

APPLICATION OF PLANT GROWTH REGULATORS IN ORNAMENTALS AND FLOWER PRODUCTION

Baghele R.D.* and Thalkari G.N.

*Horticulture Research Scheme (Vegetable),
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS) 431402
Email: rdbaghele@gmail.com*

Received-01.06.2020, Revised-24.06.2020

Abstract: Ornamental plants bear an important status in the horticultural industry of the world. Plant growth regulators consist of a large group of naturally occurring or synthetically produced organic chemicals and considered as helping tool in the modern production system of ornamentals. Most of the time plant growth regulators are being used by the commercial growers of ornamental plants as a part of cultural practice. Ornamental crops find extensive use of growth regulators for modifying their developmental processes. Plant growth regulators provide an immediate impact on crop improvement programmes and are less time consuming, applications of plant growth regulators must lead to quantifiable advantages for the user plant growth regulators must be specific in their action and toxicologically and environmentally safe. The physiological activities of flowering crops regulate by the application of growth regulators and finally affect the growth and flower production in flowering crops. Plant growth regulators have quicker impact on vegetative as well as flower yield of flowering crops. There are various methods of application of PGRs but the most popular are foliar sprays, drenching and pre-plant soaking while the efficacy of each method depends on the various factors including the mode of absorption of PGRs by different plant parts, method of application and environmental factors.

Keywords: Plant growth regulators, flowering crops, Auxin, GA3, Cytokinins, Application methods

INTRODUCTION

Ornamental plants include woody and herbaceous as well as annuals, bi-annuals and perennials. These are grown as both seed propagated and vegetative propagated cultivars. Plants are appreciated by their ability to please the eye of consumers as garden or pot plants or when sold as cut material. Ornamentals represent a great diversity of beautiful plants, including cut foliage, cut flowers, bedding plants, indoor plants, potted plants, bulbous plants, outdoor plants, which may be annuals, biennials or perennials in their growth habit. Thus ornamentals bring aesthetic feelings to our surroundings (Riazet *et al.*, 2002). The rapid rise is seen in the production of horticultural crops; including the ornamental plants (Janick, 2007) Cut flowers refer to flowers starting to blossom or flower buds that are cut with branches, stems and leaves to be used for bouquets or decorations. Flowers having long and stout stalk and prolong vase life are considered as cut flower which constitute 45% share of the total world trade in floricultural products (Dadlani, 2003). There is as such an urgent need of scientific approach and wise use to promote the relevant management practices, improvement of flower germplasm, balanced nutrient management, modern production technology, quality planting material, precision farming etc., for conservation and commercialization of the floriculture industry and diversification from the traditional field crops due to higher returns per unit area.

Now-a-day the use of plant growth regulators (PGR) is getting popularity in crop production around the

world. PGR are chemical compounds that alter plant growth and development by modifying natural hormonal action. The role of plant growth regulators in various physiological and biochemical process in plant is well known and when it is applied in plants it influences their growth and development (Randhawa, 1971). Regulations of plant growth and development using natural plant hormones for greater production have received the almost attention. Growth and flowering responses of ornamental plant to these chemical substances have been intensively studied with a view to have compact plants with greater number of flowers and also to hasten or delay flowering according to the needs of the grower. PGRs sometimes confused with plant hormones, but there are certain differences among them as the term PGRs is used by agrochemical industry to indicate synthetic plant growth regulators, while plant hormones are a group of naturally occurring, organic substances which influence physiological processes at low concentrations (Davies, 2010). Plant growth regulators consist of organic molecules produced synthetically and used to alter the growth of plants or plant parts.

The PGRs can be bio-stimulant or bio inhibitor and are active even at very low concentrations in plant cells and have ability to alter the growth and development. The plant growth regulators represents various categories and as American Society for Horticultural Science has been classified into six classes including gibberellins, auxins, cytokinins, ethylene generators, growth inhibitors and growth retardants ((Mahgoubet *et al.*, 2006). These chemicals act on plant processes at very low concentrations.

