J. Agric. Food. Tech., 7(4)1-5, 2017

ISSN 2090 – 424X
Journal of Agriculture and Food Technology
www.textroad.com

Effect of Humic and Fulvic Acid on Growth, Yield and Nutrients Balance of "Costata" Persimmon Trees

Abd El-Rheem Kh. M.[1], Kassem A. S. Mohammed[2] and Yasser A. El-Damarawy[1]

[1]Soil and Water Use Dept., [2]Plant Nutrition Dept., National Research Centre, Dokki,Giza, Egypt

ABSTRACT

A field experiment was conducted in El-Kanater El-Khairia in Kalubeia governorate, during two seasons 2014 and 2015 to study the influences of two rates of humic and fulvic acid (1 and 2 ml^{-1}) on growth, yield and N, P and K content of "Costata" persimmon trees (*Diospyros kaki* L.) budded on "Lotus" rootstock.

The results showed that high rate of humic acid (2 ml l^{-1}) given higher values of leaf area, shoot length and leaf dry weight at first season (83.40 cm^2, 68.93 cm and 9.00 g, respectively), as well as at second season (88.04 cm^2, 72.02 cm and 7.93 g, respectively). As well as the same rate of humic acid increased significantly fruit set, yield and fruit weight at first second season of "Costata" persimmon trees (*Diospyroskaki* L.). Second level of humic acid was high effect on most fruit characters, unless the first level of fulvic acid (1 ml l^{-1}) given high values of firmness at first and second season (16.25 and 15.5 Ib/inch^2, respectively. The second level of humic acid (2 ml l^{-1}) given high value of TSS and TSS: acid ratio at first and second season (24.3 and 21.4 % and 45.05 and 43.69, respectively), but the first level of fulvic acid given high value of acidity and tannins at first and second season (0.63 and 0.58 % and 0.82 and 0.76, respectively). The second level of humic acid increased significantly of N and K content, but no significantly of P content under different rates of humic and fulvic acid.

Clearly, great effect of high rate of humic acid (2 ml l^{-1}) on most growth, yield and nutrients content of "Costata" persimmon trees (*Diospyros kaki* L.) compared with two levels of fulvic acid at two seasons.

Lowest Nutrient Balance Index (NBI) was recorded under the high rate of fulvic acid (2 ml l^{-1}) was attained 26.318.

KEY WORDS: "Costata" persimmon trees, Humic acid, Fulvic acid, Growth, Yield, Nutrients balance.

INTRODUCTION

Persimmon is fleshy fibrous tropical, deciduous fruit belonging to Ebenaceae family. It is commonly cultivated in warm regions of the world. Mediterranean region is suitable for persimmon production that has reached up to 110,000 tons **(Luo, 2007 and Bubba *et. al*., 2009)**. Generally, over 400 species of persimmon are planted globally. Among these, *Diospyros kaki, Diospyros virginiana, Diospyros oleifera,* and *Diospyros lotus* **(Bibi *et al*.,2007)**.

Humic acids have a high molecular weight and poly-aromatic heterocyclic macromolecules that incorporate proto-catechuic acid, vanillic acid, vanillin, resorcinol, ferulic acid, benzoic acid, and other cyclic polyphenols resulting from the degradation of the lignin in plant cell walls. Humic acid is rich in carboxyl, hydroxyl, and carbonyl groups as well as in phenols, quinones and semi-quinones **(Bravo, 1998 and Yoshino, 1998)**. The stimulatory effects of humic substances have been directly correlated with increasing of some micronutrients uptake such as Fe, Zn and Mn **(Chen *et al*., 1990)**.

Fulvic acid is a part of the humic substances in soil rich in organic matter. It is an acid created in extremely small amounts by the action of beneficial microbes, working on decaying plant matter in a soil environment with adequate oxygen. Fulvic acid is low molecular weight and is biologically very active. Because of its low molecular weight, it has the necessity and ability to readily bond minerals and elements into its molecular structure causing them to dissolve and become mobilized fulvic complexes.

The use of DRIS technique on connotation of nutritional state of crops, this method puts the limitation of all nutrients in arrangement of plants demand, enabling the nutritional equilibrium between the nutrients in plant tissues. With the utilization of dual relation on DRIS, the problem with the impact of concentration or dilution on the nutrients in plants is settled (**Beaufils, 1973 and Walworth and Sumner,1987).**

Corresponding author: Abd El-Rheem Kh. M., Soils and Water Use Dept, National Research Centre, Dokki, Giza, Egypt.

The study aimed to investigate the effect of foliar addition of humic and fulvic acid on growth, quality and quantity of yield and nutrients balance of “Costata” persimmon trees.

