Effect of pre-plant soaking of corms in bio-regulators on growth, flowering, Yield and quality in gladiolus (Gladiolus grandiflorus L.) CV. rani

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Abstract
The present experiment entitled “Effect of pre-plant soaking of corms in bio-regulators on growth, flowering, yield and quality in gladiolus (Gladiolus grandiflorus L.) cv. Rani.” was carried out at the Jambuvadi Farm, Department of Horticulture, J. A. U., Junagadh (Gujarat) during 2019 to 2020. The results of the study indicated that, the pre-plant soaking of corms in bio-regulator GA3 (150 ppm) was found effective for earlier sprouting (6.90 days), maximum plant height (78.74 cm) and number of leaves (13.62). Regarding flowering characters, the GA3 150 ppm responded best especially in commercial traits like spike length (86.82 cm), rachis length (40.30 cm), number of floret/spike (10.63), diameter of 2nd floret (13.09 cm) and duration of flowering (22.34 days).

Keywords: Gladiolus, Bio regulators, GA3

Introduction
Gladiolus (Gladiolus grandiflorus L.) is one of the important bulbous flower crops. 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 occupies fourth place of world bulbous flower plants area and is referred to as the queen of bulbous flowers. Gladiolus is highly priced in India and abroad for 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 excellent keeping quality. Freshly harvested corn and cormels of gladiolus do not sprout immediately even it’s placing in pots. It is also used in bouquet and flower arrangement having excellent keeping quality. Freshly harvested corn and cormels of gladiolus do not sprout immediately even it’s placing in favorable growing conditions because of a period of dormancy which is regulated by changes in the stages of endogenous promotory or inhibitory substances. The physiological functions inside the corms are controlled by plant bio-regulators. Plant bio-regulators are the organic chemical compounds which modify or regulate physiological processes in an appreciable measure by breaking dormancy of gladiolus corms and stimulating cell division and cell elongation in plants.

Materials and Methodology
The present investigation was carried out at the Jambuvadi farm, Department of Horticulture, Junagadh Agricultural University, Junagadh (Gujarat) during 2019-2020. Junagadh is situated in Saurashtra region of Gujarat state. Geographically, this place is situated at 21.50 N latitude and 70.50 E longitudes with an altitude of 60 meters above the mean sea level and 80 Kilometers away from Arabian sea. The soil of this region is classified as Vertic Ustochrepts. Physical and chemical properties of the soil of the experimental field were determined with pH 7.85. Medium sized gladiolus (4-6 cm diameter) corms were selected for the experimental purpose. These corms were soaked in the fungicide solutions (Carbendazim @ 0.2 per cent) for 30 min and kept for drying in shade for 24 hrs. Then these corms were soaked for 24 hrs in water (as control) and different solutions of bio-regulators [gibberellic acid (GA3), benzyl adenine (BA), ethrel and thiourea] as per treatment requirement. These treated corms were further drying for another 24 hrs and finally these were planted in the experimental plots. Planting was carried out randomly in respective plots at a spacing of 30 cm X 20 cm with a depth of 5 cm.
Moderate irrigation was given to the plots a day before planting to keep the plots moist. The experiments were planted on 3rd November 2019. Investigation was laid out in randomized block design (RBD) comprising thirteen treatments including; Gibberellic acid @ 50 ppm (T1), Gibberellic acid @ 100 ppm (T2), Gibberellic acid @ 150 ppm (T3), Benzyl adenine @ 50 ppm (T4), Benzyl adenine @ 100 ppm (T5), Benzyl adenine @ 150 ppm (T6), Ethrel @ 250 ppm (T7), Ethrel @ 500 ppm (T8), Ethrel @ 750 ppm (T9), Thiourea @ 1% (T10), Thiourea @ 2% (T11), Thiourea @ 3% (T12) and Control (T13).

Results and Discussion
Effect of plant bio-regulators on vegetative growth parameters
The result indicates that the pre plant soaking of different solutions of bio-regulators had produced significant effect on growth parameters viz., Days to sprouting (days), plant height at 45 and 75 DAP (cm) and number of leaves per plant at 45 and 75 DAP.

