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Review Article

Impact of Plant Growth Regulators in Gladiolus: A Review

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A B S T R A C T

Gladiolus occupies fourth place of world bulbous flower plants area and highly priced in India and abroad. Its excellent spikes are profitable and spikes from hills fetch handsome prices in the markets of metropolitan cities and other large cities during off season, when it is not possible to produce the crop in plains. This is the physiological state of the living cells, which blocks the visible growth due to accumulation of growth inhibitory substances like abscisic acid (5 to 10 times more than non-dormant) in the corm tissues but still floriculturists are using the potential of this crop to grow year round by breaking its dormancy by uses of different growth regulators which helpful in regulating the flowering season according to the need of the market. The balanced development of plant is governed by the growth regulators those are being increasingly utilized to manipulate the growth and flowering of ornamental plants.

Keywords

Cytokinin, dormancy, ethrel, gibberellic acid, gladiolus, thiourea

Introduction

Gladiolus is one of the important bulbous flower crops and referred to as the queen of bulbous flowers. It belongs to the family Iridaceae and native to Cape region in South Africa. The word "gladiolus" is derived from the Latin word "gladius" meaning 'a sword' shape like leaves of the plants. It has bright, beautiful and differently coloured flowers and is use in cut flower, herbaceous borders, beddings, rockeries, pots. It is also used in bouquet and flower arrangement having to excellent keeping quality. Gladiolus can be cultivated on all types of soils and considered 6.0-7.0 pH for good growth and spike production. It can also be grown from plains to an altitude of 2500 m. It is a winter crop but can be grown in July-August at low rainfall areas with mild climatic conditions. It is propagated through corms and seeds but seeds normally require 2-4 seasons to come to flowering and hence followed only in breeding programs to

evolve new cultivars. Gladiolus cannot be grown year round for regular supply due to dormancy is one of the major barriers in the cultivation of gladiolus. It is physiological significance for gladiolus as it consents to overcome the unfavorable environmental but uses of different growth regulators increased the endogenous promoters in the tissue of corms and decreased inhibitors. Exogenous application has the great potential in promoting profuse flowering.

Plant growth regulators and importance

Plant growth regulators are organic compound, natural or synthetic, organic molecules which when present or apply at low concentration, results in a change in plant growth or development (DiPaola, 1988). The real beginning of plant growth regulators research, however, is found in a series of simple but elegant experiments conducted by Charles Darwin.

Plant growth regulators are signal molecules that individually or cooperatively direct the development of individual cells or carry information between cells and thus coordinate growth and development.

Synthetic compounds are not produced naturally but both (natural and synthetic) growth substances regulate or influence physiological processes like cell division, differentiation, root and shoot growth, flowering, senescence and nucleic acid synthesis reported by Danneberger and Street (1990).

Plants are produced hormones; include auxins, gibberellins, cytokinins, ethylene and some inhibitors which increasingly being used to suppress the plant growth in case of loose flowers whereas height of the plant does not matter. In gladiolus, plant growth regulators are enhanced inflorescence, shoot and better corms production. The site of synthesis and mode of transport for plant growth regulators, however, is not always so clearly localized. Although some tissues or parts of tissues may be characterized by higher plant growth regulator levels than others, synthesis of plant growth regulators appear to be much more diffuse and cannot always be localized to discrete organs.

There are several growth hormones used in the gladiolus cultivation during the last half century. Reasons to alter growth is present in the plant by plant growth regulators for the public interest in the different corner of the world.

Objectives of plant growth regulators application in gladiolus

To skip cold storage duration by breaking corms dormancy

To enhance the plant height in adverse conditions

To enhance the more number of florets per spike

To improve the quality of the cut spikes

To minimize the crop duration

To enhance the corms and cormels production

To produce flower in off-season

An ideal growth regulator for gladiolus is which improves spike quality and provides good output by best prize in the markets. The reported benefits of PGRs on gladiolus includes breaking dormancy, early sprouting, increased spike length, improved florets shape, colour and better vase life.

