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USE OF SALICYLIC, ASCORBIC AND BENZOIC ACIDS FOR THE PRODUCTION OF *Syngonium podophyllum* SCHOTT. PLANTS

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ABSTRACT

This work was carried out in a plastic house during the two successive seasons of 2005 / 2006 and 2006 / 2007 at the nursery of Ornamental Plants Research Department, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt, to study the influence of salicylic, ascorbic and benzoic acids on the vegetative growth and chemical constituents of *Syngonium podophyllum* plants. The obtained results showed that using ascorbic acid at 200 ppm increased the photosynthetic pigment content in the leaves and potassium percentage in shoots. Benzoic acid at 200 ppm increased plant height, number of leaves and petiole length. The concentration of 200 ppm of salicylic acid caused an increase in nitrogen percentage; however the concentration of 300 ppm was the most effective in increasing the total carbohydrates percentage in the shoots.

Key words: *ascorbic acid, benzoic acid, salicylic acid, Syngonium podophyllum.*

1. INTRODUCTION

Syngonium podophyllum Schott. "Arrowhead", Fam. Araceae is a native to the tropical parts of Mexico Central America and Panama. It produces leaves that change as the plant gets older. In the juvenile stage, it has a single united leaf blade that is more or less arrowhead shaped and about 5 inches long. As the plant matures the leaf develops two or more basal lobes that separate into individual leaflets that look like wings. The middle of the leaves is usually infused with shades of white or gray. One unusual characteristic of this group of plants is they have milky sap, which is a rarity in this family. Arrowhead plants will spill out of a hanging basket when they are young or climb a pole as they mature.

Salicylic acid naturally occurs in the plants in very low amounts. It could be raised to the status of the phytohormones as auxins, gibberellins, cytokinins, abscisic acid and ethylene and more recently to brassinosteroid because it has significant impact on various aspects of the plant life. This acid is a phenol ubiquitous in the plants generating a significant impact on plant growth and development photosynthesis, transpiration, ion uptake and chloroplast structure (Hayat and Ahmed, 2007). Gharib (2007) on basil and marjoram mentioned that salicylic acid increased plant height, number of branches and leaves per plant, fresh and dry weight of herbs, total carbohydrates and photosynthetic pigments. The application of the bioregulator salicylic acid at 1, 2 or 3 mM led to significant increases of the vegetative growth characters of yellow maize such as plant height, dry weight / plant and specific leaf weight **(**El-Wahed *et al.,* 2006). It is considered one of the key endogenous signals involved in the activation of numerous plant defense responses. It is thought to promote disease resistance (Chong *et al.,* 2001). It is involved in the systemic acquired resistance in which a pathogenic attack on older leaves causes the development of resistance in younger ones (Davies, 2004). But large concentrations of salicylic acid actually killed plants (Shah and Klessig, 1999).

Ascorbic acid (vitamin C) is an important component of the plant antioxidant system. It may be found in all the compartments in the plant cell where it plays diverse roles. It reaches a concentration of over 20 mM distributed in many different cell compartments, such as the cytosol, mitochondria, chloroplasts and apoplast (Smirnoff and Wheeler, 1999). This small molecule has roles in the reduction of prosthetic metal ions, cell wall expansion, cell division and in the detoxification of reactive oxygen generated by photosynthesis and adverse environmental conditions (Conklin *et al*., 2000). It has been demonstrated to play a role in the defense mechanism as a free – radical scavenger (Apel and Hirt, 2004). It appears to be a growth – regulating agent in the cell wall where it is a first line of defense against ozone (Smirnoff, 1996). Ascorbic acid serves as an important co-factor for the synthesis of some hormones such as ethylene, gibberellins and anthocyanins (Barth *et al*., 2006). Studies of Arisha (2000) indicated that the number of leaves / plant and shoots of potato were significantly increased with increasing vitamin C up to 200 ppm. Noby (2002) found that treating *Delphinium ajacis* plants with ascorbic acid at 100 ppm significantly increased branch number / plant, fresh and dry weights of leaves, while 100 and 150 ppm significantly increased plant height and vegetative growth fresh weight. Ismail (2004) mentioned that ascorbic acid at 2 g / L showed a highly significant increase in plant height, number of vegetative parts and fresh and dry weights of codex of *Beaucarnea recurvata* plants. El-Bassiouny *et al*. (2005) noticed that treating faba bean plants with ascorbic acid (100, 200 and 400 mg/litre) as foliar spray increased plant height, number of branches and leaves per plant, fresh and dry weights of shoots as well as chlorophyll a, chlorophyll b and carotenoid contents compared with the untreated plants. Ahmed (2005) on *Majorana hortensis* stated that ascorbic acid at 75 ppm increased plant height, number of branches / plant, fresh and dry weights, photosynthetic pigment content, nitrogen, phosphorus, potassium, and total carbohydrates percentage. Farahat *et al*. (2007) showed that foliar application of ascorbic acid at 40 ppm promoted plant height, stem diameter, number of branches, fresh and dry weights of the plant organs of *Cupressus sempervirens* plant, as well as chemical constituent content, *i.e*. chl (a), chl (b), carotenoids and total soluble sugars.

