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Foliar applications of gibberellic acid and benzyladenine increase vines of 'White Butterfly' *Syngonium podophyllum*

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ABSTRACT: *Syngonium podophyllum* 'White Butterfly' is a species of species of Araceae, and commonly cultivated as a houseplant. A pot experiment was conducted to evaluate the effect of foliar spray of gibberellic acid (GA_3) and benzyladenine (BA) both at 100, 200, 400 and 800 mg L^{-1} was compared to the control (distillated water) on growth of *Syngonium podophyllum* plants at greenhouse of Azad University Jiroft, Iran. Effect of GA_3 and BA ($p<0.05$) on No. of vines, length of side branch, petiole length, leaf chlorophyll Index and plant fresh and dry weight was significant. Effect of GA_3 and BA ($p<0.01$) on length of main branch, leaf length and width, No. of leaves/plant, 60 and 90 day, root fresh and dry weight was significant. Results showed that, 800 mg L^{-1} GA_3 increased No. of leaves/plant, 90 day of *Syngonium podophyllum* as 270.22 and 262.88% compared to control treatment. This study indicates that GA_3 and BA can increase number of vines in *Syngonium.* Leaf number increased with GA_3 concentration. Plants were normal in appearance and were fertile.

***Keywords*:** Benzyladenine, *Syngonium podophyllum,* Gibberellic acid, Leaf number, Vines number

INTRODUCTION

Members of the family Araceae, commonly called aroids, are one of the most important group of ornamental tropical foliage plants. Five aroid genera, including *Aglaonema*, *Dieffenbachia*, *Spathiphyllum*, *Epipremnum*, and *Syngonium*, were responsible for 19% of the annual wholesale volume in Florida in 1993 (Sheehan, 1994), and interest continues in developing new cultivars. Consumers prefer plants with novel foliage that perform well in interior environments. Growers seek plants with good growth rates, branching, and an attractive growth habit, in addition to insect and disease resistance. Unpredictable flowering patterns of aroids greatly hindered attempts at breeding until *Aglaonema* (Henny, 1983), *Dieffenbachia* (Henny, 1980), and *Spathiphyllum* (Henny, 1981) were induced to flower with a single foliar spray of gibberellic acid (GA_3). Although some GA_3-induced flowers may be distorted and small, fertility is not affected. The ability to control flowering of these aroids has permitted breeders to develop new *Aglaonema* and *Dieffenbachia* cultivars, and allowed commercial production of blooming *Spathiphyllum* on predictable schedules throughout the year.

The aroid genus *Syngonium* consists of ≈ 20 species native to tropical Central and South America. Because of the shape of juvenile leaves *Syngonium* are commonly referred to as nephthytis, or as arrowhead vine. A single species, *S. podophyllum* Schott, is the origin of most commercially grown nephthytis. New cultivars have been introduced directly from the wild or selected from mutants oblogically (Henley and Robinson, 1993). Extensive differences in several morphological characteristics were

observed, including plant height and width, leaf length, width and color, and number of basal shoots (Henley and Robinson, 1993). The diversity of important ornamental traits makes *Syngonium* a desirable genus for improvement by breeding. Hybridization could also be used to introduce genes into *S. podophyllum* from other species to increase the genetic base. Consequently, ability to control flowering of *Syngonium* is important. However, under low light levels in commercial greenhouse and interiorscapes, *Syngonium* does not flower.

Growth regulators (PGR) can induce runners to form either by stimulating dormant buds to grow or by preventing flower bud initiation (Pritts et al., 1986; Reid, 1983). Gibberellic acid (GA_3) has increased runner production inconsistently (Reid, 1983). Also the beneficial effect of gibberellic acid on different plants were recorded by Salehi Sardoei and Shahdadneghad (2014b) on marigold, Shedeed et al., (1991) on croton plant, Hassan Pour Asil et al., (2011) on *Polianthus tuberosa*, Bedour et al., (1994) on *Ocimum basillicum,* they concluded that gibberellic acid is used to regulating plant growth through increasing cell division and cell elongation. The effect of cytokinins especially benzyladenine on the plant growth and chemical constituents of different plants have mentioned by Eraki et al., (1993) on salvia plants, Mazrou (1992) on Datura.

