Trends in Life Sciences
An International Peer-reviewed Journal
ISSN: 2319–4731 (p); 2319–5037 (e)

RESPONSE OF APPLICATION OF GIBBERELLIC ACID AND BENZYLADENINE TO SCHEFFLERA (*SCHEFFLERA ARBORICOLA* L.) PLANTS

Ali Salehi Sardoei [1], Moazzam Hassanpour Asil [2*]

[1] Young Researchers ans Elite Club, Jiroft Branch, Islamic Azad University, Jiroft, Iran.
[2] Department of Horticultural Sciences, Faculty of Agricultural Sciences, University of Guilan, Rasht, Iran

[*]Corresponding Author Email: hassanpurm@yahoo.com

ABSTRACT
Field trials with Schefflera arboricola L. were conducted at the Faculty of Agriculture Farm, Azad University, Jiroft in the growing season of 2013. The aim of this work was to study the effect of foliar applications of gibberellic acid and benzyladenine at concentrations of 0, 50, 100 and 200 mg l^{-1} on vegetative growth characteristics and photosynthetic pigments of Schefflera plant. Results demonstrated a significant effect on most vegetative growth characteristics such as plant height, number of leaves/plant, chlorophyll index and photosynthetic pigments by application of the two factors tested in this study. All foliar applications BA and GA_3 separately promoted all the afore-mentioned characters in this study, as well as photosynthetic pigments of Chl. (a and b), total chlorophyll compared with control plants. The highest evaluations were recorded in plants treated with 200 mg l^{-1} GA_3+100 mg l^{-1} BA for plant height, number of leaves/plant, chlorophyll index and stem diameter, except for the treatment 100 mg l^{-1} GA_3+100 mg l^{-1} BA, which gave the highest evaluation for leaf area.

KEY WORDS: Leaf Area, Benzyladenine, Gibberellic Acid, growth, Schefflera Plant.

INTRODUCTION

Schefflera arboricola L. is a member of the family Araliaceae and one of the most popular foliage plants used to landscape interiors. Generally, low light intensities, typical for indoors, increase leaf drop and reduce leaf quality (Conover and Poole, 1977; Sawwan and Ghunem, 1999). It has been known that growth regulators among in the agriculture practices which is most favourable for promoting and improving plant-growth of different plants. The beneficial effect of gibberellic acid on different plants were recorded by Shedeed et al. (1991) on croton plant, Eraki (1994) on Quen Elizabeth rose plants, 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 benzyl adenine on the plant growth and chemical constituents of different plants have mentioned by Eraki et al. (1993) on salvia plants, Mazrou (1992) on Datura, Mazrou et al.*(*1994) on sweet basil, Mansoure et al. (1994) on soybean plants and Vijakumari (2003) on *Andrographis panculata*, Hassan Pour Asil et al. [2011] on *Polianthus tuberosa*. Cytokinins are important plant hormones that regulate various

ISSN: 2319–4731 (p); 2319–5037 (e)

processes of plant growth and development including cell division and differentiation, enhancement of leaf expansion and nutrient mobilization (Hassan and El-Quesni, 1989; Shudo, 1994). The response of plants to cytokinins have been also discussed in more papers where Eraki (1994) on *Hibiscus sabdarijfa* L. plants mentioned that application of BA significantly increased plant height, number of branches as well as fresh and dry weights of leaves than the control. Hassanein (1985) on *Pelargonium graveolens,* El-Sayed et al.(1989) on *Polianthus tuberosa,* Menesi et al. (1991) on *Calendula officinalis* and Mazrou et al. (1994) on sweet basil, they found that foliar application of BA increased growth of different organs, active constituents production of these plants and increased total carbohydrates content on comparison to the untreated plants. The main objective of the present work was to study the effects of different plant growth regulators, gibberellic acid and benzyladenine on the growth and photosynthetic pigments of *Schefflera arboricola* L. plants.