Benzoic acid occurs naturally in many plants and resins. The name derived from gum benzoin, which was for a long time the only source for benzoic acid. This weak acid and its salts are used as a food preservative. Benzoic acid is an important precursor for the synthesis of many other organic substances.

This work was carried out to investigate the effect of salicylic, ascorbic and benzoic acids on vegetative growth and chemical constituents of *Syngonium podophyllum* plants.

2. MATERIALS AND METHODS

A pot experiment was conducted in a plastic house at the Ornamental Nursery of Ornamental Plants Research Department, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt, during the two successive seasons of 2005 / 2006 and 2006 / 2007 to investigate the effect of salicylic, ascorbic and benzoic acids on the vegetative growth and chemical constituents of *Syngonium podophyllum* plants.

Homogenous seedlings were planted on February 28th in both seasons of 2005 and 2006 in plastic pots (20 cm diameter) filled with a mixture of clay and sand (1:1 v/v). The plants were fertilized with NPK at the ratio of 1: 1: 1 at the rate of 3 g / pot as basic. The application started on April 4th and repeated every 2 months till the termination of the experiment. The fertilizers used were ammonium sulphate (20%N), calcium superphosphate (15.5% P_2O_5) and potassium sulphate (48 % K_2O). Three concentrations of each acid (100, 200 or 300 ppm) plus the control (tap water) were used. Forty ml of each concentration were added to each plant as soil drench every two months during the period of the investigation. The application started on April 13th. The plants were irrigated whenever required. The plants were left to grow for 12 months every season. Data were taken in the following April in the two seasons.

The mechanical and chemical analyses of the soil used in the experiment are shown in Tables (A) and (B). These analyses were conducted before planting in both seasons.

At the end of the experiment of each season the following data were recorded:

Table (A): Mechanical analysis of the soil

Sand %	51.39
Silt %	31.63
Clay %	17.98
Soil texture	Sandy clay

Table (B): Chemical analysis of the soil.

Cations Meq / L		Anions Meq / L					
Na^+	1.00	HCO_3^-	1.30	pH	8.60	N	480 ppm
K^+	0.25	SO_4^-	0.30	E.C.	1.20 mmohs	P	38.0 ppm
Ca^{++}	10.00	Cl^-	0.45	Organic matter	0.23	K	564.0 ppm
Mg^{++}	8.02						

2.1. Vegetative growth

1- Plant height (cm).
2- Number of leaves / plant.
3- Blade length (cm).
4- Blade width (cm).
5- Petiole length (cm).
6- Fresh and dry weights of shoots (g).

2.2. Chemical constituents

Pigment contents in the leaves, total carbohydrate percentage and elements (N, P & K) in the shoots were estimated . The chemical analyses were performed as follows:

1- Pigment content determination was carried out in fresh leaves according to Saric *et al*. (1967).
2- Total carbohydrates in the shoots were determined according to Herbert *et al*. (1971).
3- Nitrogen percentage was determined using micro-Kjeldahl method (Pregl, 1945 and Piper, 1947).
4- Phosphorus content was determined according to Troug and Meyer (1939**).**
5- Potassium content was carried out by using operation chart for Shimadzu Atomic Absorption Flame Spectrophotometer AA-646 with a boiling air-acetylene burner and recorded readout.

The layout of the experiment was a randomized complete blocks with ten treatments, each treatment contained three replicates. Each replicate consisted of five plants, *i.e.* 15 plants in each treatment. The statistical analysis was carried out according to Snedecor and Cochran (1956). L.S.D. at 0.05 was used to compare the differences between means of treatments.

3. RESULTS

3.1. Vegetative growth

The data on the vegetative growth are presented in Tables (1) and (2).

