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Influence of PGR's and Cultivars on Flower Yield and Economics of African Marigold under Chhattisgarh Plain

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A B S T R A C T

A field trail was conducted to study the effect of different levels of growth promoters and retardants on growth and flower yield of different cultivars of African marigold. Two PGR's namely Gibberellins (GA_3) and Cycocel (CCC) were taken as growth promoter and growth retardant, respectively. Two cultivars namely Pusa Narangi Gainda and Pusa Basanti Gainda were taken to evaluate their suitability in Chhattisgarh. The result indicated that the growth and flower yield were significantly influenced by different plant growth regulators and cultivars. The maximum plant height was recorded with *cv.* Pusa Basanti Gainda as compared to *cv.* Pusa Narangi Gainda. While, maximum number of primary and secondary branches was recorded with *cv.* (V_1) Pusa Narangi Gainda. Among the growth regulators treatments GA_3 300 ppm (25 DAT) + GA_3 300 ppm (45 DAT) recorded maximum plant height. However, maximum number of primary and secondary branches, number of flowers, fresh weight of flowers per plant and flower yield ha^{-1} was noticed with treatment GA_3 300 ppm (25 DAT) + CCC 1500 ppm (45 DAT). The pooled analysis of two year data also indicated that the general cost of marigold cultivation was (59750.00 Rs. ha^{-1}) per hectare including labour cost, cost of various inputs and over head costs. The highest gross returns (236620.00 Rs. ha^{-1}), net returns (159595.00 Rs. ha^{-1}) and highest benefit: cost ratio (3.20) was found in the treatment (GA_3 300ppm + CCC 1500ppm) whereas the lowest (151020.00 Rs. ha^{-1}) was observed in control.

Introduction

African marigold (*Tagetes erecta* L.) is one of the important commercial flower belongs to the family asteraceae. It is a native of Central and South America, especially Mexico, from where it spread to different parts of the world during early parts of the 16th century (Kaplan, 1960). Chhattisgarh state has covered an area of 5131.00 million hectare with an annual production of 40448.00 metric tonnes (Anonymous, 1). African marigold is popular

throughout the world because of wide spectrum of attractive colours, shape and good keeping quality which has attracted the attention of flower growers. They are extensively used as loose flower, potted plant and also as a bedding plant. Loose flowers are in great demand for garland making as well as in religious and social functions. Globular shaped flowers with long stalks are used for cut flower purposes. The plant is very useful as both the leaves and the flowers are equally important from medicinal point of view. The paste and extracts from plant are used as cure for boils, ear ache, eye disease and ulcers. 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 recent year, use of plant growth regulators is being increased to manipulate the growth, flowering and yield of many ornamental plants. Gibberellic acid and Cycocel are very important plant growth regulators and are widely used in horticulture. Therefore, the combination of both growth promoter and growth retardant at their right level and their right stage of crop is highly desired. The application of GA_3 regulation of growth itself is involved with both cell division and cell enlargements without cell division reported by (Haber and Leopold 1960). The application of cycocel retarded stem elongation by preventing cell division in the sub-apical meristem, usually without similarly affecting the apical meristem reported by (Sachs *et al.,* 1960). Gibbrellin activates the vertical growth of plant by sensitizing the apical meristem, while cycocel enforce stop the vertical growth consequently induces the lateral or horizontal growth. Use of plant growth regulators is being increased to manipulate the growth, flowering and yield of many ornamental plants. Thus, keeping in view the potentialities of growth regulators like GA_3, CCC the present study was undertaken to find out the suitable concentration for better flowering and yield of African marigold.

Materials and Methods

The present experiment was carried out during two *rabi* seasons of the years 2014-15 and 2015-16 at Agriculture Farm Singarbhat, College of Agriculture and Research station, Kanker Chhattisgarh. The Kanker district is situated in the central part of Chhattisgarh and lies between 20º 14' N latitude and 81º 30' E longitudes at an altitude of 417 m above mean sea level. The Chhattisgarh state is situated near equator and lies under tropical climate. The maximum temperature of this region may reach as high as 42 ^{0}C during summer and the minimum may fall to 6 ^{0}C during winter. The Kanker districts enjoys both the agro-climatic zone namely Bastar plateau and Chhattisgarh plains. The experiment was laid out in Randomized Block Design (Factorial) 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. The beds were dug and prepared thoroughly to make the soil pulverized. Four weeks old seedlings were planted in the experimental field. The operation of transplanting was carried out in the afternoon followed by a light irrigation which allow for proper establishment of seedlings. 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 and number of branches per plant were recorded for observation. The yield parameters like number of flowers per plant, fresh weight of flower and flower yield were also recorded.

