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Positive effect of growth regulators on the soluble carbohydrates of *Ficus benjamina, Schefflera arboricola* and *Dizigotheeca elegantissima* plants

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Abstract

The effect of Gibberellic acid and Benzyladenineon *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima* plants was evaluated at pot cultivation conditions. This study was performed in three factorial test based on completely randomized design and 4 repeatswith 9 treatments. The aim of this work is to study the effect of foliar application with gibberellic acid (GA_3) at 0, 100 and 200 mg.$L^{-1}$and and benzyladenine (BA) at 0, 100 and 200 mg.L^{-1} levels. The results showed, Effect of gibberellic acid and the interaction ($p<0.01$) and also effect of benzyladenine ($p<0.05$) on soluble carbohydrates was significant for *Dizigotheeca elegantissima* plant. gibberellic acid, benzyladenine and the interaaction ($p<0.01$) on soluble carbohydrates was significant for *Ficus benjamina* and *Schefflera arboricola* plants. Results obtained in this investigation indicated that simultaneous application of 200 mg l^{-1} of gibberellic acid and benzyladenine significantly promoted soluble carbohydrates content in ornamental leaf *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima* plants. Results showed that 200 mg L^{-1} gibberellic acid + 100 mg L^{-1} benzyladenine increased soluble carbohydrate content of *Dizigotheeca elegantissima* and *Ficus benjamina* plants as 25.29 and 36.09% compared to control treatment.

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Introduction

Plant growth regulators (Cytokinins and gibberellins) are used in agricultural industry for stimulation and synchronization of flowering and fruit setting, promotion of rooting, reduction of vegetative growth, reduction of lodging of agronomic crops, or defoliation (Briant, 1974).

Cytokinins are important plant hormones that regulate various 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 *Polianthustuberosa,* 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.

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 (Davies, 1995). In addition, GA_3, 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 objective of the present work was to study the effects of different plant growth regulators, gibberellic acid and benzyladenine on the soluble carbohydrates of *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima* plants.

Materials and methods

Cultivation Conditions

In 2013 year, *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima* plants were cultivated at the experimental farm of University Azad Jiroft. Three 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 22ºC 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 *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima* plants 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 three 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 (Carey *et al.,* 2008).

Estimation of Soluble Carbohydrates

Method developed by Fales (1951) was used for evaluation of soluble carbohydrates. 0.1g of aerial part was mixed with 2.5ml of 80% ethanol under 90ºC for 60 min (two 30-min periods), soluble carbohydrates were extracted, the extracts were filtered using filter paper and the alcohol was evaporated. The resulted pellet was dissolved in 2.5ml of distilled water. From each sample, 200µl was transferred in to a test tube and 5ml of Anthrone reagent was added. After mixing, the mixture was placed for 17min in 90ºC bath and then was cooled. Absorbance of the mixture was read in 625nm. Concentration of each sample was calculated using standard curve as mg per gr of fresh weight.

Drawing Standard Curve

Concentrations of 20, 40, 80, 120, 160 and 200 mg/l of glucose were prepared. About 1ml of each concentration was poured in separate tubes and 5ml of Anthrone reagent was added. After mixing, the mixture was placed for 17min in 90ºC bath to blue color become apparent. Absorbance of each sample was read in 625nm by spectrophotometer and the absorbance curve based on concentration was drawn and the line equation was obtained.

Preparation of Anthrone Reagent

0.4 gr of Anthrone was dissolved in 200ml of sulfuric acid. The solution was gently added to a glass containing 60ml of distilled water and 15ml of 95% ethanol was added. The mixture was thoroughly mixed during cooling.

Statistical Analysis

All these experiments were replicated four times, and the average values are reported. The effect of Benzyladenine and Gibberellic Acid on Reducing Sugars of *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima* plants were determined using the analysis of variance (ANOVA) method, and significant differences of means were compared using Duncan's test at 5 % significant level using the SAS software (2008) program.