3.1.1. Plant height

The data reveal that, in both seasons, all the treatments of the antioxidants increase the plant height over the control. The concentration of 200 ppm of each one was the most effective in this concern. The tallest plants (59.00 and 49.00 cm, respectively) resulted from treating the plants with benzoic acid at 200 ppm, however, the shortest ones are those of the control plants (45.49 and 39.44 cm, in the first and second seasons, respectively).

3.1.2. Number of leaves / plant

The data on the number of leaves / plant showed that supplying the plants with benzoic acid at 200 ppm resulted in the greatest number of leaves / plant in the two seasons (30.67 and 17.83 leaves / plant). While, the plants treated with ascorbic acid at 300 ppm had the least number of leaves / plant (16.50 leaves/ plant) in the first season. In the second one, application of ascorbic acid at 100 ppm led to the formation of the least number of leaves / plant (14.83 leaves / plant).

3.1.3. Blade length

From the data it may be observed that in both seasons, same as in plant height, all the treatments increased the blade length over the control in both seasons except the treatment of salicylic acid at the concentration of 100 ppm in the first season. The tallest blades (13.07 cm) were formed on the plants treated with ascorbic acid at 300 ppm in the first season. While, in the second one the tallest blades (15.48 cm) resulted from supplying the plants with benzoic acid at 100 ppm. The shortest ones (7.34 cm) were those of the plants received salicylic acid at 100 ppm in the first season. However, the control plants had the shortest blades (8.42 cm) in the second one.

3.1.4. Blade width

The data indicate that all the treatments led to an increase in blade width over the control in both seasons except the treatment of salicylic acid at the rate of 100 ppm in the second season. In the first season, the widest blades (7.53 cm) were found in the plants treated with benzoic acid at 100 ppm. Meanwhile, application of ascorbic acid at 300 ppm caused the widest blades (10.63 cm) in the second season. The narrowest blades (4.18 cm) were found in the control plants in the first season. In the second one, the narrowest blades (8.78 cm) were formed in the plants treated with salicylic acid at 100 ppm.

3.1.5. Petiole length

From Tables (1) and (2) it can be noticed that, in both seasons, treating the plants with benzoic acid at 200 ppm resulted in the tallest petioles (24.20 and 25.44 cm, respectively), same as in plant height and number of leaves / plant. While, treating the plants with salicylic acid at 300 ppm caused the formation of the shortest petioles (15.04 cm) in the first season, meanwhile, in the second one the concentration of 100 ppm of salicylic acid resulted in the shortest petioles (18.54 cm).

3.1.6. Fresh and dry weight of shoots

The data point out that, in the first season, the heaviest fresh and dry weights of shoots (135.53 and 11.76 g, respectively) were due to the application of benzoic acid at 200 ppm, same as in plant eight, umber of leaves / plant and

Table (1): Effect of salicylic, ascorbic and benzoic acids on the vegetative growth of *Syngonium podophyllum* plant during the first season (2005 / 2006) .

Treatments	Plant height (cm)	Number of leaves / plant	Blade length (cm)	Blade width (cm)	Petiole length (cm)	Shoots fresh weight (g)	Shoots dry weight (g)
Control	45.49	18.83	7.65	4.18	17.78	70.43	7.47
Salicylic acid 100 ppm	51.58	24.17	7.34	6.02	19.60	87.66	8.05
Salicylic acid 200 ppm	57.39	19.61	8.89	6.74	20.93	92.98	9.38
Salicylic acid 300 ppm	47.84	20.17	9.25	7.03	15.04	72.65	8.07
Ascorbic acid 100 ppm	56.67	21.33	8.96	7.22	22.03	92.41	8.56
Ascorbic acid 200 ppm	57.94	23.33	9.22	7.26	19.75	102.72	8.77
Ascorbic acid 300 ppm	50.50	16.50	13.07	6.37	19.34	41.00	4.47
Benzoic acid 100 ppm	55.33	20.11	10.67	7.53	19.56	108.17	8.81
Benzoic acid 200 ppm	59.00	30.67	10.31	6.79	24.20	135.53	11.76
Benzoic acid 300 ppm	55.45	23.17	8.90	6.73	21.98	99.45	9.47
L.S.D. at 0.05	1.54	1.07	0.73	0.62	1.14	1.36	0.78

Table (2): Effect of salicylic, ascorbic and benzoic acids on the vegetative growth of *Syngonium podophyllum* plant during the second season (2006 / 2007).