This study was done to test the individual and possibly synergistic effects of gibberellic acid and benzyladenine on growth characteristics in *Syngonium podophyllum* 'White Butterfly', to produce a practical application for use commercially.

MATER IAL AND METHODS

Plant Material and Cultivation Conditions

The present work was conducted during the successive seasons of 2014 at greenhouse of National Research Centre (Research and Production Station). Plastic pots 15cm in diameter were used for cultivation that were filled with media containing a mixture of sand, rice husk, leaf composts and peat as 1:1:1:1 (v/v). Was the treatments of GA_3 and BA 100, 200, 400 and 800 mg L^{-1} was compared to the control (distillated water), each traetments was contain 10ml (0.l%) Tween-20 surfactant. For each plant 40cc of solution was used at each stage (three stages) with 10 days intervals (Carey et al., 2008; Salehi Sardoei et al., 2014g).

Treatments of gibberellic acid and benzyladenine combination were as follows**:** 1-Control (distillated water). 2- 100 mg $L^{-1}GA_3$. 3- 200 mg $L^{-1}GA_3$. 4- 400 mg $L^{-1}GA_3$. 5- 800 mg $L^{-1}GA_3$. 6- 100 mg l^{-1} of BA. 7- 200 mg l^{-1} of BA. 8- 400 mg l^{-1} of BA. 9- 800 mg l^{-1} of BA.

Character Evaluation

Observation were recorded on: The length of main and side branch, life length and width (cm), No. of leaves/plant, 60 and 90 days, No. of vines, petiole length (cm), leaf chlorophyll (using Spad-502, Mirolta Co.), plant and root fresh weight (g), plant and root dry weight (g).

Experimental Design and Statistical Analysis: Experiment was arranged in a factorial test with completely randomized design with four replications. Analysis of variance was performed on the data collected using the general linear model (GLM) procedure of the SPSS software) version 16, IBM Inc.). The mean separation was conducted by Dancan analysis in the same software (p= 0.05).

RESULTS

Effect of GA_3 and BA ($p<0.05$) on No. of vines, length of side branch, petiole length, leaf chlorophyll Index and plant fresh and dry weight was significant (Table 1; 2). Effect of GA_3 and BA ($p<0.01$) on length of main branch, leaf length and width, No. of leaves/plant, 60 and 90 day, root fresh and dry weight was significant (Table 1; 2). Results showed that, 800 mg L^{-1} BA increased No. of leaves/plant, 60 day of *Syngonium podophyllum* as 450% compared to control treatment (Table 3). Plants treated with GA_3 and higher BA concentrations produced more No. of leaves/plant than plants receiving other treatments. Results showed that, 800 mg L^{-1} GA_3 increased No. of leaves/plant, 90 day of *Syngonium podophyllum* as 270.22 and 262.88% compared to control treatment (Table 3). Results showed that, 400 mg L^{-1} BA increased length of main branch of *Syngonium podophyllum* as 346.06% compared to control treatment (Table 3). Results showed that, 200 mg L^{-1} GA_3 increased length of side branch of *Syngonium podophyllum* as 526.31% compared to control treatment (Table 3). Results showed that, 200 mg L^{-1} GA_3 and 200 mg L^{-1} BA increased No. of vines of *Syngonium podophyllum* as 150.37% compared to control

treatment (Table 4). Results showed that, 400 mg L^{-1} BA and 200 mg L^{-1} GA_3 increased leaf length of *Syngonium podophyllum* as 52.33 and 72.69% compared to control treatment (Table 3). Results showed that, 400 and 800 mg L^{-1} BA increased petiole length of *Syngonium podophyllum* as 251.93 and 250.58% compared to control treatment (Table 4). Results showed that, 800 mg L^{-1} GA_3 increased leaf chlorophyll Index (SPAD) of *Syngonium podophyllum* as 129.51% compared to control treatment (Table 4). Results showed that, 400 mg L^{-1} BA increased plant fresh and dry weight of *Syngonium podophyllum* as 484.41 and 631.88% compared to control treatment (Table 4). Results showed that, 800 mg L^{-1} BA increased root fresh weight of *Syngonium podophyllum* (Table 4). Results showed that, 100 mg L^{-1} BA increased root dry weight of *Syngonium podophyllum* (Table 4).

