IJBPAS, October, 2015, 4(10), Special Issue: 706-716

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

EFFECT OF SOIL AND FOLIAR APPLICATION OF HUMIC ACID ON GROWTH AND YIELD OF TOMATO (*LYCOPERSICON ESCULENTUM*L.)

AMIN FARNIA[1*] AND EZATOLLAH MORADI[2]

1- Assistant professor of department of agriculture, Boroujerd branch, Islamic Azad University, Boroujerd, Iran

2- M.Sc student of department of agriculture, Boroujerd branch, Islamic Azad University, Boroujerd, Iran

***Corresponding author: Aminfarnia@yahoo.com**

ABSTRACT

This study was laid out in order to study on effect of soil and foliar application of humic acid on yield and yield components of tomato (*Lycopersicon esculentum* L.). This study was performed in the Faculty of agronomy and plant breeding, Islamic Azad University, Boroujerd Branch, Boroujerd, Iran (Kermanshah region) during the growing seasons 2013- 2014. The experiment was laid out in a factorial based on randomized block design with three replications. Treatments were soil application of 35% humic acid in five levels such as (0, 100, 200, 300 and 400 kg.ha-1) and different stages of foliar application of 20% humic acid (control, plant transferring stage, before anthesis stage and before fruiting stage). Results showed that the effect of soil and foliar application of humic acid were significant of all traits of tomato. Combined soil application of 400 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest plant height, stem diameter and fruit weight. However, combined soil application of 300 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest number of fruit per plant. Application of 400 kg per ha 35% soil application of humic acid had the highest fruit weight and diameter. Also, combined soil application of 300 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest and the control treatment had the lowest fruit

yield. In the present study combined application of soil and foliar application of humic acid had the synergistic effect and was better than single application of them. Final results showed that, for achieve to highest fruit yield in tomato, we must apply both 300 kg/ha 35% soil application of humic acid and 20% foliar application of humic acid at before anthesis stage.

Key words: Fruit yield, soil and foliar application and tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is one of the most important agricultural plants in semi-arid and the Mediterranean areas and cultivation of tomato is very common as a major and productive crop in many parts of the world (MacCarthy et al, 1998). Tomato is rich in vitamins A, C (Block, 1992), B1, B2 and B3. Antioxidant and anticancer effects of tomato reflect the importance of its consumption (Soni, 2003). Tomato is a rich source of lycopene and vitamins. Lycopene may help counteract the harmful effects of substances called “free radicals”, which are thought to contribute to age-related processes and a number of types of cancer, including, but not limited to, those of prostate, lung, stomach, pancreas, breast, cervix, colorectum, mouth and esophagus (DeStefani et al, 2000). Lycopene in addition to neutralizing ability to singlet oxygen and antioxidant properties than beta-carotene and alpha-tocopherol, is able to prevent heart disease, cardiovascular disease and various cancers especially prostate, lung and stomach (Soni et al, 2003).

The foliar application of macro and micro-nutrients have very important role in improving fruit set, productivity and quality of fruits. Previous various experiments have been conducted on foliar spray of micro and micro nutrient in different fruit crops and shown significant response to improve yield and quality of fruits (Kumar, et al 2004). Wojciechowska et al (2005) report that foliar feeding significantly decreased nitrate contents in broccoli heads, as compared to non-feeding plants. The using of humic acid using in the soil increase the absorption of nutrients from the soil and plant nutrient efficiency (Adani et al, 1998). Humic acid can directly cause the positive effects on plant growth. Shoot and root growth is stimulated by humic acid, but its effect is more prominent on the roots. Sabzevari et al (2009) reported that humic acid increased root content and caused the root system effectiveness. Also the humic acid increases the absorption of nitrogen, potassium, calcium, magnesium and phosphorus by plants.

Ferrara and Brunetti (2010) told that humic acid application, berry weight, titratable acidity and maturity index values of Italy grape cultivar increased significantly in the full bloom period. Humic acid Application at medium levels increased yield and nutrient content of spinach (Ayas, and Gulser, 2005). They concluded that humic acid application caused increased nitrogen uptake which was the main reason of enhanced vegetation growth of spinach. Zaky et al (2006) found that the number of shoots/plant, average leaf area, total yield, average pod fresh weight and P content were increased by application of humic acid as a foliar fertilizer at a rate of 1 g/L. Yildirim (2007) reported that HA treatments improved growth and some fruit characteristics and frit yield of tomato. Zaky et al (2006) found that the number of shoots/plant, average leaf area, total yield and average pod fresh weight were increased by application of humic acid as a foliar fertilizer at a rate of 1 g/L. Application of humic acid increased head weight of lettuce (Lactuca sativa L. var. longifolia) due to increasing the availability of phosphorus and nitrogen (Cimrin and Yilmaz, 2005). The application of humic acid significantly increased the dry matter production of faba bean plants (El-Ghozoli, 2003 and L-Ghanam and El-Ghozoli, 2003). Therefore, the main aim of present study was evaluation the effects of soil and foliar application of humic acid on yield and yield components of tomato.

