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*Full Length Research Paper*

# Enhancing blooming period and propagation coefficient of tulip (*Tulipa gesneriana* L.) using growth regulators

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**A study was carried out to evaluate the effect of plant growth regulators on growth, flowering and bulb production of tulip under Karewa conditions of Kashmir Himalaya during 2009 to 2011. The three different growth regulators; gibberellic acid ($GA_3$) at 100, 200, and 400 ppm, 2-chloroethyl trimethyl ammonium chloride (CCC) and maleic hydrazide (MH) each at 100, 200 and 500 ppm along with control were applied as dip treatment and foliar spray. Plant height was recorded maximum with 400 ppm $GA_3$ (37.32 cm) followed by 200 ppm $GA_3$ (34.13 cm). $GA_3$ at 400 ppm significantly caused earliest flowering (141.30 days) followed by 200 ppm $GA_3$ (142.43 days) as compared to the control (148.93 days), while delayed flowering were observed by 500 ppm MH (152.96 days) followed by 200 ppm MH (151.93 days). The longest blooming period was recorded in 200 ppm $GA_3$ (28.46 days) followed by 400 ppm $GA_3$ (27.76 days) in comparison to the control (21.59 days). The maximum vase life was obtained with 400 ppm $GA_3$ (11.26 days) followed by 200 ppm $GA_3$ (10.43 days) over the control (7.30 days). The maximum number of bulbs and daughter bulbs per plant were recorded with 400 ppm $GA_3$ (1.43 and 3.03) followed by 500 ppm CCC (1.41 and 2.65) over the control (1.07 and 1.72), respectively and thereby enhanced propagation coefficient was obtained in 400 ppm $GA_3$ (258.66%) followed by 500 ppm CCC (237.73%) as against the control (170.00%).**

**Key words:** *Tulipa gesneriana*, gibberellic acid, 2-chloroethyl trimethyl ammonium chloride, maleic hydrazide, blooming period, propagation coefficient.

## INTRODUCTION

Tulip (*Tulipa gesneriana* L.), a bulbous flowering plant belongs to family Liliaceae, has become one of the world's most important ornamental plants owing to wide range of beautiful cultivars of attractive colours and exquisite shapes. It occupies 4$^{th}$ position among the top ten cut flowers in global floriculture trade (Jhon and Neelofer, 2006). Tulips are grown in beds, borders and pots in gardens and lawns for aesthetic purpose, and as cut flower for commercial purpose. In India, tulips are grown successfully in temperate regions of Jammu and Kashmir, Himachal Pradesh and Uttrakhand but do not grow well in plains owing to its high chilling requirements. In tulip cultivation, short blooming period and quality bulb production are major problems. Exogenous application of plant growth regulators (PGRs) play important role in manipulating growth, flowering and bulb production behaviour in flower crops. Gibberellins are involved in several plant development processes and promote number of desirable effects including stem elongation, uniform and early flowering, increased flower number and size (Al-Khassawneh et al., 2006). It determines important physiological changes such as cell division and expansion, and induce and promote flowering (Da Silva Vieira et al., 2010). Gibberellic acid ($GA_3$) is also known

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**Abbreviations: $GA_3$,** Gibberellic acid; **MH,** maleic hydrazide; **CCC,** 2-chloroethyl trimethyl ammonium chloride.

to increase bulb yield (Kumar et al., 2008).

Application of 2-chloroethyl trimethyl ammonium chloride (CCC) inhibits gibberellic acid biosynthesis (Moore, 1989), while maleic hydrazide (MH) reduce biosynthesis of nucleic acid (Ranjan et al., 2004) that results in inhibition of vegetative growth. CCC application improved number and weight of bulb and daughter bulb per plant in tulip (Ahmed et al., 2009 and Mukherjee et al., 1999). However, information on influence of plant growth regulators on tulip flowering and bulb production is scanty under Karewa condition of Kashmir Himalaya. Therefore, the present study was formulated to ascertain the optimal concentration of $GA_3$, CCC and MH on growth, flowering and bulb production attributes of tulip.

