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Research article

ENDOGENUS GIBBERELLIC ACID AND BENZYLADENINE EFFECTS ON STEM ELONGATION AND LEAF IN *SCHEFFLERA ARBORICOLA* L. PLANTS

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ABSTRACT: Field trials with Schefflera arboricola were conducted at the experimental farm of Faculty of Agriculture, University Azad Jiroft in 2013 growth seasons. The aim of this work is to study the effect of foliar application with gibberellic acid (GA_3) and benzyladenine (BA) at 0, 100 and 200 mg.L^{-1} on the vegetative growth and Photosynthetic pigments of Schefflera arboricola L plant, 120 day after spray. Results showed that 200 mg L^{-1} gibberellic acid + 200 mg L^{-1} benzyladenine increased Plant Height and leaf area index of Schefflera arboricola L. as 41.15 and 56.97% compared to control treatment. Effect of gibberellic acid, benzyladenine and the interaction significant ($p<0.01$) also effect of on No. of leaves/plant was significant. Results showed that 200 mg L^{-1} gibberellic acid + 100 mg L^{-1} benzyladenine, 200 mg L^{-1} gibberellic acid + 200 mg L^{-1} benzyladenine and 200 mg L^{-1} gibberellic acid increased No. of leaves/plant of Schefflera arboricola L. as 59.72, 54.16 and 37.5% compared to control treatment. The obtained results show, 200 mg L^{-1} gibberellic acid increased Chl. (a), Total Chl. a+b and sum pigments content of Schefflera arboricola L. as 94.55, 60.62 and 69.66% compared to control treatment.
Key words: Benzyladenine, Schefflera arboricola, Gibberellic Acid, Leaf Area Index, Photosynthetic Pigments.

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 [10, 40]. Cytokinins are plant hormones that plants produce naturally and regulate plant growth, including cell division and leaf senescence. There are several commercial plant growthregulators (PGRs) that contain benzyladenine, a synthetic cytokinin [32]. It can be applied as a foliar spray or a substrate drench at different concentrations. The useful application concentration differs greatly among the ornamental plants and is generally unknown [46]. The results Obtained with exogenous cytokinins, however, vary depending on the type and concentration of the cytokinins used [8]. GAs form a large family of diterpenoid compounds, some of which are bioactive growth regulators, that control such diverse developmental processes as seed germination, stem elongation, leaf expansion, trichome development, and flower and fruit development [11]. In addition, GA3, application increased petiole length, leaf area and delayed petal abscission and color fading (senescence) by the hydrolysis of starch and sucrose into fructose and glucose [13, 24]. It has been known that growth regulators among the agriculture practices which is most favorable for promoting and improving plant-growth of different plants [14]. The beneficial effect of gibberellic acid on different plants were recorded by Shedeed *et al.*, [41] on *Croton* plant, Brooking and Cohen [7] on *Zantedeschia*, Al-khassawneh *et al.*, [1] on Black Iris, they concluded that gibberellic acid is used to regulating plant growth through increasing cell division and cell elongation. GA_3 sprays enhanced plant dry mass, leaf area, plant growth rate and crop growth rate in Mustard [25].

The main object of the present work is to study the effect of gibberellic acid and benzyladenine on the growth and Photosynthetic pigments of *Schefflera arboricola* L. plants.

MATERIAL AND METHODS

Plant Material and Cultivation Conditions

In 2013 year, *Schefflera arboricola* plants were cultivated at the experimental farm of University Azad Jiroft. Factorial methods in completely randomized design test with 4 repeats and 9 treatments were used for this experiment. Uniform offsets size of 18-20 cm were selected, then transferred to greenhouse and were planted in pots with capacity of 20 kg soil. Greenhouse temperature was 22 to 28ºC during night and day, respectively. Plants, based on field water capacity, were uniformly irrigated. The present work was conducted during the successive seasons of 2013 year at greenhouse of national research centre (research and production station). Plastic pots of 30 cm in diameter were used for cultivation *Schefflera arboricola* plant in which that were filled with media containing a mixture of sand, rice husk, leaf composts and peat as 1:1:1:1 (v/v) during growth. The plants were fertilized with 3% liquid fertilizer in some doses after 4, 6 and 8 weeks from transplanting.