MATERIAL AND METHODS

This field experiment was laid out to study on evaluation the effects of soil and foliar application of humic acid on yield and yield components of tomato. This study was performed in the Faculty of agronomy and plant breeding, Islamic Azad University, Boroujerd Branch, Boroujerd, Iran (Kermanshah region) during the growing seasons 2013- 2014. The experiment was laid out in a factorial based on randomized block design with three replications. Treatments were soil application of 35% humic acid in five levels such as (0, 100, 200, 300 and 400 kg.ha-1) and different stages of foliar application of 20% humic acid (control, plant transferring stage, before anthesis stage and before fruiting stage). Plant to plant distance was 25 cm and during growing stages weeds were control. After harvesting yield and its components were determined as standard methods.

The statistical analyses to determine the individual and interactive effects of treatments was conducted using JMP 5.0.1.2 (18). Statistical significance was declared at $P \leq 0.05$ and $P \leq 0.01$. Treatment effects from

the two runs of experiments followed a similar trend, and thus the data from the two independent runs were combined in the analysis.

RESULTS AND DISCUSSION

Plant height: Results of analysis of variance showed that, the effect of soil and foliar application of humic acid and interaction between them on plant height were significant (table 1). The comparison of the mean values showed that combined soil application of 400 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest (95cm) and the control treatment had the lowest (71cm) plant height and difference between them was significant (table 2).

Stem diameter: Results results showed that, the effect of soil and foliar application of humic acid and interaction between them on stem diameter were significant (table 1). The comparison of the mean values showed that combined soil application of 400 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest (2.8cm) and the control treatment had the lowest (1.8cm) stem diameter (table 2).

Table 1: Analysis of variance (mean squares) for yield and yield components of tomato under soil and foliar application of humic acid

S.O.V	df	Plant height	Stem diameter	number of fruit per plant	fruit weight	fruit length	fruit diameter	fruit yield
R	2	114	0.18	204	64	0.44	0.53	1171
Soil application of humic acid (A)	4	426**	0.68**	338**	150**	0.42*	1.11**	2972**
Foliar application of humic acid (B)	3	62*	0.1*	641**	84**	0.74*	0.74**	1892**
A*B	12	23*	0.04*	50**	30*	0.38**	0.29*	390**
Error	40	10.15	0.01	4	6.8	0.14	0.12	92
CV(%)		3.59	4.11	6.6	3.6	6.1	6.7	12.1

*** and **:Significant at 5 and 1% probability levels, respectively.**

Number of fruit per plant: Results of analysis of variance showed that, the effect of soil and foliar application of humic acid and interaction between them on number of fruit per plant were significant (table 1). The comparison of the mean values showed that combined soil application of 300 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest (46) and the control treatment had the lowest (16.8) number of fruit per plant and difference between them was significant (table 2).

Fruit weight: The effect of soil and foliar application of humic acid and interaction between them on fruit weight was significant (table 1). The comparison of the mean values showed that combined soil application

of 400 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest (81g) and the control treatment had the lowest (65.8g) fruit weight and difference between them was significant (table 2).

Fruit length: The effect of soil and foliar application of humic acid and interaction between them on fruit length was significant (table 1). The comparison of the mean values showed that combined soil application of 400 kg per ha 35% humic acid and foliar application of 20% humic acid at before plant transfering stage treatment had the highest (6.68cm) and the control treatment had the lowest (5.5cm) fruit length (table 2).

Fruit diameter: Results of analysis of variance showed that, the effect of soil and foliar application of humic acid and interaction between them on fruit diameter were significant (table 1). The comparison of the mean values showed that combined soil application of 200 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest (5.83cm) and the control treatment had the lowest (4.1cm) fruit diameter and difference between them was significant (table 2).

