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The Effect of Gibberellic Acid on Reducing Sugar of Jerusalem Cherry (*Solanum pseudocapsicum* L.) Plant

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ABSTRACT

The effect of Gibberellic Acid (GA_3) on Jerusalem cherry (*Solanum pseudocapsicum* L.) was evaluated at pot cultivation conditions. This study was performed in factorial test based on complete random design plan and 4 repeats with 12 treatments. 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. Also, both method of spray and drip Compared with in spray + drip method increased reducing-sugars. The highest content of reducing-sugars obtained with application of 100 mg. L^{-1} With drip method was 27.20% higher compared to the control treatment.

Key words: Gibberellic Acid, Reducing Sugar, *Solanum pseudocapsicum*.

INTRODUCTION

Solanum pseudocapsicum L. (Solanaceae), known as winter cherry, is a poisonous plant. It is often cultivated as an indoor ornamental plant due to its beautiful but poisonous berries. It is an erect and highly branched shrub with non-spiny stem reaching a height of five meters. It bears star-shaped flowers with dark-green lanceolate leaves. At maturity, its glabrous red to yellow berries is attractive but very poisonous. The number of seeds per berry ranges from 50 to 100 while the berries could be as many as 100 per plant (Bassett and Munro, 1985). 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). On the other hand, plant growth retardants, such as ancymidol, daminozide, paclobutrazol, chlormequat chloride, and uniconazole are used specifically to reduce vegetative growth and control plant size and shape (Latimer, 1991). Gibberellins (GAs) mediate many responses in plants from seed

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germination to senescence (Davies, 1995). The most widely available compound is gibberellic acid (GA_3), which induces stem and internode elongation, seed germination, enzyme production during germination, and fruit setting and growth (Dijkstra and Kuiper, 1989; Ross et al., 1990; Davies, 1995). The beneficial effect of gibberellic acid and benzyladenine on different plants were recorded by Rahbarian et al. (2014) on Spathiphyllum plant, Salehi Sardoei *et al* (2014) on *Ficus benjamina*, they concluded that gibberellic acid is used to regulating plant growth through increasing cell division and cell elongation.

Gibberellins are commonly used as growth enhancers because they cause cell elongation in the plant. ProGibb and GibGro are commonly used in the ornamental plant industry for this. They can be used to partially overcome dormancy, increase flower size, flower number, flower uniformity, and to create standards. They may also be used to help overcome anti-GA PGR overdoses. When using GA's to overcome PGR overdoses, it is important to apply very small doses and watch the crops closely for an effect. A gibberellin overdose will result in a spindly unmarketable plant (Runkle, 2006). In order to determine how GA_3 application might affect phenolics content of *C. officinalis*, both leaves and the steams were harvested to compare the level of phenolics in the plants (Salehi Sardoei et al., 2014). GA_3 sprays enhanced plant, Offsets Production, in Aloe vera (Salehi Sardoei et al., 2013).

Gibberellins are synthesized from mevalonic acid in young tissues of shoots and developing seeds (Davies, 1995). Transport is via both the xylem and the phloem. The effects of gibberellins vary by plant species (Salisbury, 1969). Some plant species respond with an increase in height due to an increase in cell length. Other plant species respond to gibberellins by increasing cell number as well as an increase in size, most likely cell length. Gibberellins prevent the development of lateral buds when applied to decapitated shoots of several species (Salisbury, 1969). Exogenous applications of GA_{4+7} inhibited lateral bud break of *Euphorbia lathyris*, and increased plant height, quadratically (Preece, 1989).

However, gibberellins have also been noted to increase lateral branching in plants. GA_3 was applied to English ivy (*Hedra helix* L.) at various rates to pruned and intact plants (Lewnes and Moser, 1976). Pruned plants experienced an increase in bud break on primary lateral shoots. Intact plants responded differently, as GA_3 did not affect those buds that developed prior to treatment. Lateral growth occurred only on bud initiation that took place subsequent to GA_3 treatment. Imamura and Higaki (1988) experienced a slight linear decrease in the number of shoots produced from pinched juvenile *Anthurium* plants with an increase in GA_3 concentration. However, a linear increase in shoots was observed with an increase of GA_3 concentration on pinched plants. Similar results occurred with mature *Anthurium*, however, applications of 500 ppm GA_3 resulted in an increase in lateral shoots without pinching. In conclusion, the effect of gibberellins on lateral branch development varies with species and gibberellin type and is dependent on the amount of apical influence. Highest content of reducing-sugars *Spathiphyllum wallisii* obtained with application of 100 mg. L^{-1} With drip method was 88.08% higher compared to the control treatment (Salehi Sardoei et al., 2014). This research was aimed to investigating the gibberellic acid concentrations effects on reducing sugar of indoor ornamental plant, Solanum pseudocapsicum L.

