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Effect of humic and fulvic acid application on growth parameters in *Impatiens walleriana* L.

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Abstract

Impatiens walleriana L. is one of the most important plants used in landscape throughout world. The aim of the study was to determine the effects of two dose (0, 40 mg kg^{-1}) of fulvic acid (FA) and four doses (0, 40, 80 and 120 mg kg^{-1}) of humic acid (HA) treatments on growth parameters of Impatients walleriana L. The parameters investigated was the number of buds, plant height, number of main shoots, the number of secondary shoots, plant diameter, flowers number, root length, fresh root weight, dry root weight, fresh leaf weight and dry leaf weight, respectively. The highest plant height (11.3 – 9.2 cm) and flower number (12.6-7.6 number) was obtained from treatments 40 mg kg^{-1} of FA and HA respectively. The results showed that 40 mg kg^{-1} both fulvic and humic acid dose treatment was the most effective in particular on flowering and plant growth parameter when compared to with control plant.

Key words: Ornamental plant, fulvic acid, humic acid, plant growth parameters

Hümik ve fulvik asit uygulamalarının *Impatiens walleriana*'nın gelişme parametrelerine etkisi

Öz

Tüm dünyada peyzaj alanında en yaygın kullanılan süs bitkilerinden biriside cam güzeli (*Impatients walleriana* L.) bitkisidir. Yapılan çalışmada 2 farklı organik toprak düzenleyicisinin cam güzeli bitkisinin gelişim parametreleri üzerine etkisi araştırılmıştır. Bu amaçla sera koşullarında Fulvik Asitin (FA) 2 (0, 40 mg/kg) dozu ve Hümik Asit (HA) uygulamasının 4 farklı (0, 40, 80 ve 120 mg/kg) dozu kullanılarak deneme yürütülmüştür. İncelenen bitki gelişim parametreleri ise; tomurcuk sayısı, ana dal sayısı, yan dal sayısı, bitki çapı, kök uzunluğu, bitki yüksekliği, çiçek sayısı, taze kök ağırlığı, yaş kök ağırlığı, taze yaprak ağırlığı, kuru yaprak ağırlığıdır. En yüksek bitki yüksekliği ve çiçek sayısına sırasıyla 11.3-9.2 cm ve 12.6-7.6 adet olarak 40 mg/kg HA ve FA uygulamalarından elde edilmiştir. Çalışma sonucunda FA ve HA uygulamaları kontrol grubu ile karşılaştırıldığında bitki gelişim parametreleri ve çiçeklenme üzerine 40 mg/kg doz uygulamasının en etkin doz olduğu tespit edilmiştir.

Anahtar kelimeler: Süs bitkisi, fülvik asit, hümik asit, bitki gelişim parametreleri

Introduction

Impatients walleriana L. is a member of the Balsaminaceae family and one of the most important ornamental plants used in landscape design. The species is grown as ornamental plants in various parts of the world including Europa, North and South America, the Pacific Islands, Australia, and New Zealand (Mandle et al. 2010). The plant has variable flower colors such as pink, white, red, purple and orange. Some varieties have bicolour flowers as pink, red, orange, purple, and white. Some varieties have a wide, sprawling growth habit, while others tend to

grow more upright and dense. They are very suitable for landscaping in the parterre as pure, the parterre edge, under the tree and in the shade areas. It is also very suitable for use as an indoor plant such as balcony and terrace plants in pots.

