A review on performance of gibberellic acid on African marigold

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Abstract
Among plant growth regulators, Gibberellins are the most widely used and proven growth substances in Horticultural crops. Generally GA3 influences a range of developmental process in plants like stem elongation, germination, breaking dormancy, flowering, sex expression, enzyme induction and leaf and flower senescence. Looking to the mode of action of the application of GA3 in early stage enhances the growth of the plant. Thus, the GA3 allow obtaining the best ratio between the vegetative growth and flower production, thereby improving the market quality of flowers. It increases in carbohydrate production, number of branches, number of flowers, flower diameter, weight of flower, yield and quality of flower.

Keywords: Performance, of gibberellic acid, African marigold

Introduction
Marigold (Tagetes erecta L.) belonging to family Asteraceae is one of the major important commercial flower crop of this country and widely grown all over India for loose flower production. In general, the commercially cultivated marigold is of two types i.e. African and French marigold. African marigold is popular throughout the world because of wide spectrum of attractive colours, shape and good keeping quality. Marigold has gained popularity in India on account of its easy cultivation, wide adaptability and production throughout the year. Flowers of marigold are extremely used as a loose flower in India and apart from beautification, its flower petals are also being used for xanthophyll production which is a beautification, its flower petals are also being used for xanthophyll production which is a major carotenoid fraction and accounts 80-90% lutein of total xanthophylls content (Alarm et al., 1986) [1]. The carotenoids extracted from petals of marigold are the major source of pigment for poultry industry as a feed additive to intensify the yellow colour of egg yolks and broiler skin (Narsude et al., 2010) [2]. Besides this, its oil and extracts from plant are used as cure for boils, ear ache, eye disease and ulcers. The oil is reported to have bronchodilator, tranquilizing and anti-inflammatory properties. Essential oil of marigold act as a repellent against flies, ant, and mosquitoes (Chaudhari, 2001) [3]. Among plant growth regulators, Gibberellins are the most widely used and proven growth substances in Horticultural crops. Generally GA3 influences a range of developmental process in plants life like stem elongation, germination, breaking dormancy, flowering, sex expression, enzyme induction and leaf and flower senescence. The application of GA3 in early stage enhances the growth of the plant. Thus, the GA3 allow obtaining the best ratio between the vegetative growth and flower production, thereby improving the market quality of flowers (Marosz and Matisiak, 2005 and Bekheta et al., 2008) [4, 5]. GA3 also increase in carbohydrate production, number of branches, number of flowers, flower diameter, weight of flower, yield and quality of flower. Keeping these points in view, a review was conduct on Performance of GA3 on African marigold.