MATERIALS AND METHODS

Plant Material and Cultivation Conditions

These tests were done during the growing season of 2013 at the greenhouse of the National Research Centre (Research and Production Station). *Schefflera* pants were cultivated in plastic pots of 30cm in diameter filled with media that constituted a mixture of sand, rice husk, leaf compost and peat as 1:1:1:1 (v/v). The plants were fertilized with doses of 3% liquid fertilizer at intervals 4, 6 and 8 weeks from the time of transplanting. Pots were arranged as a factorial experiment based on a completely randomized design with 9 treatments and 4 replications.

Treatments

The treatment applications constituted benzyladenine (0, 100 and 200 mg l^{-1}) and gibberellic acid (0, 100 and 200 mg l^{-1}), in which each treatment contained 10 ml (0.l'%) Tween-20 surfactant. For each pot, 40 cc of solution was applied at each stage (three stages) at 15-day intervals (Carey et al. 2008; Salehi Sardoei et al. 2013).

Treatments of gibberellic acid and benzyladenine combination were as follows:

1- control
2- 0 mg $L^{-1}GA_3$+100 mg l^{-1} of BA
3- 0 mg $L^{-1}GA_3$+200 mg l^{-1} of BA
4- 100 mg $L^{-1}GA_3$+0 mg l^{-1} of BA
5- 100 mg $L^{-1}GA_3$+100 mg l^{-1} of BA
6- 100 mg $L^{-1}GA_3$+200 mg l^{-1} of BA
7- 200 mg $L^{-1}GA_3$+0 mg l^{-1} of BA
8- 200 mg $L^{-1}GA_3$+100 mg l^{-1} of BA
9- 200 mg $L^{-1}GA_3$+200 mg l^{-1} of BA

Plant-Growth Parameters

Trends in Life Sciences
An International Peer-reviewed Journal
ISSN: 2319–4731 (p); 2319–5037 (e)

At the first week of October 2013, evaluations were made for data on the following: plant height (cm), stem diameter (mm), number of leaves/plant, leaf area (cm^2), chlorophyll index (spad) and photosynthetic pigment ($mg.ml^{-1}$) Lichtenthaler method, (1987).

Data Analysis

Data analysis was done using SPSS 16. Comparisons were made using one-way analysis of variance (ANOVA) and Duncan's Multiple Range Test. Difference was considered significant at $P < 0.05$.

RESULTS AND DISCUSSION

The top leaves produced by plants were treated with applications of 200 mg l^{-1} GA_3 +100 mg l^{-1} BA, 200 mg l^{-1} GA_3+200 mg l^{-1} of BA with respectively, (22.75 and 22.5) and results showed no statistically significant difference (Table 1). In a research, by Zieslin and Tsujita (1998) on *Lilium* and Hamano et al. (2002) that reporting on tests of GA_3on cabbage plants, determined no increased leaf area. The effect of GA_3 on increasing the rate of dry material of plant can be attributed to its effect on increasing the rate of photosynthesis through increasing leaf surface area (Lester et al. 2002).

The control treatment and 100 mg l^{-1} BA had lower evaluations for number of leaves with averages of 15.75and 16.75 respectively and comparison of results for applications of 200 mg l^{-1} GA_3 +100 mg l^{-1} BA showed significant difference. Application of *Zantedeschia aethiopiea*ca used an increase in number of leaves by spraying BA solution (Majidian et al. 2012). Results shown in Table (1) demonstrate higher evaluations for plant height from applications of 200 mg l^{-1} GA_3 +100 mg l^{-1} BA, 200 mg l^{-1} GA_3+200 mg l^{-1} of BA with averages of 28.55 and 27.95 cm. Also, results showed evaluations for plant height and number of leaf/plant increased under treatments of increasing concentrations of plant growth regulators. GA_3has an effect on cellular processes, by stimulating cell division, lengthening cells cause increased growth (Stuart and Jones, 1977). GA_3 serves to produce and increase tension of cellular walls from cell wall extension though hydrolysis of starch to sugar that follows a decreased potential of cellular water, so water enters the cells and causes cell lengthening (Arteca, 1996).