Results and Discussion

Influence of Varieties

The data presented in (Table 1) show that the varieties of African marigold had significant effect on growth characters. The maximum plant height was recorded with *cv.* Pusa Basanti Gainda (V_2) as (96.44 cm) and (94.39 cm) in both the year respectively. While, minimum plant height was measured under *cv.* Pusa Narangi Gainda (V_2). The pooled mean data revealed that maximum number of primary and secondary branches (15.07 and 44.42 respectively), number of flowers (60.68), fresh weight of flower (0.28 kg) per plant and flower yield (141.44 q ha^{-1}) were recorded under *cv.* Pusa Narangi Gainda (V_1) whereas, it was found minimum under V_2 (Pusa Basanti Gainda). The maximum plant height followed due to positive response to height by the variety. The variation in plant height, number of primary and secondary branches, number of flowers, fresh weight of flower per plant and flower yield between African marigold varieties might be due to congenial environment to express the dominant genes in the genotypes and different genetic makeup of different varieties. Similar observations are conformity with the (Bhanu Pratap *et al.*, 1999; Sreekala *et al.*, 2002; Rao *et al.*, 2005) in African marigold. Similar findings were also reported by (Namita *et al.*, 2008) in French marigold and (Narsude *et al.*, 2010) in African marigold. The present findings indicate that the application of GA_3 + CCC at various levels had highly significant influence on number of primary and secondary branches per plant in African marigold. The maximum number of primary and secondary branches *i.e.* 15.71 and 45.44 respectively, were recorded under the PGR's combination of GA_3 300 ppm (25 DAT) + CCC 1500 ppm (45 DAT) whereas, minimum was recorded in distilled water (Table 1). The increase in number of branches $plant^{-1}$ with cycocel treatment might be due to reduction in shoot growth and increase in number of leaves per plant. Similar results were also reported by (Bhattacharjee and Das 1979) in gypsophila and (Biswas, 1981) in African marigold.

Flowering and yield parameters

GA_3 and CCC application at various levels had highly significant effect on the fresh weight of flowers $plant^{-1}$ and flower yield quintal ha^{-1} in African marigold (Table 2). Maximum fresh weight of flowers and flower yield was recorded with the treatment GA_3 300 ppm + CCC 1500 ppm *i.e.* 0.298 kg $plant^{-1}$ and 147.39 q ha^{-1} as compared with 0.222kg $plant^{-1}$ and 108.83 q ha^{-1} for control, respectively.

The increase in fresh weight of flowers and flower yield with GA_3 and CCC spray may be due to more number of branches and leaves per plant and also increase the number of flowers $plant^{-1}$, thus ultimately increased the flower yield plant. Similar results were also reported by (Girwani *et al.*, 1990; Narayana and Jayanthi 1993) in African marigold. Similar findings were also reported by

(Aswath *et al.,* 1993) in China aster. The combined application of GA_3 (25 DAT) and CCC (45 DAT) at the rate of 300 ppm and CCC 1500 ppm respectively enhanced the lateral vegetative as well as yield attributes.

Therefore combined use of GA_3 and CCC is better option over the sole application of GA_3 and CCC. Experimental findings also show that the number of flowers per plant in African marigold was significantly affected by GA_3 + CCC applications at various concentrations, without affecting the initiation of flower bud as well as commencement of flowering. Maximum number of flowers per plant was recorded with the treatment GA_3 300 ppm + CCC 1500 ppm *i.e.* 63.32 (P_6) flowers per plant as compared with 46.82 flowers per plant for control (Table 2).

The increase in number of flowers plant^{-1} with the application of GA_3 and cycocel may be due to increased number of branches and mobilization of biomass to flowers from sources. Similar results were also reported by (Yadav, 1997) in African marigold.

