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GROWTH AND FLOWERING OF GAILLARDIA AS INFLUENCED BY PINCHING AND CYCOCEL

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ABSTRACT

An experiment entitled "Growth and flowering of gaillardia as influenced by pinching and cycocel" was carried out during *rabi* season of the year 2012-2013 at the Farm of Horticulture Section, College of Agriculture, Nagpur. The treatment comprised of the four pinching levels *viz.*, no pinching, pinching at 30 DAT, pinching at 45 DAT and pinching at 30 and 45 DAT and four cycocel levels *viz.*, Control (water spray), cycocel 500 ppm, cycocel 1000 ppm, cycocel 1500 ppm. The experiment was laid out in Factorial Randomized Block Design with three replications.The results obtained in the present investigation indicated that, the growth parameters in terms of plant height was recorded minimum in pinching at 30 and 45 DAT (60.68 cm) as well as cycocel 1500 ppm (61.50cm). However, maximum number of primary branches plant^{-1} and spread of plant at 50% flowering were recorded in pinching at 30 DAT as well as cycocel 1000 ppm. The flowering parameters like days to first flower bud initiation, days to opening of flower from bud emergence, days to 50 per cent flowering, days to first harvesting were found earlier in no pinching as well as water spray. Whereas, the maximum flowering span was found in pinching at 30 and 45 DAT as well as cycocel 1500 ppm. Maximum yield hectare^{-1} was recorded in pinching at 30 DAT (112.62 q ha^{-1}) as well as cycocel 1000 ppm (104.64 q ha^{-1}).

(Key words: Pinching, cycocel. growth, flowering and gaillardia)

INTRODUCTION

Gaillardia flower have special importance during whole year especially for garland purposes. There is a constant demand for flowers throughout the year for various functions, festivals and floral decorations. Gaillardia (*Gaillardia pulchella*) belongs to Asteraceae family, native to North and South America. Gaillardia flowers have special importance during festival days. For production of economical yield of gaillardia flowers, it is necessary to adopt a proper agro-technique by applying standard cultural practices. This can be achieved with planting of suitable cultivars and pinching of terminal growth at suitable intervals and growth retardants. In Vidarbha region of Maharashtra state, Gaillardia is cultivated throughout the year but the productivity is low and there are no proper recommendations based on latest technology to increase the yield potential. Farmers are unable to regulate the supply of flowers to market so as to assure better price for their produce. Considering the above facts, the present investigation was undertaken to study the growth and flowering of gaillardia as influenced by pinching and cycocel.

MATERIALS AND METHODS

An experiment entitled "Growth and flowering of gaillardia as influenced by pinching and cycocel" was laid out at the field of Horticulture Section, College of Agriculture, Nagpur during 2012-2013. The treatment comprised of the four pinching levels *viz.*, no pinching, pinching at 30 DAT, pinching at 45 DAT and pinching at 30 and 45 DAT and four cycocel levels viz., Control (water spray), cycocel 500 ppm, cycocel 1000 ppm, cycocel 1500 ppm. The experiment was laid out in Factorial Randomised Block Design (FRBD) with 16 treatment combinations and three replications. The seedlings were transplanted in field on 27th October, 2012 at 60 cm x 45 cm spacing. A standard dose of NPK at the rate of 100 kg N, 50 kg P and 50 kg K hectare^{-1} was applied through urea, single super phosphate and murriate of potash. The basal dose of 50 kg N and full dose of P and K was applied at the time of transplanting, remaining 50 kg of N was applied as top dressing after 30 days of transplanting. The single pinching was done at 30th day and 45th day, double pinching was done at 30th and was repeated at 45th days after transplanting. Pinching was done by removing approximately half inch of terminal growing

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shoots. Required quantity of stock solutions of cycocel were prepared by taking required quantity of cycocel. From this stock solution working solution of required concentration as per treatments were prepared by dissolving appropriate quantity of stock solution of cycocel with water for spraying. Cycocel were sprayed as per treatments. Five plants were selected randomly from each plot for recording growth parameters *viz.*, height of plant (120 DAT), number of primary branches plant^{-1} (120 DAT) and spread of plant at 50% flowering and flowering parameters viz., days to first flower bud initiation, days to opening of flower from bud emergence, days to 50 per cent flowering, days to first harvesting, flowering span and yield of flowers hectare^{-1}. Data were statistically analysed in FRBD (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

The data presented in table 1 revealed that, different levels of pinching and different levels of cycocel had significant effect on growth and flowering parameters of gaillardia.

