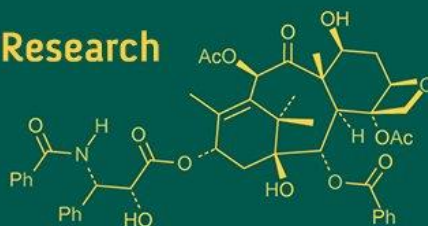


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Effect of plant growth regulators and pinching on growth parameters in Gaillardia (*Gaillardia pulchella*)

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Abstract

A field experiment was conducted during the Rabi season of 2020-21 at the College of Horticulture, Dapoli, to evaluate the effect of plant growth regulators (PGRs) and pinching on growth parameters of *Gaillardia*. The experiment was laid out in a Factorial Randomized Block Design with seven PGR treatments T₁: Control, T₂: Ethephon @ 500 ppm, T₃: Ethephon @ 1000 ppm, T₄: GA₃ @ 100 ppm, T₅: GA₃ @ 200 ppm, T₆: CCC @ 1000 ppm and T₇: CCC @ 2000 ppm and two pinching levels P₁-Pinching at 30 days after transplanting and P₂-No pinching. Among the PGR treatments, T₅-GA₃ @ 200 ppm recorded the highest plant height (107.78 cm), plant spread (69.22 cm E-W and 70.77 cm N-S), primary branches (30.33), secondary branches (44.43), and internodal length (7.26 cm), whereas T₇-CCC @ 2000 ppm recorded the lowest plant height (53.98 cm) and internodal length (2.50 cm). The minimum plant spread was observed in T₂-Ethephon 500 ppm with 60.15 cm (E-W) and 61.63 cm (N-S), while T₁ (Control) recorded the lowest number of primary branches (25.38), secondary branches (37.77), and leaf area (22.20 cm²). The maximum leaf area (29.47 cm²) was recorded in T₄-GA₃ @ 100 ppm. Pinching at 30 DAT (P₁) resulted in greater plant spread (65.44 cm E-W and 66.70 cm N-S), primary branches (27.58), secondary branches (40.33), leaf area (26.11 cm²), and internodal length (4.69 cm), whereas no pinching (P₂) produced the tallest plants (76.79 cm). The interaction effect of PGRs and pinching was non-significant for most growth parameters; however, the highest plant height (110.27 cm) was recorded in T₅P₂ (GA₃ 200 ppm + no pinching), while the highest number of secondary branches (45.60) was observed in T₅P₁ (GA₃ 200 ppm + pinching). Overall, T₅-GA₃ @ 200 ppm and P₁ (pinching at 30 DAT) were found most effective in improving vegetative growth and branching in *gaillardia*.

Keywords: *Gaillardia*, plant growth regulators, pinching

Introduction

Gaillardia (*Gaillardia pulchella*) commonly known as blanket flower, is a widely grown annual flower crop in India. It is mainly cultivated for cut flowers, while its loose flowers are used for garlands and decorations in religious and social functions. The crop is easy to grow and is influenced by factors such as environment, genetics, and crop management. Plant growth regulators (PGRs) are used to control plant growth and development, including plant height, flowering, and yield. They affect hormonal and enzymatic activities, which in turn influence plant growth, flower yield, and quality. Pinching is a common practice in flower crops that encourages side branching, resulting in more flowers and improved quality. Both PGRs and pinching also affect plant and flower biomass. Therefore, the present study was conducted to evaluate the effect of PGRs and pinching on the vegetative parameters of plants in *gaillardia*.

Material and Methods

The present study was conducted during the Rabi season of 2020-21 at the Floriculture Farm, College of Horticulture, Dapoli. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with seven plant growth regulator treatments-T₁-Control, T₂-Ethephon @ 500 ppm, T₃-Ethephon @ 1000 ppm, T₄-GA₃ @ 100, T₅-GA₃ @ 200 ppm, T₆-CCC @ 1000 ppm and T₇-CCC @ 2000 ppm combined with two pinching levels P₁-(pinching at 30 DAT and P₂-no pinching) and replicated three times. Healthy 30-day-old seedlings were transplanted at a spacing of 30 × 30 cm. Growth regulators were sprayed at 30, 60, 90, and 120 days after transplanting, while pinching was done at 30 DAT.