Table 1. Effect of GA_3 and BA on plant growth parameters of *Schefflera arboricola* L. 60 day after spray

GA_3 (mg L^{-1})	BA (mg L^{-1})	leaf Chlorophyll Index (spad)	Plant Height (cm)	Stem Diameter (cm)	Leaf area (cm^2)	No. of leaves/plant
0	0	4.62abc	31.5d	0.71ab	38.91b	15.75c
	100	17.3d	42.25c	0.75ab	38.85b	16.75bc
	200	24.35abc	46abc	0.73ab	44.77ab	18.5ab
100	0	27.35ab	39.5c	0.71ab	38.6b	18.75ab

Trends in Life Sciences
An International Peer-reviewed Journal ISSN: 2319–4731 (p); 2319–5037 (e)

	100	23.6bc	43.25bc	0.78a	48.34a	18.25ab
	200	28.45a	49.75ab	0.74ab	44.76ab	19.75ab
200	0	20.97cd	51.5a	0.64ab	45.97ab	20ab
	100	28.55a	52.5a	0.79a	43.25ab	22.75a
	200	27.95ab	52.25a	0.61b	42.78ab	22.5a

*Means separated by Duncans multiple ranges test at the P< 0.05 level

The highest stem diameter was recorded in plants treated with applications of 200 mg l^{-1} GA_3+100 mg l^{-1} BA and 100 mg l^{-1} GA_3+100 mg l^{-1} BA, respectively, with averages of 0.79 and 0.78 mg.ml^{-1} data statistics showed no significant difference, (Table 1). Leaf area was significantly affected by plant growth regulators; the highest evaluation for leaf area was recorded in the treatment of 100 mg l^{-1} GA_3+100 mg l^{-1} BA with an average of 48.34 cm^2. Results of Table (1) showed, that under increasing concentrations of growth regulators, leaf area increase was evaluated as significant. The lowest value for leaf area was recorded from the application of 100 mg l^{-1} GA_3, 100 mg l^{-1} BA and the control, with evaluations of averages as 38.6, 38/85 and 38.91cm^2, respectively (Table 1). Foliar spray should be applied in such a way that it has contact with the plant leaves, stems and meristems as cytokinesis in plants tend not travel very far from the point of initial contact (Fox and Weis, 1965; Zhu and Matsumoto, 1987). In order for cytokines to affect branching or flowering, they must be absorbed by the meristem or on the stem below it. Spray solutions should be ph adjusted to neutral pH levels to improve absorption. Foliar spray application may be made with a variety of spray techniques such as hand spraying, boom spraying or air blast spraying. Usually, a spray application should cover the entire plant but there may be some applications where only a certain part of a plant needs to be targeted. In Easter lily, research has reported better results when treatments targeted only the lower leaves and that this prevented yellowing of the lower leaves (Whitman et al. 2001). Tests on watermelon, reported the recommendation that spray application should be limited to the ovaries in order to stimulate parthenocarpy (Maroto et al. 2005). Spray applied to the lower stem stimulated branch formation in *Monstera* and *Alocasia* (Henny and Fooshee, 1990a, 1990b). Crown spray application has been tested on *Hosta* (Keever and Warr, 2005). In view of the results shown on Table (1), the highest evaluation on the chlorophyll index was recorded in the application of 200 mg l^{-1} GA_3 +100 mg l^{-1} BA and 100 mg l^{-1} GA_3 +200 mg l^{-1} BA with averages of 28.55 and 28.45. Increasing concentrations of growth regulators, resulted in increased evaluations on the chlorophyll index. Application of the growth regulators GA_3 and BA, increased evaluations on the chlorophyll index in leaves of *Zantedeschia aethiopiea* plants (Majidian et al. 2011). The lowest evaluation on the chlorophyll was recorded in the control. It seems that the BA growth regulator had a better effect than GA_3 in terms of the chlorophyll index.GA_3 stimulates sucrose synthesis and transfers it from leaf to filter vessel (Arteca, 1996). This may be attributed to stimulation of sucrose synthesis and its transfer to filter vessels as a result of GA_3application that not only causes increased growth of aerial parts of a plant that are attributed as the site of consumption, but this transfer also affects plant tissue of the underground limbs, that causes an increase in root growth. In short, it can be said that changes to growth rate by