Table 2: Mean comparison for interaction effect of soil and foliar application of humic acid on yield and yield components of tomato

Soil appilcation	foliar application	Plant height(cm)	Stem diameter(cm)	number of fruit per plant	fruit weight(g)	fruit length(cm)	fruit diameter(cm)	fruit yield (ton/ha)
0(kg/ha)	control	71j	1.8k	16.8n	65.8l	5.5h	4.1i	44k
	plant transfering before anthesis	80i	2.2j	20l	68i	6.03ef	4.8g	54j
	before fruiting	84h	2.3i	33.8f	66l	6.08def	4.8g	51j
		78i	2.1ij	25.8j	66l	6.2d	5.1ef	47k
100(kg/ha)	control	84h	2.3i	20.3k	68i	5.98f	4.8g	56i
	plant transfering before anthesis	89g	2.5g	25j	70gh	6.21d	5.2de	81f
	before fruiting	89g	2.5g	35e	72e	6.58ab	5.5c	87d
		89g	2.5g	29.8g	71f	6.07def	4.83g	85de
200(kg/ha)	control	88g	2.5g	25j	70gh	6.18de	5.3d	74g
	plant transfering before anthesis	93ab	2.7b	33f	71fg	6.48bc	4.6h	101b
	before fruiting	93ab	2.7b	43b	77c	6.58ab	5.83a	93c
		93ab	2.7b	28h	76d	6.58ab	5.23de	68h
300(kg/ha)	control	89g	2.59fg	34f	71f	6.38c	5.53c	101b
	plant	93ab	2.73bc	40c	73e	6.38c	5.53c	97c

	transfering before anthesis	92bc	2.68de	46a	79b	6.18de	5.73ab	110a
	transfering before fruiting	91bc	2.67de	28h	78b	5.78g	5.53c	82ef
400(kg/ha)	control plant	90de	2.62ef	26i	73e	5.99f	5f	83j
	transfering before anthesis	92bcd	2.7b	18m	77cd	6.68a	5.5c	93c
	transfering before fruiting	95a	2.8a	37d	81a	6.42c	5.63bc	96c
		93ab	2.75a	25j	67jk	5i	5.1ef	82ef

Means by the uncommon letter in each column are significantly different (p<0.05)

Fruit yield: Results of analysis of variance showed that, the effect of soil and foliar application of humic acid and interaction between them on fruit yield were significant (table 1). The comparison of the mean values showed that combined soil application of 300 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest (110 ton/ha) and the control treatment had the lowest (44 ton/ha) fruit yield and difference between them was significant (table 2).

Soil and foliar application of humic acid had the positive effect on yield and its components of tomato. Results showed that the effect of soil and foliar application of humic acid and interaction between them were significant on all traits of tomato (table 1). Ghosh et al (1981) told that some fertilizers such as humic acid can directly cause the positive effects on plant growth. However they told that shoot and root growth is stimulated by humic acid, but its effect is more prominent on the roots. In this area Mokhtari et al (2008) founded that the application of humic acid can increases the absorption of some nutrients such as nitrogen, potassium, calcium, magnesium and phosphorus by plants and increased yield of them. In the present study plant height was affected by soil and foliar application of humic acid and combined soil application of 400 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest plant height, stem diameter and fruit weight (table 2). Ghosh et al (1981) proposed that humic acid increased root content and caused the root system effectiveness that lead to the higher plant growth and plant height. Also, results showed that the combined soil application of 300 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest number of fruit per plant (table 2). Halime et al (2011) told that humic substances are generated through organic matter decomposition and employed as soil

fertilizers in order to improve soil structure and soil microorganisms. Yousef et al (2011) indicated that treated Chemlali olive seedlings with HA treatments was the most effective one compared with the other treatment since this treatment gave the best results concerning plant height, brunch numbers, dry weight, leaf numbers, also it increased plant diameter and leaves area comparing with control.The results found are in agreement with the findings of Abdel Fatah et al, (2008); Yaseen et al, (2006); Kashif et al, (2007) who observed that application of humic acid improved growth parameters and increased plant height.

The comparison of the mean values showed that combined soil application of 400 kg per ha 35% humic acid and foliar application of 20% humic acid at before plant transfering stage treatment had the highest fruit length (table 2). However, combined soil application of 200 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest fruit diameter (table 2). However, Yildirim (2007) have reported a significant enhancement in fruit diameter and length as a result of exogenous HA application in tomato but the author did not find any significant difference between soil HA application and control in terms of fruit diameter.

