RESEARCH ARTICLE

EFFECT OF PLANT GROWTH REGULATORS AND CULTIVARS ON FLOWERING AND YIELD OF AFRICAN MARIGOLD (*TAGETES ERECTA* L.) IN CHHATTISGARH PLAINS

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Abstract: Currently the marigold flower is well spread around the world due to their social and religious values. We do prefer it in all our social gatherings and rituals as important mean due to their specific colors and fragrance. Looking to their wide demand a very less area is taken under cultivation in Chhattisgarh due to lack of awareness which compelling them to buy it from other states. The productivity can be enhanced in Chhattisgarh by the incorporating suitable varieties and use of PGR's, which can prove to be better option for the farmers of Chhattisgarh. In this context, an experiment was conducted to investigate the effect of different levels of growth promoter and retardant on growth and flower yield of different cultivars of African marigold in Chhattisgarh plains condition at College of Agriculture and Research Station, Kanker, IGKV, Raipur in the year 2014-15 and 2015-16. The experiment was laid out in factorial RBD comprising treatment combination of two PGR (GA_3 and Cycocel) and two marigold cultivars (Pusa Narangi Gainda and Pusa Basanti Gainda). The result indicated that the growth and flower yield were significantly influenced by different plant growth regulators and cultivars. The maximum number of secondary branches plant^{-1}, minimum period for days taken to first bud emergence and 50 per cent flowering, maximum number of flowers and flower yield ha^{-1} was recorded with Pusa Narangi Gainda. While, maximum flower diameter was recorded with Pusa Basanti Gainda. Among the growth regulators treatments, GA_3 300 ppm (25 DAT) + GA_3 300 ppm (45 DAT) recorded early initiation of flower bud and earliest 50 per cent flowering and maximum flower diameter. However, maximum number of secondary branches, number of flowers plant^{-1} and flower yield ha^{-1} was noticed with treatment GA_3 300 ppm (25 DAT) + CCC 1500 ppm (45 DAT).

Keywords: Marigold, PGR, Gibberellic acid (GA_3), Cycocel (CCC). Pusa Narangi Gainda, Pusa Basanti Gainda

INTRODUCTION

Floriculture is a dynamic global enterprise in today's world and is rapidly expanding. Apart from the enormous economic importance of flowers and decorative plants, they symbolize beauty, purity, peace, love, affection and honesty. They have their own importance from birth to death. African marigold (*Tagetes erecta* L.) family Asteraceae is major one of the important commercial annual flower crop of this country and widely grown all over the India for loose flower production. 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.

In recent year, use of plant growth regulators is being increased to manipulate the growth, flowering and yield of many ornamental plants. Gibberellic acid (GA_3) and Cycocel (CCC) are very important plant growth regulators and are widely used in horticulture. The importances of PGR's in flower production are well known for improving productivity and produce quality. But the study on integrated use of both growth promoter and growth retardant in marigold is very few. The investigation was framed out in a view that initial vegetative growth is important but subsequently reproductive growth is congenial. It is important to check the further vegetative growth by using growth retardant to keep reproductive stage more healthier and productive. Therefore, the combination of both growth promoter and growth retardant at their right level and their right stage of crop is highly desired. The GA_3 regulation of growth itself is involved with both cell division and cell enlargements without cell division (Haberand and Leopold, 1960). Sachs *et al.*(1960) reported that application of CCC retarded stem elongation by preventing cell division in the sub-apical meristem, usually without similarly affecting the apical meristem. Gibbrellin activates the vertical growth of plant by sensitizing the apical meristem, while CCC enforce stop the vertical growth consequently induces the lateral or horizontal growth. It is very important for establishing source and sink relationship, which could be artificially induced by using PGR's for the proportionate vegetative and reproductive growth. Thus, keeping in view the potentialities of growth regulators like GA_3 and CCC, the present study was undertaken to find out the suitable concentration of these PGR's for better flowering and yield of African marigold cultivar suitability in Chhattisgarh.

