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Stimulatory Effect of gibberellic acid and benzyladenine on Growth and Photosynthetic pigments of *Ficus benjamina* L. Plants

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Abstract

Field trials with *Ficus benjamina* L. were conducted at the experimental farm of Faculty of Agriculture, University Azad Jiroft in 2012 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 *Ficus benjamina* plants. The obtained results show, number leaves was in a plant in 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 and respectively, with average of 133.25 and 130.5 that they did not show a meaniful diference, statically. maximum Length of lateral shoots and Number of shoot/plant was obtained in applications of 200 mg l^{-1} GA_3+200 mg l^{-1} BA with average of 30.74 cm and 21.75. The results show, by increasing concentration of regulators of growth, plant height, stem diameter, number of leaves and shoot/plant, leaf area, Length of lateral shoots, SPAD and Photosynthetic pigments is increased. highest value of chlorophyll of a, b was total and sum pigments in level of 200 mg l^{-1} GA_3, 100 mg l^{-1} GA_3+200 mg l^{-1} GA_3, 100 mg l^{-1} GA_3+200 mg l^{-1} GA_3 and 100 mg l^{-1} GA_3+200 mg l^{-1} GA_3 with average of 10.56, 5.81, 16.39 and 19.59 µg l^{-1}.

Key words: benzyl adenine (BA), *Ficus benjamina*, gibberellic acid (GA_3), leaf area, Photosynthetic pigments.

Introduction

Benjamin tree (*Ficus benjamina* L.) belongs to the Mulberry family. This ornamental plant is one of about 60 species of *Ficus* (Bailey & Bailey, 1976; Wagner *et al*., 1999). *F. benjamina* is a popular tree and cultivated worldwide for ornamental purposes. The genus *Ficus* is made up of about 1000 species from pan tropical and subtropical origins (Wagner *et al*., 1999). Plants in the genus are all woody, ranging from trees and shrubs to climbers (Neal, 1965).

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 (Padhye *et al*., 2008). It can be applied as a foliar spray or a

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substrate drench at different concentrations. The useful application concentration differs greatly among the ornamental plants and is generally unknown (Werbrouk *et al*., 1996).

The results obtained with exogenous cytokinins, however, vary depending on the type and concentration of the cytokinins used (Bosse and van Staden, 1989).

GAs form a large family of diterpenoid compounds, some of which are bioactive growth regulators, that control such diverse developmental processesas seed germination, stem elongation, leaf expansion, trichome development, and flower and fruit development (Davies, 1995). 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 (Emongor, 2004; Khan and Chaudhry, 2006).

It has been known that growth regulators among the agriculture practices which is most favorable for promoting and improving plant-growth of different plants (Eid and Abou-Leila, 2006).

The beneficial effect of gibberellic acid on different plants were recorded by Shedeed et al. (1991) on *Croton* plant, Chang *et al* (1998) on *Polianthes tuberose*, Brooking and Cohen (2002) on *Zantedeschia*, Al-khassawneh *et al* (2006) 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 (Khan *et al*., 2002).

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

Material and Methods

The present work was conducted during the successive seasons of 2012 at greenhouse of University Azad jiroft. Plastic pots 30 cm in diameter were used for cultivation that were filled with media containing a mixture of sand, Rice husk, Leaf composts and peat as1:1:1:1 by volume. Seedlings of (*Ficus benjamina* L.) leaves were planted at the first week of March in both seasons. The plants were fertilized with 3% liquid fertilizer in one doses after 4, 6 and 8 weeks from transplanting. The pots were arranged in factorial based complete randomize design with 9 treatments and 4 replicates. Application of gibberellic acid and benzyladenine 0, 100 and 200 $mg.L^{-1}$ each containing 10 ml (0.l'%) Tween-20 surfactant, at three stages that for each pot was used 40 cc of solution at each stage with 15 days intervals.

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 and shoot/plant, leaf area (cm^2), Length of lateral shoots (cm), Chlorophyll index (SPAD) and Photosynthetic pigments (µg/ml) method according to Lichtenthaler, (1987) were calculated.