Observations on plant height, branches, plant spread, leaf area, and internodal length were recorded and statistically analysed following the method of Panse and Sukhatme (1985) [10].

Results and Discussion

1. Effect of plant growth regulators and pinching on plant height of gaillardia

The data on plant height of gaillardia as influenced by the plant growth regulator and pinching treatments are presented in Table 1.

Effect of plant growth regulators

Data revealed that the plant growth regulators had significant influence on the plant height at 60 DAT, 90 DAT and 120 DAT. However, at 30 DAT, the plant height was not significantly altered by PGR treatment as the plants showed almost uniform growth till 30 DAT. Maximum plant height (42.85 cm), (77.68cm) and (107.78 cm) at 60, 90 and 120 DAT, respectively observed in T_5 (GA_3 @ 200 ppm). The lowest plant height at 60, 90 and 120 DAT, 20.37cm, 36.80cm and 53.98 cm was observed in the treatment T_7 (CCC @ 2000 ppm). The gibberellic acid is known for its effect on cell elongation in the plants. The increase in plant height with increase in GA_3 concentration was observed in current experiment. The rapid growth in GA_3 treatments might be due to a greater number of cells formed and increased elongation of the individual cell. These results are in closed confirmatory in Gaillardia reported by (Ghadage *et al.*, 2010; Kadam *et al.*, 2020) [2, 7].

Effect of pinching

It is revealed that the pinching had significant influence on the plant height at all growth stages except 30 DAT (Table 1) as pinching was done at 30 days after transplanting. At 60, 90 and 120 DAT, the significantly highest plant height (29.88 cm, 51.50 cm and 76.79 cm, respectively) was recorded in P_2 (No-pinching) treatment, while 28.88 cm, 50.65 cm and 74.29 cm plant height at 60, 90 and 120 DAT, respectively was found due to pinching at 30 DAT (P_1) treatment. The reduced plant height observed in pinched plant which might be due to fact that the vertical growth of a plant is arrested by removing top most part of the shoot i.e. apical growth. Certainly, the maximum plant height was produced by no-pinching treatment. Similar findings were also observed in marigold by (Sunita *et al.*, 2007; Patade *et al.* 2020) [18, 11].

Interaction effect

The interaction effect between PGR and pinching treatment on plant height of gaillardia was non-significant at 30, 60 and 90 DAT. However, the plant height was significantly altered by plant growth regulators and pinching treatments at 120 DAT. maximum plant height (110.27cm) was recorded in T_5P_2 (GA_3 @ 200 ppm + no pinching) treatment at 120 DAT and it was followed by T_5P_1 (105.30), T_4P_2 (101.37 cm), T_4P_1 (98.80cm) treatment combinations. While the lowest plant height was recorded in T_7P_1 (CCC @ 2000 ppm + pinching) (53.67cm) which was at par with T_7P_2 . Growth might also be increased due to osmotic uptake of water and nutrients under the influence of GA_3 which maintain swelling force against the softening of cell wall and thereby increasing the plant height (Lockhart 1960) [9].

2. Effect of plant growth regulators and pinching on plant spread (E-W and N-S) of Gaillardia

Effect of plant growth regulators

The data on plant spread of gaillardia was influenced by the plant growth regulator and pinching are presented and in Table 2 and 3. The data perused that the plant spread (E-W and N-S) at 60, 90 and 120 DAT growth stage was significantly influenced by the application of different plant growth regulators and the pinching treatments. At 30 DAT, the noteworthy difference was not observed at the treatments were imposed at 30 DAT. Their interaction showed the non-significant effect on plant spread (Table 2 and 3). The spread was increased continuously in the growth phase and it was with faster rate up to 90 DAT and the rate was lowered down afterwards.