*Corresponding Author

They have ability to accelerate or retard the plant growth. The hormones are required only in minute quantities to produce large specific physiological process. The term growth regulator is applied to organic compounds, other than nutrients, which when used in minute quantities can either inhibit, stimulate, or alter growth. The major areas where growth regulators have successfully played their roles in ornamental are in dormancy breaking, growth promotion and retardation, flowering, rooting, retarding their senescence and prolonging the vase life of flowers.

Factors affecting efficiency of PGRs

The effects of PGRs in plants depend on various factors which play important role to achieve expected results. These factors include the application method, time of application, concentration of PGRs, plant species and also the environmental conditions in which plants are grown (Wroblewska and Dębicz, 2013). The other supplementary factors may include the chemical properties of PGRs solution, particularly the pH, which plays a key role in the absorption of PGRs by the plants. The intensity of applications is also considered an important factor affecting the efficacy of PGRs, as some plants respond well to a single application, but in most of cases, multiple applications are beneficial to attain good results (Carey *et al.*, 2007).

Application methods

The possible effects of PGRs depend on their method of application due to the difference in their mode of absorption by the plant, as some chemicals are absorbed only through root, leaves or stem, and some are absorbed through all mentioned organs having an advantage to apply in either way, as ancymidol is absorbed by the roots, stem and also leaves (Whipkeret *et al.*, 2003). There are various methods of

application of PGRs in plants reported in literatures. Including foliar application, drenching, pre-plant sowing, seed priming, pasting, capillary string (Carswell *et al.*, 1996) and injection (de Vries and Dubois, 1988).The most commercially adopted methods for ornamental plants are foliar spray; drenching and pre-plant soaking.

Foliar application and soil drenching are the most common methods being used by commercial growers (Lee and Rho, 2000). It is required to use compressed air sprayer and same nozzle for all the plants to ensure the equal volume of PGRs to plants in case of foliar sprays. Foliar application can be more effective if applied at the right stage of growth for controlling specific characters and it requires information about the phenology of the target plant. Another advantage of foliar spray is the repetition of application as many times as required can be made to attain certain goals. The plant response to foliar application also depends on the absorption rate and absorption is driven by the environmental conditions, temperature and humidity are the most important. Drenching has advantage over foliar sprays because it ensures the uniformity of treatment as each plant receives the measured amount of PGRs and absorption occurs through root zone. This method is suitable for PGRs having efficient absorption through root medium (Sanderson *et al.*, 1988). The research in methods of application of PGRs reported that their early application such as dipping before planting and substrate drenching at planting time are helpful in obtaining desired results and also supportive in the efficient use of these chemicals (Magnitskiy *et al.*, 2006). Preplant soaking of plant material in PGRs is reported an efficient method but their use is relatively less common on commercial scale (Sajjad *et al.*, 2015).

Classes and functions of plant growth regulator

Class	Function (s)
Auxins	Shoot elongation
Gibberellins	Stimulate cell division and elongation
Cytokinins	Stimulate cell division
Ethylene generators	Hastens senescence
Growth inhibitors	Stops growth
Growth retardants	Slows growth

Fishel, (2007)

Use of plant Growth regulators

Plant growth regulators are not highly specific in their action and affect a variety of growth and developmental processes in the plant. Sometimes there are many overlapping and interacting effects of growth regulators in cut flower and foliage plants. However, the uses of some plant growth regulators in cut flower and foliage plants production are described below.

Germination (Seeds/Corm/ Bulb)

When seeds are sown in the fields germinated under favorable condition if the seeds/Corm/ Bulb are not

dormant. But due to physical, physiological or environmental factors, seeds may not be properly germinated leading to a very low plant stand in the field. This problem can be overcome by the application of some plant growth regulators. Khan (2013) reported that the percentage of Gladiolus corm germination varied significantly due to treatment of corms with GA₃ and BA. Faraji and Basaki (2014) observed the effect of Indole-3-acetic acid (IAA) and benzyladenine (BA) on growth, flowering and corm production of cut flower Gladiolus cv. White Prosperity. Primarily bulbs were

treated with four different concentrations of IAA (0,100,150, 200 mg/l) and benzyl adenine (0, 100, 150, 200 mg/l). The results indicated that IAA and BA increased germination rate of Gladiolus. Also, onset stalk flower, diameter of floret and bulb wing affected by IAA and BA. The results showed that highest content of sugar were in petal and leaves which were treated with IAA 100 and 200 mg/l.

