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# Reducing sugar assessment on three indoor ornamental plants with growth regulators

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**Key words:** Benzyladenine, *Dizigotheeca elegantissima, Ficus benjamina*, gibberellic acid, reducing sugar, *Schefflera arboricola*.

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**Abstract**

The effect of GibberellicAcidand 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, 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 (no spray).

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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 reducing sugar of *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima* plants.

## Materialsand 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 Reducing Sugars*

Glucose and fructose containing aldehyde and ketone groups can be oxidized by some materials. Sugars containing free anomeric carbons are called reducing sugars. In this experiment, presence of reducing sugars reduced $Cu^{+2}$ to $Cu_2O$. $Cu_2O$ reduces phosphomolybdic acid which produces blue color formation. Severity of produced color which is positively correlated with reducing sugars concentration can be evaluated by spectrophotometer. Somogymethod (1952) was used to determine the concentration of reducing sugars. 0.02 g of aerial part was pulverized with 10ml of distillated water. The mixture was transferred in to a small beaker and heated on electrical stove. Heating was stopped when the mixture reached boiling point; content of the beaker was filtrated by whatman filter paper no.1 to obtain plant extract. 2 ml of the plant extracts was transferred to test tube, 2 ml of copper sulphate was added, the tubes were sealed with cotton and incubated for 20 min in water bath 100°c. in this step, $Cu^{+2}$ is transformed in to $Cu_2O$ by reduced aldehyde monosaccharide and a brick red color is observed. When the tubes were cooled, 2 ml of phosphomolybdic acid was added and blue color appeared. The test tubes were thoroughly agitated until the color was evenly distributed in the tube. Absorbance was determined in 600 nm by spectrophotometer and concentration of the reducing sugars was calculated by drawing standard curve. The results were calculated and reported as mg per g of fresh weight.

*Drawing Standard Curve*

To draw standard curve, concentrations of 5, 10, 20, 40, 60 and 100 mg $L^{-1}$ of glucose were prepared and 2 ml of each concentration was poured in clean test tube. Other steps were performed as for unidentified samples and solution absorbance was read by spectrophotometer in 600 nm. Absorbance curve was drawn against concentration and the line equation was achieved.

*Preparation of Copper Sulphate Solution*

40 g of anhydrous sodium carbonate was dissolved in 400 ml of distillated water and added to 7.5 g of tartaric acid. After dissolving in acid, 4.5g of $CuSO_4.5H_2O$ was added and final volume was increased to 1 liter.

*Preparation of Phosphomolybdic Acid Solution*

70 g of phosphomolybdic acid and 10 g of sodium tungstate were dissolved in 700 ml of 5% hydroxide sodium and heated for 40 min. when the solution was cooled, 250 ml of 85% phosphoric acid was added and the final volume was increased to1 liter.

*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

In order to determine how $GA_3$ and Benzyladenine application might affect reducing sugars of *Ficus benjamina*, *Schefflera arboricola* and *Dizigotheeca elegantissima,* 9 different types of field trials were conducted. Aerial parts were harvested to compare the level of reducing sugar inthe plants.

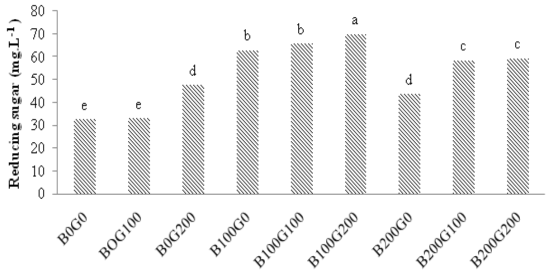


**Fig. 1.** Effect of various concentrations of Benzyladenine and Gibberellic Acid on Reducing Sugar of *F. benjamina* Plant (Means with same superscripts had no significant difference with each other (P >0.05). (B: Benzyladenine, 0, 100 and 200 (mg. $L^{-1}$), G: Gibberellic Acid, 0, 100 and 200 (mg. $L^{-1}$) are concentrations of Benzyladenine and Gibberellic Acid).

*Ficus benjamina* reducing sugars was affected by $GA_3$ and Benzyladenine application (Fig 1). The most pronounced effects on plant reducing sugar were recorded afterapplication of $GA_3$ and Benzyladenine at concentrations of 200 and 100 $mg.L^{-1}$ respectively. 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 (Fig 2). Maximal reducing sugar efficiency of *Scheffleraar boricola* was significantly increased with increasing of $GA_3$ concentration. A significant increase in reducing sugars content was observed after treatment with 200 $mg.L^{-1}$ $GA_3$, 200 $mg.L^{-1}$ BA + 100 $mg.L^{-1}$ $GA_3$ and 200 $mg.L^{-1}$ BA + 200 $mg.L^{-1}$ $GA_3$.

As can be seen from Figure (3) various concentrations of Benzyladenine and Gibberellic Acid have significant differences ($P < 0.05$) on Reducing Sugar of *Dizigotheeca elegantissima* Plant. Among studied treatments, 200 $mg.L^{-1}$ BA contained the highest amount of Reducing Sugar. 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 (no spray).

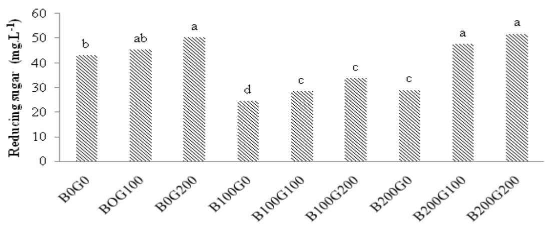


**Fig. 2.** Effect of various concentrations of Benzyladenine and Gibberellic Acid on Reducing Sugar of *S. arboricola* Plant (Means with same superscripts had no significant difference with each other ($P > 0.05$). (B: Benzyladenine, 0, 100 and 200 ($mg. L^{-1}$), G: Gibberellic Acid, 0, 100 and 200 ($mg. L^{-1}$) are concentrations of Benzyladenine and Gibberellic Acid).

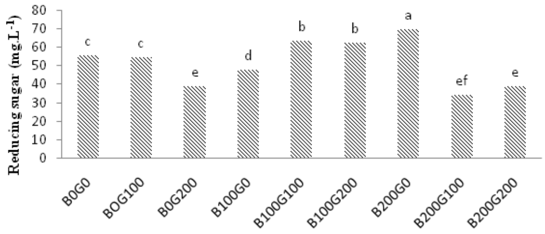


**Fig. 3.** Effect of various concentrations of Benzyladenine and Gibberellic Acid on Reducing Sugar of *D. elegantissima* Plant (Means with same superscripts had no significant difference with each other ($P > 0.05$).

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).

The effect various concentrations of Benzyladenine and Gibberellic acid on reducing sugars of *Dizigotheeca elegantissima* were shown in Figure (3). 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.

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.

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