Effect of different levels of cycocel on the vegetative growth and flowering of *Gardenia jasminoides* J. Ellis plant

M. N. Soliman *, N. M. Toaima, and S. M. Mahmoud

Department of Horticulture, Faculty of Agriculture, Al-Azhar University, Cairo, Egypt.

* Corresponding author E-mail: mahmoudnour@azhar.edu.eg (M. Soliman)

ABSTRACT:

Gardenia is one of the important indoor plants in the flower market. This study was conducted to evaluate the effect of different concentrations of cycocel (0, 1500, 3000, and 4500 ppm) on vegetative growth, flowering and pigments content of *Gardenia jasminoides* J. Ellis plant. Treatment with high concentrations of cycocel (4500ppm) led to a significant decrease in plant height and a reduction of fresh and dry weight, while it increased branching in contrast to low concentrations and control. Moreover, spraying with cycocel at rates of 4500 and 3000 ppm enhanced early flowering. The highest values of number of flowers were especially by spraying plants with 4500 ppm of cycocel, followed by plants treated with cycocel at a rate of 3000 ppm. Accordingly, the highest value of fresh and dry weights of flowers was due to treatment with cycocel moderate rate of 3000 ppm. Furthermore, the contents of chlorophyll and carotenoids were upgraded in plants sprayed with cycocel at all concentrations used.

Keywords: *Gardenia jasminoides*; cycocel; flowering; chlorophyll; carotenoids content.

INTRODUCTION

Nowadays, the indoor plants became necessary to decorate and overcome serious problems of environmental pollution, particularly in the closed place or small apartments (Mostafa *et al*., 2013 and Apeda, 2014). One of these important plants is *Gardenia jasminoides* J. Ellis (family Rubiaceae) which gives out a strong enticing smell and sweet fragrance when they are in bloom (Govaerts *et al*., 2010). The plant is native to the tropical and subtropical regions (Chen and Taylor, 2011 and Chandraju *et al*., 2011) and it is an evergreen shrub, 2–8 feet high with grayish bark with glossy, dark green leaves. The waxy, highly fragrant and white flowers are commonly borne singly in the leaf axes. Flowering start about mid-spring to mid-summer and many species are strongly scented (Kobayashi and kaufman, 2006 and Chandraju *et al*., 2011).

Today with the advancement of technology, controlling plant size is one of the most important aspects in floricultural crops which can be achieved genetically, environmentally, culturally or chemically (Cowling, 2010 and Gopichand *et al.*, 2014). The use of chemical growth retardants is a standard practice to control stem elongation needed for compact flowering plant growth whereas gardenia plant is one of them (Larson,1992 and Baerdemaeker *et al*., 1994). This in turn is required for flower production associated with reducing the costs (Halevy, 1995., Rademacher, 2000 and Latimer, 2001). On the other hand, global scale of flower trade requires that cut flowers should preserve their post-harvest quality life as long as possible, both during the market chain and at the consumer's hand (Van and Han, 2011).

The objective of the current study is to control gardenia height and produce higher quality compact potted plants by examining the efficiency of different rates of cycocel for the control of stem elongation, increasing branching and improve the quality of flowers.

MATERIALS AND METHODS

This investigation was carried out in the Experimental Farm of Horticultural Department, Faculty of Agriculture, Al- Azhar University, Nasr City, Cairo, Egypt, during the two successive seasons of 2018/2019 and 2019/2020, respectively.

Plant material and cultivation:

Rooted cuttings of *Gardenia jasminoides* plants at length of about 6 cm were obtained from the Floramix Egypt Company for cut flowers, Giza, Egypt, and were prepared to be used in this study. The cuttings were then planted in Pots of 20 cm diameter full of soil mixture (20% perlite and 80% peat moss v/v) which were prepared homogeneity before plants cultivation. The pots were arranged into groups according to the number of treatments whereas each treatment contains 3 replicates. The different groups of the prepared pots were placed on bricks with spacing of 40 cm x 40 cm (density of 8 plants/m^2) between both pots and rows. Moreover, kept inside by the greenhouse of 63% shading. The rooted cuttings were transferred to the above prepared pots and were irrigated with drip irrigation with a frequency depending on the weather and plants conditions. System of mist was used to relieve the high temperature and manipulate humidity condition inside the greenhouse to keep the plants grow under the suitable growth condition. Pinching was carried out after the 21st day (3 weeks) from planting. Soil mixture was chemically analyzed at National Research Centre, Dokki, Cairo, Egypt and the recorded data were presented in Table (1). Both the temperature and humidity were retinted in Fig. (1 & 2). The agricultural procedures (e.g., fertilization, fungicide and insecticide) were done whenever it was necessary. Different rates of cycocel [2 chloroethyl trimethyl ammonium chloride] were prepared at rates of 0.0, 1500, 3000 and 4500 ppm and were applied during the growing stage of *Gardenia jasminoides*. Cycocel treatments were started after 5 weeks from cultivation of the rooted cutting (2 weeks after pinching). The spraying solution was added by using 2-liter hand pump sprayer to cover the entire plant completely with solution. These treatments were repeated seven times every 15 days during the vegetation growth until the mid of October each season. Control plants were sprayed only with water. Afterward the treated plants remained without any treatment until the end of flowering.

The recorded data:

Vegetative growth:

These measurements were recorded at monthly intervals started after pinching until the experiments were ended.

Plant height (cm): were taken from the ground surface up to stem apex.

Number of branches/plants.

Fresh weight of plant (g/plant) was taken for the entire plants without roots.

Dry weight of plant (g/plant) was determined by weighting samples after being dried in an oven at 70C° until the weight becomes constant **(Ochoa *et al.*, 2009).**

Flowering growth:

The date of the first flower open (measured as the number of days from cultivation until the first flower open was noticed).