MATERIALS AND METHODS

In 2013 year, Jerusalem cherry (*Solanum pseudocapsicum* L.) plants were cultivated at the experimental farm of University Azad Jiroft. Factorial methods in complete random test with 4 repeats and 12 treatments were used for this experiment. Uniform offsets size of 18-20 cm were completely randomly design 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 Transplanting of Jerusalem cherry were immersed by Gibberellic Acid contained 0 [control treatment], 100, 200 and 400 mg.L^{-1}. was 0.l %. Tween-20 surfactant, by spraying, drip and spraying + drip methods was used at three stages for each pot. They used as 50 cc of solution at each stage with 10 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. Somogy method (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 $100^{\circ c}$. 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 three times, and the average values are reported. The effect of Gibberellic Acid on reducing sugars of Jerusalem cherry plant by three methods (spraying, drip and spraying + drip) were determined using the analysis of variance (ANOVA) method, and significant

differences of means were compared using Duncan's test at ($P < 0.05$) significant level using the SAS software (2008) program.

RESULTS AND DISCUSSION

The effect of GA_3 by three methods (spraying, drip and spraying + drip) on reducing sugars of Jerusalem cherry was shown in Figure (1). As can be seen from figure (1), 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 $mg.L^{-1}$ GA_3 had the least amount of reducing sugars. The treatments of 200 $mg.L^{-1}$ GA_3, 100 $mg.L^{-1}$ BA + 100 $mg.L^{-1}$ GA_3, 200 $mg.L^{-1}$ BA + 200 $mg.L^{-1}$ GA_3, 400 $mg.L^{-1}$ BA, 400 $mg.L^{-1}$ BA + 100 $mg.L^{-1}$ GA_3 and 400 $mg.L^{-1}$ BA + 200 $mg.L^{-1}$ GA_3 had higher reducing sugars than control (no spray) and treatments of 100 $mg.L^{-1}$ GA_3, 100 $mg.L^{-1}$ BA, 100 $mg.L^{-1}$ BA + 200 $mg.L^{-1}$ GA_3, 200 $mg.L^{-1}$ BA and 200 $mg.L^{-1}$ BA + 100 $mg.L^{-1}$ GA_3 had lower reducing sugars than control treatment (Salehi Sardoei et al., 2014).

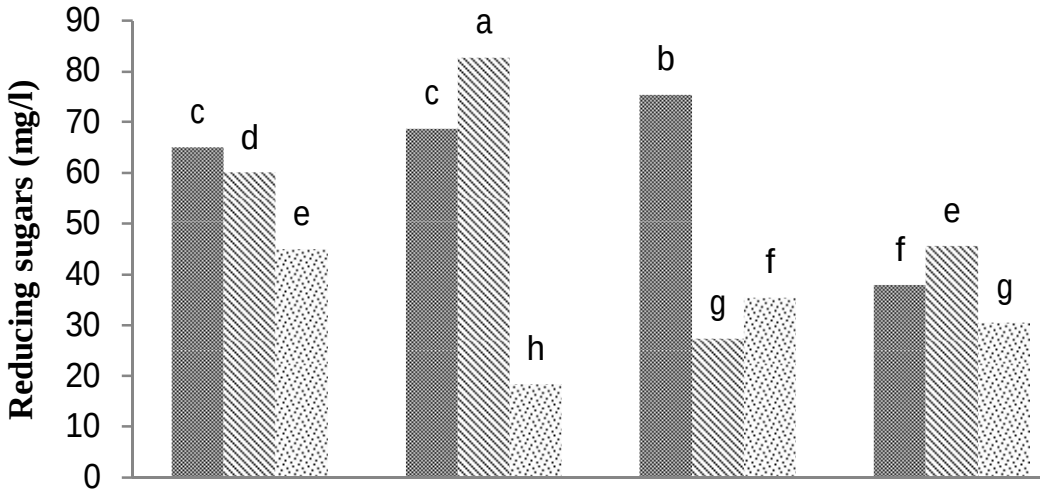

Figure 1- Effect of Gibberellic acid on reducing sugars of Jerusalem cherry by three methods (spraying, drip and spraying + drip)

Means with same superscripts had no significant difference with each other ($P > 0.05$)

In this study, plants to drip method increased the amount of reducing-sugars compared to the spray + drip method. Also, both method of spray and drip Compared with in spray + drip method increased reducing-sugars. The Highest content of reducing-sugars obtained with application of 100 mg. L^{-1} with drip method was 27.20% higher compared to the control plants (fig 1). 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). 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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