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Foliar Application of Humic Acid on Quantitative and Qualitative Characteristics of Aromas Strawberry in Soilless Culture.

MEHDI HOSSEINI FARAHI[1*], ABDOLHOSSEIN ABOUTALEBI[2], SAEID ESHGHI[3], MEHDI DASTYARAN[4] and FARIMA YOSEFI[1]

[1]Department of Agriculture, Yasouj Branch, Islamic Azad University, Yasouj, Iran.
[2]Department of Horticulture, Jahroom Branch, Islamic Azad University, Jahroom, Iran.
[3]Departments of Horticulture, College of Agriculture, Shiraz University, Shiraz, Iran.
[4]Young Researchers Club, Yasooj Branch, Islamic Azad University, Yasooj, Iran.
*Corresponding Author.

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ABSTRACT

In order to evaluate the effect of humic acid on quantitative and qualitative characteristics of strawberry (*Fragaria ananasa* c.v Aromas), an experiment was conducted as factorial arrangement in randomized complete block design with three replications in a commercial hydroponic greenhouse. The rooted daughter plants of Aromas strawberry were planted in pots containing perlite and coco-peat (1:1). Humic acid were sprayed on the plants when they were completely established. The treatments consisted of different concentrations of humic acid (Greenhum containing 13% humic acid) (0, 1.5, 3.0 and 4.5 mgL^{-1}). Certain traits were measured including leaf chlorophyll index; the weight, length, width and length/width ratio of the fruits; number of fruit in plant; yield of single plant in a 2months period; malformed fruit percent; total soluble solid percent and fruit firmness. Results indicated that the application of humic acid had positive influence on fruit number, total yield of plant, TSS, fruit firmness and chlorophyll content. Generally, foliar application of humic acid led to the improvement of quantitative and qualitative characteristics of this cultivar of strawberry. Consequently, the application of 1.5-3 mgL^{-1} humic acid is recommended in hydroponic culturing of strawberry.

Keywords: chlorophyll content, *Fragaria ananasa*, fruit quality, nutrition, single plant yield.

Abbreviations:
TSS: Total soluble solid.

INTRODUCTION

Today, greenhouse cultivation of strawberry as hydroponic is strongly increasing; nevertheless, in the course of its producing some problems loom up such as low yield, low quality, unsuitable fruit formation as well as susceptibility to unfavorable environmental conditions. Strawberry has various compositions, which has high nutritional value. Due to the high nutritional value and progress in greenhouse cultivation of strawberry in Iran, it seems mandatory on the part of the researches to improve its quality and quantity.

Humic compounds are the most abundant of the complex ligands, which are found in nature. In this regard, it is well known that the humic compounds improve soil structure, increase soil microbial population, increase soil cation exchange capacity and providing some specific materials for plant root indirectly by providing macro and micro minerals, leading to the increase of soil fertility. The humic compounds are divided into three categories: humic acids, fulvic acids and humans (Tan, 2003).

Humic acid effectively improves soil fertility and crop production especially in poor soils and alkaline-calcareous soils (Rajpar *et al*., 2011). The humic acid based on fertilizers causes yield increase (Mohamed *et al*., 2009), simulation of plant enzymes and hormones and soil fertility (Sarir *et al*., 2005; Mart, 2007). Several research works have been prominently shown the positive benefits of application of humic acid on higher plants (Ashraf *et al*., 2005; Susilawati *et al*., 2009; Mackowiak *et al*., 2001). In a study, application of compost and humic acid caused to increase total yield of strawberry significantly in comparison with the mineral fertilizers (Shehata *et al*., 2011). Zaki *et al*. (2006) observed the enhancement of shoot number in the plants, leaf area, total yield, fresh weight and phosphorus amount by application of 1 gL^{-1} humic acid as foliar

application. In a research, all morphological traits such as plant height, number of leaf and stem in plant, fresh weight of leaf, yield and yield components of cucumber showed effective influences in response to high concentration of humic acid (3 gL^{-1}) and Ecormon (0.45 cmL^{-1}) in comparison with other treatments.

Foliar application of humic acid and bio-stimulators led to positive effects on plant growth, fruit set and improvement of cucumber production (El-Nemr *et al*., 2012).In the same line, this study aimed to investigate the effects of humic acid on quantitative and qualitative characteristics of strawberry.

MATERIALS AND METHODS

Plant Material:

This experiment was carried out in a commercial greenhouse for strawberry growing with soilless culturing system (hydroponic) located in Yasouj, Nargah village in 2012. The rooted daughter plants of strawberry c.v Aromas were purchased from a commercial grower and cultured in the pots containing Perlite and Coco-peat (1:1).