DISCUSSION

Results related to attribution, showed growth of leaf that bean applicated with of GA_3 and BA was significant in comparison to control treatment. The hypothesis provoking this experiment was that the GA_3 was causing new buds to grow with such vigor the plant could not sustain the new growth, and therefore aborted them. However, BA is used to regulating plant growth through increased meristimatic activity due to enhance cell division and elongation Salehi Sardoei (2014a) on *Aloe barbadensis*. Gibberellins are known for stimulation of cell division and increasing No. of leaves/plant (Galston et al., 1980; Salehi Sardoei et al., 2014c; d). GA_3 is used to regulating plant growth through increased meristimatic activity due to enhance cell division and elongation Bhattuchajee et al., (2002) on *Corchourus olitorius* L. Rahbarian et al., (2014) and Salehi Sardoei et al., (2014a; e; f; g) showed effect of GA_3 on increase of growth index. The ratio project was based on the premise that the cytokinin (6-BA) and gibberellin (GA_{4+7}) mixture of Fascination was combined to break axillary buds from dormancy and enhance branch elongation, respectively. The number of length of side branch both increased significantly linearly and quadratically with rate (Henny and Norman, 1999). BA has been found to increase axillary branching on numerous ornamentals (Preece, 1990; Wilson and Nell, 1983; Salehi Sardoei et al., 2014h; Bell et al., 1997; Imamura and Higaki, 1988). This study indicates that GA_3 and BA can increase number of vines in *Syngonium* (Henny and Norman, 1999). Length suppression may be due to the suppression of GA_3 synthesis or the suppression of GA_3 stimulation of DNA precursors (Gressel et al., 1976). The results herein are in agreement with Shedeed et al., (1991) and Rawia and Bedour (2006) on croton, Ibrahim et al., (1992) on ment plant and Soad (2005) on Jojoba plant. In this respect Rawia and Bedour (2006) on croton cited that, BA increased general growth compared with control plants. Our results suggest that doses of BA at 200 mg L^{-1} might further increase stem diameter formation. This result agrees with those of Pritts et al., (1986) that one high dose of BA is more effective than a low dose applied repeatedly. Besides the effects of GA_3 and BA on plant growth, chlorophyll content was also affected by these treatments in a concentration-dependent manner. Chlorophyll is an indicator of crop health and productivity (Ruttanaprasert et al., 2012). Leaves chlorophyll content was influenced by GA_3 + BA treatments. Like with many of the studied traits, 200 mg L^{-1} GA_3 + BA treatment had the maximal amounts for chlorophyll index. Our findings are in well conformity with the results of Reda et al., (2007). Those scientist reported similar results on chlorophyll content of *Thymus vulgaris* L. plants in response to some plant growth regulators. It is probable that GA_3 links with chlorophyll biosynthesis in leaves and hence had visible effects on plants green factory content.

CONCLUSION

This study indicates that GA_3 and BA can increase number of vines and No. of leaves/plant, 60 and 90 days in *Syngonium*. The increased branch number should help plant breeders provide a more diverse selection of cultivars.

Table 1 Analysis of variance for *Syngonium podophyllum* plant to evaluate effects of GA_3 and BA treatments

		MS						
	df	No. of vines	The length of main branch	The length of side branch	Leaf length	Leaf width	No. of leaves/plant, 60 day	No. of leaves/plant, 90 day
Treatment	8	2.20*	595.55**	13.68*	28.59**	2.89**	32.03**	50.89**
Error	18	0.62	21.88	3.81	9.84	0.58	100	1.17
C.V	-	40.42	16.92	38.21	20.64	10.45	15.69	10.40

ns Non Significant at 0.05 probability level and *, ** Significant at 0.05 and 0.01 probability levels, respectively.

Table 2 Analysis of variance for *Syngonium podophyllum* plant to evaluate effects of GA_3 and BA treatments

		MS					
	df	Petiole length	Leaf chlorophyll Index (SPAD)	Plant fresh weight	Root fresh weight	Plant dry weight	Root dry weight
Treatment	8	28.59*	5.28*	1528.98*	306.62**	34.24*	27.57**
Error	18	9.84	1.76	612.14	75.06	14.35	3.57
C.V	-	20.64	29.54	71.41	57.40	80.74	51.85

ns Non Significant at 0.05 probability level and *, ** Significant at 0.05 and 0.01 probability levels, respectively.