Number of flowers/plants were recorded at intervals every week from the beginning of the first flower open until the end of the experiment.

Effect of cycocel on fresh and dry weights of flowers/plant.

Pigments content:

pigments content (µg/g f.w.) were determined using spectrophotometry in leaf extracts according to the method of Lichtenthaler (1987).

Statistical analysis:

The experiment was carried out in a complete randomized blocks design during the two seasons, whereas each treatment contained three replicates. Data were subjected to Analysis of Variance (ANOVA) using COSTAT computer package ver. 6.4 (CoHort software Monterey, California, USA), and means were compared by analysis of variance values (LSD) at 0.05.

RESULTS AND DISCUSSION

Vegetative growth:

Effect of cycocel on plant height (cm/plant).

The displayed results in (Table 2) indicate that using of cycocel, treatments affected significantly plant height (cm/plant). Generally, plant height was decreased linearly in relation to the increase in concentrations of cycocel. The tallest plants in both seasons were recorded from untreated plants. Yet, it is evident that treating plants by different rate of cycocel reduced shoot elongation differently according to the level of treatments compared with the control. Increasing the level of cycocel application up to 4500 ppm caused a remarkable decrease in plant height compared to the other treatments or control. The averages of plant heights for cycocel treatments were 30.40, 19.20, 17.40 and 13.50 cm/plant by using concentrations of 0, 1500, 3000 and 4500 ppm, respectively in the first season (Table 2). These results were in agreement with those of the second season (Table 2).

The remarkable inhibition of plant height because of growth retardant application appears to be due to its effect in slowing down of cell division and reducing cell expansion (Magnitskiy *et al.,* 2006). It has been also suggested that cycocel have anti-gibberellins dwarfing agents, which led to the deficiency of gibberellins and finally blocking the conversion of geranyl pyrophosphate to capably I- pyrophosphate which is the first step in gibberellins synthesis (Moore, 1980). Accordingly, the reduction in plant height might be due to the retardation of transverse cell division, particularly in stellar cambium which is the zone of the meristematic activity at the base of the internodes (Grossman, 1990; Fisher *et al.*, 1996 and Karunananda and Peiris., 2010). These results are in harmony with those obtained by Karunananda and Peiris (2010) on *Euphorbia pulcherrima* and Kumar *et al.* (2019) on *Nerium odorum*.

Effect of cycocel on number of branches/ plants.

It is evident from data presented in Tables (3) that the application of cycocel caused a significantly increase in number of branches/plants comparing with control in both seasons. This increase was noticed especially at the high levels of cycocel which significantly induced branching. It was also noticed that the lowest concentrations slightly affected the number of branches/plants but still better than the control. The number of branches/plants was increased gradually by increasing the dose of cycocel from 1500 ppm up to 4500 ppm. Application of cycocel at 4500 ppm gave the highest values of number of branches (10.1 branches/plant) followed by cycocel at rate of 3000 ppm (9.6 branches/plant) then come the low level of cycocel which is (9.3 branches/plant), The minimum number of branches was obtained with the untreated plants which gave (9.1 branches/plants) in the first season (Table 3).This trend was in the same line at the second season but it was of insignificant value between the treated plants at most cases (Table 3). The increase in number of branches because of the application of growth inhibitor could be due to the fact that they act as anti-auxin which caused the inhibition in auxin activity in the apical bud. Thereby, they prevent the polar transport of auxins towards the basal nodes leading to the increase in branching rate (Dole and Wilkins, 1999; Reddy, 2005 and Vaghasia and Polara, 2016). In detail, promotion in the number of branches due to the treatments of growth retardants more than the untreated plants is mainly attributed to the inhibitory effect of these growth regulators on the cell division in the apical bud, which subsequently might have stopped the growth of the main axis and induced more laterals production (Benedetto and Molinari 2007 and Benjawan *et al.*, 2007).Our results agree with other relative previous researches experimented with plant growth retardants e.g. Ghatas (2016) on *Chrysanthemum frutescens* and Khan *et al.* (2012) on African Marigold (*Tagetes erecta* L.).

Effect of cycocel on fresh and dry weights (g/plant).

From the presentation of data in Table (4) it appears that significant differences were observed among the results of fresh and dry weights (g/plant) during the two successive seasons due to application of cycocel treatments. There was a remarkable decrease in fresh and dry weights (g/plant) due to application of cycocel treatments in their various levels compared to the control. However, the minimum value of fresh weight was recorded with cycocel at rate of 4500 ppm (41.83 g/plant), followed by cycocel at rate 3000 ppm which recorded 64.93 g/plant then comes cycocel at rate of 1500 ppm which recorded 80.67 g/plant, while the highest value of fresh weight was recorded with the untreated plants (94.47 g/plant) in the first season Table (4). On the other hand, dry weights were decreased gradually by increasing cycocel levels. The lowest value of dry weight (10.76 g/plant) was from treatments of 4500 ppm cycocel, followed by cycocel at rate of 3000 ppm which registered (15.27 g/plant), then the least amount was from plants treated by cycocel at rate of 1500 ppm as they registered (22.75 g/plant). In contrast, the untreated plants recorded the greatest dry weight of (25.02 g/plant) in the first season Table (4). The same trend was noticed in the second season. The decrease of fresh and dry weights as a result of the growth retardants treatments is due to that growth retardants suppress stem elongation and reduce overall growth and shoot biomass accumulation (Alem, 2014). These results are in harmony with those obtained by Al Shaer (2004) on *Grindelia camporum* plant and Hill (2004) on *Rudbeckia hirta*.

