of fruit, glutamic acid content of new leaves, and leaf chlorophyll content of Japanese pear tree grown in containers under greenhouse conditions. Also, Caronia et al. (2010) worked on (*Citrus sinensis* L.) they indicated that amino acids especially L-proline foliar application improved yield, fruit weight, diameter and T.S.S. content.

Jasmonic acid is considered a new class of endogenous growth substances identified in many plant species. They influence a wide variety of physiological and developmental response (Parthier et al., 1992). In addition, Moons et al. (1997) stated that jasmonate is an antagonistically regulate the expression of salt stress inducible proteins, associated with salt stress in rice. In his respect, Oliva et al. (1988) work on Pummelo, cv. March Jibarito sprayed with jasmonic acid at 40 ppm + GA at 40 ppm 17 days after full bloom gave the highest fruit set. Moreover, Sheteawi (2007) investigated that treatment with jasmonic acid on soybean under salt stress mitigated the harmful effect of NaCl and gave the greatest yield. Furthermore, Salimi et al. (2012) indicated that application of methyl jasmonate on chamomile under salt stress showed the significant increased in proline content that leads to cell membrane stability and salt resistance.

The present study was carried out to investigate the effect of ascorbic acid, proline and jasmonic acid at different concentrations on leaf characters, fruit set, yield and fruit quality traits of Manzanillo olive trees under salt stress.

2. Materials and methods

This investigation was carried out during two successive seasons 2011 and 2012 at Experimental orchard of El Maghara Station of Desert Research Center, North Sinai Governorate (latitude 30.35 N, longitude 33.20 E) in Egypt. Manzanillo olive trees aged 14 years old grown in sandy soil, and spaced 5 m × 5 m apart under drip irrigation system from well. Physical and chemical analysis of the experimental soil shown in Table 1, meanwhile the chemical analysis of used water from irrigation is recorded in Table 2. Forty two trees healthy, nearly uniform in shape and size and productivity and received the same horticulture practices, were subjected to seven treatments as: control tap water, ascorbic acid as foliar sprays at 2000 ppm, ascorbic acid as foliar sprays at 3000 ppm, proline as foliar sprays at 75 ppm, proline as foliar sprays at 150 ppm, jasmonic acid as foliar sprays at 15 ppm, and jasmonic acid as foliar sprays at 30 ppm.

The experiment was designed as randomized complete block design with three replicates for each treatment and each replicate was represented by two trees. Foliar sprays of ascorbic acid, proline and jasmonic acid treatments were carried out at three times i.e., the first foliar sprays was done at full bloom, the second one was performed 4 weeks later and the third one was performed 4 weeks later after the second one. Meanwhile, the control trees were sprayed with tap water at the previously mentioned times. Response of Manzanillo olive trees to the tested ascorbic acid, proline and jasmonic acid treatments were evaluated through the following determinations.

2.1. Leaf characters

The area of leaves was determined by using portable area planimeter Mod Li3100 Ali (Li-Cor) while leaf total chlorophyll content was determined by Minolta chlorophyll meter SPAD-502. And leaf proline content was determined according to Bailcy (1967).

2.2. Fruit set percentage

Fruit set percentage was calculated in relation to total number of flowers on the same twig after 15 days from full bloom.