Dormancy

Plant growth regulators can be successfully used in breaking dormancy. Freshly harvested corms, cormels and bulbs of some cut flowers undergo a period of dormancy which is regulated by changes in the levels of endogenous promotory or inhibitory substances. Seed dormancy is mechanisms by which seed can inhibit their germination in order to wait for more favorable conditions. (Finkelstein *et al.* 2008). GA₃ induces the formation of hydrolytic enzymes which regulates the mobilization of reserves; ultimately break the dormancy and resulting early sprouting of Gladiolus corm (Groot and Karssen, 1987). Dormancy is caused by the effect of abscisic acid during seed development. Such seeds may never germinate (Bewley, 1997).

Growth Promotion

The plant growth regulators are also used to regulate the promotion of growth.

Vegetative growth

Vegetative growth of various ornamental plants is influenced by different plant growth regulators. Sharma *et al.* (1995) reported the effect of foliar application of plant growth regulators on growth and flowering of Chrysanthemum var. Move-in-Carvin. Plants were sprayed with Maleic hydrazide (MH) (250, 500, 750 and 1000 ppm), NAA (25, 50, 75 and 100 ppm) and control. Plant height was inversely proportional to MH concentration and directly proportional to that of NAA. MH and NAA had no effect on plant girth. Ramesh *et al.* (2001) revealed that the application of gibberellic acid @150 ppm had maximum plant height (75.10 cm) in China aster whereas highest number of branches per plant (13.15) noted with Maleic Hydrazide @1500 ppm. Ram *et al.* (2012) assessed the effect of salicylic acid on growth and flowering of Gladiolus. The results showed that the foliar application of 100 ppm salicylic acid increased number of leaves, leaf length, and leaf width.

Flowering Quality

Exogenous application of growth regulators can influenced flowering by retarding the vegetative growth. Dorajeero and Mokashi (2012) noted that foliar spray of cycocel at 3000 ppm on garland Chrysanthemum produced maximum number of flowers per plant, as compared to other concentrations. Kumar *et al.*, (2014) performed a study to understand the role of abscisic acid (ABA) in ethylene insensitive floral senescence in Gladiolus (*Gladiolus grandiflora* Hort.). It was observed that ABA accumulation increased in attached petals of

Gladiolus flowers as they senesced. Singh *et al.* (2013) studied the effect of GA₃ on growth and flowering attributes in Gladiolus cultivars. The results regarding flowering parameters early spike emergence was noticed in cv. Sabnum when, GA₃ was sprayed at higher concentrations (300-400 ppm). GA₃ at 300 ppm exerted maximum length of spike, whereas maximum number of florets per spike was recorded with cv. Snow Princess when GA₃ was applied at 100-200ppm. Ethrel at a concentration of 100 ppm increased the number of flowers per scape and showed earliness in days to flower scape emergence and first flower opening in *Hippeastrum* (Jamil *et al.*, 2015).

Seed (corm, cormel, bulb and bulblet) production

Seeds like corm, cormels, bulb and bulblets are also influenced by the application of various growth regulators. Sudhakar and Kumar (2012) revealed that the Gladiolus plant spray with CCC @500 ppm was found the best in terms of corms and cormels production. Ragaa (2012) studied the effect of some growth regulators on growth, flowering, bulb productivity and chemical composition of Iris plants. He revealed that the highest of fresh weight of new bulbs and bulblets/plant and the highest number of bulblets / plant were obtained by the application of GA₃ at 750 ppm, CCC at 1000 ppm and Alar at 500 ppm. Jamil *et al.* (2015) stated that the plants treated with 500 ppm GA₃ observed the highest number of bulblets per plot (40.00), bulbs weight per plot (4056 g) along with bulb yield (40.56 t/ha) were also obtained in GA₃ at 500 ppm.