Growth parameters

Effect of pinching

Significantly minimum plant height was noticed in double pinching at 30 and 45 days after transplanting (60.68 cm) which was at par with pinching at 45 days after transplanting (62.03 cm). Whereas, significantly maximum plant height was recorded in no pinching (68.36 cm). In pinching removal of apical growth of the plant arrested the vertical growth of plant. Therefore, pinching reduced plant height. Obvious that maximum plant height was produced by control treatment (no pinching) and reduction in plant height was found due to pinching treatments. Significantly maximum number of primary branches plant^{-1} was recorded in single pinching at 30 days after transplanting (30.45) followed by single pinching at 45 days after transplanting (27.11) and double pinching at 30 and 45 days after transplanting (24.85). However, significantly minimum number of primary branches plant^{-1} was recorded in no pinching (20.99).In pinching, the apical portion of main stem was pinched and therefore, more side branches were formed below pinched portion because of removal of apical bud and diversion of auxins towards the auxiliary vegetative buds below pinched portion. Significantly maximum spread of the plant at 50% flowering was noticed in single pinching at 30 days after transplanting (61.21 cm) which was at par with pinching at 45 days after transplanting (58.32 cm) and pinching at 30 and 45 days after transplanting (57.92 cm). Whereas, significantly minimum spread of the plant at 50% flowering was recorded in control treatment i.e. no pinching (53.22 cm). Increase in spread of plant might be due to pinching and removal of the apical growth from plant which arrested the vertical growth and auxiliary buds below pinched portion may gives rise to primary branches of plant. Therefore, there was enhanced spread. As the number of pinching increased, the spread of plant was reduced. These results are in close agreement with the findings of Pawar (2001) in chrysanthemum. Sehrawat *et al.* (2003) observed reduction in plant height by pinching in marigold, Benival *et al.* (2003) revealed that, plant spread was highest at the 20 cm x 30 cm spacing and at early pinching i.e. pinching at 25 days after transplanting in chrysanthemum. Ghormade *et al.* (2017) reported minimum plant height and maximum stem diameter in double pinching at 15 DAT and 30 DAT, maximum number of branches plant^{-1} and plant spread in single pinching at 30 DAT in African marigold.

Effect of cycocel

Significantly minimum plant height was noticed in cycocel 1500 ppm (61.50 cm) followed by the treatments cycocel 1000 ppm (62.62 cm) and cycocel 500 ppm (65.10 cm). However, significantly maximum plant height was recorded in control treatment (67.19 cm). From above results it is indicated that, plant height was reduced with the increase in concentration of cycocel. The higher concentration of cycocel 1500 ppm recorded lowest height of plant. This might be due to the fact that cycocel act as a growth retarding substance. In cycocel treated plant, it might have reacted with gibberelic acid or IAA oxidase to lower down the level of diffusible auxin, thereby suppressing the vegetative growth. Significantly maximum number of primary branches plant^{-1} was recorded in cycocel 1000 ppm (27.76) which was followed by cycocel 1500 ppm (26.46) and cycocel 500 ppm (25.77). Cycocel 500 ppm and Cycocel 1500 ppm were statistically at par with each other. However, significantly minimum number of primary branches plant^{-1} were recorded in control treatment (23.42). From above results, it is indicated that number of primary branches plant^{-1} were increased as concentration of cycocel increased. The concentration of cycocel 1000 ppm recorded maximum number of primary branches plant^{-1}. This might be due to the fact that, cycocel act as a growth retarding substance. Cycocel arrests the vertical growth as it acts as antagonistically to auxin and thus counteracts apical dominance resulted into increased number of primary branches. In cycocel treated plant, suppression of apical dominance may be attributed to increase the number of primary branches plant^{-1}. Significantly maximum spread of the plant at 50% flowering was noticed in cycocel 1000 ppm (62.40 cm) and it was followed by cycocel 1500 ppm (56.44 cm) and cycocel 500 ppm (55.90 cm). Whereas, significantly minimum spread of the plant at 50% flowering was recorded in control treatment (54.43 cm). This might be due to fact that cycocel decreases the auxin content and act antagonistically to auxin and thus counteracts apical dominance. Cycocel increases the number of leaves and primary branches plant^{-1}. The results are in close agreement with the findings of Gowda and Jayanti (1991), who observed that the application of cycocel to marigold plant at 1000 ppm, 1500 ppm and 2000 ppm concentrations reduced the plant height and increased the number of branches with increase in concentration of cycocel. Naik *et al.* (2004) observed that foliar application of cycocel at 1000 ppm