Flowering growth:

Effect of cycocel on flowering start (days after cultivation).

Data tabulated in Table (5) indicated that cycocel treatments had a significant effect on flowering start in *G. jasminoides* comparing with control. The effect of cycocel at its various levels on flowering start of *G. jasminoides* was statistically significant in the two experimental seasons. The earliest time to first flower open occurred with spraying cycocel at rates of 4500 and 3000 ppm which recorded (291.8 and 295.2 days). In this case days from cultivation time until flowering was less than the untreated plants by about (10.5 – 7.1 days) in the first season respectively (Table 5). Plants which were treated with cycocel at 1500 ppm begin to flower after (298.8 days) as they were less than the control plant by about (3.5 days) which started flowering after (302.3 days) in the 1st season (Table 5). This trend holds true also in the second season. This earliest flowering which was occurred in plants by spraying of cycocel may be due to the potential improvement in carbohydrate accumulation, changes in morphogenesis, photosynthetic capacity and phytohormonal balance, as well as, promoting the sucrose content in leaves by a considerable coefficient during the full blossoming period (Zheng *et al.,* 2012). Other researchers reveal that using cycocel led to an inducing of flowering start of some related crops e.g., Singh (2004) on rose, Dhanasekaran (2018) on *Jasminum sambac* and Alami and Karimi (2020) on *Zinnia elegans* plant.

Effect of cycocel concentrations on the number of flowers /plants.

The number of flowers as affected by CCC treatments were tabulated in Table (6). The results show that there is a significant difference between number of flowers due to application of cycocel treatments at their various levels. Generally increasing cycocel levels resulted in a gradual increase in the values of flowers number, whereas the highest mean values of flowers number were obtained from spraying the plants with 4500 ppm of cycocel (4.10 and 5.19 flowers/plant) in the first and second seasons respectively. Treating plants with cycocel level of 3000 ppm recorded (3.52 and 4.25 flowers/plant), while those had cycocel at rate of 1500 ppm gave flowers number of (3.36 and 3.93 flowers/plant), then it, followed by untreated plants (2.45 and 2.38 flowers/plant) in the first and second seasons respectively (Table 6). The increase in number of flowers could be due to promotion in the number of branches due to treatments of growth retardants more than the untreated plants (Prashanth *et al*., 2006 and Benedetto and Molinari 2007). The promotive effect of cycocel on number of flowers was reported also by Saffari *et al*. (2004) on *Rosa damascene*, khudus *et al*. (2014) on *Calendula officinalis* L. and Rajiv *et al.* (2018) on *Nerium oleander* L. plant.

Effect of cycocel on fresh and dry weights of flowers/plant.

The data in Table (7) clear that there is a remarkable difference between fresh and dry weights of flowers/plant due to the applications of cycocel on Gardenia plants during the 1st and 2nd seasons. Spraying of cycocel treatments resulted in an enhancement at the fresh and dry weights compared to the untreated plants. It was evident that the highest value of fresh weight was observed with cycocel at moderate rate of 3000 then come the high and low concentrations 4500 and 1500 ppm as they recorded 3.88, 3.49 and 3.33 g/flowers respectively in the first season, and (3.54, 3.32 and 3.11g/flowers), in 2nd season respectively (Table 7). The lowest values (3.19 and 3.02 g/flowers) were found in control plants in 1st season and 2nd season, respectively. In addition, the dry weight takes the same trend as that of the fresh weight. The highest dry weight of flowers was recorded in treating with cycocel at rate of 3000, 4500 and 1500 ppm which recorded 0.53, 0.50 and 0.44 g/flower respectively, while the minimum value of dry weight of flower was obtained with the untreated plants as recorded 0.42 g/flower in the 1st season g/flower. This trend was in the same line at the second season. The current results are generally in agreement with those of Vaghasia and Polara (2015) on Chrysanthemum, Sable *et al.,* (2015) on gladiolus and Ghatas (2016) on *Chrysanthemum frutescens* plant. The increase in weight of flowers might be due to that growth retardants that induced the production of a greater number of secondary shoots at the early growth stage, which in turn resulted in accumulation of carbohydrates needed for proper flower bud induction Dhanasekaran, (2018). In addition, this finding was previously confirmed by (Ahmed *et al*., 1988, Sujatha *et al*., 2002 and Zheng *et al*., 2012).

Pigments content:

The obtained data in Table (8) summarized the effect of cycocel on chlorophyll and carotenoids content in *G. jasminoides* leaves (µg/g fresh weight). Cycocel at all its levels enhanced the contents of chlorophyll and carotenoids content compared with the control in both seasons. Increasing cycocel rates from 1500 up to 4500 ppm resulted in linearly enhancement in chlorophyll content. In the first season, the values were (3539.6, 3565.8 and 3706.9 µg/g f.w.) for cycocel concentrations of 1500, 3000 and 4500 ppm respectively. The minimum values of chlorophyll (3427.0 µg/g f.w.) were recorded with control in 1st season (Table 8). Data of the second season were in the same direction of those of the first one. Many researchers stated that using cycocel led to an improvement in chlorophyll content of some crops e.g. Sendhilnathan *et al* (2016) on *Catharanthus roseus* plant and Sunayana (2017) on *Tagetes erecta* L.

With respect to the influence of cycocel at different levels on carotenoids content. Carotenoids amounts were significantly increased with all levels of growth retardants.