MATERIAL METHOD

The present experiment was carried out during two *Rabi* seasons of the years 2014-15 and 2015-16, at

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Agriculture Farm Singarbhat, College of Agriculture and Research station, Kanker, (C.G.). The experiment was laid out in Factorial Randomized Block Design with three replications comprising fourteen treatment combinations of seven levels of PGR's *viz.*, GA_3 200 ppm at 25 DAT+ GA_3 200 ppm at 45 DAT (P_1), GA_3 300 ppm at 25 DAT+ GA_3 300 ppm at 45 DAT (P_2), GA_3 200 ppm at 25 DAT + CCC 1000 ppm at 45 DAT(P_3), GA_3 300 ppm at 25 DAT + CCC 1000 ppm at 45 DAT(P_4), GA_3 200 ppm at 25 DAT + CCC 1500 ppm at 45 DAT(P_5), GA_3 300 ppm at 25 DAT + CCC 1500 ppm at 45 DAT (P_6) along with distill water spray (P_7) and two varieties *viz*., Pusa Narangi Gainda and Pusa Basanti Gainda of African marigold were taken. Seedlings of African marigold were raised in the beds of the nursery. Four weeks old seedlings were planted in the experimental field. Desired quantities of the GA_3 were first dissolved in few drops of alcohol (C_2H_5OH) and then volume was made up to 500 ml of distilled water to make the proper concentrations of GA_3. Cycocel was dissolved in required amount of distilled water for preparation of stock solution and then diluted before spraying. The spraying was done in the morning hours with the help of hand sprayer. Two time periods of crop growth were chosen for spraying of PGR's i.e., first at 25 DAT and at 45 DAT. Observations were recorded at 30, 60 and 90 days after transplanting. The various growth parameters like height of plant (cm), number of branches per plant were recorded for observation. The yield parameters like number of flowers per plant, fresh weight of flower (kg) and flower yield (q/ha) were also recorded.

RESULT AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Effect of Cultivars

Data presented in Table-1 and Table-2 revealed that the cultivars of African marigold had significant influence on growth and flowering characters. The maximum number of secondary branches plant $^{-1}$ was recorded with *cv.* Pusa Narangi Gainda (V_1) as 45.58 and 43.27 in the year 2014-15 and 2015-16, respectively. While, minimum number of secondary branches plant $^{-1}$was measured under *cv.* Pusa Basanti Gainda (V_2).

The pooled mean data revealed that the minimum period for days taken to first bud emergence (31.18 DAT) and 50 per cent flowering (60.93 DAT) and maximum number of flowers plant $^{-1}$ (60.68) and flower yield ha^{-1} (141.44 q) were recorded under *cv.* Pusa Narangi Gainda (V_1) as compared to. Pusa Basanti Gainda. While, maximum flower diameter (5.53 cm) was recorded with Pusa Basanti Gainda. This might be due to the congenial environment to express the dominant genes in the genotypes and also different genetic makeup of the different variety. Similar findings are noticed by Choudhary *et al.* (2013), Gourishankaraya *et al.* (2005) in African marigold, Singh and Singh (2010) and Raghuvanshi and Sharma (2011) in French marigold.

Effect of plant growth regulators:

During the first year of the investigation, the application of growth regulators treatments, GA_3 300 ppm (25 DAT) + GA_3 300 ppm (45 DAT) recorded early initiation of flower bud (33.76 DAT) and earliest 50 per cent flowering (62.96 DAT) and maximum flower diameter (5.77 cm) as compared to control. Similar trend was observed in second year of trial as well as in pooled mean data. The early enhancement in first flower bud formation and 50 per cent flowering in GA_3 treatments may be due to increase in the endogenous level of gibberellins which by virtue of its flower inducing characteristics might have also promoted the first flower bud formation. Similar results have also been reported by Sunitha *et al*. (2007) and Ramdevputra *et al*. (2009) in marigold and Shinde *et al*. (2010) in chrysanthemum. Increase in flower diameter might be due to cell elongation in the flower. Gibberellins are also known to increase the sink strength of actively growing parts. The similar findings were also noted by Rajhansa *et al.* (2015) and Shivaprakash *et al.* (2011) in marigold and by Shinde *et al*. (2010) in chrysanthemum.