## MATERIALS AND METHODS

The study was conducted at the experimental farm of the Central Institute of Temperate Horticulture, Srinagar during 2009 to 2011 using tulip cv. Apeldoorn. The bulbs were procured from the Department of Plant Introduction, Directorate of Floriculture, Kashmir, Srinagar, India. The experimental field is situated at about 33° 59' N latitude and 74° 46' E longitude and 1674.88 m elevation above mean sea level. The soil characteristics of experimental field were clay loam to silt clay, pH 6.81 and EC 0.36 $dsm^{-1}$ with adequate drainage and water holding capacity. Healthy and uniform bulbs of 8 to 10 cm circumference were used as planting material. Ten different treatments of plant growth regulators viz., $GA_3$, CCC and MH including control were laid out in randomised block design with three replications. The concentration of growth regulators were 100, 200 and 400 ppm of $GA_3$, 100, 200 and 500 of each CCC and MH with a control comprising distilled water. The treatments were applied by soaking bulb in respective growth regulator solutions for 1 h and then dried at room temperature overnight before planting and again same treatments were applied as uniform foliar spray at three leaf stage during growing season. 50 bulbs per treatment per replication were planted on 1st November at the spacing of 15 x 20 cm and at a depth of 6 to 8 cm. Uniform intercultural operations were followed during the experimentation. The data recorded on the following parameters pertained to growth, flowering and bulb production from ten randomly selected plants leaving border plants in each replication.

### Days to sprouting of bulb (days)

The numbers of days taken from planting to sprouting of bulbs are mentioned as days to sprouting.

### Plant height (cm)

Plant height was measured with the help of scale from the ground level to the top of plant after 150 days of planting when flowers were fully opened.

### Number of leaves per plant

Number of leaves per plant counted from randomly selected plants at the end of flowering.

### Wrapper leaf area ($cm^2$)

Wrapper leaf area was measured with the help of leaf area meter (YMJ-B model) after 150 days of planting.

### Flower stem diameter (mm)

Flower stem diameter was measured from three points (upper, middle and lower) with the help of digital vernier calliper; mean was worked out and expressed in millimetre.

### Field life (days)

This is the number of days from planting to the drying of plant.

### Days to flower bud appreance, colour break stage and flowering

These are the numbers of days from planting to appreance of flower buds, change in the colour of buds (when buds show colour) and flower opening, respectively.

### Flower size (cm) and flower stem length (cm)

Flower size is the diameter of flower, while flower stem length was measured from the base of stem to the end of stem, when flowers were fully opened.

### Blooming period (days)

Blooming period was counted from opening of first flower to wilting of last flower.

### Vase life (days)

Flowers vase life was counted from opening of flower till the tapels faded colour and started shedding, wilting and expressed in days.

### Number of bulbs per plant

This is the total number of flowering bulb (large size bulb which can produce flower) produced per plant.

### Bulbs weight per plant (g/plant)

This is the total weight of flowering bulbs produced per plant weighted with help of electronic weight balance.

### Bulb weight (g)

This is the weight of single flowering bulb and expressed in gram.

### Bulb size (cm)

This is the circumference of flowering bulb measured from widest point and expressed in centimetre.

### Number of daughter bulbs per plant

This is the total number of nonflowering bulb (small size bulb which cannot produce flower) produced per plant.

**Daughter bulbs weight per plant (g)**

This is the total weight of non flowering bulbs produced per plant.

**Propagation coefficient**

The plant propagation coefficient (%) is the ratio of the total weight of bulb and daughter bulb produced and the weight of bulb planted, multiplied by 100.

**Statistical analysis**

The values given in the tables represent the mean of three replications and each replication is mean of ten randomly selected plants. The F value was calculated by dividing treatment mean square with error mean square as per the methods of Gomez and Gomez (1984). The critical difference (CD) value was used to determine difference between treatments worked out at 5% level of significance by using the following formula suggested by Chandel (2004).