The higher levels of cycocel at 4500 ppm and 3000 ppm respectively gave the maximum values of carotenoids content (404.74 and 385.37 µg/g f.w.) respectively in 1st season, but with the lower rate of cycocel at 1500 ppm the value was (377.64 µg/g f.w.) compared the untreated plants as recorded (369.14 µg/g f.w.) in 1st season (Table 8). This trend was in the same line at the 2nd season. These results were in agreement with those obtained by Kazemi *et al.* (2014) on *Calendula officinalis* plant and Taherpazir and Hashemabadi (2016) on Zinnia plant. The content of total chlorophyll and carotenoids was increased by the application of growth retardants that may be due to the elevated production of endogenous cytokinin, which enhances differentiation of chloroplasts, chlorophyll synthesis and prevents its degradation (Fletcher *et al.*, 2000). In addition, the inhibitor effect of growth retardant tended to produce smaller cells and thus resulted in more concentrated chlorophyll content inside the reduced cell volume (Thakur *et al.*, (2006). Furthermore, Tsegaw *et al.* (2005) suggested that higher pigment content in leaves was due to enhancement of chlorophyll synthesis by growth retardant application and for more densely spaced chloroplasts per leaf area unit.

REFERENCES

Ahmed, M., Shankar, G., Muthoo, A.K. 1988: Effect of paclobutrazol on growth and flowering of cosmos (*Comos bipinnatus* Cav.). Punjab Horticultural Journal, 28 (1-2):105-108.

Alami, E., Karimi, M. 2020: Effect of cycocel and Uniconazole on Some Morphological and Biochemical Properties of Zinnia. International Journal of Horticultural Science and Technology Vol. 7, No. 1; March 2020, pp 81-91.

Alem, P.O. 2014: Irrigation, fertilization and non-chemical plant growth regulation in greenhouse production. Ph.D. thesis, dept. university of Georgia in partial.

AL-Shaer, A.E.I. 2004: Effect of some hormonal treatments and cultural medium on growth, flowering and resin content of *Grindelia camporum* green plants. B. Sc. Thesis, Dept. Fac. Agric., Al-Azhar Univ., Cairo, Egypt.

Apeda, 2014: Agricultural and Processed Food Products Export Development Authority, is responsible for export promotion and development of floriculture in India. http://www.apeda.gov.in/apedawebsite/SubHead_Products/Floriculture.htm .

Baerdemaeker, C.I.D., Huylenbroeck, J.M.V., Debergh, P.C. 1994: Influence of paclobutrazol and photoperiod on growth and flowering of *Gardenia jasminoides* Ellis cultivar 'Veitchii'. Scientia Horticulturae (58) 315-324.

Benedetto, A.D., Molinari, J. 2007: Influence of river waste-based media on efficacy of paclobutrazol in inhibiting growth of *Petunia hybrida*. International Journal of Agricultural Research. 2: 289-295.

Benjawan, C., Chutichudet, P., Chanaboon, T. 2007: Effect of Chemical Paclobutrazol on Growth, Yield and Quality of Okra (*Abelmoschus esculentus* L.) Har Lium Cultivar in Northeast Thailand. Pakistan Journal of Biological Sciences, 10: 433-438.

Chandraju, S., Thejovathi, C., Chidan Kumar, C.S. 2011: Impact of Distillery Spentwash Irrigation on Sprouting and Growth of Gardenia (Rubiaceae) Flowering plant. J. Chem. Pharm. Res., 3(5): 376-381.

Chen, T., Taylor, C.M. 2011: *Gardenia jasminoides* J. Ellis. In: Wu, Z.Y., Raven, P.H. & Hong, D.Y. (eds). Flora of China, Vol. 19. (Rubiaceae). Science Press, Beijing: 142–143.

Cowling, W. 2010: The challenge of breeding canola hybrids- new opportunities for WA growers. Western Australian Pty Ltd, Agribusiness Crop.

Dhanasekaran, D. 2018: Influence of growth regulating chemicals on growth and flowering in Jasmine (*Jasminum sambac*.Ait.). J. Hortl. Sci. Vol. 13(2): 88-94.

Dole, J.M., Wilkins, H.F. 1999: Plant growth regulation. In: Dole, J.M., Wilkins, H.F. (Eds). Floriculture: Principles and Species. Prentice-Hall, Eaglewood Cliffs, NJ, 90-104.

Fisher, R., Heins, D., Lieth, H. 1996: Modeling the stem elongation response of poinsettia to chlormequat. Journal of the American Society for Horticultural Science. 121(5): 861-868.

Fletcher, R., Gilley, A., Sankhla, N., Davis, T. 2000: Triazoles as plant growth regulators and stress protectants. Horticultural Reviews, v.24, p.55-138.

Ghatas, Y.A.A. 2016: Influence of paclobutrazol and cycocel sprays on the growth, flowering and chemical composition of potted *Chrysanthemum frutescens* plant. Annals of Agric. Sci., Moshtohor, Vol. 54(2) (2016), 355–364.

Gopichand, Y., Padmalatha, T., Pratap, M., Siva Sankar, A. 2014: Effect of bioregulators and stage harvesting on seed maturity and quality in African marigold (*Tagetes erecta* L.). Indian J Agric Res, 48(5):342-351.

Govaerts, R., Ruhsam, M., Andersson, L., Robbrecht, E., Bridson, D.M., Davis, A.P., Schanzer, I., Sonke, B. 2010: World Checklist of Rubiaceae. Royal Botanic Gardens Kew Published on the internet at www.kew.org/wcsp/rubiaceae [accessed 21 June 2010].

Grossmann, K. 1990: Plant growth retardants as tools in physiological research. Physiol. Plant., 78(4):640-648.

Halevy, A.H. 1995: The use of plant bioregulators in ornamental crops. Acta Hort, 394:37-43.