Table.1 Effect of varieties and plant growth regulators on Number of flowers and flower yield of African marigold

Treatments	Number of flowers per plant			Flower yield (q/ha)		
Varieties	**2014-15**	**2015-16**	**Pooled Mean**	**2014-15**	**2015-16**	**Pooled Mean**
Pusa Narangi Gainda - V_1	62.31	59.05	60.68	146.73	136.16	141.44
Pusa Basanti Gainda - V_2	50.49	47.24	48.87	127.83	116.56	122.19
SEm SEm±	1.462	1.472	1.108	1.706	2.116	1.212
CD(p=0.05)	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)	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)	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)	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)	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)	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)	66.57	60.06	63.32	154.17	140.62	147.39
P_7 - Distilled water	46.37	47.26	46.82	110.27	107.40	108.83
SEm±	**2.735**	**2.754**	**2.073**	**3.191**	**3.958**	**2.268**
CD (p=0.05)	**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**

Table.2 Effect of varieties and plant growth regulators on Economics (Rs. ha^{-1}) of African marigold

Treatment Combinations (G x V)	Total Cost (Rs.)	Yield (q/ha)	Gross return (Rs./ha)	Net return (Rs.)	Benefit: cost ration
G_1 V_1- GA_3 200 ppm (25 DAT) +GA_3 200 ppm (45 DAT)	79750.00	133.26	199890	120140	2.50
G_1 V_2- GA_3 200 ppm (25 DAT) +GA_3 200 ppm (45 DAT)	79750.00	115.63	173445	93695	2.28
G_2V_1- GA_3 300 ppm (25 DAT) +GA_3 300 ppm (45 DAT)	89750.00	136.90	205350	115600	1.96
G_2V_2- GA_3 300 ppm (25 DAT) +GA_3 300 ppm (45 DAT)	389750.00	117.58	176370	86620	3.03
G_3V_1- GA_3 200 ppm (25 DAT) +CCC 1000 ppm (45 DAT)	71000.00	143.42	215130	144130	2.58
G_3V_2- GA_3 200 ppm (25 DAT) +CCC 1000 ppm (45 DAT)	71000.00	122.32	183480	112480	2.94
G_4V_1- GA_3 300 ppm (25 DAT) +CCC 1000 ppm (45 DAT)	76000.00	149.19	223785	147785	2.52
G_4V_2- GA_3 300 ppm (25 DAT) +CCC 1000 ppm (45 DAT)	76000.00	127.26	191940	115940	3.20
G_5V_1- GA_3 200 ppm (25 DAT) +CCC 1500 ppm (45 DAT)	71625.00	152.87	229305	157680	2.80
G_5V_2- GA_3 200 ppm (25 DAT) +CCC 1500 ppm (45 DAT)	71625.00	133.86	200790	129195	3.08
G_6V_1-GA_3 300 ppm (25 DAT) + CCC 1500 ppm (45 DAT)	76625.00	157.48	236220	159595	2.68
G_6V_2-GA_3 300 ppm (25 DAT) + CCC 1500 ppm (45 DAT)	76625.00	137.31	205965	129340	2.93
G_7V1- Distilled water	59750.00	116.99	175485	115735	2.93
G_7V2- Distilled water	59750	100.68	151020	91270	2.52

*Selling Price of marigold – Rs. 15/kg

The interaction between varieties and growth regulators did not show any significant results for vegetative characters and flowering and yield components. This may be because of these treatments acted independently rather than synergistically. Similar results were also reported by (Singh *et al.*, 1991; Tomar *et al.*, 2004; and Sunitha *et al.*, 2007) in African marigold. Thus, it can be concluded that varieties and foliar spray of plant growth regulators (GA_3 and CCC) jointly or separately gave higher flower yield in African marigold.

Economics

An inquisition of the pooled data in Table 2 also depicted the general cost of marigold cultivation was (59750.00 Rs. ha^{-1}) per hectare including labour cost, cost of various inputs and over head costs. The highest gross return of (236220.00 Rs. ha^{-1}) was found in

the treatment (GA_3 300ppm + CCC1500ppm) followed by (GA_3 200ppm + CCC 1500ppm) of (229305.00 Rs. ha^{-1}) whereas the lowest (151020.00 Rs. ha^{-1}) was observed in control. The highest benefit: cost ratio (3.20) was calculated in GA_3 200ppm + CCC 1500ppm followed by GA_3 300ppm + CCC1500ppm. As per the economic point of view the GA_3 200ppm + CCC 1500ppm gained more benefit: cost ratio, thus this combination was more better for high return from the cultivation of marigold. This might be due to the fact that the foliar application of growth regulators and varietal response might have improved the yield and quality of African marigold flower. Similar findings are noticed by (Naik *et al.,* 2005) in African marigold.

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