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

The most number of produced leaves was in a plant in 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 and respectively, with average of 133.25 and 130.5 that they did not show a meaniful diference, statically (table 1). In a research, by Zieslin and Tsujita (1998) on *Lilium* and Hamano *et al* (2002) 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 surface (Lester et al, 2002).

The application witnessed control, 100 mg l^{-1} GA_3 and 100 mg l^{-1} BA with least number of leaves, with averages of 97.25, 105 and 108.25 respectively that they showed a meaningful difference with application of 400 mg l^{-1} BA. Application of *Zantedeschia aethiopiea* caued to increase number of leaves by spraying solution of BA (Majidian et al, 2012).

In view of results of table (1), maximum Length of lateral shoots and Number of shoot/plant was obtained in applications of 200 mg l^{-1} GA_3+200 mg l^{-1} BA with average of 30.74 cm and 21.75. The results show, by increasing concentration of regulators of growth, Length of lateral shoots and Number of shoot/plant is increased, too. It seems regulators of growth of length GA_3 have shown better effect than BA in index of Length of lateral shoots and Number of shoot/plant. GA_3 by effecting cellular processes such as cellular division stimulation, lengthening cells caused to increase growing growth (Stuart and Jones, 1977). GA_3 s 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 (Arteca, 1996).

The most number of Stem Diameter was in a plant in applications of 100 and 200 mg l^{-1} GA_3, control and respectively, with average of 0.45, 0.43and 0.43 that they did not show a meaniful diference, statically (table 1). Leaf surface was under a meaningful effect of regulators of growth, maximum leaf surface was in application of 400 mg l^{-1} GA_3+200 mg l^{-1} BA and 400 mg l^{-1} GA_3+100 mg l^{-1} BA with averages of 63.56 and 51.73 cm^2, respectively. Results of table (1) showed, by increasing concentration of regulators of growth, leaf surface increased as meaningful, too. Minimum value of leaf surface in witness application, was obtained as 100 mg l^{-1} BA, control and 100 mg l^{-1} GA_3+100 mg l^{-1} BA, on average as 37.16, 37/58 and 40.96 cm^2, respectively. Levels of 400 mg l^{-1} BA had a meaningful difference to each other in comparison with control level (table 1). GA_3s cause to accelerate cellular division by stimulating existing cells in phase G_1 to enter phase S and shortening phase S (Baninasab and Rahemi., 1994).

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 (Fox and Weis, 1965; Zhu and Matsumoto, 1987). 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.

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 (Whitman et al., 2001). In watermelon, sprays should be limited to the ovaries in order to stimulate parthenocarpy (Maroto et al., 2005). Lower stem sprays have been used to stimulate branching in *Monstera* and *Alocasia* (Henny and Fooshee, 1990a, 1990b). Crown sprays have been used on *Hosta* (Keever and Warr, 2005).

Table 1- Effect of GA_3 and BA on plant growth parameters of *Ficus benjamina* kept for 60 day

GA_3	BA	leaf Chlorophyll Index (SPAD)	Plant Height (cm)	Length of lateral shoots (cm)	No. of shoot/plant	Stem Diameter (cm)	Leaf area (cm^2)	No. of leaves/plant
0	0	12.58b	57.5d	29.1b	12.25e	0.43a	37.58e	97.25d
	100	18.57ab	64.25bc	27.77bc	12.75de	0.4ab	37.16e	108.25cd
	200	16.49b	65.75bc	28.25bc	14.5cd	0.32c	44.39cd	126.75ab
100	0	12.78b	60.5cd	29.15b	15.25bc	0.45a	43.83cd	105cd
	100	13.48b	63bcd	27.75bc	17b	0.42ab	40.96de	117.5bc
	200	13.75b	64bc	28.3bc	20a	0.41ab	47.73bc	114.75bc
200	0	16.97b	63.75bcd	27.35c	14.25cde	0.43a	45.68cd	114c
	100	13.66b	69.25b	28.7bc	16.25bc	0.36bc	51.73b	133.25a
	200	23.66a	76.5a	30.74a	21.75a	0.39ab	63.56a	130.5a