Table 3 Effect of a single foliar spray of GA_3 and BA, applied during August, on plant growth and flowering of *Syngonium podophyllum* 'White Butterfly' grown in 15-cm pots. Means are averages for 5 plants per treatment.

Treatment	The length of main branch	The length of side branch	Life length	Life width	No. of leaves/plant, 60 day	No. of leaves/plant, 90 day
Control	12.33f	1.33c	10.73b	5.56d	2d	4.5d
100 mg L^{-1} GA_3	11.33f	7ab	12.01ab	6.21cd	1.33d	8.66c
200 mg L^{-1} GA_3	35.66b	8.33a	17.42a	8.11a	5.33c	13.33b
400 mg L^{-1} GA_3	31.33bc	4bc	15.96ab	6.63bcd	9b	9.33c
800 mg L^{-1} GA_3	16.5ef	4bc	18.53a	8.03ab	8.66b	8.66c
100 mg l^{-1} BA	26.33cd	7.16ab	15.12ab	7.21abc	5.66c	9c
200 mg l^{-1} BA	22.33de	4bc	10.47b	7.86ab	5.66c	8.33c
400 mg l^{-1} BA	55a	5.5ab	17.62a	8.47a	8.66b	16.66a
800 mg l^{-1} BA	38b	4.66abc	17.78a	7.69ab	11a	16.33a

Means followed by same letter are not significantly different at P< 0.05 probability using Duncan's test.

Table 4 Effect of a single foliar spray of GA_3 and BA, applied during August, on plant growth and flowering of *Syngonium podophyllum* 'White Butterfly' grown in 15-cm pots. Means are averages for 5 plants per treatment.

Treatment	No. of vines	Petiole length	Leaf chlorophyll Index (SPAD)	Plant fresh weight	Root fresh weight	Plant dry weight	Root dry weight
Control	1.33b	5.95b	2.88c	12.19c	2.12d	1.38c	0.45d
100 mg L^{-1} GA_3	1.66b	6.82b	3.42bc	17.06bc	5.43d	1.86c	1.63cd
200 mg L^{-1} GA_3	3.33a	19.75a	3.21bc	59.05abc	16.7abc	8.15ac	1.03d
400 mg L^{-1} GA_3	1.33b	11.66ab	3.6bc	22.42bc	22.33abc	3.07abc	5.06bc
800 mg L^{-1} GA_3	1.66b	10.66ab	6.61a	21.34bc	9.77cd	2.71bc	2.51cd
100 mg l^{-1} BA	1.66b	14.99ab	5.63ab	28.58abc	26.5ab	3.99abc	8.75a
200 mg l^{-1} BA	1b	11.61ab	5.55ab	18.63bc	6.47cd	2.09bc	1.74cd
400 mg l^{-1} BA	2.33ab	20.94a	4.09bc	71.24a	15.04bcd	10.1a	3.56cd
800 mg l^{-1} BA	3.33a	20.86a	5.4abc	61.28ab	31.46a	8.86ab	8.05ab

Means followed by same letter are not significantly different at P< 0.05 probability using Duncan's test.

REFERENCES

Bhattuchajee, A.K. - Mittra, B.W. - Miltra, P.C. 2002. Seed agronomy of Jute. III. Production and quality of Corchorus oliforius L. seed as influenced by growth regulators. Seed Sciences and Technology, vol. 28, 2002, pp. 421-436.

Bedour, H. - Abou-Leila, M.S. - Abdel-Hady, N.F. 1994. Effect of foliar application of GA3 and Zn on Ocimum basillicum L. grown in different soil type. Egypt Journal Physiology Sciences, vol. 18, 1994, pp. 365-380.

Bell, M.L. - Larson, R.A. - Bailey, D.A. 1997. Vegetative growth responses of florist azaleas to dikegulac, GA4+7, and benzylamino purine. HortScience, vol. 32(4), 1997, pp. 690-693.

Carey, D. - Whipker, B. - Mc-Call I. - Buhler, W. 2008. Benzyladenine foliar sprays increase offsets in Sempervivum and Echeveria. Journal Horticulture Sciense, vol. 53, 2008, pp. 19-21.

