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EFFECTS OF HUMIC ACID AND GRAPE SEED EXTRACT ON GROWTH AND DEVELOPMENT OF *Spathiphyllum wallisii* REGEL

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ABSTRACT. *The humic acids, available in liquid form, powder or granules are used on crops in the field and in the protected areas as growth biostimulators of plants and soil improvers. The study was conducted at the Floriculture Research Area, Faculty of Agriculture and Horticulture of Craiova, to investigate the potential effects of some natural biostimulators obtained from humic acids from lignite (HA 2.5 %), from the grape seed extract (GSE 0.25%) and their 1:1 mixture, on plant growth and development, depending on their age. The Spathiphyllum wallisii plants (mature plants and offsets) were exposed to four treatments: HA 2.5%, GSE 0.25%, combination of HA 2.5% and GSE 0.25% (1:1) and control (treated with tap water), resulting in eight experimental variants. The results showed that HA treatment determined increasing plant height, the number of leaves/plant (mature plants), the number offsets/plant (mature plants) and the size of spathe. GSE treatment has the best effect on the number of inflorescences per plant. Also, the combination of HA and GSE increased the number of offsets/plant (young plants), the number of leaves/plant (young plants) and the average size of the leaves.*

KEYWORDS: *Spathiphyllum wallisii, humic acids; grape seed extract, growth, flowering.*

ABBREVIATIONS: *GSE (grape seed extract), HA (humic acids)*

INTRODUCTION

Peace lily (*Spathiphyllum wallisii* Regel) is a member of the family *Araceae* and one of the most popular indoor houseplants (Sardoei 2014). Interest in peace lily is steadily increasing as it is a shade tolerant indoor plant, easy-care, dark green foliage and white spathes. The showy white spathes *Spathiphyllum* enhance its popularity and market niche as a “flowering” foliage plant (Henny et al. 2004). Although it was initially a plant for container, in recent years, the culture of this plant has been greatly expanded for the production of cut flowers. Applying organic fertilizers and biostimulators has led to a decrease in the use of chemical products and has provided high quality products free of harmful agrochemicals for human safety (Mahfouz & Sharaf Eldin 2007). Biostimulants are plant extracts and contain a wide range of bioactive compounds that are mostly still unknown. These products are usually able to improve the nutrient use efficiency of the plant and enhance tolerance to biotic and abiotic stresses. Particular attention should be paid to intensive agricultural systems such as horticultural and floricultural crops. In floriculture, biostimulants used in bedding plant production stimulated the growth of plants, which reached the blooming and commercial stages earlier, thus optimizing space in the greenhouse (Bulgari et al. 2014).

According to many researchers, the application of organic products such as humic acid is one method that may improve soil physical property, ion exchange capacity (Ibrahim 2012), increase the nutrients uptake (Fernandez-Escobar et al. 1996), reduce water evaporation and increase its use by plants (Khaled & Fawy 2011, Haghighi et al. 2011), promote the root length (Canellas et al. 2002) and stimulate the shoot growth (Chen & Aviad 1990, Fernandez-Escobar et al. 1996). Therefore, it improves plant growth increase total yield and helps plants resist droughts (El-Nemr et al. 2012, Dinu et al. 2012). Furthermore, the growth promoting activity of humic substances was found to be caused by plant hormone-like material contained in the humic substances (Zhang & Ervin 2004, Albuzio et al.1989). Humic materials may also increase root growth in a manner similar to auxin (Tatini et al. 1991) The auxinic activity of HS, demonstrated

in recent studies, is probably the main biological factor responsible for the positive effects exerted by HA on plant physiology (Trevisan et al. 2010).

The effect of humic acids on ornamental plants has been studied in a small number of species, also recording positive results. Studies have shown that humic substances may increase yield and quality of many ornamental crops (Nikbakht et al. 2008). In *Gerbera* hydroponics production HA could be successfully considered as a compound to decrease**s** nutrients input, to produce visibly better and healthier plant growth and to increased the number of harvested flowers per plant (52%) (Haghighi et al. 2014, Nikbakht et al. 2008). The humic substances application can improve quality and quantity of gerbera through improving root architecture, leading to enhanced nutrient uptake and possibly affecting hormone-like activities (Yazdani B. et al. 2014).

The results obtained by Fan et al. (2014) have shown that the morphological indices (stem diameter, fresh weights of shoots and roots, the root to shoot ratios, dry weights of shoots and roots, leaf area, flower diameter), the net photosynthesis rate and the content of chlorophyll of *Chrysanthemum* improved obviously after foliar application of humic acid compared with those of the control and the NPK fertilizer.