Treatment:

The treatments were sprayed on the plants when they were completely established. The treatments consisted of humic acid 0, 1.5, 3.0 and 4.5 gL^{-1} (Greenhum containing 13% humic acid). Before spraying, all flowers and fruits were eliminated from plants until the treatments effect was well known. In order to increase contact, a few drops Tween20 were added to the area of solution and leaves. For maximum absorption, foliar spraying was done in the morning when air was cooler. Program of plant nutrition was separately performed in vegetative and generative stages. Irrigation and nutrition of the plants were daily conducted once a day. For preparation of nutritive solutions the ozone water was used an hour-worked and preserved for 12 hours. Also 150 ml nitric acid was added to nutritive solutions.

Quantitative and Qualitative Characteristics:

Chlorophyll index of leaf was measured by SPAD-502 (Minolta, Japan). Fruit weight was measured by digital scales and fruit length and wide by using digital caliper. Total weight of the produced fruits from each plant (2 months period) was calculated. Total soluble solid (TSS) was measured by manual refractometer (Atago, Japan) and fruit firmness by using Texture analyzer device.

Data Analysis:

Data was analyzed by using SAS software and the means were compared by Duncan's multiple range test (DMRT) and the charts were drawn by Excel software.

RESULTS

Effect of Humic Acid on Fruit Number:

The obtained results indicated that application of humic acid increased fruit number of Strawberry c.v Aromas. The results in Fig. 1 show that application of 3 gL^{-1} humic acid led to the increase in fruit number in comparison with the untreated plants.

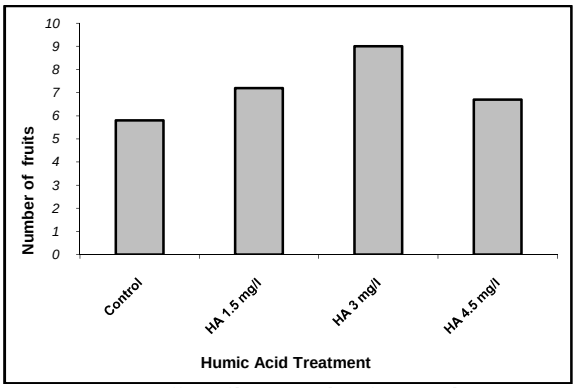

Fig 1. Effect of humic acid on fruit number.

Effect of Humic Acid on Plant Yield:

Due to the findings, the sprayed plants with different levels of humic acid produced more yield in comparison with the untreated plants. The presented results in Fig. 2 showed that application of 3 gL^{-1} humic acid increased single plant yield (126.5 g) in a two-month period. Also the results revealed that the concentrations more than 3 gL^{-1} humic acids decreases single plant yield.

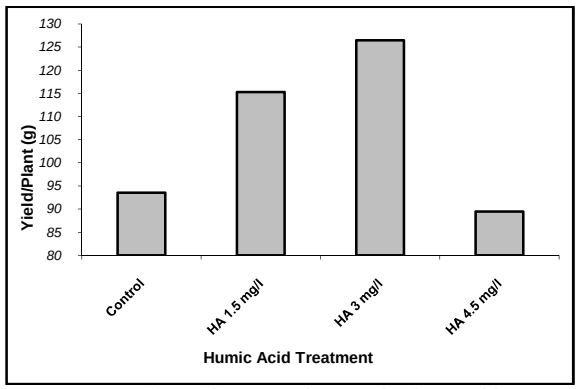

Fig 2. Effect of humic acid on single plant yield.

Effect of Humic Acid on Leaf Chlorophyll Index:

Results demonstrated that chlorophyll index in the leaves of the sprayed strawberry plants by different concentrations of humic acid was more than the untreated plants. The presented results in Fig. 3 showed that the highest and the lowest amount of leaf chlorophyll index were observed in the sprayed plants by 4.5 gL^{-1} humic acid and control treatments respectively.

Effect of Humic Acid on Fruit Firmness:

Application of 1.5 gL^{-1} humic acid produced firmer fruits than other treatments. Fruit firmness decreased by increasing humic acid concentration. The revealed results in Fig. 4 indicated that the highest and the lowest fruit firmness obtained from the sprayed plants by 1.5 and 4.5 gL^{-1} humic acid treatments respectively.