Discussion about plant growth regulators and their impact in gladiolus

Gibberellic acid

It is the active substance isolated from fungus *Gibberella fujikuroi* the concentration of GA_3 is highest in mature propagated materials. Gibberellins have also been found effective in overcoming both kinds of dormancy, buds as wells as seeds. Gibberellins stimulate growth, break dormancy and delay senescence. In case of gladiolus several scientist worked on it. Here some results are revealed by those who treated the gladiolus corms or plant by gibberellic acid:

Gibberellic acid dipping method

According to Salisbury and Ross (1978), gibeberellins overcome the seed dormancy and promote the germination and Groot and Karssen (1987) reported that the effect of gibberellic acid in inducing the formation of hydrolytic enzymes may be a factor, which regulates the mobilization of reserves, ultimately resulting in early sprouting with GA_3. Corms of American Beauty dipped in 125 ppm solution which sprouted in less number of days (17 days) and 50% sprouting in 29 days registered by Suresh *et al.,* (2009). Kumari *et al.,* (2011) found that the maximum number of leaves per plant was recorded under GA_3 100 ppm (5.29) which was statistically at par with GA_3 50 ppm (4.80), while, minimum number of leaves in control at 30 days after planting. More number of leaves per plant and it was maximum (7.16) with higher level of solution (150 ppm) reported by Kumar and Singh (2005). Ramachandrudu and Thangam (2007) also found GA_3 at 150 ppm improved the leaf length. In case of Ginzburg (1974) statement GA_3 promotes vegetative growth and then accumulation of enough photosynthates required for reproductive phase and Misra *et al.,* (1993) also reported GA_3 application enhanced vegetative growth and flowering. Another study was concluded by Negi and Raghava (1986) that application of GA_3 increased plant height and number of leaves and shoots per plant as well as increased number and size of florets. Plant height and spike length increased by application of GA_3 (100 ppm) at 5°C observed in Bhalla and Singh (2000). But Bhalla and Kumar (2007) reported that when treated with GA_3 300 ppm produced maximum plant height (105.60 cm) and maximum number of leaves per plant (8.07). Kumari *et al.,* (2011) also reported maximum plant height with GA_3 100 ppm (56.20 cm) treatment which was at par with GA_3 50 ppm (52.79 cm), while the minimum value for plant height was recorded in control. In case of earlly spike emergence Kumari *et al.,* (2011) observed under GA_3 100 ppm corm treatment (74.61 days), which was statistically significant with GA_3 50 ppm (76.44 days), while spike emergence was delayed in control and according to Baskaran and Misra (2007) earliness in flowering was maximum data recorded under GA_3 at 500 ppm followed by 1000 ppm. In the study of Rana *et al.,* (2005) application of GA_3 at 100 ppm advanced flowering and minimum days (108.04 and 108.08) were required for flowering under this treatment but in general, untreated plant started flowering later than those of treated one. Number of florets per spike increased significantly with increasing concentrations of GA_3 and the maximum number was recorded under GA_3 at 150 ppm reported by Singh *et al.,* (2007). Mmaximum number of spikes per plant was recorded in GA_3 at 100 ppm treatment (1.33) followed by GA_3 50 ppm (1.16) while minimum in control by Kumari *et al.,* (2011). Gibberellins lead to increased cell division and cell growth

apparently which lead to increased elongation of root (Stewart and Jones, 1977). In case of corms production Kumar and Singh (2005) reported that the lowest dose of GA_3 (50 ppm) resulted heaviest daughter corm (52.30 g/plant). According to Misra *et al.,* (1993) corms treated with 100 ppm GA_3 produced 135.84% higher cormels hill-1 over control and GA_3 100 ppm and 200 ppm gave encouraging results. Dua *et al.,* (1984) also reported that number and weight of cormels produced/plant also increased by the application of GA_3. Treatments of GA_3 also delayed the flowering significantly. However, 100 and 150 ppm treatments remained statistically at par in this regard but the plants under control hastened the flowering by Singh *et al.,* (2007).

Gibberellic acid spraying method

Early sprouting was recorded when GA_3 was sprayed @ 300 ppm followed by 400 ppm because GA_3 induced early and vigorous sprouting (Ogale *et al.,* 2000). According to Neetu *et al.,* (2013) reported that treatment with GA_3 @ 200 ppm produced maximum sprouting percentage in all the cultivars with treatment GA_3 @ 200 ppm resulted in maximum sprouting percentage followed by GA_3 @ 100 ppm in cv. Archana. Free GA_3 is active in breaking down the reserved food material by hydrolytic enzymes and hence caused earlier sprouting with enough moisture this statement was given by Vijaikumar and Singh (2005). But Neetu *et al.,* (2013) also reported GA_3 @ 200 ppm resulted in highest number of leaves/plant followed by GA_3 spraying @ 100 ppm. According to Tawar *et al.,* (2003) reported that vegetative growth increased with increasing dose of GA_3 in gladiolus cv. Jester. If increasing level of GA_3 then improve all growth parameters noticed by Singh *et al.,* (2002) and Pranav Rana *et al.,* (2005). Spike length increased with GA_3 might be due to rapid intermodal elongation as a result of increased cell division and cell elongation in the intercalary meristem observed by Sauter and Kende (1992). Baskaran and Misra (2007) found that GA_3 at 1000 ppm gave the maximum plant height but Umrao *et al.,* (2007) reported that GA_3 at 300 mg/l level produced significantly the tallest plant (97.17 cm) over control (90.20 cm). The positive effect of GA_3 in increasing field life of gladiolus spikes was reported by Gaur *et al.,* (2003).