Hill, S.N. 2004: *Phlox paniculata* 'Blue Boy' and Rudbeckia hirta 'Indian Summer': cultural guidelines for greenhouse growth and powdery mildew control. M.Sc. Thesis, Dept. Hort; Fac. of Agric. The Virginia Polytechnic Institute and State University.

Karunananda, D.P., Peiris, S.E. 2010: Effects of pinching, cycocel and b-nine treatments on branching habit of pot poinsettia *(Euphobia pulcherrima Willd)*. Tropical Agricultural Research. 21(3):284 -292.

Kazemi, S.S., Hashemabadi, D., Torkashvand, A.M., Kaviani, B. 2014: Effect of cycocel and daminozide on vegetative growth, flowering and the content of essence of pot marigold (*Calendula officinalis*). Journal of Ornamental Plants. 4(2): 107-114.

Khan, M.I., Muzamil, S., Abid, M., Hassan, A., Mathew, B. 2012: Effect of different levels of cycocel and maleic hydrazide on growth and flowering of African Marigold (*Tagetes erecta* L.) cv. PUSA NARANGI GAINDA. The Asian journal of horticulture 7(2): 294- 296.

Khudus, S., Prasad, V.M., Jogdand, S.M. 2014: Effect of Plant Growth Regulators on Growth and Flower Yield of Calendula (*Calendula officinalis* L.) cv. Bon Bon. Chemical Science Review and Letters, 6(22), 1290-1294.

Kobayashi, K.D., Kaufman, A.J. 2006: Common Gardenia. Ornamentals and Flowers OF-32 May 2006.

Kumar, S., Haripriya, K., Haripriya, S., Muraleedharan, A., Kamalakannan, S. 2019: Effect of cycocel on growth, flowering and yield of nerium (*Nerium odorum* L.). Journal of Pharmacognosy and Phytochemistry, 8(3): 2226-2228.

Larson, R.A. 1992: Introduction to floriculture 2nd Edition Academic Press San Diego, CA.

Latimer, J.G. 2001: Selecting and using plant growth regulators on floricultural crops. In "Virginia Cooperative Extension". Publication Number 430-102, Virginia Tech.

Lichtenthaler, H.K. 1987: Chlorophylls and carotenoids: pigments of photosynthetic biomembranes. Methods Enzymol. 148: 350-382.

Magnitskiy, S.V., Pasian, C.C., Bennett, M.A., Metzger., J.D. 2006: Controlling plug height of verbena, celosia, and pansy by treating seeds with paclobutrazol. HortScience. 47:158-167.

Moore, T.C. 1980: Biochemistry and physiology of plant hormone, Narosja publishing house, New Delhi, 107- 131.

Mostafa, M.A., Alawlaqi, M.M., Reyad, N.E. 2013: Control of Gardenia Leaf Spot and Bud Rot Diseases Using Some Natural Plant Oils. Journal of Microbiology Research 2013, 3(5): 185-196.

Ochoa, J., Franco, J.A., Bañón, S., Fernández, J.A. 2009: Distribution in plant, substrate and leachate of paclobutrazol following application to containerized *Nerium oleander* L. seedlings. Spanish Journal of Agricultural Research .7(3): 621-628.

Prashanth, P., Reddy, S.A., Srihari, D. 2006: Studies on the effect of certain plant growth regulators on growth of Floribunda Roses (*Rosa hybrida* L.). Orissa J. Hort., 34 (2): 78-82.

Rademacher, W. 2000: Growth retardants: Effects on gibberellin biosynthesis and other metabolic pathways. Ann Re Plant Physiol Plant Mol Biol, 51:501-531.

Rajiv, G., Jawaharlal, M., Subramanian, S., Sudhakar, D., Uma, D. 2018: Effect of Plant Growth Retardants on the Growth and Flowering of Nerium (Nerium Oleander L.) Cv. Red. Chemical Science Review and Letters, 7(28), 875-879.

Reddy, P. 2005: Effect of growth retardants and nipping on growth and yield parameters in cowpea (*Vigna unguiculata* L.) B. Sc. Thesis, Fac. Agric., Dharwad University.

Sable, P.B., Ransingh, U.R., Waskar, D.P. 2015: Effect of Foliar Application of Plant Growth Regulators on Growth and Flower Quality of Gladiolus Cv. 'H.B.Pitt'. J Horticulture, Volume 2, Issue 3, 141.

Saffari, V.R., Khalighi, A., Lesani, H., Babalar, M.b., Obermaier, J.F. 2004: Effect of different plant growth regulators and time of pruning on yield components of *Rosa damascene* Hill. International Journal of Agriculture and Biology. 6: 1040- 1042.

Sendhilnathan, R., Karuppaiah, P., Rajkumar M., Sureshkumar, R. 2016: Effect of plant growth regulators on growth and yield of periwinkle [*Catharanthus Roseus* (L.) G. Don] cv. rose purple flowered, International Journal of Current Research, 08 (07), 35505-35506.

Singh, A.K. 2004: Plant growth and flower production in rose as influenced by CCC, TIBA and SADIA spraying. Progressive Horticulture. 36(1): 40-43.

Sujatha, A.N., Singh, V., Sharma, T. 2002: Effect of plant growth regulators on yield and quality of gerbera under Bay Island conditions. Indian J Hort.; 59(1):100- 105.

Sunayana, S., Manjusha, A.V.M., Rajagopalan, A., Madala, A. 2017: Effect of growth retardants

(Alar and Cycocel) on flower yield and carotenoid content in African marigold (*Tagetes erecta* L.) varieties. Journal of Tropical Agriculture 55 (2): 205-208.

Taherpazir, S., Hashemabadi, D. 2016: The Effect of Cycocel and Pot Size on Vegetative Growth and Flowering of Zinnia (*Zinnia elegans*). Journal of Ornamental Plants, Volume 6, Number 2: 107-114.