Trends in Life Sciences
An International Peer-reviewed Journal ISSN: 2319–4731 (p); 2319–5037 (e)

GA_3 application may be caused by stimulation of the rate of photosynthesis, increase activity of some enzymes or cause changes in distribution of photosynthetic materials and or by the interaction of these aforementioned effects that are all the result of increased leaf area (Arteca, 1996; Aggarwal and Sachar., 1995). On the one hand, GA_3 causes transformation of proteins to amino acids such as tryptophan that is a prerequisite of auxin, by stimulating activity of some protease enzymes. Therefore, some of its effects are indirect through auxin production (Leshem, 1973). GA_3 also causes an increased plasticity of cell walls. This problem can be due to acidification of the cellular wall or as a result of absorption of calcium ions inside the cytoplasm (Baninasab and Rahemi., 1994). It has been proved that GA_3 increases activity of the oxygenase carboxilación phosphate ribulose (Rabisco) enzyme that is the main enzyme in plant photosynthesis.

Table 2. Effect of foliar application of GA_3 and BA on the Photosynthetic pigments of *Schefflera arboricola* L. Plant 60 day after spray

GA_3 (mg l^{-1})	**BA (mg l^{-1})**	**(mg.ml^{-1} fresh weight)**				
		Chl. (a)	Chl. (b)	Total Chl. a+b	Carotenoids	**sum pigments**
0	0	9.4c	4.28b	13.68c	2.59ab	**16.27ef**
	100	9.72bc	4.22b	14.44bc	2.63ab	**16.57def**
	200	10.34b	4.88ab	15.22b	2.52ab	**17.75bcd**
100	0	9.29c	4.29b	14.09bc	2.07b	**15.66f**
	100	9.76bc	4.87ab	14.63bc	2.48ab	**17.11cde**
	200	10.61b	5.72a	15.34b	2.53ab	**18.87b**
200	0	9.84bc	3.93b	13.77c	2.91a	**16.68cdef**
	100	10.38b	5.05ab	15.43b	2.49ab	**17.92bc**
	200	13.17a	6.22a	19.39a	2.26ab	**21.65a**

*Means separated by Duncans multiple ranges test at the P< 0.05 level

The results (Table 2) of these tests indicate that the plant regulators BA and GA_3 were effective on production of photosynthetic pigments. Higher values of chlorophyll a, b were total and sum pigments in levels of 200 mg l^{-1} GA_3+200 mg l^{-1} BA, with averages of 13.17, 6.22, 19.39 and 21.65 mg.ml^{-1}. Increasing concentrations of GA_3 and BA, determined increased values for chlorophyll a. Results for evaluations of chlorophyll of leaf showed that application of GA_3 had a significant difference compared to the control application, and these results suitable with results of Mynett et al. (2001) in *Freesia* and Yaghoubi et al. (2013) in *Bellis perennis* about the effect of GA_3 that showed an increased greenness. GA_3 has a structural role in the membrane of chloroplast and stimulates photosynthesis (Janowsk and Jerzy, 2003). Minimum values of chlorophyll a, b and total chlorophyll were recorded in the treatment control, 200 mg l^{-1} GA_3, control and 100 mg l^{-1} GA_3 with averages of 9.4, 3.93 and 13.68 and 15.66 mg.ml^{-1} (Table 2). Chlorophyll has an

important role in terms of absorption and use of light energy in photosynthesis. So, the effect of plant growth regulators has a direct affect on biosynthesis and decomposition of chlorophyll (Arteca., 1996).

The highest value of carotenoids was determined from the BA application of 200 mg l^{-1} with an average of 2.91 mg.ml^{-1}. The minimum value of carotenoids was determined from the GA_3 application of 100 mg l^{-1} with an average of 1.89 mg.ml^{-1} (Table 2). These results adapted with results of Rahbarian et al. [2014] and Salehi Sardoei et al. [2014a, b, c] on effects of GA_3 on increase of growth parameters, chlorophyll and carotenoids contents.