Effect of GA3 on Plant Growth
Spraying of GA3 at 200 ppm recorded maximum plant height (46.39 and 58.93, cm respectively), more number of branches (14.13 and 13.77, respectively) and more number of flowers (22.87 and 84.80, respectively) in marigold and china aster (Lal and Mishra, 1986) [6]. Application of GA3 at 100 ppm resulted in the tallest plants and largest flower diameter and peduncle length in African marigold (Girwani et al., 1987) [7]. Ravidas et al., (1992) [8] GA3 at 100 ppm resulted in maximum plant height (53.87 cm) and more number of leaves per plant (6.33), maximum number of florets (16.0) per spike, weight of corm (35.61 g) and weight of cormels (13.48 g) compared to GA1 100 ppm in gladiolus cv. Friendship. Das et al., (1992) [9] observed significant increase in plant height (69.30 cm) and number of leaves (26.00)
compared to control (45 cm and 18 cm, respectively) with the spray of GA$_3$ at 200 ppm in *Hemerocallis aurantiaca* (Day lily). Dutta *et al.* (1993) [10] while working on chrysanthemum observed that GA$_3$ at 50 ppm increased the duration of flowering, which was longest (212.67 and 219 days) compared with (83.67 and 87.33 days) the untreated controls. The highest yield (0.682 and 0.685 kg) per plant were obtained with GA$_3$ at 150 ppm and this treatment also resulted in the longest cut flowers and shelf life when compared to control. Application of GA$_3$ at 40 ppm significantly increased the plant height (65.36 cm) and more number of leaves (25.80) per plant compared to control (45.56 cm and 21.20, respectively) in chrysanthemum (Talukdar and Paswan, 1994). Goyal and Gupta (1996) observed that GA$_3$ at 45 ppm increased plant height (91.63 cm) and more number of shoots (14.62) per plant increased the number of flowers (18.00) and flower yield (249.29 g) per plant compared to control in rose. Singh and Biju (2001) recorded an increase in plant height (35.15 cm) and more number of leaves (32.83) per plant, increased number of florets (41.66) per spike and weight of florets (55.40 g) per plant in tuberose with GA$_3$ at 200 ppm treatment compared to control. Spraying of GA$_3$ at 100 ppm recorded maximum plant spread (31.10 cm), more number of leaves (15.19), more number of flowers (18.63) per pot and diameter of flower head (7.53 cm) compared to control in gerbera (Sujatha *et al.* 2002) [14]. Maurya and Nagda (2002) [20] noticed the maximum height (104.50 cm) in the plant treated with 100 ppm GA$_3$ as compared to control (95.10 cm) in gladiolus cv. Friendship. Spraying of GA$_3$ at 100 ppm increased the number of corms per plant (1.87), weight of corms per plant (78.70 g) and weight of corms per bed (1.60 kg) compared to control (1.20, 53.30 g and 0.95 kg/bed, respectively). Khan and Tewari (2003) [21] GA$_3$ at 90 ppm significantly increased the plant height (69.00 cm), produced more number of branches (6.60) and flowers (15.80) per plant compared to control in dahlia. Maximum height (62.00 cm), number of branches (20.27) per plant, number of flowers (67.33) per plant, flower weight (2.86 g) and flower yield (192.59 g) with GA$_3$ at 200 ppm as compared to GA$_3$ 100 ppm in China aster cv. Kamini (Kumar *et al.*, 2003). Kulkarni (2003) [20] observed induction of early flowering (88.60 days) with the application of GA$_3$ at 200 ppm compared to control (97.10 days) in chrysanthemum. Tripathi *et al.* (2003) [20] observed that GA$_3$ at 400 ppm recorded the highest flower yield per plant (127.71 g) and number of flowers per plant (78.83) in French marigold. Verma and Parmar (2003) recorded maximum plant height (65.94 cm), maximum number of flowers per plant (7.25) and maximum stem length (58.25 cm) in GA$_3$ at 100 ppm applied twice in carnation. GA$_3$ at 50 ppm produced buds of maximum size (1.83 cm) and maximum flower diameter (6.96 cm). Verma and Arha (2004) reported that GA$_3$ at 200 ppm registered maximum yield yield per plant (82.62 g) and yield per hectare (9617.48 kg) in African marigold as compared to control (59.46 g and 7018.37 kg, respectively). Spraying of GA$_3$ at 100 ppm significantly increased plant height (119.88 cm), number of florets (14.29) per spike, number of corms (1.66) per plant and corm weight (50.80 g) compared to control in gladiolus (Rana *et al.*, 2005) [32]. Chandrappa *et al.*, (2006) recorded the maximum plant height (46.44 cm) with spraying of GA$_3$ at 750 ppm compared to control (45.22 cm) in anthurium cv. Royal Red. Sunitha *et al.*, (2007) found that spraying of GA$_3$ 200 ppm recorded significantly higher plant height (101.2 cm) and number of primary branches (14.4) in marigold. Pandey and Chandra (2008) reported that GA$_3$ 450 ppm significantly increased plant height, number of branches, diameter of main stem, number of leaves, number of flowers and total yield of flowers in French marigold as compared to other treatments. Maximum vegetative growth, flower yield and quality with treatment of GA$_3$ at 150 ppm in gerbera under polyhouse conditions. While, early flowering was noticed with 50 ppm GA$_3$ application (Dalal *et al.*, 2009) [8]. Mayoli *et al.*, (2009) [34] observed early flowering, highest quality flower, maximum stem diameter, early flower bud initiation, maximum flower head diameter and maximum tuberous root fresh weight in ranunculus cut flower when tuberous roots were soaked in 100 mg/l GA$_3$ before planting. Parmar *et al.*, (2009) [15] observed that GA$_3$ twice i.e. 45 and 60 days after planting had shown superiority in all vegetative, floral and yield characters viz., plant height (79.92 cm), number of leaves per plant (60.33), leaf width (7.23 cm), leaf area (377.92 cm$^2$), dry weight of plant (0.97 kg), flower diameter (4.26 cm), days taken for first spike emergence (53.38 days), days taken for first flower emergence (61.14 days), spike length (89.62 cm), number of flowers per spike (17.32), fresh flower weight (2.85 g), dry flower weight (0.38 g), yield (50812 flower bud bundles/hectare). Shrivaprapaksh *et al.