Growth retardation

The use of growth regulators to retard the stem elongation has been a very popular subject of research in ornamental crops. This is the area where lot of works has been carried out. Growth retardants, which reduce plant height, are mostly synthetic compounds that either slow down cell division or inhibit cell elongation. Navale *et al.*, (2010) studied the influence of plant growth regulators on growth, flowering and yield of Chrysanthemum (*Dendratherma grandiflora* Tzvelev) cv. IIHR-6. The results revealed that plants sprayed with MH 1250 ppm recorded the maximum reduction in plant height with maximum number of branches and plant spread. Jain *et al.* (2016) was observed that there was a significant reduction in plant height, plant spread, internode distance and shoot length of Bougainvillea with the application of maleic hydrazide @ 2500 ppm followed by drenching with paclobutrazol.

Senescence inhibition

Rao *et al.* (1982) reported kinetin (10mg/l) was more effective in the delay of petal senescence in *Rosa damascena* than IAA and GA₃. 2% NAA has been reported to prevent senescence and dropping of petals in the flowers of *Ipomoea purpurea* (Parkhi and Khalatkar, 1986). Behara *et al.* (1990) found that the ABA treatment retarded petal senescence in leafy flowering shoots of cut carnation by reducing the

loss of total protein. Hatamzadeh *et al.* (2012) assessed the effect of salicylic acid (SA) on the quality and vase life of cut *Gladiolus* cv. "Wings Sensation" flowers over four developmental stages (bud stage, half bloom, full bloom, senescence). The flowers were treated in different concentrations of SA (50, 100, 150 and 200 mg/L). The results showed that the SA delayed flower senescence and leakage of ion in petals, as well as decreased fresh weight loss and lipid peroxidation.

Vase life

Prolonging the vase life of cut flowers is very important issue for helping the commercial growers as well as users. The growth regulators can be used with success not only for prolonging the life of cut flowers but also making possible to harvest blooms in tight bud stage and allowing them to open normally (Murti and Upreti, 1995). Some growth regulators, normally used in ornamental plants for prolonging vase life. Ethylene can pose considerable problems in the post-harvest handling of ornamentals, causing a range of effects, including early wilting of flowers, yellowing or necrosis (death) of leaves, and shattering of leaves, buds, petals and flowers. In recent years a number of growth regulator approaches to overcoming the effects of ethylene have become available. A new gaseous inhibitor of ethylene, 1-methylcyclopropene

(1-MCP), is presently being registered for use with ornamentals and appears to have considerable commercial potential as an inhibitor of ethylene action (Serekand Reid, 1997). Kumar (2015) assessed the effect of pulsing solutions on postharvest life of *Gladiolus* cv. Peater Pears cut spikes. Among all the pulsing treatments, treatment, 20% Sugar + 200ppm STS + 200 ppm GA₃ gave maximum vase life, floret size, minimum days to open basal floret, maximum floret longevity, floret opening percentage while treatment 20% sucrose + 300 ppm Al₂SO₄ + 200 ppm GA₃ attained maximum number of floret, floret weight and floret open at a time during the study. Raj *et al.* (2013) studied the effect of preservative solutions on post-harvest quality of Rose. The plants pulsed with 4% sucrose + 200 ppm salicylic acid attained maximum fresh weight and dry weight of flowers.

Plant tissue culture

In vitro clonal propagation through tissue culture is an effective method for large scale rapid multiplication of plants. Plant growth regulators are widely used in plant tissue culture techniques. The four classes of growth regulators are commonly used in tissue culture media. The type of growth regulators and concentration used will vary according to the cell culture purpose.