Application of GA_3 at 200 ppm resulted in maximum number of florets/spike in cv. Snow Princess followed by GA_3 at 100 ppm in cv. Snow Princess and floret diameter significantly increased with GA_3 at 200 ppm followed by at 300 ppm observed by Neetu *et al.,* (2013). Umrao *et al.,* (2007) reported that the number of florets per spike was maximum (14.20) with 400 mg/level of GA and highest number of corms per plant (1.20) observed in 400 mg/l of GA. In case of cormels Mohanty *et al.,* (1994) reported number of cormels per plant was also increased significantly by GA_3 sprayings and its 200 mg/l concentration resulted in the highest number of cormels per plant (6.00) over control.

Cytokinin

First endogenous cytokinin was isolated from maize kernels named as zeatin. Synthetic cytokinins are kinetin, benzyladenine and ethoxy ethladenine. There are some major roles of cytokinin in the plants like Cell divisions, elongation and enlargement, induction of flowering, apical dominance-overcoming, delay senescence, tissue culture morphogenesis, breaking dormancy, improves N_2 metabolism. In present days different cytokinin treatments are given to gladiolus crop for improving its

physiological characteristics which are create desirable acceptance in public view and some researchers done work on these portion:

Cytokinin dipping method

According to Tsukamoto and Yagi (1960) reported that benzyladenine solution (20 ppm) for 24 h, followed three days later by re-soaking in 100 ppm gibberellin solution resulted in good dormancy breaking and good root and shoot growth. But Gowda (1994) observed that fist emergence (29.60 days) when treated with 50 ppm BA followed by 75 ppm BA and lower concentration showed early sprouting than higher concentration. BA induced early sprouting of corms (7 day after treatment, compared with 57 days after soaking in water for 24 h) according to Pal and Chowdhury (1998) and BA is responsible for multiple shooting reported by Murti and Upreti (1995).

Baskaran and Misra (2007) found that 100 ppm solution gave the maximum number of shoots per corm. Another statement was given by Richards and Wilkinson (1984) where cytokinins induce good branching responses without any of the disadvantages.

Anju Pal *et al.,* (2003) reported that the exogenous application of cytokinins to various plants has been found to stimulate axillary bud break and subsequent shoot growth. In case of corm characters 50 ppm concentration of solution obtained the largest corm compared to different levels of BA (Mahesh and Misra, 1993).

Cytokinin spraying method

Kumar (2008) reported that application of BA @ 75 ppm observed more number of shoots per corm.

Ethylene

Ethylene is formed naturally in plants in amounts sufficient to bring about regulatory effects and it might be considered as plant hormone. Synthetic chemical known as etherel, ethephon, chloroethyl phosphonic acid (CEPA) has been reported to release ethylene when applied on plants. Some important roles of ethylene in the plants are breaking dormancy, induce abscission of leaves and inhibit elongation and lateral bud growth. In gladiolus so many work have been done throughout the world but some important works are discus below:

Ethylene dipping method

The ethylene releasing compound (CEPA-2-chloro ethyl phosphonic acid) promotes the germination of dormant gladious cormals (Ginzburg, 1974). And according to Denny and Miller (1934) and Denny (1938) reported that use of 3-5 ml of 40 per cent ethylene chlorohydrin per litre of air space within a closed container for 3-5 days hastened sprouting of five gladiolus cultivars. But room temperature was found effectively for early sprouting with application of ethephon 1000 ppm (Bhalla and Singh, 2000). Another statement reported by Umrao *et al.,* (2006) where 500 ppm ethrel produced significantly the higher number of sprouts per corm than its lower and higher doses and control. In the case of Evenari *et al.,* (1950) observed that 0.3 per cent solution of ethylene chlorohydrin shortened the rest period and stimulated early sprouting and flowering in summer gladiolus cv. Picardy. Sprouting enhanced by 30 min dipping of corms at various concentrations of ethrel but ethrel at 1000 ppm also enhanced sprouting when corms were stored at high temperature (Halevy *et al.,* 1970). Mukhamed (1985) observed that corm treatment with ethephon at 0.05 per