Thakur, R., Sood, A., Nagar, P.K., Pandey, S., Soboti, R.C., Ahuja, P.S. 2006: Regulation of growth of Lilium plantlets in liquid medium by application of paclobutrazol or ancymidol, for its amenability in a bioreactor system: Growth parameters. Plant Cell Rep. 25 (5), 382-391.

Tsegaw, T., Hammes, S., Robbertse, J. 2005: Paclobutrazol-induced leaf, stem, and root anatomical modifications in potato. HortSci. 40 (5), 1343-1346.

Vaghasia, V., Polara, N.D. 2016: Effect of plant growth retardants on growth, flowering and yield of chrysanthemum (*Chrysanthemum Morifolium* Ramat.) cv. IIHR-6. Malaysian Journal of Medical and Biological Research. 2(5)161-166.

Van, D.W.G., Han, S.S. 2011: Postharvest quality of cut lily flowers. Postharvest Biology and Technology.62: 1–6.

Zheng, R., Wu, Y., Xia, Y. 2012: Chlorocholine chloride and paclobutrazol treatments promote carbohydrate accumulation in bulbs of Lilium Oriental hybrids 'Sorbonne'. J. Zhejiang Univ-Sci. B (Biomed. Biotechnol.), 13 (2), 136-144.

Table 1: Physical and chemical properties of the experimental soil.

Items			1st season	2nd season
Organic matter (%)			48.0	46.3
Calcium carbonate CaCO3 (%)			0.2	0.2
PH			4.50	4.40
EC. ds/m			76.0	74.3
SAR			0.7	0.6
Soluble ions (meq/l, soil paste)	Anions	Cl-	3.8	3.6
		CO3-	0.0	0.0
		HCO3-	1.0	1.0
		SO4-	8.2	8.0
	Cations	Ca++	6.0	6.1
		Mg++	4.0	4.1
		Na+	2.1	2.0
		K +	0.9	1.0
Available Macronutrients (mg/kg soil)		N	3.60	3.46
		P	46.3	47.4
		K	431.1	436.6
Available Micronutrients mg/kg soil)		Fe	7863	7768
		Zn	963.5	956.3
		Mn	318	320
		Cu	101	95.6

Source: Central Laboratory for Agricultural Climate. (CLAC) Cairo, Egypt.

Table 2: Effect of cycocel concentrations on the monthly averages of plant height of *Gardenia jasminoides* during seasons of 2018/2019 and 2019/2020.

Treatments	Concentrations	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Mean
Average plant height (cm/plant)														
1st season														
Control	0.0 ppm	7.4	9.8	13.5	19.5	24.4	29.1	35.7	40.7	42.3	44.6	47.4	50.3	30.4
	1500 ppm	7.8	9.6	12.6	15.6	18.5	19.9	21.0	21.7	22.8	24.1	27.4	29.2	19.2
Cycocel	3000 ppm	7.3	9.4	12.1	13.9	15.4	17.8	18.7	19.9	20.5	22.5	24.4	26.3	17.4
	4500 ppm	7.1	9.0	11.4	12.7	13.3	13.9	14.5	15.1	15.3	16.0	16.5	16.9	13.5
LSD 0.05		0.80	1.14	0.97	1.05	1.04	1.26	3.11	4.17	4.14	3.44	4.53	2.59	
2nd season														
Treatments	Concentrations	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Mean
Control	0.0 ppm	7.1	8.5	12.9	17.1	19.9	22.5	27.2	33.0	38.6	42.6	47.4	52.6	27.4
	1500 ppm	7.1	8.2	11.0	13.9	16.1	18.8	21.4	23.5	25.5	28.7	31.5	32.1	19.8
Cycocel	3000 ppm	7.2	7.7	9.9	12.4	15.1	17.3	19.5	21.0	22.8	25.1	27.9	29.6	18.0
	4500 ppm	7.2	7.6	9.4	11.6	12.7	13.7	15.4	17.3	18.6	20.2	22.6	24.4	15.1
LSD 0.05		0.31	0.46	0.44	0.97	1.22	0.79	0.77	1.96	0.87	1.19	1.56	2.51	

Table 3: Effect of cycocel concentrations on the monthly averages of the branch number of *Gardenia jasminoides* during seasons of 2018/2019 and 2019/2020.

Treatments	Concentrations	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Mean
Average branch number/plant														
1st season														
Control	0.0 ppm	-	5.5	6.0	6.7	7.0	7.8	8.4	10.2	11.1	11.7	12.4	13.2	9.1
	1500 ppm	-	5.4	6.2	6.9	7.5	8.3	8.9	10.3	10.8	11.9	12.7	13.4	9.3
Cycocel	3000 ppm	-	5.6	6.3	7.1	8.1	8.7	9.2	11.0	11.3	12.1	12.8	13.3	9.6
	4500 ppm	-	5.5	6.5	7.3	9.2	9.6	10.1	11.5	11.8	12.6	13.2	14.0	10.1
LSD 0.05		-	0.56	0.50	0.67	0.70	0.82	0.66	0.54	1.00	0.81	0.97	0.87	
2nd season														
Treatments	Concentrations	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Mean
Control	0.0 ppm	-	5.5	5.5	6.4	6.9	7.4	8.2	8.7	9.1	10.2	12.3	12.6	8.4
	1500 ppm	-	5.4	6.4	6.8	7.3	7.7	8.4	9.1	9.4	10.4	12.6	13.1	8.8
Cycocel	3000 ppm	-	5.5	6.5	7.1	7.6	8.0	8.8	9.4	10.3	11.2	13.2	13.3	9.2
	4500 ppm	-	5.8	6.8	7.5	8.2	8.8	9.4	9.8	10.5	11.7	14.3	14.7	9.8
LSD 0.05		-	0.19	0.51	0.30	0.52	0.56	0.42	0.54	0.87	0.53	0.98	0.75	

Table 4: Effect of cycocel concentrations on the fresh and dry weights g/plant of *Gardenia jasminoides* during seasons of 2018/2019 and 2019/2020.