concentration reduced the plant height and increased number of secondary branches in African marigold. Kudmate *et al.*(2016) found maximum plant spread (47.10 cm) in cycocel 1500 ppm in annual chrysanthemum.

Interaction effect

The interaction effect due to pinching and cycocel on height of plant, number of primary branches plant^{-1} and spread of plant at 50% flowering was found to be non significant.

Flowering parameters

Effect of pinching

Significantly minimum days to first flower bud initiation was noticed in control treatment i.e. no pinching (59.94 days) followed by single pinching at 30 days after transplanting (66.68 days) and pinching at 45 days after transplanting (68.75 days). Whereas, significantly maximum days to first flower bud initiation was recorded in pinching at 30 and 45 days after transplanting (72.77 days). Significantly minimum days to opening of flower from bud emergence was observed in control treatment i.e. no pinching (6.56 days) followed by pinching at 30 days after transplanting (8.19 days) and pinching at 45 days after transplanting (10.07 days). Whereas, significantly maximum days to opening of flower from bud emergence was observed in pinching at 30 and 45 days after transplanting (11.80 days). Significantly minimum days to 50% flowering was observed in control treatment i.e. no pinching (75.16 days) which was followed by pinching at 30 days after transplanting (87.12 days) Whereas, significantly maximum days to 50% flowering was observed in pinching at 30 and 45 days after transplanting (98.61 days) which was at par with pinching at 45 days after transplanting (95.15 days). Significantly minimum days to first harvesting was recorded in control treatment i.e. no pinching (98.10 days) which was at par with single pinching at 30 days after transplanting (104.97 days) and pinching at 45 days after transplanting (106.97 days). Pinching at 30 days after transplanting, pinching at 45 days after transplanting and pinching at 30 and 45 days after transplanting were at par with each other. Significantly maximum flowering span was noticed in pinching at 30 and 45 days after transplanting (75.10 days) which was followed by pinching at 45 days after transplanting (73.02 days) and pinching at 30 days after transplanting (68.91 days). Whereas, significantly minimum flowering span was recorded in control treatment i.e. no pinching (60.51 days). Shoot tip pinching increased the number of primary branches and leaves plant^{-1} which help to maximize duration of flowering than control treatment. The delay in flowering by pinching was due to removal of matured portion and the new shoots which emerged out from pinched plants took more time to become physiological inductive to produce flowers than non pinched plants. These results are in close agreement with the findings of Bholane (1998), who reported that pinching after four weeks of planting delayed flower bud emergence and flower bud opening in chrysanthemum. Pawar (2001) conducted an experiment on chrysanthemum cv. 'PKV Subhra' and reported that pinching done at 4, 6 and 8 weeks after planting delayed flower bud emergence and flower bud opening. Bhat and Shephered (2007) reported that single pinching at 35 days after transplanting gave earliest number of days to first flowering (47.85) in African marigold. Taksande *et al.* (2017) reported minimum days to first flower bud emergence, days to fully opened flower bud from bud emergence, days to 50% flowering in control i.e. no pinching (43.39 days,15.40 days and 59.57 days) respectively and maximum blooming period (45.83 days) in pinchng at 45 days after transplanting in annual chrysanthemum. Significantly maximum yield of flowers hectare^{-1} was noticed in pinching at 30 days after transplanting (112.62 q). Whereas, significantly minimum yield of flowers hectare^{-1} were recorded in no pinching (72.82 q). Early pinching produced more number of branches plant^{-1}, more number of flowers plant^{-1} and more flower yield plot^{-1} which might have increased yield of flowers hectare^{-1}. These results are in close agreement with the findings of Pawar (2001), who reported increase in number of flowers plant^{-1} and yield of flowers plot^{-1} when pinching done at 4 weeks after transplanting in chrysanthemum cv. PKV Subhra. Khandelwal *et al.* (2003) recorded more number of flowers plant^{-1} (63.15) and flower yield hectare^{-1} (167.80 q ha^{-1}) in plants pinched at 20 days after transplanting compared to control (39.57 and 125.5 q ha^{-1} respectively) in marigold.