Treatments

This study was performed in factorial test based on completely randomized design and 4 repeationwith 9 treatments. Application of benzyladenine (0, 100 and 200 mg L^{-1}) and gibberellic acid (0, 100 and 200 mg L^{-1}) in which each contained 10 ml [0.l'%] Tween-20 surfactant. For each pot was used 40 cc of solution at each stage (three stages) with 15 days intervals [9].

Plant-Growth Parameters

The first was at the first week of April, the second was one month from the first at both seasons while the control was sprayed distilled water. An agricultural processes were performed according to normal practice. At the first week of October 2012, the following data were recorded: plant height (cm), stem diameter (mm), number of leaves, leaf area (cm^2) and chlorophyll index (SPAD) were determined.

Estimation of Chlorophyll and Carotenoids

Photosynthetic pigments were measured using Lichtentaller method [25]. 0.2 g of fresh leaf tissue was weight by laboratory balance with accuracy of 0.0001gr and pulverized with mortar in the presence of 10ml of 80% acetone. The resulted solution was filtered through wattman filter paper mounted in glass funnel. The solution volume was increased to 15ml by addition of 80% acetone. 3ml of the solution containing chlorophyll a and b and carotenoid was poured in cuvet and its absorbance was measured in wavelengths of 663.3 nm (chlorophyll a), 646.8 nm (chlorophyll b) and 470 nm (carotenoids) using spectrophotometer device; concentration of the pigments were calculated using.

$$Chl_a\ (mg.ml^{-1}) = (12.5 * A_{663.2})-(2.79* A_{646.8})$$
$$Chl_b\ (mg.ml^{-1}) = (21.51*A_{646.8})-(5.1*A_{663.2})$$
$$Chl\ T\ (mg.ml^{-1}) = Chl.a + Chl.b$$
$$Car\ (mg.ml^{-1}) = (1000* A_{470})-(1.8* Chl.a)-(85.02* Chl.b)/198$$

Where chl.a, chl.b, ch1 total and car are concentration of chlorophyll a, chlorophyll b and carotenoids (carotene and xanthophyll); and $A_{663.2}$, $A_{646.8}$ and A_{470} stand for absorbance in 663.2 nm (chlorophyll a), 646.8 nm (chlorophyll b) and 470 nm (carotenoids), respectively.

Data Analysis

Analysis was performed on data using SPSS ver 16. Comparisons were made using one-way analysis of variance (ANOVA) and Duncan's multiple range tests. Differences were considered to be significant at $P < 0.05$.

RESULTS AND DISCUSSION

Effect of gibberellic acid and the interaction ($p<0.01$) and ($p<0.05$) and also effect of benzyladenine on Leaf Chlorophyll Index was or non significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid + 100 mg L^{-1} benzyladenine and, 200 mg L^{-1} gibberellic acid and 200 mg L^{-1} gibberellic acid + 200 mg L^{-1} benzyladenineand increased Leaf Chlorophyll Index of *Schefflera arboricola* L. as 35.99, 35.66 and 35.63% compared to control treatment (Table 2). GA_3 by effecting cellular processes such as cellular division stimulation, lengthening cells caused to increase growing growth [42]. GA_3 by increasing tension of cellular wall, i.e. Wall extension though hydrolysis of starch to sugar that follows decrease of potential of cellular water, cause to enter water inside cell and lengthen cell [3].

The response of plants to gibberellic acid and cytokinins have been also discussed in more papers where Salehi sardoei *et al.*, [34, 35, 36, 37, 38, 39] and Rahbrian *et al.*, [33] mentioned that application of GA_3 and BA significantly increased plant height, number of leaf as well as than the control treatment.
Effect of the interaction significant (p<0.01) also effect of gibberellic acid and benzyladenine on Plant Height was or non significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid + 200 mg L^{-1} benzyladenine increased Plant Height of *Schefflera arboricola* L. as 41.15% compared to control treatment (Table 2). In a research, by Zieslin and Tsujita [49] on *Lilium* and Hamano *et al.*, [19] on Cabbage, using usage of GA_3 on plants can cause to increase leaf than application that was seen. The effect of GA_3 on increasing rate of dry material of plant can b attributed to its effect on increasing photosynthesis rate through increasing leaf area [27]. Effect of benzyladenine and the interaction significant (p<0.05) and (p<0.01) also effect of gibberellic acid on stem diameter was or non significant (Table 1). Results showed that 100 mg L^{-1} benzyladenine increased stem diameter of *Schefflera arboricola* L. as 2.12% compared to control treatment (Table 2). GA_3 cause to accelerate cellular division by stimulating existing cells in phase G_1 to enter phase S and shortening phase S [6]. GA_3 causes to stimulate sucrose synthesis and transfer it from leaf to filter vessel [3]. may be, stimulation of sucrose synthesis and transfer of it to filter vessel in effect of applying application of GA_3 not only causes to increase growth in aerial parts of a plant that are discussed as consumption place, but another part are transferred from material inside underground limbs, too that causes to increase growth of root. In short, it can be said that variability of growth rate by GA_3 may be stimulation of photosynthesis rate, increase of activity of some enzyme or change in distribution of photosynthesis materials and or participative effect of these cases, due to increase in effective level of leaf [2, 3]. on the one hand, GA_3 cause to transform proteins to amine acid such as tryptophan that is prerequisite of auxin, by stimulating activity of some enzyme of protease. Therefore, they apply some of their effects as indirect through auxin, too [28].