The application of growth regulators treatment GA_3 300 ppm (25 DAT) + CCC 1500 ppm (45 DAT) was recorded maximum number of secondary branches plant^{-1}(46.60) number of flowers plant^{-1} (66.57) and flower yield ha^{-1} (154.17 q.) as compared to control during both the years of trial as well as in pooled mean data. Maximum number of secondary branches plant^{-1} was recorded with application of cycocel which might be due to check in apical dominance due to lower levels of endogenous auxins which in turn induced sprouting of auxiliary buds or the increase may be due to its inhibitory effects on cell division in apical bud which subsequently might have stopped the growth of main axis. This in turn might have accelerated the growth of auxiliary buds and enhanced the number of laterals. The increase in number of laterals with CCC was reported earlier by Ramesh *et al.* (2001) and Veena joshi and Amarender Reddy (2006) in China aster. Simillar resuts were obtained by Singh (2004), Rathore *et al.* (2011) and Kumar *et al.* (2011) in African marigold.

Increases number of flowers plant^{-1} in African marigold with the application of cycocel might be due to more number of branches. The apical dominance of the plant suppressed it and allowed the lateral branches or auxiliary shoots with flowers located terminally resulting in increased number of flowers plant^{-1}. These results are in close agreement with findings of Khimani *et al*. (1994) in gaillardia,

Table 1. Influence of varieties and plant growth regulators on Number of secondary branches plant^{-1}, Days to first bud appearance and Days to 50% flowering of African marigold (*Tagetes erecta* L.) in Chhattisgarh Plains 2014-15 and 2015-16

Treatments	**Number of secondary Branches plant^{-1}**			**Days to first bud appearance** (DAT)			**Days to 50% flowering** (DAT)		
Varieties	**2014-15**	**2015-16**	**Pooled Mean**	**2014-15**	**2015-16**	**Pooled Mean**	**2014-15**	**2015-16**	**Pooled Mean**
Pusa Narangi Gainda - V_1	45.58	43.27	44.42	30.36	32.00	31.18	60.75	61.116	60.93
Pusa Basanti Gainda - V_2	41.46	39.04	40.25	40.42	42.60	41.51	72.44	74.72	73.58
SEm SEm±	**0.56**	**0.811**	**0.456**	**0.85**	**1.41**	**1.00**	**0.708**	**0.56**	**0.475**
CD(p=0.05)	**1.65**	**2.371**	**1.333**	**2.48**	**4.12**	**2.93**	**2.071**	**1.663**	**1.388**
PGR									
P_1- GA_3 200 ppm (25 DAT) + GA_3 200 ppm (45 DAT)	42.56	40.15	41.35	35.23	37.21	36.22	64.90	66.23	65.56
P_2 - GA_3 300 ppm (25 DAT) + GA_3 300 ppm (45 DAT)	43.13	41.85	41.99	33.76	34.35	34.05	62.96	65.01	63.99
P_3 - GA_3 200 ppm (25 DAT) + CCC 1000 ppm (45 DAT)	43.53	41.16	42.34	35.20	37.76	36.48	66.80	68.36	67.58
P_4 - GA_3 300 ppm (25 DAT) + CCC 1000 ppm (45 DAT)	44.36	42.58	43.47	34.13	35.93	35.03	66.49	67.60	67.04
P_5 - GA_3 200 ppm (25 DAT) + CCC 1500 ppm (45 DAT)	45.66	43.27	44.47	35.60	38.53	37.06	68.20	69.38	68.79
P_6 - GA_3 300 ppm (25 DAT) + CCC 1500 ppm (45 DAT)	46.60	44.28	45.44	35.66	35.66	35.66	66.76	67.67	67.21
P_7 - Distilled water	38.80	35.77	37.28	38.16	41.66	39.91	70.06	71.16	70.61
SEm±	**1.06**	**1.518**	**0.853**	**0.45**	**0.75**	**0.53**	**1.325**	**1.064**	**0.888**
CD (p=0.05)	**3.09**	**4.436**	**2.493**	**1.33**	**2.20**	**1.57**	**3.874**	**3.111**	**2.596**
Treatment combinations (PGR X V) CD (p=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2. Influence of varieties and plant growth regulators on Flower diameter**,** Number of flowers and Flower yield of African marigold (*Tagetes erecta* L.) in Chhattisgarh Plains 2014-15 and 2015-16