MATERIALS AND METHODS

The present investigation was carried out during two successive seasons, 2014 and 2015 on "Costata" persimmon trees (*Diospyros kaki* L.) budded on “Lotus” rootstock; and grown on clay loamy soil at El-Kanater El-Khairia in Kalubeia governorate. Two rates of humic and fulvic acid (1 and 2 ml l^{-1}) were added at four times, the first at vegetative growth start, the second at after two weeks from fruit setting, the third after month from second time and the fourth at month before harvest. Mineral fertilization (N, P and K) was added as recommended doses. The chemical analysis of the soil of the experimental field showed that it contained 110 ppm N, 26.8 ppm P_2O_5, 214 ppm K_2O, 5.13 ppm Fe, 2.20 ppm Zn, 0.64 ppm Mn.

All samples of plant were dried at 65C° for 48 hrs, ground and wet digested using H_2SO_4: H_2O_2 approach **(Cottenie, 1980)**. The digests samples were then subjected to measurement of N using Micro-Kjeldahle method; P was inspected using molybdenum blue method and determined by spectrophotometer and K was determined by Flame Photometer (**Chapman and Pratt, 1961)** while Fe, Zn and Mn were planned using atomic absorption spectrophotometer. Total Soluble Solids (TSS) were determined by hand refractometer, acidity (as malic acid/100ml juice) and tannins in the juice of the fruits content were determined **(A. O. A. C., 1990).**

The DRIS index of all nutrients was calculated by using the following index equations by **Bailey *et al.*, (1997)**:-

$$\text{N- Index} = \frac{-f(N/P) - f(K/N) + f(N/Fe) - f(Zn/N) - f(Mn/N)}{5}$$

$$\text{P-Index} = \frac{-f(N/P) - f(K/P) - f(Fe/P) - f(Zn/P) - f(Mn/P)}{5}$$

$$\text{K- Index} = \frac{f(K/N) + f(K/P) + f(K/Fe) + f(Zn/K) + f(K/Mn)}{5}$$

$$\text{Fe-Index} = \frac{-f(N/Fe) + f(Fe/P) - f(K/Fe) - f(Zn/Fe) - f(Mn/Fe)}{5}$$

$$\text{Zn-Index} = \frac{f(Zn/N) + f(Zn/P) + f(Zn/K) + f(Zn/Fe) - f(Mn/Zn)}{5}$$

$$\text{Mn-Index} = \frac{f(Mn/N) + f(Mn/P) - f(K/Mn) + f(Mn/Fe) + f(Mn/Zn)}{5}$$

RESULTS AND DISCUSSION

Regarding the response of growth, obtained data (Table, 1) indicated that the impact of humic and fulvic acid rates on leaf area, shoot length and leaf dry weight. High level of humic acid (2 ml l^{-1}) given higher values of leaf area, shoot length and leaf dry weight (85.72 cm^2, 70.47 cm and 8.465 g, respectively).

Table (1): Effect of humic acid and fulvic acid on growth and yield of "Costata" persimmon.

Treatments		Growth			Yield		
		Leaf area (cm^2)	Shoot length (cm)	Leaf dry weight (g)	Fruit set (%)	Yield (kg /tree)	Fruit weight (g)
Control		71.71	56.45	6.530	42.26	22.66	99.4
Humic acid	1 ml l^{-1}	81.90	65.25	7.645	48.52	25.87	117.5
	2 ml l^{-1}	85.72	70.47	8.465	54.41	28.42	125.9
Fulvic acid	1 ml l^{-1}	74.41	58.35	6.725	44.21	23.87	118.9
	2 ml l^{-1}	77.64	61.85	6.905	45.93	27.32	123.4

Sharifi *et al.*, (2002) showed that humic acid could promote photosynthetic tissues and thus total dry weight would raise. **Abdel- Mawgoud *et al.*, (2007)** reported that humic acid increased plant growth out of chelating various nutrients to beat the deficiency nutrients, and have helpful effects on growth and production rise.

Regarding the response of yield, obtained data (Table, 1) indicated that the impact of humic and fulvic acid on fruit set, yield and fruit weight. High level of humic acid (2 ml l^{-1}) given higher values of fruit set, yield and fruit weight (54.41 %, 28.42 kg and 125.9 g, respectively). **Mahmoudi *et al.*, (2013)** reported that using humic acid (0.2 %) led to increase the fruit weight of kiwi fruit, because the application of organic acids increase the fruit weight by activating hormones like auxine and cytokinin and result in high weight of fruits.