CONCLUSION

In view of the obtained results, the growth rate of *Schefflera arboricola* L. plants can be stimulated through increasing synthesis of photosynthetic pigments by applications of GA_3 and BA.

REFERENCES

Aggarwal KK and Sachar RC (1995). Gibberellin stimulates synthesis of a protein kinase in dwarf pea epicotyls. Photochemistry. **40(2):** 383-387.

Arteca RN (1996). Plant growth substances: principles and application . chap man and hall, N ew York, USA, pp: 132.

Baninasab B and Rahemi M (1994). Effect of gibberellic acid on the growth of pistachio seedlings. Iranian Journal of Agricultural Sciences. **29 (1):** 32-45.

Bedour H, Abou-Leila MS and Abdel-Hady NF (1994). Effect of foliar application of GA_3 and Zn on *Ocimum basillicum* L. grown in different soil type. Egypt. J. Physiol. Sci. **18**: 365-380.

Carey D, Whipker B, Mc-Call I and Buhler W (2008). Benzyladenine foliar sprays increase offsets in Sempervivum and Echeveria. J Hort Sci. **53**: 19-21.

Eraki, M.A., Mazrou, M.M & Afify, M.M. (1993). Influence of Kinetin and Indole 3-acetic acid (IAA) on the growth, drug yield and essential oil content *of Salvia officinalis* L. Plant. Zagazig J. Agric. Res. **20**: 1233-34.

Eraki MA (1994a). 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. **2**: 436-444.

Eraki MA (1994b). Effect of benzyladenine (BA) application on the growth, fruit yield and some chemical constituents of *Hibiscus sabdariffa* L. plants. Minofiya J. Agric. Res. **2**: 623-637.

El-Sayed AA, Salem MA and El-Maadawy EI (1989). Effect of gibberellic acid (GA_3) and benzyladenine (BA) on *Polianthus tuberosa* L.J. Agric. Res. TantaUniv. **15**: 301-311.

Fox, J.E & Weis, J.S. (1965). Transport of the kinin, N6-benzyladenine: Non-polar or polar? Nature. **206**: 678-679.

Hassan, E.A & El-Quesni, F.M. (1989). Application of growth regulators in agriculture. A cytokinin-induced new morphogenetic phenomena in carnation *(Dianthus caryophyllus* L). Bull. Fac. Agric, Cairo Univ. **40:** 187-196.

Hassanein MA (1985). Effect of some growth regulators and potassium feritilizers on growth, yield and essential oil production of geranium plants *(Pelargonium graveolens* L). M. Sc. Thesis, Fac. Agric, Cairo University.

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

Hamano M, Yamato Y, Ymazaki H and Miura H (2002). Endogenus gibberellins and their effects on flowering and stem elongation in cabbage (*Brassica oleracea* var. *capitata*). Journal of Horticultural Science & Biotechnology. **77(2):** 220-225.

Henny RJ and Fooshee WC (1990a). Thidiazuron stimulates basal bud and shoot formation in *Alocasia X Chantrieri Andre*. HortScience. **25 (1):** 124.

Henny RJ and Fooshee WC (1990b). Use of Thidiazuron in attempt to stimulate basal branching of *Monstera siltepecana*. In CFREC-Apopka Research Report RH. Pp: 24-90.

Janowsk B and Jerzy M (2003). Effect of gibberrelic acid on post harvest leaf longevity of *Zantedeschia elliottiana*. Journal of Fruit and Ornamental pland Research. **11**: 69-76.

Lester DC, Carter OG, Kelleher FM and Laing DR (2002). The effect of gibberellic acid on apparent photosynthesis and dark respiration of simulated swards of pennisetum clandestinum Hochst. Australian jurnal of Agriculture Research. **23**: 205-213.

Leshem Y (1973). The molecular and hormonal basis of plant growth regulation. Department of life Science. Bar- Ilon University Ramat-GAn. Israel. pp: 159.

Lichtenthaler HK (1987). Chlorophylls and carotenoids: Pigments of photosynthetic bio membranes. Methods of Enzymology. **148**: 350-380.