cent shortened dormancy period and advanced flowering in artificial light. But Bylov *et al.,* (1988) reported that corm treatments viz., the ethephon based preparations, Hydreol, Flodimex and Composan were the best in shortening the dormancy period of corms. The treatments like smoking once a day for 3 days, cracking the outer shell of the corm or treating with 400 ppm ethrel (ethephon) significantly broke the dormancy and increased the sprouting percentage in cvs. Spic and Span & True Love (Hong and Goo, 1991). If corms are treated with ethrel at 8000 mg/l positively affected both corms obtained from summer and autumn crops with respect to sprouting percentage and days taken for 50 per cent sprouting reported by Muthoo and Maurya (1995). Pal and Choudhury (1998) observed that the crop reduced the number of days for sprouting over control with application of ethrel at 100 ppm for 24 h. But according to Goo *et al.*, (1999) reported an increase in sprouting percentage, and reduction in the number of days to sprouting with ethephon (1000 ppm) treatment in the cvs. Spic and Span, Topaz & White Prosperity. Ethrel 1500 ppm took minimum number of days (20.23) to sprout, whereas maximum number of days (25.33) to sprout was taken by untreated corms but in case of flowering it gave earlier flowering (87.87d), whereas, the untreated corms took maximum number of days observed by Bhalla and Kumar (2007). In the different concentrations of ethrel only lower dose (250 ppm) could increase the placement (3.40 cm) and its two higher doses decreased the distance between two florets as compared to control (Mohanty *et al.*, 1994). By the observation of Kumar and Singh (2005) reported the duration of spike was reduced linearly with every increase in concentrations of ethrel. In corms characters Umrao *et al.*, (2006) registered that the weight of corm decreased linearly with increasing concentration of ethrel and its higher dose (750 ppm) reduced the weight of corm (38.01 g) over control (38.95 g), but the lower dose (250 ppm) resulted in the heavier daughter corm (40.91 g) over control.

Thiourea

Thiourea is an organosulfur compound its structurally similar to urea, except that the oxygen atom is replaced by a sulfur atom, but the properties of urea and thiourea differ significantly. Thiourea is a reagent in organic synthesis and sometime use to break the dormancy of bulbs in tuberose and corms in gladiolus. Some works have been done on this aspect:

Thiourea dipping method

According to Padmalatha *et al.,* (2013) found that 2% solution to be highly effective in breaking the dormancy of corms with high percentage of sprouting, more number of buds sprouted per corm and number of big cormels per plant was increased significantly and again Padmalatha *et al.*, (2014) reported that 2% solution more effective in increasing the vegetative growth but Chahal *et al.*, (2013) reported that 500 ppm solution significantly increased the plant height excluding spike up to maximum (50.71 cm).

Naphthaleneacetic acids (NAA), dipping method

Auxin is a Greek word which means to *increase*. It is a generic term for chemicals that typically stimulate cell elongation, but auxins also influence a wide range of growth and development response. Long vegetative phase in plants might have delayed the spike emergence (Ramachandrudu and Thangam, 2007).

BR, spraying method

According to Mandava and Thompson (1983) gibberellins caused only elongation of the upper internodes but, BRs characteristically evoked both cell elongation and cell division resulting in elongation, swelling, curvature and splitting of second internode in the bean second internode bioassay.

Such activity of BR is called brassisin activity. In all the bioassays, it was found that BRs produce activity at concentrations much lower than those effective for gibberellins.

Forchlorfenuron CPPU- 1-(2-cl-4-pyridine-3-phenyl-urea), spraying method

The increase in plant height may be ascribed to the stimulation of cell division and cell enlargement with the application of CPPU as explained by Yu *et al.,* (2001).

Triiodobenzoic Acid (TIBA), spraying method

Spraying in gladiolus crop to change the some physiological activities which are desirable in public interest. According to Ravidas *et al.,* (1992) observed that the flowering delay in cv. Friendship and Darginaviciene and Maksimov (2001) registered that TIBA inhibited both *in vivo* and *in vitro*, the processes of specific IAA binding and physiological activity of the resulting IAA protien complexes of spring wheat coleoptile cell plasmalemma.

Cycocel Chlormequat Chloride (CCC), spraying method

According to Kumar (2008) application of 1000 ppm CCC on gladiolus, produced more number of florets (15.2).

Note: Hereby, we have to bear in mind that not all the plant growth regulator dissolved in the water or ethanol that may be required a specific solution or buffer to dissolve the plant growth regulator. Before using plant growth regulators it's necessary to read all the instruction which is for that particular PGR.

Improving physiological activities of gladiolus it's possibly grown throughout the year with desirable quality by application of different plant growth regulators. Methods may be used according to acceptability in the growing area of the growers that would be pre-planting application or later spraying on the plant. There are several plant growth regulators available and used for the different purposes like improve plant height, to increase number of florets per spike, to produce more number of corms per plant, minimize crop duration etc. and it applicable for the different corner of the world.

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