Humic and fulvic acids are called humin materials widely consist of a part of soil organic matter (65-70%) (Stott and Martin, 1990). These organic complexes are found naturally in soil (Mackowiak et al. 2001). Those humin materials affect the soil properties and physiological properties of plants due to carboxyl (COOH–) and phenolic (OH–) groups (Schnitzer 1992). There are direct and indirect effects on plant growth because of the multiple roles of humic and fulvic acid (Pal and Biswas, 2005). Humic acid (HA) treatments improve soil aggregation, structure, water permeability, air conditioning, fertility, and moisture holding capacity, and increases microbial activity of microbial population and cation exchange capacity (Mohamed, 2012). Moreover, they are responsible for the growth patterns of the plants such as leaf development, stem and root elongation, flowering etc. and they are included in some biological process such as the production of plant growth-influencing substances as free enzymes (Arancon et al. 2007). Besides those humin materials help to conserve of resources as environmentally friendly treatments. Previously, different doses of HA treatments increased the number of flowers and stimulate root growth of gerbera plants (Nikbakht et al. 2015) and increased the root growth of marigold, pepper, and strawberry plants (Arancon et al. 2003). Photosynthetic efficiency and chlorophyll contents of grass were increased by HA application (Russo and Berlyn, 1990). Flower yield and quality of gerbera increased with HA application (Nikbakht et al. 2015). On the other hand, other studies pointed out that humic acid treatments stimulated growth parameters such as root fresh and dry weights of marigold, pansy, geranium and impatiens (Li and Evens, 2000). HA treatment resulted in higher flower quality, longer vase life, higher number of cormels per clump, and greater cormel diameter and weight of Gladiolus (*Gladiolus grandiflorus* L.) (Ahmad et al. 2013). Foliar application of HA increased the growth and development of chrysanthemum that improved net photosynthetic rate due to the high content of chlorophyll (Fan et al. 2014) and it increased the growth and nutrition of plant *Calathea insignis* (Zhang et al, 2014).

This work aimed to study the growth and development of *Impatiens walleriana* L. For this purpose, a greenhouse experiment was investigated the potential effects of increasing concentrations of humic and fulvic acid on the growth, yield, quality and number of buds of plant.

Materials and Methods

The experiment was carried out in the Department of Horticultural at Agrıcultural Faculty Ataturk University under unheated greenhouse condition in Erzurum (40º31'N; 40º54' E), Turkey in 2014. *Impatients walleriana* L. was used as plant material. Plants were obtained from seeds and were grown under natural light conditions, approximately day/night temperatures of 27/14ºC and 75% relative humidity during the experiment. After germination, seedlings were transferred in 20-cm-diameter polyethylene pots when reaching at the same height and width. In the research, a mixture of 2 soil+1 peat+1 sand was used as growing medium. Humic acid was applied as in four doses named as control HA0, HA1 (40 mg kg^{-1}), HA2 (80 mg kg^{-1}) and HA3 (120 mg kg^{-1}) and fulvic acid was applied to plants in two doses of control (FA0) and FA (40 mg kg^{-1}) because in pre experiment all plants was died over 40 mg kg^{-1}. The applied humic acid included 10% organic matter, 15% total (humic+fulvic) acid, 1% water soluble potassium oxide (K_2O) and the applied fulvic acid included 38% organic matter, 2.5% nitrogen and 0.2% hydroxy proline. Each potting media was treated 4 times with HA and FA, 10 day intervals (10, 20, 30 and 40 days after transplanting) during the plant development period. HA and FA were diluted with distilled H2O as 4%, 8%, 12% proportion. The soil samples were air-dried, crushed, and passed through a 2-mm sieve prior to chemical analysis. Soil pH was determined in 1:2 extracts, and calcium carbonate concentrations were determined. Electrical conductivity (EC) was measured in saturation extracts according to McLean (1982). Soil organic matter was determined using the Smith-Weldon method. The characteristics experemential soil are given in Table 1.

Shoot, root, flower diameter was measured at the blossom stage and end of trial with a ruler. Studies were under taken based on a completely randomized design with 3 replicates per treatment and there were ten plants in each replication. All data were subjected to analysis of variance using SPSS 18

statistical program. Means were separated by Duncan's multiple range tests (DMRT) (SPSS Inc. 2004).