Days to sprouting (days): The effect of different bio-regulators on days to sprout was presented in Table-1. Days to corm sprouting ranged from 6.90 to 16.36 days under different treatments. It was found that treatment T3 (GA3 @ 150 ppm) took the shortest time (6.90 days). Whereas the untreated corms T13 (control) took the longest period to sprout the corm (16.36 days). These findings might be due to the fact that gibberellic acid breaks the dormancy of corms by activating α-amylase enzyme that stimulates the hydrolyzation of stored food (starch) into simple sugar and provides nourishment and energy during sprouting of bulbous crops. These findings are in agreement with the findings of Halevy et al. (1970) [4], Kirad et al. (2001) [6], Kumar et al. (2010) [8] and Padmalatha et al. (2013) [17]. The report of Khan et al. (2013) [5] and Sarkar et al. (2014) [20] emphasized the formation of hydrolytic enzymes may be a factor, which regulates the mobilization of reserves, ultimately resulting in early sprouting with gibberellic acid. The report of Kumar et al. (2009) [7] showed that the gibberellic acid breaking down the reserved food material of mother corms by hydrolytic enzymes and hastened the sprouting process.

Plant height at 45 and 75 DAP (cm): Pre-planting soaking of corm in different bio regulators solution had significant effect on plant height is presented in Table-1. In all treatment the maximum plant height was obtained in T3 (GA3 @ 150 ppm) at 45 DAP and 75 DAP (50.68 and 78.74 respectively). While, T13 (control) registered in minimum plant height at 45 DAP and 75 DAP (19.63 and 45.20 cm respectively). These findings might be due to the application of GA3 which increased cell division and cell elongation in plants resulting in more number of cells and increase in cell length which ultimately affected plant growth (Taiz and Zeiger, 1998) [24]. This may be due to that it enhances cell division by promoting DNA synthesis in cell (Sharma et al., 2006) [21]. Gibberellins are known to promote the elongation of stem by cell elongation and cell multiplication. This response is in agreement with the results obtained in gladiolus by Suman et al. (2008) [23] and Misra et al., (1996) [13] in gladiolus cv. Sylvia. It might occur due to application of optimum doses of GA3 that helps to regulate the vegetative growth by inducing active cell division in the apical meristem.

Number of leaves per plant at 45 and 75 DAP: Higher concentration of T3 (GA3 @ 150 ppm) was found effective in increasing the number of leaves at 45 (9.74) and 75 (13.82) days after planting. This may be because GA3 enhances cell division by promoting DNA synthesis in cell and increasing vegetative growth characters. Earliness in sprouting would be due to the breaking of corm dormancy by GA3 application. GA3 also induces active cell division in apical meristem and is also helpful in elongation of individual cells which results in improved vegetative growth (Laishram and Hatibarua, 2013) [10]. The growth regulator promoted cell division and cell elongation thereby, significantly influencing the leaf number and leaf area. Growth regulator application further enhanced the translocation of sugars (Montessori et al., 2013) [14].

Effect of plant bio-regulators on flowering, yield and quality parameters
The result indicates that the pre plant soaking of different solutions of bio-regulators had produced significant effect on flowering, yield and quality parameters viz., Spike length (cm), rachis length (cm), number of florets per spike, diameter of flower (2nd florets) (cm), duration of flowering (days) and spike yield per ha (in thousands).

Spike length (cm): The length of spike differed significantly due to various bio regulators treatments of corms (Table-2). Among the all treatment the highest spike length was obtained in the treatment T3 (GA3 @ 150 ppm). On the other hand shortest spike length (56.39) was produced by T13 (control). These results are in accordance with Bhalia and Kumar (2007) [1]. It might be due to rapid intermodal elongation as a result of increased cell division and cell elongation in the intercalary meristem by GA3. As GA3 promotes vegetative growth and increases the photosynthetic and metabolic activities causing more transport and utilization of photosynthetic products. This might have resulted in increased spike length represented by Reddy et al. (2013), Chopde et al. (2015) [3] and Pal and Chowdhary (1998) [18]. Suman et al. (2011) claimed that increased spike length may be due to that the gibberellic acid which might have increased auxin content in tissue as it is involved in auxin synthesis.