Table 1: Analysis of variance for the effects of gibberellic acid and benzyladenine on *Schefflera arboricola* L. plant. 120 day after spray

S.O.V						MS					
	Df	Leaf Chlorophyll Index	Plant Height	Stem Diameter	Leaf area index	No. of leaves/plant	Chl. (a)	Chl. (b)	Total Chl. a+b	Carotenoids	Sum pigments
gibberellic acid	2	79** 413/	113.84 ^{ns}	0.017^{ns}	56.28 ^{ns}	48.52**	1.33**	0.092^{ns}	1.32**	0.087**	1.62**
benzyladenine	2	0.86 ^{ns}	26.88 ^{ns}	0.035*	515.06**	81.02**	1.57**	0.703^{ns}	1.57**	0.213*	4.56**
gibberellic acid × benzyladenine	4	30.51*	**349.22	0.033**	207.67**	34.86**	3.54**	1.87*	3.54**	0.066**	9.80**
Error	27	8.40	55.46	0.008	32.03	7.07	0.142	0.314	0.142	0.010	0.289

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

Effect of benzyladenine and the interaction significant (p<0.01) also effect of gibberellic acid on leaf area index was or non significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid + 200 mg L^{-1} benzyladenine, 200 mg L^{-1} gibberellic acid + 100 mg L^{-1} benzyladenine and 200 mg L^{-1} gibberellic acid increased leaf area index of *Schefflera arboricola* L. as 56.97, 49.65 and 47.62% compared to control treatment (Table 2). Foliar sprays should be made in such a way as to contact the plant leaves, stems, and meristems as cytokinins will not travel very far in the plant from the point of contact [15, 48]. In order for cytokinins 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 sprays may be made with hand sprayers, boom sprayers, and air blast sprayers.
Effect of gibberellic acid, benzyladenine and the interaction significant (p<0.01) also effect of on No. of leaves/plant was significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid + 100 mg L^{-1} benzyladenine, 200 mg L^{-1} gibberellic acid + 200 mg L^{-1} benzyladenine and 200 mg L^{-1} gibberellic acid increased No. of leaves/plant of *Schefflera arboricola* L. as 59.72, 54.16 and 37.5% compared to control treatment (Table 2). Usually, the entire plant should be covered, but there are some applications where only certain parts of the plant should be targeted. In Easter lily, it is best to target only the lower leaves in order to prevent lower leaf yellowing [45]. In watermelon, sprays should be limited to the ovaries in order to stimulate parthenocarpy [29]. Lower stem sprays have been used to stimulate branching in *Monstera* and *Alocasia* [17, 18]. Crown sprays have been used on *Hosta* [23].

Table 2: Effect of gibberellic acid and benzyladenine on plant growth parameters of *Schefflera arboricola* L. 120 day after spray

GA_3	BA	leaf Chlorophyll Index (SPAD)	Plant Height (cm)	Stem Diameter (cm)	Leaf area (cm^2)	No. of leaves/plant
0	0	41.64d	62.25c	0.94ab	62.29e	18d
	100	45.95c	70bc	0.96a	72.26d	19.50cd
	200	47.64bc	72.12bc	0..90abc	86.07bc	21.50bcd
100	0	46.33c	74.75b	0.84abc	78.92cd	21.75bcd
	100	48.22bc	76.75ab	0.80cde	85.61bc	23bc
	200	51.14b	77ab	0.82abcd	87.35bc	23bc
200	0	56.49a	80.87ab	0.80cde	92.08ab	24.75ab
	100	56.63a	79.62ab	0.78cd	93.22ab	28.75a
	200	56.48a	87.87a	0.68d	97.78a	27.75a