Results and discussion

Dizigotheeca elegantissima Test Results

Effect of gibberellic acid and the interaction ($p<0.01$) and also effect of benzyladenine ($p<0.05$) on soluble carbohydrates was significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid + 100 mg L^{-1} benzyladenine and 200 mg L^{-1} benzyladenine increased soluble carbohydrate content of *Dizigotheeca elegantissima* as 25.29 and 21.43% compared to control treatment (fig 1). Juvenile *Spathiphyllum wallisii* regel in height were given a foliar spray to runoff with benzyladenine (BA) at 0, 100, 200 and 400 mg. L^{-1} and gibberellic acid (GA_3) at 0, 100 and 200 mg.L^{-1}. At 6 months after treatment a linear increase in reducing sugar in *Spathiphyllum wallisii* regel plants was evident with increasing BA and GA_3 concentration (Salehi sardoei *et al*., 2014a).

A second experiment involved Jerusalem Cherry (*Solanum pseudocapsicum* L.) plants of similar size to those in the first experiment. In this test The main factor was included spraying, drip and spraying + drip. Secondary factor was included concentrations of GA_3 at 0, 100, 200 and 400 mg.L^{-1} levels. Result showed that GA_3 concentration and its usage methods had significant effect on ($P<0.05$) reducing sugars content. By increasing in concentration, reducing sugar decreased at three methods respect to control. Drip method with 100 mg.L^{-1} contained the highest amount of reducing sugars, whereas spraying + drip method with 100 mg.L^{-1} had the least amount of reducing sugars. In this study, plants to drip method increased the amount of reducing-sugars compared to the spray + drip method (Salehi sardoei *et al*., 2014b).

Schefflera arboricola Test Results

Effect of gibberellic acid, benzyladenine and the interaction ($p<0.01$) on soluble carbohydrates was significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid + 100 mg L^{-1} benzyladenine, 200 mg L^{-1} benzyladenine and 200 mg L^{-1} gibberellic acid +

200 mg L^{-1} benzyladenine increased soluble carbohydrate content of *Schefflera arboricola* as 23.52, 21.43 and 18.68% compared to control treatment (fig 2). The increase in the sugar content with advancement in age could be due to stimulation of amylase and other hydrolytic enzymes promoting the hydrolysis of storage reserves due to senescence. It is expected that with advancement in the crop growth, metabolic activity of the plants is increased to support the reproductive growth. Plant growth regulators (growth promoter and growth retardants) are known to regulate the metabolism in the plant by increasing the duration of the source there by maintaining the proper balance of source and sink. The degree of perfect physiological relations indirectly affects the flowering without causing malformation in the plants. In this connection, application of growth retardants to optimize plant production by modifying growth, development and the quantitative and qualitative yield of crop plant hold promise and sunflower is not an exception for this.

Table 1. Analysis of variance for the effects of Gibberellic Acid and Benzyladenine on *Dizigotheeca elegantissima, Schefflera arboricola* and *Ficus benjamina* plants.

S.O.V	df	MS		
		Dizigotheeca elegantissima	Schefflera arboricola	Ficus benjamina
Gibberellic Acid	2	215.93**	691.97**	3459.05**
Benzyladenine	2	288.15*	442.05**	1175.65**
Gibberellic Acid × Benzyladenine	4	390.40**	254.38**	206.15**
Error	27	80.17	75.09	47.99

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

Ficus benjamina Test Results

Effect of gibberellic acid, benzyladenine and the interaction ($p<0.01$) on soluble carbohydrates was significant (Table 1). Results showed that 200 mg L^{-1} gibberellic acid and 200 mg L^{-1} gibberellic acid + 200 mg L^{-1} benzyladenine increased soluble carbohydrate content of *Ficus benjamina* as 36.09 and 20.90% compared to control treatment (fig 3). Thus *Ficus benjamina* plants were higher than control plants in all plotstreated with GA_3 and Benzyladenine, while treatment of 100 mg.L^{-1} GA_3 had no significant difference with control treatment. Reducing sugars content in *Schefflera arboricola* plant remained unaffected with 0 mg.L^{-1} BA + 100 mg.L^{-1} GA_3 treatment, while it was decreased markedly by 100 mg.L^{-1} BA, 100 mg.L^{-1} BA + 100 mg.L^{-1} GA_3, 100 mg.L^{-1} BA + 200 mg.L^{-1} GA_3 and 200 mg.L^{-1} BA. The treatments of 100 mg.L^{-1} BA + 100 mg.L^{-1} GA_3, 100 mg.L^{-1} BA + 200 mg.L^{-1} $GA_3$and 200 mg.L^{-1} BA had higher reducing sugars than control and treatments of 200 mg.L^{-1} GA_3, 100 mg.L^{-1} BA, 200 mg.L^{-1} BA + 100 mg.L^{-1} GA_3 and 200 mg.L^{-1} BA + 200 mg.L^{-1} GA_3 had lower reducing sugars than control treatment (Salehi sardoei *et al.*, 2014c).