In *Gladiolus grandiflorus* HA application proved best for more foliage growth per plant, greater leaf area, and total leaf chlorophyll contents, earlier spike emergence, greater number of florets per spike, longer stems and spikes, and greater diameter of a spike, higher flower quality, longer vase life, higher number of cormels per clump, and greater cormel diameter and weight; plants grown without HA had poor growth, reduced yield, and inferior quality (Ahmad et al. 2013). Phenolic compounds, ubiquitous in plants are of considerable interest and have received more and more attention in recent years due to their bioactive functions (Ignat et al. 2011 b). The polyphenols could interfere with the plant hormones, thus influencing either stimulation or ihibition of plant development. Low concentrations of polyphenols enhance seed germination and plant growth, whereas higher concentrations usually exert an inhibitory effect (Ignat et al. 2009, Ignat et al. 2013). In recent years, naturally occurring plant phenolics in grape by-products have raised a lot of attention, due to their health-

promoting effects and to the antioxidant role they play in biological and food systems (Ignat et al. 2011 a). The extract obtained from the seeds of *Vitis vinifera*, due to its the content of polyphenols it is recommended to be used in order to protect certain chemical components of plants against oxidation by increasing the antioxidant activity of soil (Bita & Preda 2007, Bita et al. 2009, Shi et al. 2003).

Taking into account these considerations, this paper aims to present the results of the natural biostimulators effect on the *Spathiphyllum* growth and development, depending on plant age.

MATERIALS AND METHODS

The biological material consisted of *Spathiphyllum wallisii* Regel plants, from the Floriculture collection of the Faculty of Agriculture and Horticulture of Craiova. The plants were obtained by the separation of the bushes and planted by age: mature plants (1 year old) and young plants (resulted by separating the offsets from the base). Uniform plants were planted singly in 19 cm (mature plants) and 15 cm (offsets) diameter plastic pots, containing a soil mix consisting of peat and perlite (2:1). Plants were watered regularly depending upon the season. All the cultural practices were uniform for all the treatments.

The *Spathiphyllum* plants (mature plants and offsets) were exposed to four treatments: HA (humic acids 2.5%), GSE (grape seed extract 0.25%), HA + GSE 1: 1 (humic acid 2.5% + grape seed extract 0.25%) and control (treated with tap water), resulting in eight experimental variants. The experiment was laid out in a complete randomized complete blocks designed with three replications. The bioproducts used for testing were provided by the professors at the University of Craiova, Faculty of Chemistry, Biochemistry discipline. The treatments were started after a week from planting date (march 2012) and were applied every two weeks throughout the growing season, alternatively to soil (a drench to the plant root area) and foliar. During the 9 months since the experiment started it was observed the evolution of the vegetative growth rate of *Spathiphyllum* plants under the influence of applied treatments. To estimate the influence of plant growth substances with humic acids and antioxidants from the seeds of *Vitis vinifera* on the growth and flowering process of the peace lily plants, the observations and measurements were: the average height of the plants, the number of offsets produced per plant, the number of leaves per plant, the leaves size, the number of

inflorescences per plant and the average length of the spathe. The data collected was the mean of values from three replicates.

RESULTS AND DISCUSSIONS

This paper presents the final results regarding effect of biostimulators on the *Spathiphyllum* growth and development recorded after 9 months from the establishment of the experiment. As shown in Table 1, the average height of the *Spathiphyllum* plants ranged from 32.72 to 34.67 cm for the mature plants and from 19.3 to 21.37 cm for the young plants. As a result of the applied treatments, the best results were obtained in the variants treated with HA (34.67 cm) for mature plants and HA + GSE (21.37 cm) for young plants and the minimum values of the plants height correspond to the untreated plants (32.72 cm respectively 19.30 cm). According to the presented data, the treatments determined higher values of the average plant height but statistically, the differences compared to the untreated controls were not significant (Table 1).

Table 1. Influence of humic acid and grape seed extract on the average height of plants.

Treatments	Mature plants			Offsets		
	Height plant (cm)	Difference	Signif.	Height plant (cm)	Difference	Signif.
HA	34.67	+1.95	NS	21.30	+2.00	NS
HA+GSE	33.37	+0.65	NS	21.37	+2.07	NS
GSE	33.15	+0.43	NS	19.83	+0.53	NS
CONTROL	32.72	-	-	19.30	-	-
	DL 5%=2.18; DL 1%=3.06; DL 0.1%=4.32			DL 5%=2.39; DL 1%=3.36; DL 0.1%=4.75		

Several research works have been shown the positive effects of application of humic acid on higher plants (Arancon et al. 2003, Ashraf et al. 2005, Mackowiak et al. 2001).