Table 1. Some properties of the experimental soil

Properties	Value
pH	7.19
$CaCO_3$ (%)	1.85
Organic Matter (%)	5.78
EC (µS/cm)	228

Results and Discussion

All growth parameters studied in the experiment were significantly ($p<0.05$) effected by HA and FA treatments (Figure 1). The positive effects of FA and HA on growth parameters and blossom may be due to the nutrients supplied by these amendments or to the effects of the amendments on nutrient and water retention, pH, aeration, and other physical and chemical characteristics of the media. Humic acid affects physical and chemical properties of soils (Boyle et al. 1989; Schnitzer 1992). Ibrahim and Goh (2004) reported humic substance applications increased pH, cation exchange capacity and organic carbon content of the soil. Humic substances can improve soil properties such as aggregation, aeration, permeability, water holding capacity, hormonal activity, microbial growth, organic matter (OM) mineralization, and solubilization and availability of microelements (e.g., Fe, Zn, and Mn) and some macro elements (e.g., K, Ca, and P) (Chen and Aviad, 1990; Ayuso et al. 1996; Sharif et al. 2002). Similarly, Nisar and Mir (1989) reported that humic substances can be use as plant growth promoter or soil conditioner as fertilizer.

The effect of HA and FA treatments doses on the plant height of *Impatients walleriana* L. compared with control groups are shown in Figure 1a. The results showed that the maximum plant height was observed in 40 mg kg^{-1} dose (11.3 cm) treatments of FA (Figure 1). Similarly, maximum plant height was observed of HA 40 mg kg^{-1} dose treatments. Minimum was observed HA dose treatment (HA3). The *Impatients walleriana* L. height has been increased by 40 mg kg^{-1} HA and 40 mg kg^{-1} FA treatment. A similar trend was reported by Memon et al. (2014) who determined that plant height of Zinnia increased with humic acid treatment. Plant height of Petunia hybrida 'Dream Neon Rose' increased with humic acid treatment as indicated by Chamani et al. (2008). Arancon et al. (2003) reported that different levels of HA significantly increased stem length of marigold.

The data to number of flowers of *Impatients walleriana* L. are showed in Figure 1b. The addition of HA1 (40 mg kg^{-1}) and FA doses (40 mg kg^{-1}) in soil significantly increased the number of flowers in the plant. Flowers of the plant slightly increased also in HA2 and HA3 treatments. 40 mg kg^{-1} does of HA and FA treatments produced maximum flower numbers per plant as 8 and 13, respectively. These results are supported by Nikbakht et al. (2015) who reported that treatments of higher concentrations of HA (500 and 1000 mg/L) increased in the number of gerbera flowers. Kutuk et al. (2000) reported that humic acid treatments improved the flower yield in a number of flower species. Effects of humic acid showed increased flowering of Petunia hybrida 'Dream Neon Rose' as well (Chamani et al. 2008). Pin et al. (2011) reported that using HA improved the growth and increased the flowering of Gladiolus. Dudley et al. (2004) found that application of humic substances showed positive impacts on the flower production of Zinnia elegans Jacq. and Tagetes patula.

The number of buds of Impatients walleriana L. was affected by different levels of HA and FA treatments (Figure 1c). 40 mg kg^{-1} does of HA and FA treatments increased the number of buds per plant. There were statistically significant differences observed between 40 mg kg^{-1} doses of HA and FA. The most significant increase was observed in the fulvic acid treatment as compared to the control. Memon et al. (2014) indicated the number of flower buds increasing with humic acid treatments in *Zinnia elegans*.

Plant diameters were affected significantly in particular by HA1 (40 mg kg^{-1}) and FA (40 mg kg^{-1}) treatments and these treatments gave the highest plant diameters as 22.2 cm and 23.2 cm, respectively (Figure 1d). Duncan test demonstrated significant differences on the plant diameter among applications when compared with control ($P<0.05$). Ansari et al. (2011) reported that cut gerbera flowers gave the widest flower diameter when treated with humic acid. Foliar application of humic acid increased the plant diameters of chrysanthemum flowers (Fan et al. 2015). Plant diameters are affected to important degree by application of different percentages of biochar (BC) (at 0, 20, and 35%) and/or humic acid (HA) (0, 0.5,

and 0.7%) on ornamental plant *Calathea insignis* (Zhang et al. 2014).