Fresh and dry weights (g/plant)					
Treatments	Concentrations	1st season (2018/2019)		2nd season (2019/2020)	
		Fresh weight/g	Dry weight	Fresh weight	Dry weight
Control	0.0 ppm	94.47	25.02	92.83	23.70
	1500 ppm	80.67	22.75	70.18	19.24
Cycocel	3000 ppm	64.93	15.27	66.52	16.79
	4500 ppm	41.83	10.76	40.18	10.18
LSD 0.05		11.69	2.89	6.28	2.12

Table 5: Effect of cycocel concentrations of flowering start (days after cultivation) of *Gardenia jasminoides* during seasons of 2018/2019 and 2019/2020.

Treatments	Concentrations	1st season (2018/2019)	2nd season (2019/2020)
Control	0.0 ppm	302.3	304.5
Cycocel	1500 ppm	298.8	303.9
	3000 ppm	295.2	300.6
	4500 ppm	291.8	295.7
LSD 0.05		4.41	4.09

Table 6: Effect of cycocel concentrations on the flower number of *Gardenia jasminoides* during seasons of 2018/2019 and 2019/2020.

Flower number /plant								
1st season								
Treatments	Dates Concentrations	22 Apr	29 Apr	6 May	13 May	20 May	27 May	Means
Control	0.0 ppm	0.00	2.50	3.50	4.17	2.67	1.89	2.45
Cycocel	1500 ppm	1.00	4.89	6.25	5.22	1.78	1.00	3.36
	3000 ppm	1.28	5.31	6.33	5.33	1.72	1.17	3.52
	4500 ppm	2.28	7.17	6.86	5.61	1.67	1.00	4.10
LSD 0.05		0.34	1.89	1.79	1.64	0.75	0.33	
2nd season								
Treatments	Dates Concentrations	22 Apr	29 Apr	6 May	13 May	20 May	27 May	Means
Control	0.0 ppm	0.00	2.11	3.33	3.92	3.00	1.89	2.38
Cycocel	1500 ppm	1.89	5.42	6.33	5.67	2.58	1.67	3.93
	3000 ppm	2.28	6.50	6.42	5.92	2.92	1.50	4.25
	4500 ppm	2.72	8.83	8.42	6.25	3.08	1.83	5.19
LSD 0.05		0.19	0.86	0.66	0.67	0.62	0.63	

Table 7: Effect of cycocel concentrations on fresh and dry weights of flowers/plant of *Gardenia jasminoides* during seasons of 2018/2019 and 2019/2020.

Fresh and dry weights of flowers (g/plant)					
Treatments	Concentrations	1st season (2018/2019)		2nd season (2019/2020)	
		Fresh weight/g	Dry weight	Fresh weight	Dry weight
Control	0.0 ppm	3.19	0.42	3.02	0.41
Cycocel	1500 ppm	3.33	0.44	3.11	0.44
	3000 ppm	3.88	0.53	3.54	0.50
	4500 ppm	3.49	0.50	3.32	0.45
LSD 0.05		1.07	0.11	0.82	0.03

Table 8: Effect of cycocel concentrations on chlorophyll and carotenoids content in leaves of *Gardenia jasminoides* during 2018/2019 and 2019/2020 seasons.

Chlorophyll and carotenoids content (µg/g fresh weight)					
Treatments	Concentrations	1st season (2018/2019)		2nd season (2019/2020)	
		Total chlorophyll	Carotenoids	Total chlorophyll	Carotenoids
Control	0.0 ppm	3427.0	369.14	3441.3	332.5
Cycocel	1500 ppm	3539.6	377.64	3566.9	359.9
	3000 ppm	3565.8	385.37	3636.5	395.3
	4500 ppm	3706.9	404.74	3702.4	403.6
LSD 0.05		85.77	7.21	64.56	7.71