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

Effect of gibberellic acid, benzyladenine and the interaction significant ($p<0.01$) also effect of benzyladenine on Chl. (a) was significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid increased Chl. (a) content of *Schefflera arboricola* L. as 94.55% compared to control treatment (Table 3). Effect of the interaction significant ($p<0.01$) also effect of gibberellic acid and benzyladenine on Chl. (b) was or non significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid + 200 mg L^{-1} benzyladenine and 200 mg L^{-1} gibberellic acid increased Chl. (b) content of *Schefflera arboricola* L. as 9.75 and 7.80% compared to control treatment (Table 3). Effect of gibberellic acid, benzyladenine and the interaction significant ($p<0.01$) also effect of gibberellic acid and benzyladenine on Total Chl. a+b was significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid increased Total Chl. a+b content of *Schefflera arboricola* L. as 60.62% compared to control treatment (Table 3). Effect of gibberellic acid and the interaction significant ($p<0.01$) and also effect of benzyladenine on Carotenoids was significant ($p<0.05$) significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid + 100 mg L^{-1} benzyladenine and 100 mg L^{-1} gibberellic acid increased carotenoids content of *Schefflera arboricola* L. as 179.64 and 153.09% compared to control treatment (Table 3). Effect of gibberellic acid, benzyladenine and the interaction significant ($p<0.01$) also effect of on Sum pigments was significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid increased sum pigments of *Schefflera arboricola* L. as 69.66% compared to control treatment (Table 3).

Table 3: Effect of foliar application of gibberellic acid and benzyladenine on the Photosynthetic pigments of *Schefflera arboricola* L. 120 day after spray

GA_3	BA	(mg/ml fresh weight)				
		Chl. (a)	Chl. (b)	Total Chl. a+b	Carotenoids	sum pigments
0	0	6.43d	4.10abc	10.54d	1.13c	11.67d
	100	6.54d	4.16abc	10.70d	1.57bc	12.27d
	200	8.33c	3.79c	12.12c	1.91b	14.03c
100	0	8.14c	4.13abc	12.26bc	1.85b	14.12c
	100	8.60c	4abc	12.60bc	1.97b	14.33bc
	200	9.84b	3.93bc	13.78b	2.15b	15.94b
200	0	12.51a	4.42ab	16.93a	2.86a	19.80a
	100	11.94a	4.12abc	16.06a	3.16a	19.23a
	200	8.82bc	4.50a	13.33bc	1.90b	15.26bc

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

Results of the investigation showed that application of plant growth regulators in higher concentrations had positive effects on leaf chlorophyll content of Ficus benjamina, Schefflera arboricola and *Dizigotheeca elegantissima* foliage plants [36]. Using regulators of growth of GA_3 and BA, increased rate of chlorophyll in leaves of *Zantedeschia aethiopiea* plant [30]. GA_3 causes to increase plasticity of cellular wall, too. This problem can be due to acidification of cellular wall or as a result of absorption of calcium ion inside cytoplasm [6]. it has been proved that GA_3 increases activity of oxigenase carboxilase non phosphate ribolose (Rabisco) enzyme that is a main photosynthesis enzyme in plants. Results related to attribution, showed chlorophyll of leaf that application of GA_3 has a meaningful difference with control application that these results adapted with results of Mynett *et al.*, [31] in *Freesia* and Yaghoubi *et al.*, [47] in *Bellis perennis* about effect of GA_3 on increase of greenness index. GA_3 has structural role in membrane of chloroplast and causes to stimulate photosynthesis [21]. Chlorophyll has primary basic role from view of absorption and use of light energy in photosynthesis. So, effect of regulators of plant growth are effective on biosynthesis and decomposition of chlorophyll on photosynthesis, directly [3].
The done studies show in field of growth regulators such as GA_3 that they can cause to increase rate of dominant pigments like carotenoids [22, 20, 16].

CONCLUSION

In view of the obtained results, growth of a plant *Schefflera arboricola* L. can be stimulated through increase of synthesis of photosynthesis pigments by GA_3 and BA.

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