Fresh and dry root weights of control, HA1, HA2, HA3 and FA1 were 0.8, 1.6, 0.8, 0.8, 1.7 and 0.1, 0.2, 0.1, 0.1, 0.3 g respectively (Figure 1e). Fresh and dry shoot weights of control, HA1, HA2, HA3 and FA were 3.4, 10.1, 7.5, 5.5, 10.8 and 0.2, 0.8, 0.6, 0.4, 0.9 g respectively (Figure 1f). Fresh and dry weights of shoots and roots were higher when compared to the control group. Jack and Evans (2000) reported that humic acid treatments increased the root fresh weight of marigold seedlings and the geranium root fresh weight. Maximum fresh flower weight was obtained from the humic acid treatment in marigold (*Calendula officinalis* L.) flower (Mohammadipour et al. 2012). Alstroemeria gave the highest fresh mass with humic acid treatment reported by Chamani et al. 2012. Chrysanthemum flowers fresh weight increased with foliar humic acid application (Fan et al. 2015).

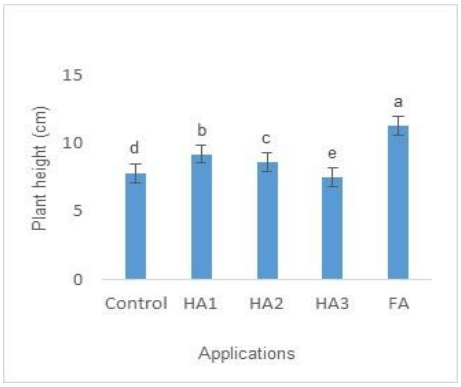

Figure 1a. Effects of HA and FA treatments on plant height

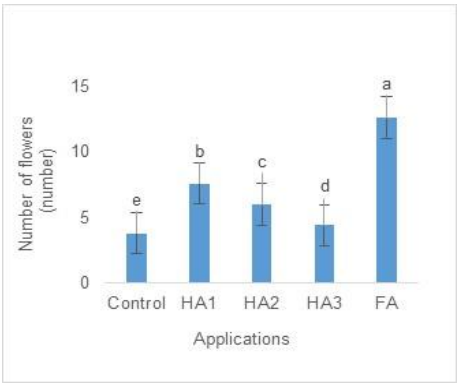

Figure 1b. Effects of HA and FA treatments on number of flowers

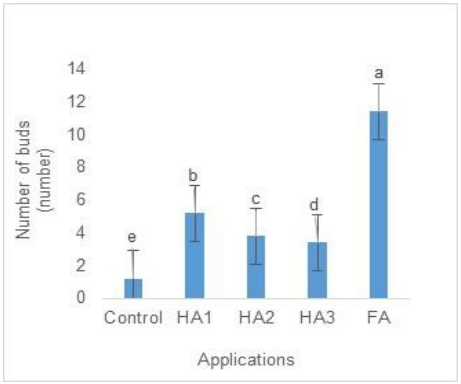

Figure 1c. Effects of HA and FA treatments on number of buds

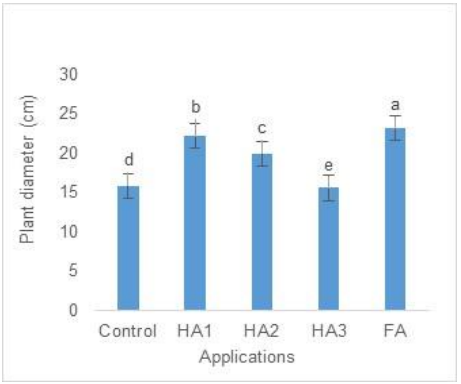

Figure 1d. Effects of HA and FA treatments on plant diameter

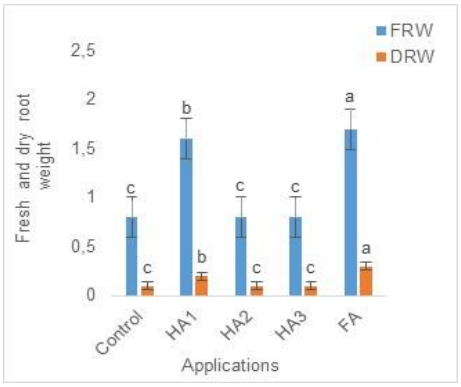

Figure 1e. Effects of HA and FA treatments on fresh and dry root weight

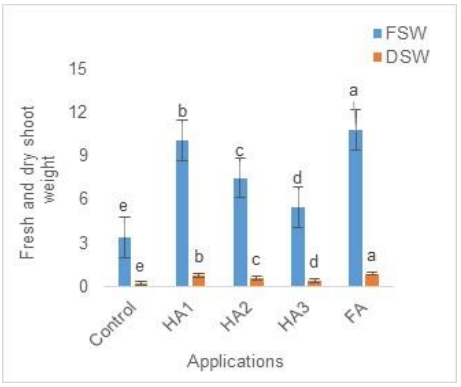

Figure 1f. Effects of HA and FA treatments on fresh and dry shoot weight

Table 2. Effect of humic acid (HA) and fulvic acid (FA) applications on number of buds, plant height, the number of main shoot, the number of side shoots, plant diameter and number of flowers of *Impatiens walleria* L.