Data in (Table, 2) showed that high the influence of second level of humic acid appeared on most fruit characters such as volume, length, diameter, unless the second level of fulvic acid (2 ml l^{-1}) given high value of firmness (15.8Ib/inch^2). **El-Desuki (2004)** showed that addition humic acid increased growth, nutrients uptake and quality and quantity of yield. Humic acid was reported to promote the quantitative properties of fruit, such as yield fruit weight, width, length and diameter of plants **(Mackowlak *et al*., 2001 and Shehata *et al*., 2011)**. Humic acid increase the fruit diameter by increasing the cell division and enlargement and result in more development and diameter of fruits **(Salman, 2005)**.

Table (2): Effect of humic acid and fulvic acid on fruit characters of "Costata" persimmon

Treatments		Fruit characters			
		Volume (cm^3)	length (cm)	diameter (cm)	Firmness (Ib/inch^2)
Control		100.9	5.58	5.4	14.1
Humic acid	1 ml l^{-1}	118.6	6.05	5.91	15.2
	2 ml l^{-1}	130.5	6.38	6.19	14.3
Fulvic acid	1 ml l^{-1}	119.1	5.70	5.79	15.6
	2 ml l^{-1}	123.4	5.88	5.88	15.8

Regarding the response of fruit quality, obtained data in (Table, 3) indicated that the influence of humic and fulvic acid rates on TSS, acidity, TSS/acid ratio and tannins of fruits. Second level of humic acid (2 ml l^{-1}) given high value of TSS and TSS: acid ratio (22.85% and44.37, respectively), but the second level of fulvic acid given high value of acidity and tannins (0.605 and 0.79 %, respectively). **Saleh *et al*., (2006)** showed that when humic acid applied on 'Canino' apricot when it enhanced TSS and decreased acidy. **Abbas *et al*. (2013)** indicated that using humic acid (2 ml l^{-1}) led to increase of TSS by 17.84% in fruit of Kinnow mandarin.

Table (3): Effect of humic acid and fulvic acid on fruit quality of "Costata" persimmon cultivar.

Treatments		TSS (%)	Acidity (%)	TSS/acid ratio	Tannins (%)
Control		18.81	0.505	31.46	0.63
Humic acid	1 ml l^{-1}	20.43	0.555	37.64	0.67
	2 ml l^{-1}	22.85	0.525	44.37	0.64
Fulvic acid	1 ml l^{-1}	19.25	0.570	33.65	0.71
	2 ml l^{-1}	19.87	0.605	35.71	0.79

Data in (Table, 4) indicated that the effectiveness of two levels of humic and fulvic acid on nutrients (N, P, K, Fe, Zn and Mn) index of leaves. A nutrient index is a mean of the variation from the optimum or norms values. The passive index values mention that the nutrient levels are beneath the optimum. Consequently, the more negative index, the more insufficient the nutrient, likewise a positive index points that the nutrient levels are above the optimum, and the more positive index the more excrescent the nutrient that is proportional to normal, and the DRIS index is equal to zero indicating that the nutrient is at optimum levels.

Table (4): Effect of humic acid and fulvic acid on nutrient indices of "Costata" persimmon leaves.

Treatments		Nutrient Index						NBI
		N	P	K	Fe	Zn	Mn	
Control		-1.967	-8.374	2.542	-10.151	8.146	9.804	40.984
Humic acid	1 ml l^{-1}	-4.466	-6.237	0.849	-7.807	11.237	6.419	37.02
	2 ml l^{-1}	8.233	-5.220	5.812	-13.150	1.703	5.635	39.753
Fulvic acid	1 ml l^{-1}	-1.756	-5.172	3.953	-9.03	0.241	11.764	31.916
	2 ml l^{-1}	3.125	-6.167	6.139	-6.482	-0.510	3.895	26.318

Data exposed that the lowest Nutrient Balance Index (NBI) was listed under the high rate of fulvic acid (2 ml l^{-1}) was attained 26.318. **Fuhr and Sauerbeck (1967)** showed that the transfer of Fulvic acid to the shoot is more than humic acid. **Saeed and Simin (2014)** indicated that hormone-like effects of humic substances is more in acidic groups and smaller molecules than aliphatic ones. Fulvic acid has smaller molecules and more acidic groups than humic acids.

REFERENCES

- **Abbas, T., S. Ahmad, M. Ashraf, M. A. Shahid, M. Yasin, R. M. Balal, M. A. Pervez and S. Abbas, 2013.** Effect of humic and application at different growth stages of kinnow mandarin (*Citrus reticulate* Blanco) on the basis of physio-biochemical and reproductive responses. Academia Journal of Biotechnology, 1: 14-20.