CD = SE difference x t at 5% for error degree of freedom

Where, SE difference $=\sqrt{2V_E}/r$, $V_E$ = pooled error mean square and r = number of replications.

## RESULTS AND DISCUSSION

### Vegetative attributes

Data presented in Table 2 reveals that $GA_3$ application significantly led to early sprouting of bulbs. The earliest sprouting was recorded with 400 ppm $GA_3$ (78.62 days) as compared to the control (82.89 days). High ABA content in the bulb act as inhibitors and application of $GA_3$ probably reduced the levels of inhibitor (Geng et al., 2007) and leading to early sprouting. Early sprouting was also reported by Tonecki (1989) in gladiolus and Rudnicki et al. (1976) in tulip by $GA_3$ application. CCC and MH delayed sprouting of bulbs mostly in the case of 500 ppm MH (86.30 days) and 500 ppm CCC (86.16 days) treatments. $GA_3$ at higher concentration of 200 and 400 ppm significantly improved plant height over the control. Plant height was recorded maximum with 400 ppm $GA_3$ (37.32 cm) followed by 200 ppm $GA_3$ (34.13 cm). Application of 100 ppm $GA_3$ resulted in 32.83 cm plant height which was at par with the control (31.91 cm). $GA_3$ increased height of the plant over control which may be due to the growth promotion effect of $GA_3$ in stimulating and accelerating cell division, increasing cell elongation and enlargement or both (Hartmann et al., 1990). CCC and MH reduced plant height in comparison to the control and shortest plant height was observed with 500 ppm MH (27.78 cm). The CCC decreases, inhibits, and/or block gibberellins biosynthesis (Moore, 1989) and thereby inhibits the cell division, while MH inhibits cell division by reducing nucleic acid biosynthesis (Ranjan et al., 2004), which may results in reduction of plant height. Application of 500 ppm CCC resulted in maximum number of leaves per plant (4.76) followed by 200 ppm CCC (4.64) and 400 ppm $GA_3$ (4.54) as compared to the control (3.62). The leaves are already developed inside the bulb but application of $GA_3$ and CCC possibly helped in their expression. Increased number of leaves per plant was also obtained by Ali and Elkiey (1995) in calla with $GA_3$ and CCC treatments.

All treatments of $GA_3$ increased wrapper leaf area and maximum wrapper leaf area (137.20 $cm^2$) was recorded with 400 ppm $GA_3$ followed by 200 ppm $GA_3$ (131.43 $cm^2$), while CCC and MH at higher concentration reduced wrapper leaf area and minimum wrapper leaf area was obtained with 500 ppm CCC (117.16 $cm^2$). The enlargement of leaf area by $GA_3$ probably owing to increase in cell division and cell enlargement (Hartmann et al., 1990), while reduction of leaf area with growth retardants may be due to inhibition of cell division (Ranjan et al., 2004). The findings are in conformity with Kavitha (2001) in jasmine and Sujatha et al. (2002) in gerbera. $GA_3$ increased flower stem diameter significantly and recorded maximum with 100 ppm $GA_3$ (6.86 mm) followed by 200 ppm $GA_3$ (6.32 mm) over control (5.75 mm). Similar results were also obtained by Khan et al. (2007) in tulip.

However, application of CCC and MH was at par with the control in respect of flower stem diameter except 500 ppm CCC application. Field life of plant was found maximum with 500 ppm CCC (184.75 days) followed by 400 ppm $GA_3$ (183.70 days). The field life of plants was significantly extended by higher concentration of $GA_3$ that is, 200 and 400 ppm, which were in accordance with the findings of Rana et al. (2005) in gladiolus.