Effect of cycocel

Significantly minimum days to first flower bud initiation was noticed in control treatment (63.88 days) which was at par with cycocel 1000 ppm (66.50 days) and cycocel 500 ppm (68.59 days). Whereas, significantly maximum days to first flower bud initiation was observed in cycocel 1500 ppm (69.59 days). Significantly minimum days to opening of flower from bud emergence was observed in control treatment (7.84 days). It was followed by cycocel 500 ppm (8.84 days) and cycocel 1000 ppm (9.36 days). Whereas, significantly maximum days to opening of flower from bud emergence was observed in cycocel 1500 ppm (10.34 days). Significantly minimum days to 50 % flowering was observed in control treatment (83.48 days). Whereas, significantly maximum days to 50 % flowering was observed in cycocel 1500 ppm (93.35 days) which was at par with cycocel 1000 ppm (91.15 days). Significantly minimum days to first harvesting was recorded in control treatment (98.58 days) which was at par with cycocel 500 ppm (104.65 days) and cycocel 1000 ppm (107.85 days). Treatments cycocel 500 ppm, cycocel 1000 ppm and cycocel 1500 ppm were found at par with each other. Significantly maximum days to first harvesting was recorded in cycocel 1500 ppm (112.26 days). Significantly maximum flowering span was recorded in cycocel 1500 ppm (73.50 days), it was followed by cycocel 1000 ppm (70.96 days) and cycocel 500 ppm (67.81 days). Whereas, significantly minimum flowering span was noticed in control treatment (65.47 days). Maximum flowering span was observed in cycocel 1500 ppm might be due to more number of branches and leaves which help to produce more carbohydrates in plant. The carbohydrates produced were

Table 1. Growth and flowering parameters of gaillardia as influenced by pinching and cycocel

Treatments	Height of plant at 120 DAT (cm)	Number of primary branches plant $^{-1}$ at 120 DAT	Spread of plant at 50% flowering	Days to first flower bud initiation	Days to opening of flower from bud emergence	Days to 50% flowering	Days to first harvesting	Flowering span (days)	Yield of flowers ha^{-1} (q)
A. Pinching (P)									
No pinching (P_0)	68.36	20.99	53.22	59.94	6.56	75.16	98.10	60.51	72.82
Pinching at 30 DAT (P_1)	65.35	30.45	61.21	66.68	8.19	87.12	104.79	68.91	112.62
Pinching at 45 DAT (P_2)	62.03	27.11	58.32	68.75	10.07	95.15	106.97	73.02	99.70
Pinching at 30 and 45 DAT (P_3)	60.68	24.85	57.92	72.77	11.80	98.61	113.48	75.10	96.77
SE (m) ±	0.46	0.30	1.71	1.06	0.21	1.29	3.36	0.67	3.08
CD at 5%	1.35	0.88	3.42	3.08	0.62	3.72	9.69	1.93	8.89
B. Cycocel (C)									
Control (C_0)	67.19	23.42	54.43	63.88	7.84	83.48	98.58	65.47	79.80
CCC 500 ppm (C_1)	65.10	25.77	55.90	66.50	8.84	88.06	104.65	67.61	97.04
CCC 1000 ppm (C_2)	62.62	27.76	62.40	68.59	9.36	91.15	107.85	70.96	104.64
CCC 1500 ppm (C_3)	61.50	26.46	56.44	69.59	10.34	93.35	112.26	73.50	100.74
SE (m) ±	0.46	0.30	1.71	1.06	0.21	1.29	3.36	0.67	3.08
CD at 5%	1.35	0.88	3.42	3.08	0.62	3.72	9.69	1.93	8.89
C. Interaction PxC									
SE (m) ±	0.93	0.61	4.93	2.13	0.43	2.58	6.72	1.34	6.16
CD at 5%	--	--	--	--	--	--	--	--	--