*, (2011) [12] recorded more plant height, maximum stem girth, more dry matter production in stem, leaf and flower with 200 ppm GA$_3$ in African marigold (*Tagetes erecta* L.) cv. Orange Double. The same treatment also recorded significantly more diameter of flower, number of flowers per plant, yield per plot (6.45 kg) and yield per ha (9.83 t) than control. GA$_3$ application at 350 ppm was found most effective as it gave highest flower yield per plant, maximum fresh weight per flower and highest number of flowers per plant and earlier flower bud initiation and flowering and also increased number of leaves as well as recorded maximum plant height in African marigold (Kumar *et al.*, 2012) [19, 22]. Sarkar *et al.*, (2018) [11] reported that the application of GA$_3$ at 200 ppm recorded significantly higher plant height (85.36 cm), number of branches/plant (39.72 branches/plant), total leaf number (183.43), number of flowers (63.80) and flower yield per hectare (10.19). **Effect of GA$_3$ On Flowering and Yield** Badge and Panchbhai (2018) stated that foliar application of gibberellic acid 300 ppm recorded maximum flower yield, gross, net monetary returns with higher B:C ratio. Single spray of GA$_3$ at 150 ppm recorded significantly higher plant height (83.30 cm), leaf area (1188.58 cm$^2$), number of flowers per plant (78.49), average weight of flower (4.85 g) and yield of flowers per plant (365.23 g) as well as per hectare (132.27 q/ha) in African marigold (Kanwar *et al.*, 2013) [18]. Application of GA$_3$ at 200 ppm registered significantly maximum flower yield per plant (639.18 gm) with longest duration of flowering (87.18 days) as compared to control in African marigold (Kumar *et al.*, 2012) [19, 22]. Application of GA$_3$ at higher concentration of 100 ppm as a pre-harvest spray exerted a significant influence on crop growth and recorded highest mean values for plant height (76.18 cm), stalk length (60.98 cm), stem girth (1.66 cm) and total chlorophyll content (1.826 mg g$^{-1}$) of rose. Similarly, the application of GA$_3$ at 100 ppm level drastically increased the quality traits viz., mean flower diameter (6.89 cm), anthocyanin content (0.1970 OD value) and vase life (2.6 days). Likewise the earliest flowering (40 days) was also obtained from pre-harvest spray of GA$_3$ at 100 ppm (Kumar *et al.*, 2012) [19, 22]. Ramdevputra *et al.* (2009) [16] observed that
all the vegetative growth characters of African marigold were
highly influenced by GA3 at 300 ppm. Maximum number of
flowers per plant (86.43), weight of flowers (248.67 g) per
plant and flower yield (79.56 q/ha) were obtained by spraying
significantly maximum number of branches, plant spread,
number of suckers per plant, number of flowers per plant,
yield of flowers per plant as well as per hectare with the
spraying of GA3 at 200 ppm in chrysanthemum (Chrysanthemum
morifolium R.) cv. IIHR-6. However, minimum number of days for initiation of flowering and that
for peak flowering, maximum duration of flowering, flower
diameter, fresh flower weight, shelf and vase life of flowers
were obtained with 150 ppm GA3. Bihari and Narayan (2009)
[6] revealed that spraying of 100 ppm GA3 at 15 days after
transplanting proved significantly effective for a floriferous
reported that the greatest fresh (14.55 g) and dry weights
(2.57 g) of 30 leaves per plant in French marigold were
observed with GA3 at 100 ppm and the greatest plant height
(59.77 cm) was recorded with GA3 at 200 ppm. GA3 at 200
ppm also increased the number of seeds per flower (96.43).
GA3 at 100 ppm increased seed weight per flower (0.38 g)
and 100 seed weight (0.41 g). The highest seed yield per plant
(63.41 g) was also recorded with GA3 at 200 ppm. African
marigold and China aster were sprayed with GA3 at 100 and
200 ppm after 15 days of transplanting and twice more at 10
days intervals, the best results with regard to the number of
flowers per plant and seed yield were obtained with GA3 at
200 ppm in both the species (Syamal et al., 1990) [16]. Singh et
al. (1991) [17] Induction of early flowering (85.36 days) and
increased the number of flowers (56.00), flower yield (574.55
 g) per plant and test weight of seed (3.31 g) were noticed with the
application of GA3 at 500 ppm compared to control (91.45
days, 27.67, 274.84 g / plant and 2.12 g, respectively) in
African marigold. Nagarjuna et al. (1988) [18] working with the
chrysanthemum reported that 50 per cent flowering was
fastened by GA3 at 100 to 200 ppm. Flower diameter was
found maximum with GA3 at 200 ppm. Beura and Maharantha
(1990) [19] stated that the highest shoot: root ratio (2.12) and
lowest number of tubers per plant (6.25) and tuber yield (110
gm) were obtained with 200 ppm GA3 in Dahlia variabilis.
Hore and Sen (1986) [190] reported that GA3 at 50 and 100 ppm
fastened the flowering in marigold by 9 days. GA3 at 100
ppm also showed marked increase in plant height over the
control. Shedeed et al. (1986) conducted an experiment
during two successive seasons with Zinnia elegans and
Tagetes erecta. Both the species were treated with GA3 at
100-400 ppm at 4 weeks from planting out and again a month
later. In both species, GA3 generally increased the plant
height. Flowering time was not affected by GA3 whereas,
GA3 (200 ppm) increased the seed yield in African marigold.
Dahab et al. (1987) [20] reported that when the Chrysanthemum frutescens were treated with GA3 at 250,
500, 1000 ppm; three times during the early stages, the
treatment especially at 500 ppm and 1000 ppm increased the
plant height, plant spread, diameter and the number of shoot
per plant and the length of shoots. GA3 accelerated flowering
but under higher concentrations it decreased the number
of inflorescence per plant.

**Conclusion**

Based on the results obtained from above study conclusion
have been drawn: The plant height, plant spread, diameter and
the number of shoot per plant, the length of shoots, number of
flowers, flower yield per plant and test weight of seed
increase with increases level of GA3 foliar application.

**References**