### Flowering attributes

Perusal of data presented in Table 3 divulges that the number of days taken to flower bud appearance, colour break stage and flowering decreased with increasing concentration of $GA_3$. These results are in conformity with the results of Tonecki (1989) in gladiolus. Rapid growth and flowering with $GA_3$ application was also reported by Geng et al. (2005) in tulip while the numbers of days taken to flower bud appearance, colour break stage and flowering increased with increasing concentration of CCC and MH. These results are in agreement with the results of Navale et al. (2010) in chrysanthemum. Delayed flowering was also reported by Taha (2012) in iris with CCC application. $GA_3$ at 400 ppm significantly caused earliest flowering (141.30 days) followed by 200 ppm $GA_3$ (142.43 days) over the control (148.93 days) while delayed flowering were observed in 500 ppm MH (152.96 days) and 200 ppm MH (151.93 days) as well as in 100 ppm MH and 500 ppm CCC. Delayed anthesis in tulip with CCC application was also obtained by Mohamed and Fawzi (1980). $GA_3$ at all concentration significantly increased blooming period (Figure 1) over control.

**Table 1.** Average monthly weather condition prevailed during experimentation (2009-2011).

| Month | Atmospheric temperature (°C) | | | Relative humidity (%) | Total monthly rainfall (mm) |
|---|---|---|---|---|---|
| | Maximum | Minimum | Average | | |
| November | 16.60 | 0.82 | 8.71 | 66.19 | 22.60 |
| December | 10.50 | -2.86 | 3.82 | 79.00 | 36.05 |
| January | 9.47 | -0.98 | 4.24 | 77.15 | 56.70 |
| February | 9.80 | 0.54 | 5.17 | 74.81 | 94.55 |
| March | 17.76 | 4.19 | 10.97 | 65.02 | 52.00 |
| April | 20.37 | 6.70 | 13.54 | 68.02 | 91.15 |
| May | 20.91 | 8.37 | 14.64 | 67.00 | 60.65 |

**Table 2.** Effect of $GA_3$, CCC and MH on vegetative attributes of tulip cv. Apeldoorn.

| Treatment | Days to sprouting of bulb | Plant height (cm) | Number of leaves per plant | Wrapper leaf area ($cm^2$) | Flower stem diameter (mm) | Field life (days) |
|---|---|---|---|---|---|---|
| $GA_3$ 100 ppm | $81.38^{c}$ | $32.83^{bc}$ | $3.77^{de}$ | $126.80^{c}$ | $6.86^{a}$ | $178.20^{e}$ |
| $GA_3$ 200 ppm | $80.25^{b}$ | $34.13^{b}$ | $4.31^{abc}$ | $131.43^{b}$ | $6.32^{b}$ | $181.05^{cd}$ |
| $GA_3$ 400 ppm | $78.62^{a}$ | $37.32^{a}$ | $4.54^{ab}$ | $137.20^{a}$ | $6.15^{b}$ | $183.70^{ab}$ |
| CCC 100 ppm | $83.25^{d}$ | $31.51^{d}$ | $3.67^{e}$ | $123.36^{d}$ | $5.62^{d}$ | $180.75^{cd}$ |
| CCC 200 ppm | $85.47^{ef}$ | $29.93^{ef}$ | $4.64^{ab}$ | $119.56^{f}$ | $5.76^{d}$ | $182.00^{cd}$ |
| CCC 500 ppm | $86.16^{f}$ | $29.08^{ef}$ | $4.76^{a}$ | $117.16^{g}$ | $6.06^{bc}$ | $184.75^{a}$ |
| MH 100 ppm | $83.32^{d}$ | $30.09^{e}$ | $3.77^{de}$ | $122.80^{d}$ | $5.86^{cd}$ | $181.50^{cd}$ |
| MH 200 ppm | $84.55^{e}$ | $28.75^{fg}$ | $3.83^{cde}$ | $119.00^{f}$ | $5.86^{cd}$ | $180.49^{d}$ |
| MH 500 ppm | $86.30^{f}$ | $27.48^{g}$ | $4.21^{bcd}$ | $117.50^{g}$ | $5.81^{cd}$ | $182.39^{bc}$ |
| Control | $82.89^{d}$ | $31.91^{cd}$ | $3.62^{e}$ | $120.90^{e}$ | $5.75^{d}$ | $178.04^{e}$ |
| CD (*P*=0.05) | 1.08 | 1.31 | 0.49 | 1.22 | 0.27 | 1.65 |

Means within the columns followed by the same letters are not significantly different at 0.05 level of significance.