translocated towards the reproductive parts of plant for the development of floral parts. Cycocel being a growth retardant have inhibited the endogenous synthesis of gibberellins responsible for flower bud initiation and hence delayed flowering. It might be due to growth retardation rather than direct effect on flowering stimulus. Similar results were found by Parmar and Singh (1988), who observed that cycocel delayed initiation of first flower bud initiation in marigold. Dutta *et al.* (1993) observed that foliar spray of cycocel at 2000 ppm concentration to chrysanthemum produced earlier flowering. Khandelwal *et al.* (2003) conducted an experiment on African marigold and reported that foliar application of cycocel at 3000 ppm delayed first flower initiation (49.02 days) and increased duration of flowering (54.93 days). Taksande *et al.* (2017) reported minimum days to first flower bud emergence, days to opening of flower bud from bud emergence, days to 50% flowering in control i.e water spray (46.82 days,15.51 days and 61.67 days) respectively and maximum blooming period (43.28 days) in cycocel 1500 ppm in annual chrysanthemum. Significantly maximum yield of flowers hectare^{-1} was recorded in cycocel 1000 ppm (104.64 q) which was at par with cycocel 1500 ppm (100.74 q) and cycocel 500 ppm (97.04 q). Whereas, significantly minimum yield of flowers hectare^{-1} was noticed in control treatment (79.80 q). Yield of flowers hectare^{-1} was increased as foliar application of cycocel increased number of branches plant^{-1}, number of flowers plant^{-1} and yield of flowers plot^{-1}. These results are in close agreement with the findings of Parmar and Singh (1988), who noticed more number of flowers (11.70 and 9.00) and flower yield plant^{-1} (102.00 and 106.30 g) with foliar spray of CCC at 500 and 750 ppm respectively compared to control (7.80 and 72.90 g respectively) in marigold. Khandelwal *et al.* (2003) observed significantly more number of flowers (67.01) and flower yield (186.80 q ha^{-1}) with CCC at 3000 ppm spray to marigold compared to control (39.57 and 124.50 q ha^{-1} respectively). Naik *et al.* (2004) observed that foliar application of cycocel at concentration of 1000 ppm increased the flower yield in African marigold.

Interaction effect

The interaction effect due to pinching and cycocel on days to first flower bud initiation, days to opening of flower from bud emergence, days to 50 per cent flowering, days to first harvesting, flowering span and yield of flowers hectare^{-1} was found non significant.

From the findings of present investigation, it may be concluded that significantly minimum plant height was recorded in pinching at 30 and 45 days after transplanting (60.68 cm) as well as cycocel 1500 ppm (61.50 cm). However, significantly maximum number of primary branches plant^{-1} and spread of plant at 50% flowering were found in pinching at 30 days after transplanting as well as cycocel 1000 ppm. The flowering parameters *viz.*, days to first flower bud initiation, opening of flower from bud initiation, days to 50 % flowering and days to first harvesting from transplanting were found earlier in no pinching as well as water spray. Whereas, maximum flowering span was found in double pinching at 30 and 45 days after transplanting as well as cycocel 1500 ppm. Maximum yield hectare^{-1} was recorded in pinching at 30 days after transplanting (112.62 q ha^{-1}) as well as cycocel 1000 ppm (104.64 q ha^{-1}).

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