Growth regulators used and their functions in plant tissue culture

Class	Growth regulators	Functions
Auxin	IAA ,NAA 2,4-D ,IBA	It is required for the induction of cell division and root initiation in cultured tissues
Cytokinins	Kinetin, 2ip BAP , Zeatin	Promote cell division, shoot proliferation, organogenesis and somatic embryogenesis
Gibberellins	GA3	Used for plant regeneration and elongation
Abscisic acid	ABA	Useful in embryo culture somatic embryogenesis

Prasad and Kumar, (2003)

Priya *et al.* (2013) reported that in *Dendrobium* Sonia Earsakul, the culture establishment medium of ½ MS supplemented with 4 mg L⁻¹ BA was observed to give early bud break. In the shoot multiplication stage, treatment combinations of 2.0 mg L⁻¹ kinetin and 0.1 mg L⁻¹ NAA was found to give earliest (11.00) shoot multiplication and maximum numbers (4.66) of healthy shoots. The rooting media supplemented with 0.5 mg L⁻¹ NAA gave earliest rooting (19.6). The highest adventitious shoot in *Begonia rex* regeneration with an average number of 41.6 was obtained from leaf disc explants after 5 weeks culture on MS medium supplemented with 1 mg/l BA and 0.5 mg/l IBA (Kabirnataj, 2012).

Future challenges for PGRs and their alternatives

The use of PGRs is encouraged in the modern production system of ornamentals and floriculture it is also helpful in altering various growth characteristics but their unjudicial use can threaten the environment and also effect the consumer

acceptability, as commercial available PGRs formulations consists of synthetic growth regulators. The synthesis of ecological safe formulation of PGRs and their usage in optimum dosage will enhance their acceptability by the growers as well as consumers. The second way is to use alternative approaches for alteration of growth characteristics in ornamentals including the genetic engineering, gene silencing, and manipulation of environmental. Factors especially temperature, light and water stress technique are to control growth of ornamentals.

CONCLUSION

Plant growth substances have key role in different physiological processes related to growth and development of ornamentals and flowers crop. It is obvious that changes in the level of endogenous hormones for the crop growth and any sort of manipulation including exogenous application of

growth substances would help for yield improvement or at least sustenance of the crop. Plant growth regulators are valuable production tools that can enhance product quality and marketability while reducing labor for pinching and/or pruning and plant maintenance. They must be used with proper attention to other cultural practices, especially proper fertility and irrigation management. Hence the levels of hormones will change over the lifespan of a plant and are dependent upon season and environment.