The comparison of the mean values showed that combined soil application of 300 kg per ha 35% humic acid and foliar application of 20% humic acid at before anthesis stage treatment had the highest and the control treatment had the lowest fruit yield(table 2). Application of soil application of humic acid as 300 kg with foliar application of them increased fruit weight and fruit yield of tomato. Dell'Agnola and Nardi, (1987) told that to elucidate the effects of humic substances and bio-stimulators, several hypotheses suggesting the formation of a complex between these substances and mineral ions, their involvement in the enhancement of enzyme catalysis, their influence of stimulating respiration, photosynthesis and nucleic acid metabolism, and their hormonal activity have been reported. Collectively, the reported findings that HA treatments improved growth and some fruit characteristics and frit yield of various plants including cucumber, tomato, eggplant and pepper (Arancon et al, 2006; Karakurt et al, 2009; Yildirim, 2007) were confirmed in our study.

Also, El-Ghozoli (2003) and L-Ghanam and El-Ghozoli (2003) indicated that the application of humic acid significantly increased the dry matter production of faba bean plants. Humic acid effectively improves

soil fertility and crop production especially in poor soils and alkaline-calcareous soils (Rajaei, 2010). The positive effects of the humic substances were also observed on the studies such as dry matter yield that increases on corn and oat seedling (Celik et al, 2008); yield increases on radish and green bean seedlings (Bramley, 2000). Our results is supported by the finding of Russo and Berlyn (1992) and Hao and Papadopoulos (2003) who reported that HA sprays increased fruit yield and reproductive growth of tomato. Tahir et al (2011) by investigating the effect of different levels of humic acid on wheat concluded that humic acid levels had significant differences between stem weight and plant height and crop yield. Foliar sprays of these substances also promote growth, and increases yield and quality in a number of plant species at least partially through increasing nutrient uptake, serving as a source of mineral plant nutrients and regulator of their release (Atiyeh et al, 2002). In the present study combined application of soil and foliar application of humic acid had the better effect than single application of them. However, we concluded that both soil and foliar application of humic acid had the synergistic effect on growth and fruit yield of tomato. The results of the present study reviled that for achieve to highest fruit yield in tomato, we must apply both 300 kg/ha 35% soil application of humic acid and 20% foliar application of humic acid at before anthesis stage.

REFERENCES

1. Adani, F., Genevini, P., Zaccheo, P., Zocchi, G. 1998. The effect of humic acid on tomato plant growth and mineral nutrition. Journal of Plant Nutrition. 21: 561–575.
2. Arancon NQ, Edwards CA, Lee S, Byrne R (2006). Effects of humic acids from vermicomposts on plant growth. European J. Soil Biol., 42: 65-69.
3. Atiyeh RM, Edwards CA, Metzger JD, Lee S, Arancon NQ (2002). The influence of humic acids derived from earthworm-processed organic wastes on plant growth. Biores. Technol., 84: 7-14.
4. Block G B (1992). Fruit vegetables and cancer prevention: a review of the epidemiological evidence Journal Nutrition. Cancer.18: 1-29.
5. Dell'Agnola, G. and S. Nardi, 1987. Hormone-like effect and enhanced nitrate uptake induced by depolycondensed humic fractions obtained from Allolobophora rosea

and A. caliginosa faeces. Biology and Fertility of Soils, 4: 115-118.

6. Ghosh, D.K., Roy and Malic, S.C. 1981. Effect of fertilizers and spacing on yield and other characters of black cumin (Nigella sativa L.). Indian Agric. 25: 191-197.

7. Halime, O.U., U. Husnu, K. Yasar and P. Huseyin, (2011). Changes in fruit yield and quality in response to foliar and soil humic acid application in cucumber. Scientific Research and Essays, 6(13): 2800-2803.

8. Karakurt Y, Unlu H, Unlu H, Padem H (2009). The influence of foliar and soil fertilization of humic acid on yield and quality of pepper. Acta Agriculturae Scandinavica Section B Plant Soil Science, 59 (3): 233- 237.

9. MacCarthy, P., C.E. Clapp, R.L. Malcolm, and P.R. Bloom (eds.). 1998.
Humic substances in soil and crop sciences: Selected readings. Amer. Soc. Agronomy, Madison, WI.

10. Mokhtari I, Abrishamchi P, Ganjeali A (2008). The effects of Calcium on amelioration of injuries salt stress on seed germination of tomato (Lycopersicon esculentom L.). Iranian Journal of Sciences and Food Technology. 22(1): 89-100.