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

In view of results of table (1), maximum index of chlorophyll was obtained in application of 200 mg l^{-1} GA_3 +200 mg l^{-1} BA and 100 mg l^{-1} BA with average of 23.66 and 18.57. By increasing concentration of regulators of growth, index of chlorophyll was increased, too. Using regulators of growth of GA_3 and BA, increased rate of chlorophyll in leaves of *Zantedeschia aethiopiea* plant (Majidian et al, 2011). Minimum value of index of chlorophyll was obtained in witness application. It seems, regulator of growth of BA has shown a better effect than GA_3 in index of chlorophyll content. GA_3 causes to stimulate sucrose synthesis and transfer it from leaf to filter vessel (Arteca, 1996). 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 (Arteca, 1996; Aggarwal and Sachar., 1995). on the one hand, GA_3s 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 (Leshem, 1973).

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 (Baninasab and Rahemi., 1994). 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.

The results (table 2) of this test indicated this problem that regulators of BA and GA_3 were effective on photosynthesis pigments. The highest value of chlorophyll of a, b was total and sum pigments in level of 200 mg l^{-1} GA_3, 100 mg l^{-1} GA_3+200 mg l^{-1} GA_3, 100 mg l^{-1} GA_3+200 mg l^{-1} GA_3 and 100 mg l^{-1} GA_3+200 mg l^{-1} GA_3 with average of 10.56, 5.81, 16.39 and 19.59 μg l^{-1}. By increasing concentration of GA_3 and BA, value of chlorophyll a is increased. 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 (2001) in *Freesia* and Yaghoubi et al (2013) 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 (Janowsk and Jerzy., 2003). Minimum value of chlorophyll of a, b and total was in100 mg l^{-1} GA_3, 200 mg l^{-1} BA and control application with average of 4.87, 2.37 and 9.09 μg l^{-1} (table 2). 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 (Arteca., 1996).

Table 2. Effect of foliar application of benzyladenine (BA) and gibberellic acid (GA_3) on the Photosynthetic pigments of *Ficus benjamina* Plant kept for 60 day

GA_3	BA	(µg/ml fresh weight)				
		Chl. (a)	Chl. (b)	Total Chl. a+b	Carotenoids	sum pigments
0	0	5d	4.09bc	9.09e	2.73c	11.82c
	100	5.38d	4.39b	9.77de	2.62c	12.39c
	200	7.91c	2.37d	10.29d	1.89d	12.18c
100	0	4.87d	3.49c	9.86de	2.74c	11.1c
	100	9.63ab	5.18a	14.81c	3.85a	18.66ab
	200	10.53a	5.81a	16.39a	3.19b	19.59a
200	0	10.56a	5.32a	15.88ab	2.92bc	18.8ab
	100	9.34b	5.39a	14.73c	2.18d	16.91b
	200	9.58ab	5.52a	15.11c	2.13d	17.24ab

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

The highest value of carotenoids was obtained in application of 100 mg l^{-1} GA_3+ 100 mg l^{-1} BA and 100 mg l^{-1} GA_3+ 200 mg l^{-1} BA with average of 3.85 and 3.19 μg l^{-1}. 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 (Kim *et al*, 2006; Hyun Jin et al, 2007; Glick et al, 2007). Minimum value of carotenoids was in application 200 mg l^{-1} BA with average of 1.89 μg l^{-1} (table 2). Application of 100 mg l^{-1} GA_3 +200 mg l^{-1} BA, 200 mg l^{-1} GA_3 and 100 mg l^{-1} GA_3 +100 mg l^{-1} BA with averages of 19.59, 18.8 and 18.66 μg l^{-1} followed highest value of sum of pigments and its minimum was obtained in100 mg l^{-1} GA_3 and control application with average of 11.1 and 11.82 μg l^{-1} (table 2).

Conclusion

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

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