An important characteristic of foliage plant cultivars is production of enough lateral or basal shoots to give a full and compact appearance. In some cases it may be necessary to treat nonbranching cultivars with growth regulators that induce lateral or basal shoot development to achieve this result (Henny 1990**).** The *Spathiphyllum* plant produces offsets at the base and in time displays a dense and compact growth habit.

The results obtained show that after 9 months from the placement of the experimental variants; the applied treatments significantly influenced the average number of offsets/plant, the obtained values being superior for the untreated control plants. At the end of the experiment, the average values for number of offsets/plant were ranging between 3.24 (Co) and 5.25 (HA) for mature plants and between 1.33 (Co) and 3.75 (HA + GSE) for young plants. The best results were recorded in the mature plants treated with HA (5.25) and in the young plants treated with HA + GSE (3.75) similar to the case of the average plant height. The analysis of the variants shows that all the treated variants recorded positive significant differences compared to the control plant (Table 2).

Table 2. Influence of humic acid and grape seed extract on the average number of offsets/plant.

Treatments	Mature plants			Offsets		
	No. of offsets/pl.	Difference	Signif.	No. of offsets/pl.	Difference	Signif.
HA	5.25	+2.01	***	3.5	+2.17	***
HA+GSE	4.66	+1.42	***	3.75	+2.42	***
GSE	4.25	+1.01	***	3.33	+2.00	***
CONTROL	3.24	-	-	1.33	-	-
	DL5%=0.47; DL1%=0.67; DL0.1%=0.95			DL5%=0.80; DL1%=1.13; DL0.1=1.59		

Regarding the average number of leaves/plant, the values range between 6-7 leaves for mature plants and from 4.66 to 6.25 leaves for the young plants. The maximum number of leaves/plant for mature plants were recorded by the variants treated with HA (7 leaves), and with HA + GSE for the young plants (6.25 leaves). The minimum values of this parameter

correspond to the untreated variants. Statistically, the mature plants obtained significant positive differences compared to the control plants treated only with HA and for the variants treated with GSE, HA+ GSE the differences compared to the control were insignificantly positive. The young plants recorded positive significant differences in the variants treated with HA and HA + GSE and distinct significantly positive values at the application of treatments with GSE compared to the control (Table 3). The enhancement of HA of this trait are in accordance of Saleem et al. (2013) and Baldotto & Baldotto (2013) for *Gladiolus.*

Table 3. Influence of humic acid and grape seed extract on the average number of leaves/plant.

Treatments	Mature plants			Offsets		
	No. of leaves/pl.	Difference	Signif.	No. of leaves/pl.	Difference	Signif.
HA	7	+1	**	5.75	+1.09	***
HA+GSE	6	0	NS	6.25	+1.59	***
GSE	6.5	+0.5	NS	5.5	+0.84	**
CONTROL	6	-	-	4.66	-	-
	DL5%=0.63; DL1%=0.88; DL0.1%=1.25			DL5%=0.58; DL1%=0.82; DL0.1%=1.16		

The average size of the leaves has registered positive differences for all the treated variants compared to the control, with one exception, in the case of plants treated with GSE. The average values of leaf length for mature plants ranged from 16.40 to 18.25 cm, and for the young plants between 14.06 to 16.10 cm. At the end of the experiment, the variants with the best results from this point of view were those treated with HA + GSE (18.25cm respectively 16.1 cm), followed by those treated with HA (18,05 cm, respectively 15.07 cm) (Figure 1). These results are in accordance with the findings of Yildirim (2007) in tomato, who observed that foliar and soil HA treatments had improved growth parameters.

The market value of *Spathiphyllum* depends heavily on the presence of flowers (Chen et al. 2005). Humic substance promoted not only the vegetative growth, but also flowering was improved (Ahmad 2013).