REFERENCES

- Bewley, J.D.** (1997). Seed germination and dormancy. *Plant Cell*, **9**:1055-1066.
- Behera, P. K., Sarangi, C. S., Mishra, D., and Patra, H. K.** (1990). Effect of abscisic acid and kinetin on enzyme activities during petal senescence in cut Carnation flowers. *Israel J. of bot.*, **39**(3), 229-238.
- Carey, D.J., B.E. Whipker, I. McCall, and W. Buhler.** (2007). Cytokinin based PGR affects growth of vegetative Petunia, p.285. In: S.M. Reed (ed.), Growth Regulators. Proc. Southern Nursery Assoc. Res. Conference, 8-9 Aug. 2007, Atlanta, America.
- Carswell, F.E., J.S. Day and Gould, K.S.** (1996). Cytokinins and the regulation of plant form in three species of Sophora. *New Zealand J. Bot.*, **34**:123-130.
- Dadlani, N. K.** (2003). Global positioning of Bangladesh floriculture. In A Paper presented on a Seminar held on 6th November.
- Davies, P.J.** (2010). The plant hormones: their nature, occurrence, and function, pp.1-15. In: P.J. Davies (ed.), Plant Hormones: biosynthesis, signal transduction, action. *Springer*, Netherlands.
- De Vries, D.P. and DuboisL, A.M.** (1988). The effect of BAP and IBA on sprouting and adventitious root formation of 'Amanda' rose single-node softwood cuttings. *Sci. Hortic.*, **34**:115-121.
- Dorajeerao, AVD and Mokashi, A.N.** (2012). Yield and quality parameters of garland Chrysanthemum (*Chrysanthemum coronarium* L.) as influenced by growth regulators/chemicals. *Indian J. of Plant Sci.*, **1** (1):16-21.
- Faraji, S. and Basaki, T.** (2014). Effect of indole acetic acid and benzyladenine on morphological and biochemical properties of Gladiolus. *J. Curr. Res. Sci.*, **5**:580-84.
- Fishel, F. M.** (2007). Plant Growth Regulators. University of Florida. IFAS Extension. PI-102.
- Finkelstein, R., Reeves, W., Ariizumi, T. and Steber, C.** (2008). Molecular aspects of seed dormancy. *Annu Rev Plant Biol.*, **59**:387-415.
- Groot, S.P.C. and Karssen, C.M.** (1987). The role of Gibberellins in germination. *Planta*. **171**:525-532.
- Hatamzadeh, A., Hatami, M. and Ghasemnezhad, M.** (2012). Efficiency of salicylic acid delay petal senescence and extended quality of cut spikes of *Gladiolus grandiflora* cv. Wings sensation. *African J of Agri. Res.*, **7**(4):540-545.
- Jain, Ritu, Jankiram, T. and Kumawat, G. L.** (2016). Effect of growth retardants on growth and flowering of Bougainvillea (*Bougainvillea spectabilis*) cv. Shubra. *Indian J. of Agri. Sci.*, **86** (9): 1145-1150
- Janick** (2007). The origins of horticultural technology and Science. *Acta Hort.*, **759**:41-60.
- Jamil, M. K., Mizanur, Rahman, M., Mofazzal Hossain, M., Tofazzal Hossain, M. and Sirajul Karim, A. J. M.** (2015). Effect of plant growth regulators on flower and bulb production of Hippeastrum (*Hippeastrum hybridum* Hort.). *Bangladesh J. Agril. Res.*, **40**(4): 591-600.
- Khan, F. N., Rahman, M. M., Hossain, M. M. and Gazipur, B.** (2013). Effect of benzyladenine and gibberellic acid on dormancy breaking, growth and yield of Gladiolus corms over different storage periods. *J. of Ornam. Plants.*, **3**(1), 59-71.
- Kumar, M., Singh, V.P., Arora A. and Singh, N.** (2014). The role of abscisic acid (ABA) in ethylene insensitive Gladiolus (*Gladiolus grandiflora* Hort.) flower senescence. *Acta Physiologiae Plantarum.*, **36**(1):151-159.
- Kumar, M.** (2015). Effect of pulsing with chemicals on postharvest quality of gladiolus (*Gladiolus hybridus* hort.) cv. Peater Pears. *J. of Plant Development Sci.*, **7**(3):293-294.
- Kabirnataj, Sara, Ghasemi, Yousef, Nematzadeh, Ghorbanali, Asgharzadeh, Roghayeh, Shahin, Kaleybar Behzad and Yazdani, Mohammad** (2012). Effect of explant type and growth regulators on in vitro micropropagation of *Begonia rex*. *Intl. Res. J. Appl. Basic. Sci.*, **3** (4): 896-901.
- Lee, S.W. and Rho, K.H.** (2000). Growth control in 'New Guinea' Impatiens (*Impatiens hawkeri* hybrid) by treatments of plant growth retardants and triazole fungicides. *Kor. J. Hort. Sci., Technol.*, **18**:827-833.
- Mahgoub, M.H., El-Ghorab, A.H. and Bekheta, M.H.** (2006). Effect of some bioregulators endogenous phytohormones, chemical composition, essential oil and its antioxidant activity Carnation (*Dianthus caryophyllus* L.). *J. Agric. Sci. Mansoura Univ.*, **31**:4229-4245.
- Magnitskiy, S.V., Pasian, C.C., Bennett, M.A. and Metzger, J.E.** (2006). Controlling plug height of Verbena, Celosia, and Pansy by treating seeds with paclobutrazol. *Hort. Sci.*, **41**:158-161.
- Murti, G.S.R. and Upreti, K.K.** (1995). Use of Growth Regulators in Ornamental Plants. In: Advances in Horticulture. Vol.12-Ornamental plants. Eds: K.L. Chada and S.K. Bhattacharjee. *Malhotra Publishing House*, New Delhi, India. pp. 863-883.
- Navale, M.U., Aklade, S.A., Desai, J.R. and Nannavare, P.V.** (2010). Influence of plant

regulators on growth, flowering and yield of Chrysanthemum (*Dendranthema grandiflora* Tzvelev) cv. IIHR-6. *Int. J. of pharma and Bio Sci.*, **1**(2):115-120.