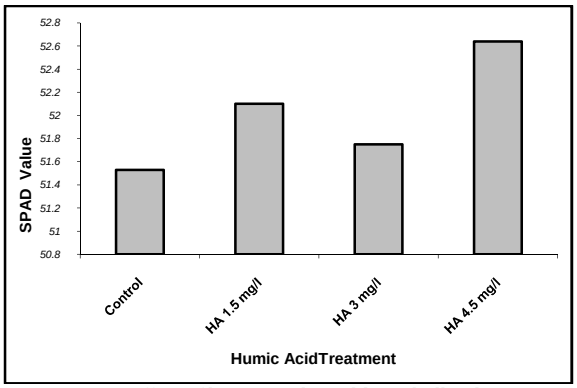

Fig 3. Effect of humic acid on Chlorophyll index.

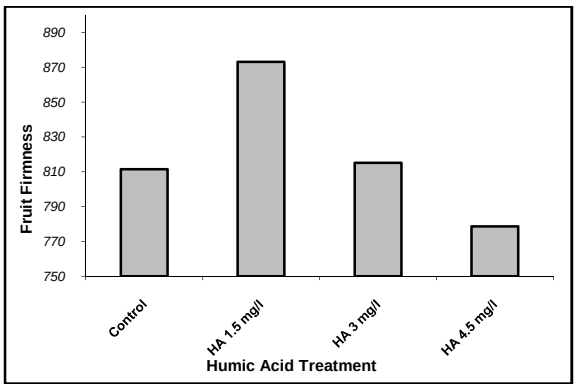

Fig 4. Effect of humic acid on fruit firmness.

Effect of Humic Acid on TSS:

Application of humic acid increased TSS amount in strawberry fruits. The highest TSS was observed in 1.5 and 3.0 gL^{-1} humic acid treatments. TSS decreased by increasing humic acid concentration to 4.5 gL^{-1} (Fig 5).

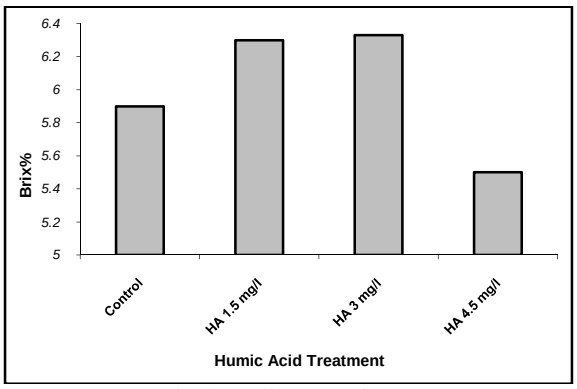

Fig5. Effect of humic acid on TSS.

Discussion

The results of this study showed that application of humic acid has increased quantitative and qualitative characteristics of strawberry in hydroponic system. Increasing leaf area, weight of first and second fruits, achene's number, fruit length, shoot fresh and dry weight, root fresh and dry weight and yield of strawberry c.v Selva by using humic acid has been reported by Zare (2011), which is in accordance tour findings.

Increasing quantitative and qualitative characteristics by using humic acid have been reported by some researchers such as: Kamari-Shahmaleki *et al*. (2012), Ferrara and Brunetti (2010) and Pouzeshi *et al*. (2011). Formation of complex between humic acid and mineral ions, catalysis of humic acid by the enzymes in plant, influence of humic acid on respiration and photosynthesis, stimulation of nucleic acid metabolism and hormonal activity of humic acid are amongst effective assumptions that has been expressed to describe the effect of humic acid on plants growth parameters (Turkmen *et al*., 2004). Some researchers (Atiyeh *et al*., 2002) reported that the reason behind the effectiveness of humic acid on plant growth and development is the existence of plant growth regulators such as IAA, GAs and CKs. Moreover, some investigators attributed the positive effects of humic acid due to its influence on plants root (Adani *et al*., 1998; Atiyeh *et al*., 2002; Turkmen *et al*., 2004; Yildrim, 2007 and Ozdamarullu *et al*., 2011). High concentrations of humic acid simulate growth of the root in hydroponic systems and cause to increase root volume, which may be due to easier absorption and more efficient nutrients. It is likely that increasing nutrient uptake by plants can particularly be associated with an increase in root growth. Also root development can be due to hormone-like activity of humic acid (David *et al*., 1994). Cangi *et al*. (2006) indicated that foliar spraying of humic acid and amino acids on Asparagus plants increase uptake of macro and micro elements in shoot and rhizome has increased carbohydrates production, chlorophyll and carotenoids in edible stems. Enhancing the quantitative and qualitative characteristics as a result of increased respiration, photosynthesis and total protein in the plants, due to humic acid and folic acid application has also been reported by Nardi *et al*. (2002).

CONCLUSION

Generally speaking, the results of this experiment show that the application of humic acid as foliar spray will improve quantitative and qualitative properties of strawberry fruits. For that reason, application of 1.5 to 3.0 gL-1 humic acid in hydroponic system is recommended.

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