Rachis length (cm): The length of rachis was significantly influenced by different bio regulators treatments of corms in gladiolus (Table-2). Plants from T3 (GA3 @ 150 ppm) produced the longest rachis length (40.30 cm). Whereas, plant grown from without bio regulator T13 (control) produced the shortest rachis length (26.46 cm). Most of the growth regulators acted as growth promoter but the effect of GA3 150 ppm was dominant among all other treatments. These results are in agreement with those reported by Naveen Kumar et al. (2011) [25], found length of rachis and spike increased due to different chemical treatments. Kumar et al. (2009) [7] reported increase in rachis length due to chemicals and growth regulators.

Number of florets per spike: Significantly highest number of florets per spike (10.63) were observed in the plants grown from the corms treated with T3 (GA3 @ 150 ppm). The minimum number of florets per spike (6.13) was produced in T13 (control). Gibberellic acid acted as a growth promoting chemical, it was also due to early sprouting and good vegetative growth. These results are in agreement with those
reported by Suman et al. (2008) \cite{15} was reported that more number of florets per spike and flowering duration due to dipping of corms in growth regulators. Gibberellic acid promotes the auxiliary buds to grow vigorously and their flowering, it might be main reason for production of more flowering spikes (Montessori et al., 2013) \cite{16}.

**Diameter of flower (2nd florets) (cm):** The diameter of floret was significantly influenced by the different plant bio regulators (Table-2). The maximum diameter of floret (13.09 cm) was noted in treatment T3 (GA3 @ 150 ppm) and lowest diameter of floret (9.50 cm) was recorded in treatment T13 (control). Application of 150 ppm GA3 significantly increased floret diameter. The results are in close conformity with the findings of Padaganur et al. (2005) \cite{12} in tuberose. The increase was mainly due to the increase in the number of leaves per plants which might have increased the production of photosynthates needed to enhance reproductive growth (Sindu and verma, 1998) \cite{17} in gladiolus.

**Duration of flowering (days):** The duration of flowering was significantly influenced by the different plant bio regulators (Table-2). Maximum flowering duration observed in T3 (GA3 @ 150 ppm) (22.34), while the minimum flowering duration was found in T13 (control) (13.54). GA3 application was found effective in increasing flowering duration as compared to BA, ethrel and including control. It might be due to the role of plant growth regulators in delaying the senescence of flower and reduced the effect of ethylene. There is a possibility of plant growth regulator by delaying the natural rise in ethylene production (Mayak and Halevy, 1980) \cite{18}. Gibberellins is quite effective in reducing juvenile period of plant and inducing reproductive phase (Chopde et al., 2015) \cite{19}.

**Spike yield per ha (in thousands):** The spike yield per ha was significantly influenced by the different plant bio regulators (Table-2). The maximum spike yield was observed in T6 (BA @ 150 ppm) (162.71 spike yield/ha). However, minimum spike yield was recorded in T13 (control) (81.18). BA increased the spikes yield, it might be due to the maximum number of shoots per corm (Aier et al., 2015). Variation of spikes yield among the treatments might be due to significant difference in per cent sprouting of corms, number of spikes per plant which is controlled by genotypic factor along with effect of growth regulators. Similar views are expressed by Kumar and Singh (2005) \cite{20}, Chopde et al., (2011) \cite{21} and Manasa et al., (2017) \cite{22} in gladiolus.