- **Abdel - Mawgoud A.; M. R. N. El Greadly, Y. I. Helmy and S. M. Singer, 2007**. Responses of tomato plants to different rates of humic based fertilizer and NPK fertilization. Journal of Applied Sciences Research, 3:169-174.

- **A. O. A. C., 1990.** Official of analysis the association on official analytical chemists.15th Ed, West Virginia, U.S.A, Washington D. C.

- **Bailey J. S., J. A.M. Beattie and D. J. Kilpatrick, 1997.** The Diagnosis and Recommendation Integrated System (DRIS)for diagnosing the nutrient status of grassland swards: I. Model establishment. Plant and Soil, 197: 127-135.

- **Beaufils, E. R., 1973.** Diagnosis and Recommendation Integrated System (DRIS). University of Natal, Pietermaritzburg, S. Africa., (Soil Science Bulletin, 1).

- **Bibi N., Khattak A.B., Mehmood Z., 2007.** Quality improvement and shelf life extension of persimmon fruit *Diospyroskaki*. J Food Eng., 79:1359–63.

- **Bubba M.D.; E. Giordani, L. Pippucci L, A. Cincinelli, L. Checchini, P. Galvan, 2009.** Changes in tannins ascorbic acid and sugar contents in astringent persimmons during on-tree growth and ripening and in response to different postharvest treatments. J. Food Comp. Anal., 22:668-77.

- **Chapman, H.D. and R. E. Pratt, 1961.** Methods of analysis for soil, Plants and WaterDept. of Soil, Plant Nutrition, Univ. of California. U.S.A.

- **Chen, Y., and T. Aviad, 1990.** Effects of humic substances on plant growth. In: *Humic Substances in Soil and Crop Science: Selected Readings,* eds.P. MacCarthy, C. E. Clapp, R. L. Malcolm, and P. R. Bloom, pp. 161–186. Madison, WI: American Society of Agronomy and Soil Society ofAmerica.

- **Cotteine, A., 1980.** Soil Management for Conservation and Production. New York, pp. 245-250.

- **El-Desuki M., 2004.** Response of onion plants to humic acid and mineral fertilizers application. Annals of Agric. Sci., Moshtohor, 42:1955-1964.

-**Fuhr; F and D. Sauerbeck, 1967.** The uptake of colloidal organic substances by plant roots as shown by experiments with "C-labelled humus compounds. p. 73-82. In Report FAO/IAEA Meeting, Vienna, Pergamon Press, Oxford.

- **Luo Z., 2007.** Effect of 1-methylcyclopropene on ripening of postharvest persimmon (*Diospyros kaki* L.) fruit. LWT Food Sci Technol., 40:285–91.

- **Mackowiak C. L.; P. R. Grossl and B. G. Bugbee, 2001.** Beneficial effects of humic acid on micronutrients availability to wheat. Soil Sci. Soc. Of Amer. J., 56: 1744-1750.

-**Mahmoudi M.; S. Samavat, M. Mostafavi, A. Khalighi and A. Cherati, 2013.** The Effects of Proline and Humic acid on Quantitative Properties of Kiwifruit.Intl. Res. J. Appl. Basic. Sci., 6: 1117-1119.

- **Saeed;S. and S. Simin, 2014.** The effects of fulvic acid and sugar cane molasses on yield and qualities of tomato. International Research Journal of Applied and Basic Sciences, 8: 266-268.

- **Saleh, M.M.S.; S. El-Ashry and A.M. Gomaa, 2006.** Performance of Thompson Seedless Grapevine as Influenced by Organic Fertilizer, Humic Acid and Biofertilizers under Sandy Soil Conditions. Research Journal of Agricultureand Biological Sciences, 2: 467-471.

-**Salman S.R., 2005.** Fruit yield and quality of watermelon as affected by hybrids and humic acid application. Egypt J. Appl. Sci., 20: 244-259.

- **Sendecor, G. W. and W. Cochran, 1980.** Statistical methods 7th ED., Aiwa State Univ., Press Ames, Aiwa, USA.pp. 507.

- **Sharifi M.; R. A. khattak and M. S. Sarir, 2002**. Effect of different levels of lignitic coal derived humic acid on growth of surface-irrigated wheat. Agricultural science, 52:207-210.

- **Shehata S. A.; A. A. Gharib, M. Mohamed, K. F. El Mogy and A. Sh. Emad, 2011.**Influence of Compost, Amino acids and Humic acids on the Growth, Yield and Chemical Parameters of Strawberries. Journal of Medicinal Plants Research, 5: 2304-2308.

- **Walworth, J. L. and M. E. Sumner, 1987.** The Diagnosis and Recommendation Integrated System (DRIS). Advances in Soil Sciences, 6:149-188.