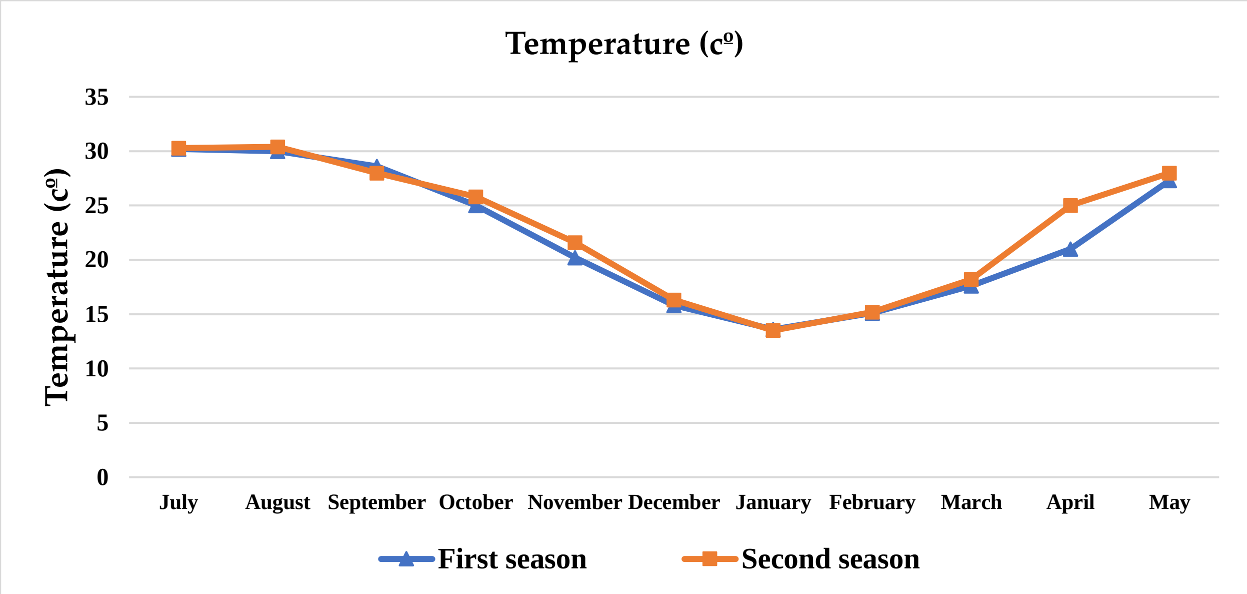

Figure 1: The climatic of temperature during the growing seasons of *Gardenia jasminoides* during 2018/2019 and 2019/ 2020 seasons.

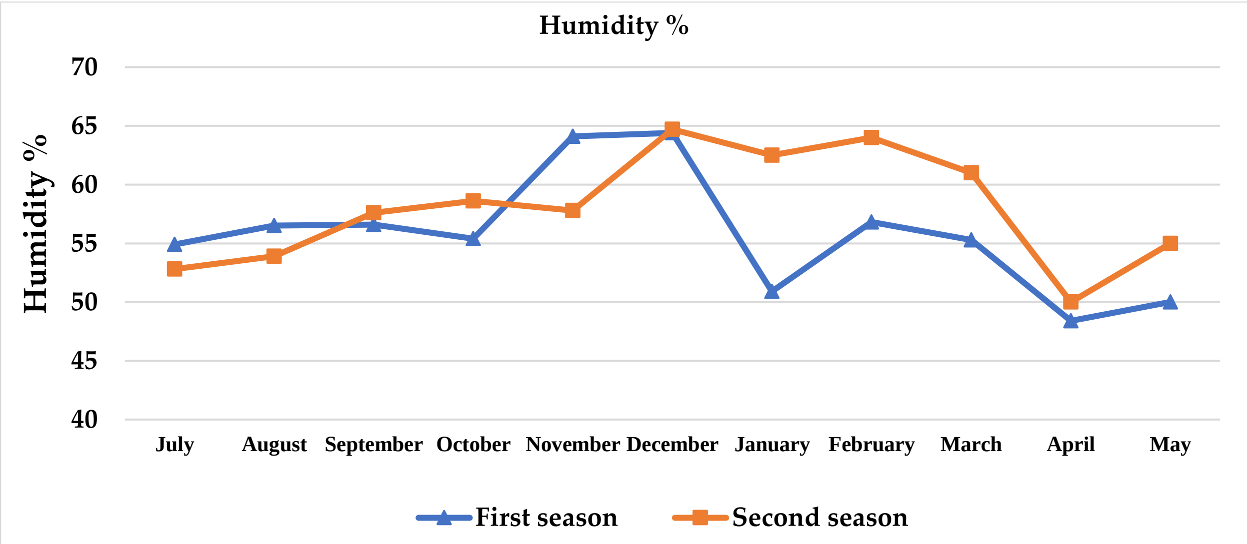

Figure 2: The climatic of humidity during the growing seasons of *Gardenia jasminoides* during 2018/2019 and 2019/ 2020 seasons.

تأثير المستويات المختلفة من السيكوسيل على النمو الخضرى والزهرى فى نبات الجاردنيا

محمود نور الدين عباس سليمان *، نبيل محمد طعيمة، صلاح الدين محمد محمود

قسم البساتين، كلية الزراعة ، جامعةالأزهر، القاهرة ، مصر

*البريد الالكتروني للباحث الرئيسي: mahmoudnour@azhar.edu.eg

الملخص العربي:

نبات الجاردينا هو أحد النباتات الداخلية المهمة في سوق الزهور. أجريت الدراسة لتقييم تأثير تركيزات مختلفة من السيكوسيل (صفر ، 1500 ، 3000 ، 4500 جزء في المليون) على النمو الخضري ، التزهير ومحتوى والأصباغ لنبات الجاردينيا. أدت المعالجة بتركيزات عالية من السيكوسيل (4500 جزء في المليون) إلى انخفاض معنوي في ارتفاع النبات وانخفاض في الوزن الرطب والجاف، بينما زاد التفرع على عكس التركيزات المنخفضة والكنترول. علاوة على ذلك ، فإن الرش بمركب السيكوسيل بمعدلات (4500 ، 3000 جزء في المليون) عزز الإزهار المبكر. وأعطى أعلى القيم لعدد الأزهار خاصة مع نباتات رشت بـ (4500 جزء في المليون) من السيكوسيل ، تليها النباتات المعالجة بالسيكوسيل بمعدل (3000 جزء في المليون). تبعا لذلك ، كانت أعلى قيمة لأوزان الزهور الطازجة والجافة ناتجة عن المعاملة بمعدلات سيكوسيل معتدلة (3000 جزء في المليون). علاوة على ذلك ، زادت محتويات الكلوروفيل والكاروتينويدات في النباتات التي تم رشها بالسيكوسيل بجميع تركيزاته.

الكلمات الاسترشادية: جاردينيا جاسمينويدس ، سكيوسيل ، التزهير ، محتوى الكلوروفيل والكاروتينويدات