Mazrou MM (1992). The growth and tropane alkaloids distribution on the different organs of *Datura innoxia* Mill. Plant on relation to benzyladenine (BA) application. Monofiya, J. Agric. Res. **17**: 1971-1983.

Mazrou MM, Afify, M.M., El-Kholy, S.A & Morsy, G.A. (1994). Physiological studies on *Ocimum bosillicum* L. plant. I. Influence of kinetin application on the growth and essential oil content. Menofiya. J. Agric. Res. **19**: 421-434.

Mansour FA, El-Shahaby OA, Mostafa HAM, Gaber AM and Ramadan AA (1994). Effect of Benzyl adenine on growth, pigments and productivity of soybean plant. Egypt. J. Physiol. Sci. **18**: 245-364.

Majidian N, Nadari A and Majidian M (2012). The Effect of Four Levels of GA_3 and BA on The Quantitative and Qualitative Characteristics of *Zantedeschia aethiopica* cv. Childsiana Pot Plant. Journal of Horticultural Science. **25(4):** 361-368.

Menesi FA, Nofal EMS and El-Mahrouk EM (1991). Effect of some growth regulators on *Calendula officinalis* L. Egypt. J. Applied Sci. **6**: 1-15.

Maroto JV, Miguel A, Lopez-Galarza AS, Bautista B, Pascual D, Alagarda J and Guardiola JL (2005). Parthenocarpic fruit set in triploid watermelon induced by CPPU and 2,4-D applications. Plant Growth Regulation. **45**: 209-213.

Mynett K, Startek L, Zurawik P and Ploszaj B (2001). The Effect of Gibrescol and Flordimex on The Emergence and Growth of *Freesia* Rocz. AR w Poznaniu CCCXXXII, Ogrodn. **33**: 103-110.

Rahbarian P, Salehi Sardoei A and 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. **2(1):** 230-237.

Salehi Sardoei A, Sarhadi H, Rahbarian P, Rohany Yazdi, M, Arbabi M and Jahantigh M (2013). Effect of gibberellic acid and benzyladenine growth regulators on offsets production of *Aloe barbadensis* at greenhouse conditions. International journal of Advanced Biological and Biomedical Research. **1(11):** 1457-1465.

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

Salehi Sardoei A and 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. **2(6):** 1887-1893.

Salehi Sardoei A (2014c). Evaluation chlorophyll contents assessment on *Spathiphyllum wallisii* Regel with plant growth regulators. International Journal of Biological Sciences. **1(1):** 35-39.

Shedeed MR, Gamassy KM, Hashim ME and Almulla AMN (1991). Effect of fulifirtil fertilization and growth regulators on the vegetative growth of croton plants. Annals Agric. Sci., Ain. Shams Univ., Cairo. **36**: 209-216.

Shudo K (1994). Chemistry of phenylurea cytokinins. In Cytokinins: Chemistry, activity and function Mokk, D.V. and Mc Mok (Eds.). CRC Press, Boca Raton. Pp: 35-42.

Stuart DI and Jones RL (1977). Roles of extensibility and trugor in gibberellin-and dark-stimulated growth. Plant Physiolgy. **59**: 61-68.

Whitman CM, Heins, RD, Moe R and Funnell KA (2001). GA_{4+7} plus benzyladenine reduce foliar chlorosis of Lilium longiflorum. Scientia Horticulturae. **8**: 143-154.

Yaghoubi, L., Hatamzadeh, A & Bakhshi, A. (2013). Effect of gibberellic acid and matel jasmonat on Growth and Photosynthetic pigments of *Bellis perennis* Plants. Proceedings 8^{red} Congree Sciences Horticulture Branch hemadan, Ali Sina university, Iran. Pp: 3100-3096.

Zieslin N & Tsujita MJ (1988). Regulation of stem elongation of *lilies* by temperature and the effect of gibberellin. Scientia Horticulturae. **37(1-2):** 165-169.

Zhu XR & Matsumoto K (1987). Absorption and translocation of 6-benzylamino purine in satsuma (*Citrus unshiu* Marc.) trees. Journal of the Japanese Society for Horticultural Science. **56 (2):** 159-165.