**Table 3.** Effect of $GA_3$, CCC and MH on flowering attributes of tulip cv. Apeldoorn.

| Treatment | Days to flower bud appearance | Days to colour break stage | Days to flowering | Flower size (cm) | Flower stem length (cm) | Vase life (days) |
|---|---|---|---|---|---|---|
| $GA_3$ 100 ppm | $135.23^{b}$ | $141.03^{c}$ | $143.50^{b}$ | $5.67^{c}$ | $24.50^{c}$ | $9.40^{c}$ |
| $GA_3$ 200 ppm | $131.84^{a}$ | $138.46^{b}$ | $142.43^{ab}$ | $6.39^{b}$ | $26.36^{b}$ | $10.43^{b}$ |
| $GA_3$ 400 ppm | $130.72^{a}$ | $136.20^{a}$ | $141.30^{a}$ | $6.70^{a}$ | $31.96^{a}$ | $11.26^{a}$ |
| CCC 100 ppm | $140.21^{cde}$ | $142.43^{cd}$ | $148.83^{c}$ | $5.39^{d}$ | $23.90^{cd}$ | $8.90^{de}$ |
| CCC 200 ppm | $141.89^{e}$ | $143.80^{de}$ | $150.83^{d}$ | $5.25^{de}$ | $21.86^{e}$ | $9.33^{cd}$ |
| CCC 500 ppm | $143.81^{f}$ | $146.86^{f}$ | $151.75^{de}$ | $4.99^{f}$ | $20.50^{f}$ | $10.33^{b}$ |
| MH 100 ppm | $139.03^{c}$ | $143.60^{d}$ | $151.40^{d}$ | $5.29^{de}$ | $21.90^{e}$ | $8.26^{f}$ |
| MH 200 ppm | $140.02^{cd}$ | $145.33^{ef}$ | $151.93^{de}$ | $5.28^{de}$ | $20.10^{f}$ | $8.53^{ef}$ |
| MH 500 ppm | $141.70^{de}$ | $145.63^{f}$ | $152.96^{e}$ | $5.16^{ef}$ | $18.86^{g}$ | $7.63^{g}$ |
| Control | $139.03^{c}$ | $142.30^{cd}$ | $148.93^{c}$ | $5.40^{d}$ | $22.86^{de}$ | $7.30^{g}$ |
| CD (*P*=0.05) | 1.85 | 1.66 | 1.33 | 0.23 | 1.22 | 0.44 |

Means within the columns followed by the same letters are not significantly different at 0.05 level of significance.

Maximum blooming period was recorded in 200 ppm $GA_3$ (28.46 days) followed by 400 ppm $GA_3$ (27.76 days) as compared to control (21.59 days). Similar results were also obtained by Singh et al. (1991) in the experiment with marigold and enhanced flowering of *Freesia* was reported by Cocaazza (1985) with $GA_3$ application. $GA_3$