Treatments	Number of buds	Plant Height	The number of main shoot	The number of side shoots	Plant Diameter	Number of flowers
Control	1.2d±1.3	7.8d±0.8	1b±0	4.6b±0.89	15.9d±1.02	3.8b±0.83
HA1	5.2b±1.3	9.2b±1.64	2a±0.7	4.8b±084	22.2b±0.84	7.6b±2.3
HA2	3.8bc±0.8	8.6cd±0.4	1.6ab±0.54	4.4b±0.55	20c±1.87	6b±1.2
HA3	3.4c±1.1	7.5d±0.35	1.2b±0.44	4.4b±0.55	15.6d±1.34	4.4b±1.1
FA	11.4a±0.8	11.3a±0.45	1.6ab±0.55	8.8a±2.16	23.2a±0.45	12.6a±5.3

The same letters within the same column indicate that there are not significant differences among treatments for plant ($p<0.05$)

Table 3. Effect of humic acid (HA) and fulvic acid (FA) applications on root lenght, fresh root weight, dry root weight, fresh leaf weight and dry leaf weight of *Impatiens walleria* L.

Treatments	Root lenght	Fresh root weight	Dry root weight	Fresh leaf weight	Dry leaf weight
Control	17.8d±1.45	0.8b±0.13	0.1c±0.0	3.4e±0.29	0.2e±0.09
HA1	20.6c±1.14	1.6a±0.45	0.2b±0.1	10.1b±4.05	0.8b±0.22
HA2	25.8a±0.83	0.8b±0.35	0.1c±0.1	7.5c±1.42	0.6c±0.15
HA3	23.4b±1.14	0.8b±0.36	0.1c±0.04	5.5d±0.83	0.4d±0.11
FA	20c±1.87	1.7a±0.63	0.3a±0.83	10.8a±5.3	0.9a±0.20

The same letters within the same column indicate that there are not significant differences among treatments for plant ($p<0.05$)

Conclusion

This paper analyses the effects of humic and fulvic acid on the growth parameters of *Impatients walleriana* L. The experiment results showed that treatments of HA (40 mg kg^{-1}) and FA (40 mg kg^{-1}) enhanced the growth significantly when compared to the control groups. This results shows the promoting effects of HA and FA on plant growth parameters as the number of buds, plant height, number of main shoots, number of side shoots, plant diameter, root length, fresh root weight, dry root weight, fresh shoot weight and dry shoot weight.

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