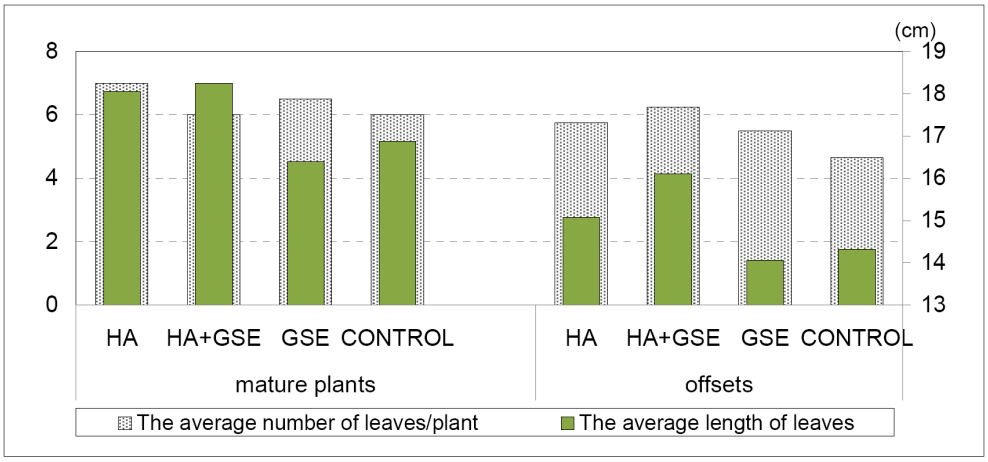

Figure 1. Influence of humic acid and grape seed extract on the average size of the leaves.

From the data presented in figure 2 regarding the effect on the flowering of *Spathiphyllum*, there can also be observed positive differences compared to the untreated controls both in terms of inflorescence number per plant and the average length of the spathe. In terms of the average number of inflorescences per plant, the treatments with GSE caused the highest values, both at the mature and young plants (2.25 and respectively 1.5 inflorescences/plant). Similar findings have also been presented by Arancon et al. (2006), Nikbakht et al. (2008) and Baldotto & Baldotto (2013), who reported that HA increased flowering and yield of pepper, gerbera, and gladiolus.

The average length of the spathe, as the main decorative element, recorded the highest values for the plants treated with HA (8 cm respectively 6.8 cm) or with the combination HA + GSE (8.4 cm respectively 6.4 cm). No significant differences were noted for flowering date.

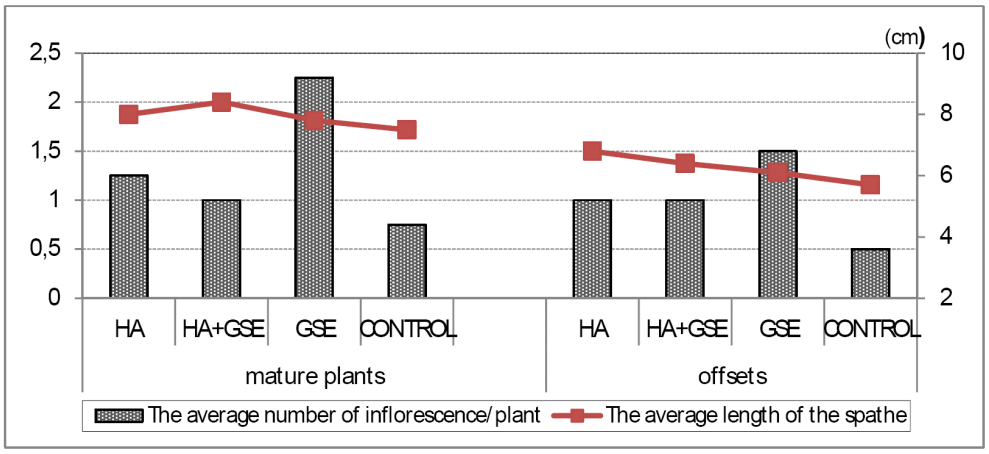

Figure 2. Influence of humic acid and grape seed extract on flowering of peace lily.

CONCLUSIONS

The presented data suggest that application of biostimulators during vegetative growth stages can improve plant growth and development of peace lily. The results showed that: HA 2.5% treatment has the best effect on the plant height, the number of leaves/plant (mature plants), the number offsets/plant (mature plants) and the size of spathe; GSE 0.25% treatment has the best effect on the number of inflorescences per plant; HA and GSE (1:1) treatment increased the number of offsets/plant (young plants), the number of leaves/plant (young plants) and the average size of the leaves.

The treatments with biostimulators significantly influenced the average number of offsets/plant, the obtained values being superior for all the treated variants compared the untreated control plants. Analyzing the response of the plants depending on their age, it is clear that the effect of the treatments with biostimulators on the average number of leaves/plant was manifested more strongly at the young plants, who obtained significant positive differences for all the treated variants compared with the untreated control plant.

More research is needed for testing the plants reaction to the applied concentrations, to the number of treatments, the time period and the method of application.

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