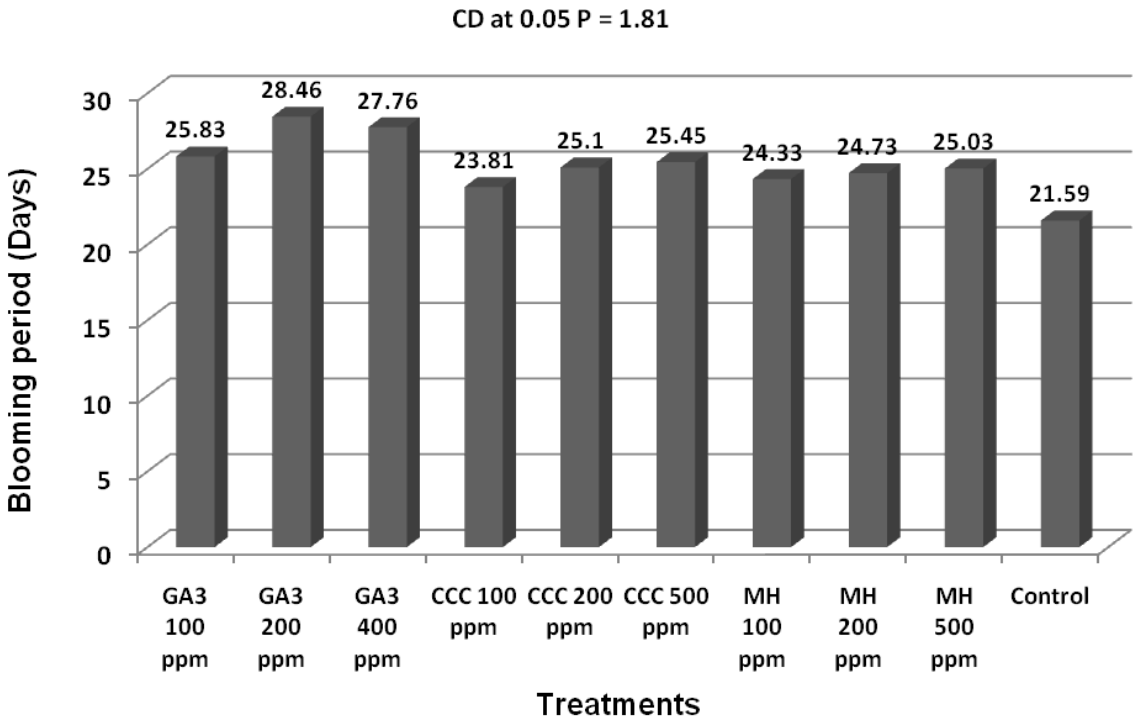


**Figure 1.** Effect of $GA_3$, CCC and MH on blooming period of tulip cv. Apeldoorn.

promote flowering as it may cause an increase in the available substrate at the time of flower initiation (Corr and Wilmer, 1980). Application of CCC and MH also significantly improved blooming period over control which is in accordance with the findings of Susamma (1990) in tuberose. Among all the treatments, 400 ppm $GA_3$ resulted in the largest size of flower (6.70 cm) followed by 200 ppm $GA_3$ (6.39 cm), while CCC and MH reduced flower size as compared to the control. Flower stem length was found maximum with 400 ppm $GA_3$ (31.96 cm) and 200 ppm $GA_3$ (26.36 cm) over control (22.86 cm). Increased flower stem length was also obtained by Cocaazza and Caputo (1980), and Khan et al. (2007) in tulip. CCC and MH reduced flower stem length and smallest flower stem length was recorded with MH 500 ppm (18.86 cm) followed by 200 ppm MH (20.10 cm). All PGRs improved vase life of flowers and maximum vase life was obtained with 400 ppm $GA_3$ (11.26 days) followed by 200 ppm $GA_3$ (10.43 days) and 500 ppm CCC (10.33) over control (7.30 days). Similar findings were also noted by Sarkar et al. (2009) in tuberose with $GA_3$ application. The variation in vase life was probably due to different temperature condition (Table 1) during experimentation along with PGRs effect.