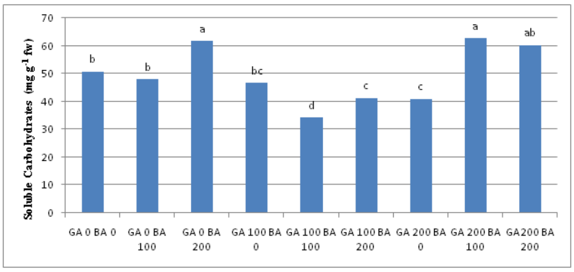

Fig. 1. Effect of various concentrations of gibberellic acid and benzyladenine on soluble carbohydrates of *Dizigotheeca elegantissima* plant (Means with same superscripts had no significant difference with each other (P >0.05). GA: Gibberellic Acid, 0, 100 and 200 (mg. L^{-1}) and B: Benzyladenine, 0, 100 and 200 (mg. L^{-1}) are concentrations of Gibberellic Acid and Benzyladenine.

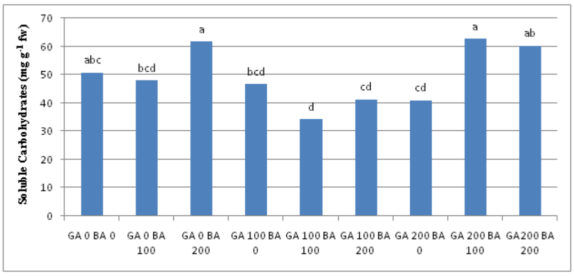

Fig. 2. Effect of various concentrations of gibberellic acid and benzyladenine on soluble carbohydrates of

Schefflera arboricola plant (Means with same superscripts had no significant difference with each other (P >0.05). GA: Gibberellic Acid, 0, 100 and 200 (mg. L^{-1}) and B: Benzyladenine, 0, 100 and 200 (mg. L^{-1}) are concentrations of Gibberellic Acid and Benzyladenine.

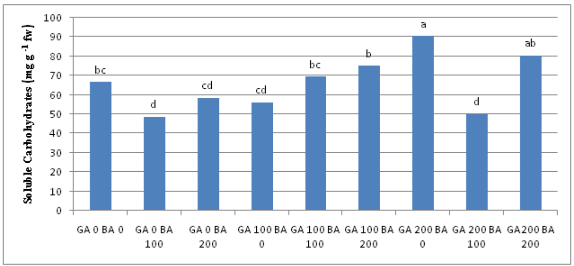

Fig. 3. Effect of various concentrations of gibberellic acid and benzyladenine on soluble carbohydrates of *Ficus benjamina* plant (Means with same superscripts had no significant difference with each other (P >0.05). GA: Gibberellic Acid, 0, 100 and 200 (mg. L^{-1}) and B: Benzyladenine, 0, 100 and 200 (mg. L^{-1}) are concentrations of Gibberellic Acid and Benzyladenine.

Abiotic stresses cause change in carbohydrate content whose amount is positively correlated with photosynthesis. As a physiologic process, photosynthesis has the highest sensitivity to high temperature. The result of increased temperature and consequent damages is disequilibrium between photosynthesis and respiration. In general, increased temperature results in reduction of photosynthesis and increase in respiration photorespiration (Pancheva and Popova., 1998). Under stress condition, plant respiration is increased and plant demands more substrate to produce energy. Moreover, heat stress has significant influence on biosynthesis of starch and sucrose by reducing activity of sucrose synthase, ADP-glucose pyrophosphorylase and invertase. Regarding reduced photosynthesis and declined content of soluble sugars, carbohydrate stores are concerted to soluble sugars. Since soluble carbohydrates are cellular osmolytes, increase in soluble sugar content is effective in water retention and prevention of dehydration (Camejo *et al.*, 2005). Accumulation of soluble sugars in geranium leaves increased accumulation of starch for retention of cell turgescence. When water potential in a leaf is reduced, accumulation of sugars probably plays the main role of osmotic adjustment (Arora *et al.*, 1998).

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