Treatments	Plant height (cm)	Number of leaves / plant	Blade length (cm)	Blade width (cm)	Petiole length (cm)	Shoots fresh weight (g)	Shoots dry weight (g)
Control	39.44	15.78	8.42	8.88	22.04	64.77	11.68
Salicylic acid 100 ppm	43.83	16.50	13.68	8.78	18.54	76.99	15.78
Salicylic acid 200 ppm	48.00	16.17	13.92	9.28	19.05	81.93	16.20
Salicylic acid 300 ppm	44.72	17.22	14.26	9.38	23.18	128.54	20.70
Ascorbic acid 100 ppm	40.83	14.83	12.17	9.13	23.40	42.79	10.57
Ascorbic acid 200 ppm	42.11	16.50	13.18	9.33	22.07	95.10	19.16
Ascorbic acid 300 ppm	41.50	15.94	11.84	10.63	21.17	74.55	15.55
Benzoic acid 100 ppm	48.22	17.67	15.48	9.78	20.48	73.17	13.22
Benzoic acid 200 ppm	49.00	17.83	13.12	9.53	25.44	89.16	17.26
Benzoic acid 300 ppm	46.33	16.89	12.60	9.05	20.86	86.40	14.67
L.S.D. at 0.05	1.26	1.00	0.58	0.75	1.11	1.28	1.14

petiole length. The plants treated with ascorbic acid at 300 ppm had the least fresh and dry weights of shoots (41.00 and 4.47 g, respectively). In the second season, the heaviest fresh and dry shoots (128.54 and 20.70 g, respectively) were formed as a result of treating the plants with salicylic acid at 300 ppm. The least fresh and dry weights of shoots (42.79 and 10.57 g, respectively) were found in the plants that received ascorbic acid at 100 ppm.

3.2. Chemical constituents of shoots

3.2.1. Photosynthetic pigments in fresh leaves

3.2.1.1. Chlorophyll (a) content

The data in Table (3) indicate that treating the plants with ascorbic acid at 200 ppm led to the greatest content of chlorophyll (a) (0.35 and 0.42 mg / g FW, respectively) in both seasons. The least content of chlorophyll (a) (0.21 mg / g FW) was formed as a result of supplying the plants with benzoic acid at 200 ppm in the first season. While, in the second one the application of salicylic acid at 100 ppm resulted in the least amount of chlorophyll (a) (0.22 mg / g FW).

3.2.1.2. Chlorophyll (b) content

As shown in Table (3) the data on chlorophyll (b) show that the highest content of chlorophyll (b) in the two seasons (0.24 and 0.17 mg / g FW, respectively) was detected in leaves of the plants supplied with ascorbic acid at 200 ppm. However, the plants treated with salicylic acid at 300 ppm had the least content of chlorophyll (b) (0.15 mg / g FW) in the first season. While, treating the plants with benzoic acid at 200 ppm produced the least chlorophyll (b) content (0.12 mg / g FW) in the second season.

3.2.1.3. Total chlorophylls (a + b) content

Data in Table (3) reveal that the highest content of total chlorophylls (a + b) in both seasons (0.59 mg / g FW) resulted from supplying the plants with ascorbic acid at 200 ppm. The least amount (0.38 mg / g FW) was determined in the leaves of the plants received benzoic acid at 200 ppm in the first season. While, application of salicylic acid at 100 ppm resulted in the formation of the least content of total chlorophylls (0.37 mg / g FW) in the second season.

3.2.1.4. Carotenoid contents

From the data shown in Table (3) it can be remarked that the highest content of carotenoids was due to treating the plants with ascorbic acid at 200 ppm in both seasons. The values were 0.26 and 0.27 mg / g FW, respectively same as in chlorophylls (a) and (b). Meanwhile, the plants received salicylic acid at 300 ppm or benzoic acid at 100 ppm had the least amount of carotenoids (0.22 mg / g FW) in the first season. While, in the second one, the least content of carotenoids (0.19 mg / g FW) was determined in the leaves of the control plants or those treated with benzoic acid at 100 ppm.

3.2.2. Total carbohydrate percentages

The data on total carbohydrates contents as shown in Table (4) pointed out that, in the two seasons, the highest total carbohydrates percentages (33.65 and 30.00 %, respectively) were accumulated in the plants treated with salicylic acid at 300 ppm. Meanwhile, salicylic acid at 100 ppm resulted in the formation of the least content of total carbohydrates (23.42 %) in the first season. However, in the second one the least percentage of total carbohydrates (24.42 %) was detected in the plants treated with ascorbic acid at 300 ppm

3.2.3. Nitrogen percentage

The recorded data for nitrogen percentage in *Syngonium podophyllum* plants (Table 4) reveal that, in both seasons, the highest accumulation of nitrogen (3.53 and 2.60 %, respectively) was detected in the plants treated with salicylic acid at 200 ppm. The least percentage of nitrogen (1.10 and 1.33 % in both seasons, respectively) was determined in the plants treated with benzoic acid at 100 ppm.