**Table 1:** Effect of plant bio-regulators on vegetative growth parameters

| Treatment  | Treatment details | Days to sprouting (days) | Plant height (cm) | Number of leaves per plant |
|------------|-------------------|--------------------------|-------------------|---------------------------|
|            |                   |                          | 45 DAP   | 75 DAP   | 45 DAP | 75 DAP |
| T1         | GA3 @ 50 ppm      | 7.56                     | 41.82    | 69.59    | 7.07   | 9.55   |
| T2         | GA3 @ 100 ppm     | 7.83                     | 43.46    | 69.03    | 8.29   | 12.66  |
| T3         | GA3 @ 150 ppm     | 6.90                     | 50.68    | 78.74    | 9.74   | 13.62  |
| T4         | BA @ 50 ppm       | 10.23                    | 36.94    | 62.07    | 7.00   | 10.77  |
| T5         | BA @ 100 ppm      | 8.20                     | 28.74    | 49.84    | 8.11   | 11.11  |
| T6         | BA @ 150 ppm      | 11.40                    | 32.53    | 54.33    | 8.26   | 11.25  |
| T7         | Ethrel @ 250 ppm  | 11.93                    | 40.63    | 65.73    | 7.93   | 10.66  |
| T8         | Ethrel @ 500 ppm  | 12.96                    | 35.34    | 59.84    | 6.72   | 8.96   |
| T9         | Ethrel @ 750 ppm  | 12.65                    | 30.80    | 56.33    | 7.76   | 9.94   |
| T10        | Thiourea @ 1%     | 8.03                     | 45.77    | 73.21    | 9.14   | 12.15  |
| T11        | Thiourea @ 2%     | 7.96                     | 47.24    | 75.84    | 9.52   | 13.26  |
| T12        | Thiourea @ 3%     | 7.70                     | 43.61    | 65.92    | 9.58   | 13.52  |
| T13        | Control           | 16.30                    | 19.63    | 45.20    | 5.06   | 8.44   |
|            | S.Em.±            | 0.486                    | 2.501    | 2.901    | 0.454  | 0.763  |
|            | C.D. at 5%        | 1.41                     | 7.30     | 8.46     | 1.32   | 2.22   |
|            | C.V. %            | 8.44                     | 11.33    | 7.91     | 9.82   | 11.77  |

**Table 2:** Effect of plant bio-regulators on flowering, yield and quality parameters

| Treatment | Treatment details | Spike length (cm) | Rachis length (cm) | Number of florets/spike | Diameter of flower (2nd floret) (cm) | Duration of flowering (days) | Spike yield/ha (thousand) |
|-----------|-------------------|-------------------|--------------------|-------------------------|-----------------------------------|-----------------------------|--------------------------|
| T1        | GA3 @ 50 ppm      | 74.28             | 34.66              | 8.38                    | 11.89                             | 19.36                       | 135.00                   |
| T2        | GA3 @ 100 ppm     | 74.42             | 31.80              | 8.52                    | 12.95                             | 20.55                       | 134.19                   |
| T3        | GA3 @ 150 ppm     | 86.82             | 40.30              | 10.03                   | 13.09                             | 22.34                       | 142.55                   |
| T4        | BA @ 50 ppm       | 63.33             | 27.16              | 6.91                    | 11.40                             | 18.21                       | 141.08                   |
| T5        | BA @ 100 ppm      | 68.51             | 30.56              | 7.86                    | 10.94                             | 17.89                       | 156.35                   |
| T6        | BA @ 150 ppm      | 71.09             | 26.83              | 7.61                    | 11.56                             | 16.51                       | 162.71                   |
| T7        | Ethrel @ 250 ppm  | 61.07             | 31.33              | 8.83                    | 11.18                             | 17.03                       | 105.33                   |
| T8        | Ethrel @ 500 ppm  | 66.90             | 31.40              | 7.83                    | 11.30                             | 18.22                       | 117.93                   |
| T9        | Ethrel @ 750 ppm  | 69.28             | 32.10              | 8.38                    | 11.18                             | 18.26                       | 126.18                   |
| T10       | Thiourea @ 1%     | 75.36             | 32.50              | 8.52                    | 12.18                             | 17.60                       | 135.68                   |
| T11       | Thiourea @ 2%     | 82.24             | 37.83              | 8.72                    | 12.79                             | 21.85                       | 141.75                   |
| T12       | Thiourea @ 3%     | 77.90             | 33.03              | 9.83                    | 12.45                             | 21.67                       | 144.19                   |
| T13       | Control           | 56.39             | 26.46              | 6.13                    | 9.50                              | 13.54                       | 81.18                    |
|            | S.Em.±            | 4.288             | 1.637              | 0.418                   | 0.621                             | 0.924                       | 6.857                    |
|            | C.D. at 5%        | 12.51             | 4.77               | 1.22                    | 1.81                              | 2.70                        | 20.01                    |
|            | C.V. %            | 10.41             | 8.86               | 8.71                    | 9.18                              | 8.6                         | 8.96                     |
Conclusions
On the basis of results obtained in the present investigation, it can be concluded that the higher concentration of GA3 (150 ppm) was most effective in increased minimum days to sprouting, plant height, number of leaves per plant, spike length, rachis length, number of florets per spike, diameter of florets and duration of flowering. While, higher concentration of benzyl adenine (150 ppm) was the most effective to spike yield.

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