11. Rajaei M. 2010. Plant nutrition. Text booklet of Islamic Azad University of Jahrom, Khayam Press.

12. SAS Institute 2002. JMP statistics and graphics guide. SAS Institute Inc., Cary, NC.

13. Soni J (2003). Separation of carotenoids from fruits and vegetables, US2003/0180435.

14. Tahir, M.M., Khurshid, M., Khan, M.Z., Abbasi, M.K., Kazmi, M.H. 2011. lignite- derived humic acid effect on growth of wheat plants in different soils, Pedosphere. 21: 124-131.

15. Yildirim E (2007). Foliar and soil fertilization of humic acid affect productivity and quality of tomato. Acta Agriculturae Scandinavica Section B-Soil Plant Science, 57: 182-186.

16. DeStefani, E., Oreggia, F., & Boffetta, P.(2000). Tomatoes, tomato-rich foods, lycopene and cancer of the upper aero digestive tract: A case control in Uruguay. Oral Oncol 36: 47-53.

17. Kumar, S., Kumar, S., & Verma, D.K. (2004). Effect of micro-nutrients

and NAA on yield and quality of litchi cv.

18. Dehradun; Abstr; (in) Proceedings of International Seminar on Recent Trend in Hi-tech Horticulture and Post Harvest Technology, pp 193, held during February 4–6 at CSAUA & T, Kanpur.

19. Wojciechowska, R., Rożek, S., & Rydz, A.(2005). Broccoli yield and its quality in spring growing cycle as dependent on nitrogen fertilization. Folia Hort., 17/2:141–152.

20. Ferrara, G., Brunetti, G. (2010). Effects of the times of application of a soil humic acid on berry quality of table grape (Vitis vinifera L.) cv Italia. Spanish J. Agric. Res., 8: 817-822.

21. Ayas, H., & Gulser, F. (2005). The effects of sulfur and humic acid on yield components and macronutrient contents of spinach. J. Biol. Sci., 5(6): 801-804.

22. Zaky, M.H., Zoah, E.L., & Ahmed, M.E. (2006). Effects of humic acids on growth and productivity of bean plants grown under plastic low tunnels and open field. Egypt. J. Appl. Sci., 21(4B): 582-596.

23. EL-Ghozoli, A.A.(2003). Influence of humic acid on faba bean plants grown in cadmium polluted soil. Ann. Agric. Sci. Moshtohor, 41(4): 1787-1800. Faostat (http://faostat.fao.org)

24. 29. El-Ghanam, M.M., & EL-Ghozoli, A.A. (2003). Remediation role of humic acid on faba bean plants grown on sandy lead polluted soil. Annals of Agric. Sci. Moshtohor., 41(4): 1811-1826.

25. Cimrin, KM., & Yilmaz, I. (2005). Humic acid applications to lettuce do not improve yield but do improve phosphorus availability. Acta. Agr. Scand. B-S P., 55: 58-63.

26. Russo, R.O., & Berlyn, G.P. (1992). Vitamin humic algal root biostimulant increases yield of green bean. Hortic. Sci., 27(7): 847.

27. Hao, X., Papadopoulos, A.P. (2003). Effect of calcium and magnesium on growth, fruit yield and quality in a fall greenhouse tomato crop grown on rockwool. Can. J. Plant Sci., 83: 903-912.

28. Celik, H., Katkat, A.V., Ayk, B.B., Turan, M.A. (2008). Effects of Soil Application of Humus on Dry Weight and Mineral Nutrients Uptake of Maize under Calcareous Soil

Conditions. Archives of Agron. Soil Sci., 54(6): 605-614.

29. Yousef, Aml., Hala, R.M., Emam, & Saleh, S. (2011). Olive seedlings growth as affected by humic and amino acids, macro and trace elements applications. Agric. Biol. J. N. Am., 2(7): 1101-1107.

30. Bramley, P.M. (2000). Is lycopene beneficial to human health? Phytochem 54: 233-235, 2000.

31. Abdel Fatah, H., Boshra, G., El Sayed, A., & Shahin, S.M. (2008). The role of humic acid in reducing the harmful effect of irrigation with saline water on tifway turf. J. Bio. Chem. Environ. Sci., 3(1): 75-89

32. Yaseen, M., Arshad, M., & Khalid, A. (2006). Effect of acetylene and ethylene gases released from encapsulated calcium carbide on growth and yield of wheat and cotton. Pedobiologia., 50: 405-411.

33. Kashif, S.R., M. Yaseen, M. Arshad and M. Abbas. (2007). Evaluation of response of Calcium carbide as a soil amendment to improve nitrogen economy of soil and yield of okra. Soil and Environ., 26(1): 69-74.