## Bulb characteristic and propagation coefficient

The data presented in Table 4 indicates that all the PGRs positively affected the bulb characteristic of tulip. Maximum number of bulbs per plant was recorded with 400 ppm $GA_3$ (1.43) followed by 500 ppm CCC (1.41) over the control (1.07). Similar results were recorded by Kumar et al. (2008) in gladiolus with $GA_3$ and CCC application and Hetman et al. (1992) in tulip with CCC application. Bulbs weight per plant was recorded maximum with 400 ppm $GA_3$ (19.36 g) followed by 500 ppm CCC (17.66 g) in comparison with the control (12.76 g). All the PGRs improved bulb weight and size significantly over control. The maximum bulb weight and size was noticed with the treatment 400 ppm $GA_3$ (15.26 g and 11.60 cm) followed by 500 ppm CCC (13.76 g and 9.86 cm) as compared to control (9.86 g and 7.33 cm), respectively. The results are in agreement with the results of Kumar et al. (2008) by $GA_3$ and CCC application and Due et al. (1984) by gibberellic acid application in gladiolus. The increase in bulb weight and size may be attributed to cell enlargement caused by $GA_3$ and it also possibly due to increased maximum carbohydrate which was transferred to bulb for storage (Karuna et al., 2011). The number and weight of daughter bulbs per plant was significantly improved by $GA_3$ application and highest value was recorded with 400 ppm $GA_3$ application (3.03 and 6.50 g) followed by 500 ppm CCC (2.65 and 6.10 g) over control (1.72 and 4.23 g), respectively. Similar results have been previously reported by Kumar et al. (2008) in gladiolus.

The number and weight of daughter bulbs per plant was comparatively less affected by MH application and number of daughter bulbs per plant was at par with

**Table 4.** Effect of $GA_3$, CCC and MH on bulb characteristic of tulip cv. Apeldoorn.

| Treatment | Number of bulbs per plant | Bulbs weight per plant (g) | Bulb weight (g) | Bulb size (cm) | Number of daughter bulbs per plant | Daughter bulbs weight per plant (g) |
|---|---|---|---|---|---|---|
| $GA_3$ 100 ppm | $1.18^{d}$ | $14.96^{d}$ | $11.76^{d}$ | $8.43^{e}$ | $2.16^{d}$ | $4.63^{d}$ |
| $GA_3$ 200 ppm | $1.30^{bc}$ | $16.13^{c}$ | $13.13^{bc}$ | $8.86^{cd}$ | $2.51^{c}$ | $5.44^{c}$ |
| $GA_3$ 400 ppm | $1.43^{a}$ | $19.36^{a}$ | $15.26^{a}$ | $11.60^{a}$ | $3.03^{a}$ | $6.50^{a}$ |
| CCC 100 ppm | $1.18^{d}$ | $12.73^{f}$ | $10.70^{e}$ | $8.56^{de}$ | $1.81^{e}$ | $4.63^{d}$ |
| CCC 200 ppm | $1.33^{b}$ | $16.20^{c}$ | $12.53^{cd}$ | $8.96^{cd}$ | $1.83^{e}$ | $5.50^{c}$ |
| CCC 500 ppm | $1.41^{a}$ | $17.66^{b}$ | $13.76^{b}$ | $9.86^{b}$ | $2.65^{b}$ | $6.10^{b}$ |
| MH 100 ppm | $1.23^{cd}$ | $12.73^{f}$ | $10.73^{e}$ | $8.26^{e}$ | $1.76^{efg}$ | $4.40^{de}$ |
| MH 200 ppm | $1.32^{b}$ | $13.80^{e}$ | $13.66^{b}$ | $9.13^{c}$ | $1.79^{ef}$ | $4.73^{d}$ |
| MH 500 ppm | $1.19^{d}$ | $16.10^{c}$ | $12.73^{c}$ | $8.23^{e}$ | $1.68^{g}$ | $4.53^{de}$ |
| Control | $1.07^{e}$ | $12.76^{f}$ | $9.86^{f}$ | $7.33^{f}$ | $1.72^{fg}$ | $4.23^{e}$ |
| CD (*P*=0.05) | 0.08 | 0.90 | 0.81 | 0.41 | 0.09 | 0.35 |

Means within the columns followed by the same letters are not significantly different at 0.05 level of significance.