3.2.4. Phosphorus percentage

Phosphorus percentage as affected by the antioxidants is presented in Table (4). In the first season, the greatest amount of P (0.46 %) was determined in the plants received ascorbic acid at 300 ppm. However, the least percentage (0.37 %) was found in the plants treated with salicylic acid at 100 ppm. In the second season, application of salicylic acid at 200 ppm caused the formation of the greatest percentage of P (0.37 %). While, benzoic acid at 100 ppm reduced the accumulation of P to the least percentage (0.26 %), same as in nitrogen percentage.

3.2.5. Potassium percentage

Data shown in Table (4) indicate that in both seasons, most treatments led to a significant increase in potassium percentage over control plants. The greatest percentage of potassium in both seasons (1.81 and 1.83 %, respectively) was determined in the plants treated with ascorbic acid at 200 ppm. While, the least percentages (1.43 and 1.48 % in both seasons, respectively) were found in the plants received ascorbic acid at 100 ppm.

Table (3): Effect of salicylic, ascorbic and benzoic acids on photosynthetic pigments (mg / g fresh weight) in the leaves of *Syngonium podophyllum* plant during the two successive seasons of 2005 / 2006 and 2006 / 2007.

Treatments	Chlorophyll (a)		Chlorophyll (b)		Total chlorophylls		Carotenoids	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	0.29	0.33	0.17	0.13	0.46	0.46	0.25	0.19
Salicylic acid 100 ppm	0.25	0.22	0.18	0.15	0.43	0.37	0.24	0.25
Salicylic acid 200 ppm	0.26	0.29	0.18	0.16	0.44	0.45	0.23	0.21
Salicylic acid 300 ppm	0.27	0.31	0.15	0.13	0.42	0.44	0.22	0.20
Ascorbic acid 100 ppm	0.31	0.35	0.20	0.14	0.51	0.49	0.23	0.22
Ascorbic acid 200 ppm	0.35	0.42	0.24	0.17	0.59	0.59	0.26	0.27
Ascorbic acid 300 ppm	0.31	0.37	0.21	0.13	0.52	0.50	0.24	0.21
Benzoic acid 100 ppm	0.32	0.36	0.19	0.13	0.51	0.49	0.22	0.19
Benzoic acid 200 ppm	0.21	0.26	0.17	0.12	0.38	0.38	0.23	0.22
Benzoic acid 300 ppm	0.33	0.36	0.22	0.14	0.55	0.50	0.24	0.24
L.S.D. at 0.05	0.02	0.03	0.03	0.01	0.04	0.03	0.01	0.02

Table (4): Effect of salicylic, ascorbic and benzoic acids on total carbohydrates and mineral percentages in the shoots of *Syngonium podophyllum* plant during the two successive seasons of 2005 / 2006 and 2006 / 2007.

Treatments	Total carbohydrates %		Nitrogen %		Phosphorus %		Potassium %	
	First season	Second season	First season	Second season	First season	Second season	First season	Second season
Control	26.75	28.67	2.23	1.60	0.40	0.28	1.55	1.51
Salicylic acid 100 ppm	23.42	25.38	3.30	2.30	0.37	0.32	1.60	1.60
Salicylic acid 200 ppm	24.33	25.63	3.53	2.60	0.40	0.37	1.76	1.72
Salicylic acid 300 ppm	33.65	30.00	2.63	2.15	0.38	0.33	1.70	1.61
Ascorbic acid 100 ppm	25.83	25.42	1.30	1.35	0.40	0.30	1.43	1.48
Ascorbic acid 200 ppm	25.50	24.88	3.33	1.57	0.45	0.30	1.81	1.83
Ascorbic acid 300 ppm	24.50	24.42	3.37	1.93	0.46	0.31	1.74	1.75
Benzoic acid 100 ppm	25.63	25.88	1.10	1.33	0.39	0.26	1.58	1.66
Benzoic acid 200 ppm	26.08	26.00	1.55	1.57	0.40	0.27	1.74	1.72
Benzoic acid 300 ppm	27.75	26.88	1.20	1.40	0.42	0.31	1.77	1.73
L.S.D. at 0.05	2.06	1.71	0.22	0.16	0.02	0.03	0.03	0.04