Parkhi, R.D. and Khalatkar, A.S.(1986).Incompatibility in *Ipomoea purpurea* (Roth).Plant Incompatibility.*Newsletter.*,**18**:13-18.

Prasad, S. and Kumar, U. (2003).Techniques of Plant Tissue Culture for Flower Production. In: Commercial Floriculture. Published by Agrobios(India). pp. 280-383.

Kumari, Priya, Sabina, I.,George, T. and Rajmohan, K. (2013).Influence of plant growth regulators on in vitro clonal propagation of Dendrobium Sonia Earsakul. *J. Bio. Innov.*,**2**(2):51-58.

Ram, M., Pal, V., Singh, M.K. and Kumar, M. (2012). Response of different spacing and salicylic acid levels on growth and flowering of Gladiolus (*Gladiolus grandiflorus* L). *Hortflora Res. Spec.*,**1**(3):270-273.

Ramesh, K.M., Selvarajan, M. andChezhiyan, N.(2001).Effect of certain growth substances and salicylic acid on the growth and yield of China aster cv. Kamini.*Orissa J Hort.*, **29**(2):41-45.

Ragaa, A. Taha(2012).Effect of some growth regulators on growth, flowering, bulb productivity and chemical composition of Iris plants.*J. Hort. Sci. &Ornam. Plant*, **4** (2): 215-250.

Riaz, A., Batool,Z.,Younis, A. and Abid, L.(2002). Green areas: a source of healthy environment for people and value addition to property. *Int. J. Agric. Biol.*,**4**:478-481.

Raj, S., Kumar, M., Singh, R. and Kumar (2013).Effect of floral preservatives on post-harvest quality of Rose(*RosaHybrida*) cv. Grand Gala.*Anl.ofHorti.*,**6**(2):321-325.

Randhawa, G.S. (1971).Plant Growth Regulators and GA. Indian Council of Agric. Research., New Delhi.pp. 139.

Rao, T.R., Murti, G.S.R. and Challa, P. (1983).Cytokinins in Gladiolus (*Gladiolus grandiflorus*) Corm.*Ann. Bot.*, **52**: 703-710.

Sanderson, K.C., Martin, JrW.C. and McGuire, J.(1988). Comparison of paclobutrazol tablets, drenches, gels, capsules, and sprays on chrysanthemum growth. *Hort Science.*, **23**:1008–1009.

Serek, M. and Reid, M. S. (1997).Use of growth regulators for improving the postharvest quality of ornamentals.*Perishables Handling Quarterly*, **92**: 7-9.

Sharma, H.G., Verma, L.S., Jain, V. and Tiwary, B.L.(1995).Effect offoliar application of some plant growth regulators on growth and flowering of Chrysanthemum var. Move-in-Carvin.*Orissa J. of Hort.*,**23**(1/2):61-64.

Sajjad, Y., Jaskani,M.J.,Qasim,M.,Mehmood,A., Ahmad, N. and Akhtar, G.(2015). Pre-plant soaking of corms in growth regulators influences the multiple sprouting, floral and corm associated traits in *Gladiolus grandiflorus* L. *J. Agric. Sci.*,**7**:173-181.

Singh, A.K, Kumar, R. andSisodia, A. (2013). Effect of GA₃ on growth and flowering attributes of gladiolus cultivars. *Ann Agric Res New Series*,**34**:315-19.

Sudhakar, M. and Ramesh Kumar, S. (2012).Effect of growth regulators on growth, flowering and corm production of Gladiolus (*Gladiolus grandifloras* L.) cv. White friendship.*Indian J. of Plant Sci.*, **1** (2-3): pp.133-136.

Wroblewska,, K. and R. Debicz(2013). Influence of time of benzyladenine application on rooting of cuttings and subsequent development of *Portulacaumbraticolakunth*.*Acta Sci. Pol.*,**12**:89-99.

Whipker, B.E., Gibson,J.L.,Cavins,T.J., McCall,I. and Konjoinan, P. (2003).Growth regulators. pp. 85-112. Ball Redbook.Ball Publishing, Batavia, Illinois, USA.