Treatments	**Flower diameter (cm)**			**Number of flowers plant^{-1}**			**Flower yield (q/ha)**		
Varieties	**2014-15**	**2015-16**	**Pooled Mean**	**2014-15**	**2015-16**	**Pooled Mean**	**2014-15**	**2015-16**	**Pooled Mean**
Pusa Narangi Gainda - V_1	5.24	5.29	5.27	62.31	59.05	60.68	146.73	136.16	141.44
Pusa Basanti Gainda - V_2	5.45	5.61	5.53	50.49	47.24	48.87	127.83	116.56	122.19
SEm SEm±	**0.064**	**0.070**	**0.046**	**1.462**	**1.472**	**1.108**	**1.706**	**2.116**	**1.212**
CD(p=0.05)	**0.187**	**0.206**	**0.135**	**4.274**	**4.303**	**3.238**	**4.986**	**6.184**	**3.544**
PGR									
P_1- GA_3 200 ppm (25 DAT) + GA_3 200 ppm (45 DAT)	5.09	5.24	5.17	50.54	48.23	49.38	130.45	118.44	124.45
P_2 - GA_3 300 ppm (25 DAT) + GA_3 300 ppm (45 DAT)	5.77	6.07	5.92	54.02	50.66	52.34	132.58	121.90	127.24
P_3 - GA_3 200 ppm (25 DAT) + CCC 1000 ppm (45 DAT)	5.39	5.42	5.40	55.52	52.76	54.14	137.93	127.81	132.87
P_4 - GA_3 300 ppm (25 DAT) + CCC 1000 ppm (45 DAT)	5.32	5.49	5.40	59.48	56.00	57.74	144.45	132.70	138.58
P_5 - GA_3 200 ppm (25 DAT) + CCC 1500 ppm (45 DAT)	5.49	5.74	5.61	62.31	57.06	59.69	151.10	135.63	143.37
P_6 - GA_3 300 ppm (25 DAT) + CCC 1500 ppm (45 DAT)	5.30	5.36	5.33	66.57	60.06	63.32	154.17	140.62	147.39
P_7 - Distilled water	5.05	4.85	4.95	46.37	47.26	46.82	110.27	107.40	108.83
SEm±	**0.120**	**0.132**	**0.086**	**2.735**	**2.754**	**2.073**	**3.191**	**3.958**	**2.268**
CD (p=0.05)	**0.350**	**0.385**	**0.253**	**7.996**	**8.049**	**6.059**	**9.329**	**11.596**	**6.630**
Treatment combinations (PGR X V) CD (p=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Narayan Gowda and Jayanti (1986), Yadav (1997)), Khan *et al*. (2012) and Kumar *et al*. (2011) in African marigold.

Maximum flower yield per hectare in African marigold with the application of GA_3 in early growth stage and cycocel in mid growth stage might be due to increase in number of branches and leaves per plant which might have produced more number of flowers plant^{-1}and also increasing weight of flowers ultimately increasing the flower yield plant^{-1}and per hectare. Similar results were also reported by Khan *et al.* (2011), kumar *et al.*(2012) and Yadav (1997) in African marigold.

The interaction effect of growth regulator and variety treatments was found to be non-significant for all the characters. This may be due to the similar effect of plant growth regulator on both the varieties of marigold.

CONCLUSION

It can be concluded from the present investigation that cultivar Pusa Narangi Gainda was observed to be superior in terms of growth and flower yield attributes. The flowering parameters *viz*., days to first bud appearance, days to 50 per cent flowering and flower diameter were found early with GA_3 300 ppm + GA_3 300 ppm and for variety in Pusa Narangi Gainda. The combination of PGR, gibberellins and cycocel gave positive impact on growth and flower yield over the sole application of GA_3 and CCC at 25 and 45 DAT. Thus, the present investigation clearly indicates that the application of gibberellic acid 300 ppm at early growth stage and Cycocel 1500 ppm at later stage have been found effective in the direction of increasing number of branches, number of flowers and flower yield of African marigold.

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