Eraki, M.A. - Mazrou M.M. - Afify, M.M. 1993. Influence of kinetin and indole3-acetic acid (IAA) on the growth, drug yield and essential oil content of Salvia officinalis L. plant. Zagazig Journal Agriculture Research, vol. 20, 1993, pp. 1233-1239.

Eraki, M.A. 1994. The effect of gibberellic application and chelated iron nutrition on the growth and flowering of Queen Elizabeth rose plants. The first Conf. of Ornamental Hort, vol. 2, 1994a, pp: 436-444.

El-Sayed, A.A. - Salem M.A. - El-Maadawy, E.I. 1989. Effect of gibberellic acid (GA3) and benzyladenine (BA) on Polianthus tuberosa L. Journal Agriculture Research. Tanta Univ, vol. 15, 1989, pp. 301-311.

Galston, A. - Davies P. - Li Satter, R. 1980. The life of a green plant. 2nd ed. Prentice Hall, Englewood Cliffs, N.J.

Gressel, J. - Kadouri, A. – Atsmon, D. - Cohen, N. 1976. Effects of dikegulac sodium on nucleic acid syntheses. Collected abstracts of the paper demonstrations: The 9th international conference of plant growth substances. pp. 1-2.

Hassanpour Asil, M. – Roein, Z. - Abbasi, J. - 2011. Response of Tuberose (Polianthes tuberose L.) to Gibberellic Acid and Benzyladenine. Hort. Environ. Biotechnol, vol. 52(1), 2011, pp: 46-51

Henny, R.J. - Norman, D.J. 1999. Gibberellic Acid-induced Flowering of Syngonium podophyllum Schott 'White Butterfly'. HortScience, vol. 34(4), 1999, pp. 676–677.

Henley R.W. - Robinson, C.A. 1993. Nephthytis cultivars to know and grow. Florida State Horticultural Society, vol. 106, 1993, pp. 343–347.

Henny, R.J. 1983. Flowering of Aglaonema commutatum 'Treubii' following treatment with gibberellic acid. HortScience, vol. 18, 1983, pp. 374.

Henny, R.J. 1981. Promotion of flowering in Spathiphyllum 'Mauna Loa' with gibberellic acid. HortScience, vol. 16, 1981, pp. 554–555.

Henny, R.J. 1980. Gibberellic acid (GA3) induces flowering in Dieffenbachia maculata 'Perfection'. HortScience, vol. 15, 1980, pp. 613.

Imamura J.S. - Higaki, T. 1988. Effect of GA3 and BA on lateral shoot production on Anthurium. HortScience, vol. 23(2), 1988, pp. 353-354.

Ibrahim, M.E. Tarraf, S.H.A. - Omer E.A. - Turky, K.A. 1992. Response of growth, yield and essential oil of Mentha piperita L. to some growth regulators. Zagazig, J. Agric. Res, vol. 19, 1992, pp. 1855-1868.

Lichtenthaler, H.K. 1987. Chlorophylls and carotenoids: Pigments of photosynthetic biomembranes. Methods of Enzymology, vol. 148, 1987, pp. 350-380.

Mazrou, M.M. - Afify, M.M. - El-Kholy, S.A. Morsy, G.A. 1994. Physiological studies on Ocimum basillicum plant. Influence of kinetin application on the growth and essential oil content. Menofiya Journal Agriculture Research, vol. 19, 1994, pp. 421-434.

Preece, J.E. 1990. Growth stimulation of Euphorbia lathyris L. by GA4+7 and BA. Journal of Plant Growth Regulation, vol. 9, 1990, pp. 85-88.

Pritts, M.P. - Posner G.S. - Worden, K.A. 1986. Effects of 6-BA application on growth and development of 'Tristar', a strong day-neutral strawberry. HortScience, vol. 21, 1986, pp. 1421–1423.

Rahbarian, P. - Salehi Sardoei, A. - Fallah Imani, A. 2014. Stimulatory effect of benzyladenine and gibberellic acid on growth and photosynthetic pigments of (Spathiphyllum wallisii Regel) plants. International journal of Advanced Biological and Biomedical Research, vol. 2(1), 2014, pp. 230-237.