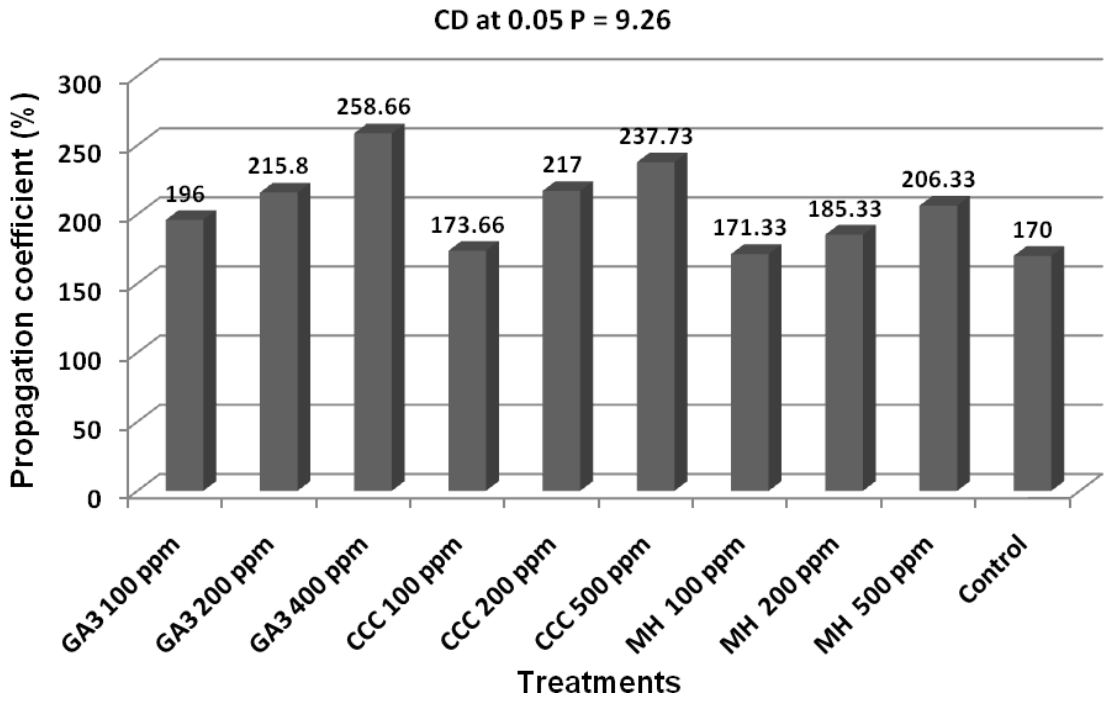


**Figure 2.** Effect of $GA_3$, CCC and MH on propagation coefficient of tulip cv. Apeldoorn.

control. The propagation coefficient reveals the multiplication rate by overall bulbs and daughter bulbs production by plant. Among all the PGRs, $GA_3$ significantly improved propagation coefficient over control. This may be due to long field life and more number of leaves, and leaf area per plant that results in more assimilation of food material and its diversion towards bulbs production. The propagation coefficient (Figure 2) was found maximum in 400 ppm $GA_3$ (258.66 %) followed by 500 ppm CCC (237.73 %) as against the control (170.00 %). CCC application improved number and weight of bulb and daughter bulb per plant resulted in increased bulb production ratio as compared to control in tulip (Ahmed et al., 2009; Mukherjee et al., 1999). All treatments of CCC and MH significantly improved propagation coefficient over control, except 100 ppm CCC and 100 ppm MH which were at par with control.

## Conclusion

It is conclusively proved that application of $GA_3$ resulted in improved growth, flowering and bulb attributes of tulip, while application of CCC reduced plant height, delayed flowering but improved blooming period and propagation coefficient over control.

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