4. DISCUSSION

The results of this investigation can be discussed as follows. Benzoic acid at 200 ppm is the most effective treatment on vegetative growth. This is followed by Benzoic acid at 100 ppm or ascorbic acid at 300 ppm. While, salicylic acid is the least effective on vegetative growth of *Syngonium podophyllum*. The rate of 100 ppm of salicylic acid led to a decrease in blade length. Salicylic acid at 200 ppm led to an increase in N percentage in the shoots. The rate of 200 ppm ascorbic acid is the most effective treatment on increasing the content of photosynthetic pigments in the leaves and K percentage in the shoots. However, the concentration of salicylic acid at 300 ppm increased the accumulation of total carbohydrates percentage in the shoots. Supplying the plants with ascorbic acid at 100 ppm resulted in a decrease in K percentage in the shoots. Benzoic acid at 100 ppm caused a decrease in carotenoid content in the leaves and N percentage in the shoots. The effect of the antioxidants on growth and the chemical constituents of plants were investigated by some authors. Conklin *et al*. (2000) showed that ascorbic acid has roles in the reduction of prosthetic metal ions, cell wall expansion and cell division. El-Bassiouny *et al.,* (2005) noticed that treating faba bean plants with ascorbic acid (100, 200 and 400 mg/litre) as foliar spray increased plant height, number of branches and leaves per plant, fresh and dry weights of shoots chlorophyll a, chlorophyll b and carotenoid contents compared with the untreated plants. Ahmed (2005) on *Majorana hortensis* stated that ascorbic acid at 75 ppm increased plant height, number of branches / plant, fresh and dry weights, nitrogen, phosphorus, total carbohydrates percentage, photosynthetic pigments content and potassium percentage. Barth *et al.* (2006) pointed out that ascorbic acid serves as an important co-factor for the synthesis of some hormones such as gibberellins. Hayat and Ahmed (2007) stated that salicylic acid naturally occurs in plants in very low amounts. It could be raised to the status of the phytohormones as auxins, gibberellins and cytokinins because it has significant impact on various aspects of the plant life. Gharib (2007) on basil and marjoram mentioned that salicylic acid increased plant height, number of branches and leaves per plant, fresh and dry weight of herbs, photosynthetic pigments and total carbohydrates percentage. Farahat *et al*. (2007) showed that foliar application of ascorbic acid at 40 ppm promoted plant height, stem diameter, number of branches, fresh and dry weights of the plant organs of *Cupressus sempervirens* plant, as well as total soluble sugars, chlorophyll (a), chlorophyll (b) and carotenoids content.

Recommendation

For the production of the best vegetative growth of *Syngonium podophyllum*, it is recommended to supply the plants with 40ml benzoic acid at 200 ppm for each plant as soil drench every 2 months throughout the growing season.

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استخدام أحماض الساليسليك والأسكوربيك والبنزويك لإنتاج نباتات السينجونيوم

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ملخص

أجرى هذا البحث داخل صوبة بلاستيكية فى أصص قطر 20 سم مملوءة بخليط من الطمى والرمل بنسبة 1 : 1 حجماً فى مشتل قسم بحوث نباتات الزينة – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة خلال الموسمين 2005 / 2006 و 2006/ 2007 لدراسة تأثير إضافة أحماض الساليسليك والأسكوربيك والبنزويك على النمو الخضرى والمكونات الأساسية لنباتات السينجونيوم . وكانت أهم النتائج كالآتى:-

1. أدت إضافة حمض الأسكوربيك بتركيز 200 جزء فى المليون إلى زيادة محتوى الأوراق من الصبغات ، كما أدى إلى زيادة نسبة البوتاسيوم فى المجموع الخضرى .
2. أدت إضافة حمض البنزويك بتركيز 200 جزء فى المليون إلى زيادة ارتفاع النبات وعدد الأوراق على النبات وطول عنق الورقة .
3. أدت المعاملة بحمض الساليسليك بتركيز 300 جزء فى المليون إلى زيادة نسبة الكربوهيدرات الكلية فى المجموع الخضرى .

4. أدت إضافة حمض الساليسليك بتركيز 200 جزء فى المليون إلى زيادة نسبة النتروجين فى المجموع الخضرى . وبالتالى فإنه للحصول على نباتات سينجونيوم ذات نمو خضرى قوى تعامل النباتات بحمض البنزويك بتركيز 200 جزء فى المليون .

المجلة العلمية لكلية الزراعة – جامعة القاهرة – المجلد (59) العدد الثانى (ابريل 2008):123-131.