Rawia, A. - Bedour Abou-Leila, H. 2006. Response of croton plants to gibberellic acid, benzyladenine and ascorbic acid application. World Journal Agriculture Sciences, vol. 2, 2006, pp. 174-179.

Reda, F. Baroty, G.S.A. - Talaat, I.M. - Abdel- Rahim, I.A. - Ayad, H.S. 2007. Effect of some growth regulators and vitamins on essential oil, phenolic content and activity of oxidoreductase enzymes of (Thymus vulgaris L.). World Journal of Agricultural Sciences, vol. 3, 2007, pp. 630-638.

Ruttanaprasert, R. Jogloy, S. - Vorasoot, N. - Kesmala, T. - Kanwar, R. - Holbrook C. - Patanothai, A. 2012. Relationship between Chlorophyll Density and SPAD Chlorophyll Meter Reading for Jerusalem artichoke (Helianthus tuberosus L.). SABRAO journal of Breeding and Genetics, vol. 44, 2012, pp. 149–162.

Reid, J.H. 1983. Practical growth regulator effects on strawberry plants-a review. Crops Research, vol. 23, 1983, pp. 113–120.

Salehi Sardoei, A. 2014a. Gibberellic Acid and Benzyladenine Application increase offsets in Aloe barbadensis. European Journal of Experimental Biology, vol. 4(1), 2014a, pp. 646-650.

Salehi Sardoei, A - Shahdadneghad, M. 2014b. Effects of foliar application of gibberellic acid on chlorophyll and carotenoids of Marigold (Calendula officinalis L.). International journal of Advanced Biological and Biomedical Research, vol. 2(6), 2014b, pp. 1887-1893.

Salehi Sardoei, A. - Hassanpour Asil. M. 2014c. Response of Application Gibberellic Acid and Benzyladenine to Schefflera (Schefflera arboricola L.) Plants. Trends in Life Sciences, vol. 3(2), 2014c, pp. 290-297.

Salehi Sardoei, A. - Roien, A. - Shahadadi, F. - Sadeghi T. - Sattaei Mokhtari, T. 2014d. Endogenus gibberellic acid and benzyladenine effects on stem elongation and leaf in Schefflera arboricola L. plants. International Journal of Plant, Animal and Environmental Sciences, vol. 4(3), 2014d, pp. 431-437.

Salehi Sardoei, A. Rahbarian P. – Shahdadneghad, M. 2014e. Evaluation Estimate Chlorophyll Contents on Three indoor ornamental Plants with Growth Regulators. European Journal of Experimental Biology, vol. 2014e, 4(2), pp. 306-310.

Salehi Sardoei, A. 2014f. Plant Growth Regulators Effects on the Growth and Photosynthetic pigments on three indoor ornamental Plants. European Journal of Experimental Biology, vol. 4(2), 2014f, pp. 311-318.

Salehi Sardoei, A. Shahdadi, F. - Shahdadneghad, M. – Sadeghi, T. 2014g. Positive Effect of Growth Regulators on the Soluble Carbohydrates of Ficus benjamina, Schefflera arboricola and Dizigotheeca elegantissima Plants. International Journal of Biosciences, vol. 4(10), 2014g, pp. 263-268.

Salehi Sardoei, A. - Rahbarian P. - Fallah Imani, A. 2014h. Stimulatory Effect of gibberellic acid and benzyladenine on Growth and Photosynthetic pigments of Ficus benjamina L. Plants. International journal of Advanced Biological and Biomedical Research, vol. 2(1), 2014h, pp. 34-42.

Shedeed, M.R. - Gamassy, K.M. – Hashim, M.E. - Almulla, A.M.N. 1991. Effect of fulifirtil fertilization and growth regulators on the vegetative growth of croton plants. Annals Agriculture Sciences, vol. 36, 1991, pp. 209-216.

Sheehan, P. 1994. Foliage facts. Florida Dept. Agr. & Consumer Serv.

Soad, M.M. 2005. Response of vegetative growth and chemical composition of jojoba seedlings to some agricultural treatments. Ph.D. Thesis, Fac. Of Agric. Minia Univ. Egypt,

Wilson, M.R - Nell, T.A. 1983. Foliar applications of BA increase branching of ‘Welkeri’ Dieffenbachia. HortScience, vol. 18(4), 1983, pp. 447-448.