Effect of plant growth regulators

At 30 DAT, the plants showed nearly uniform spread and within the range of 13.93 cm to 15.97 cm (East-West) and 15.18 to 17.17 cm (North-South). At 60 DAT, treatment T_5 (GA_3 @ 200 ppm) recorded the significantly highest east-west plant spread (33.93cm) which was at par with T_6 , T_7 , and T_1 treatments. The lowest east-west plant spread (26.47cm) was recorded in the treatment T_2 (Ethephon @ 500 ppm) which was at par with T_3 treatment. In case of north-south plant spread, the highest value (35.52 cm) was registered in T_5 (GA_3 @ 200 ppm) The minimum plant spread (North-South) was observed in T_2 treatment (28.84 cm) and it was at par with T_3 . At 90 DAT, the maximum plant spread (63.20 cm east-west and 64.73 cm north-west) was recorded in T_5 treatment (GA_3 @ 200 ppm) and it was at par with T_1 treatment (Control). Lowest plant spread (45.58cm and 47.32 cm, respectively) was observed in T_2 (Ethephon @ 500 ppm) treatment. The similar trend was consistently noticed in at 120 DAT and the significantly maximum east-west and north-south plant spread (69.22cm and 70.77 cm) was recorded in T_5 treatment (GA_3 @ 200 ppm). The lowest (E-W) plant spread (60.15 cm) and (N-S) plant spread (61.63 cm) was recorded in T_2 (Ethephon @ 500 ppm). GA_3 was found effective in increasing plant spread in gaillardia. According to (Verma, 1991) [19] it was due to the formation of new cells in meristematic region and an increase in size and mass of cells produced. The promotive effect of gibberellins on growth may be due to increasing auxin level of tissues which causes cell division and cell elongation which in terms induces the lateral growth and ultimately also increases the number of branches and thereby plant spread. The similar results were reported in chrysanthemum (Gohel 2001; Gupta and Dutta 2001) [3, 4].

Effect of Pinching

At 60 DAT, 90 DAT and 120 DAT the maximum plant spread (31.73cm, 56.48cm and 65.44 cm, respectively for east-west direction and 33.58cm, 57.85 cm and 66.70 cm, respectively for north-south direction) was in P_1 (pinching at 30 DAT) treatment which was significantly superior over P_2 (no pinching) treatment (30.50 cm, 54.55 cm and 63.37 cm, respectively for east-west direction and 32.18 cm, 56.11cm and 64.80 cm, respectively for north-south direction) .The higher plant spread in pinched plants was possibly due to the fact that by removal of the apical portion more energy might have been created to promote the number of side branches. (Moon *et al.*, 2018) [9] also observed higher plant spread of plant at 50% flowering were recorded in pinching at 30

DAT and. The similar results were reported in marigold (Jyothi *et al.*, 2018) ^[6].

Interaction Effect

The interaction effect between PGR and pinching treatment on plant spread (east-west and north-south) of gaillardia was non-significant at all growth stages.

3. Effect of plant growth regulators and pinching on primary and secondary branches of Gaillardia

The data pertaining to the effect of number of primary and secondary branches at 30, 60, 90 and 120 days interval are presented in Table 4 and 5.

Effect of plant growth regulators

It is revealed that the plant growth regulators had significant influence on the number of primary and secondary branches at 60, 90 and 120 DAT.

At 60 DAT, the treatment T₅ (GA₃ @ 200 ppm) registered the highest number of primary branches (22.70). The lowest number of primary branches per plant (17.30) was in T₆ (CCC @ 1000 ppm). At 90 DAT, the significantly highest number of primary branches (25.53) was recorded in treatment T₄ (GA₃ @ 100 ppm) which was closely followed by T₅ treatment. The least number of primary branches (22.52) was in T₃ i.e. Ethephon @ 100 ppm treatment which was at par with the rest of the treatments. At 120 DAT, the trend was changed and again the highest number of primary branches (30.33) was recorded in treatment T₅ (GA₃ @ 200 ppm) and it was at par with T₄ treatment. The lowest number of primary branches (25.38) was observed in T₁ (Control) treatment. At 60 DAT, 90 DAT and 120 DAT maximum number of secondary branches were observed in treatment T₅ (GA₃ @ 200 ppm) i.e. 27.38, 39.72 and 44.43, respectively. Lowest number of secondary branches was recorded in the treatment T₆ (23.07) in control at 60 DAT. Minimum number of branches at 90 DAT was recorded in T₆ (CCC @ 1000 ppm) and at, 120 DAT treatment T₁ (Control) recorded minimum number of branches. Increase in the number of branches by GA₃ treatment might be due to hyper elongation of internodal length and result antincrease in internodal count of the main axis. The similar observations were also recorded gaillardia and marigold (Patil, 2002; Joshi *et al.*, 2002; Ramdevputra *et al.*, 2009) ^[12, 5, 13].

Effect of Pinching

It is revealed that the pinching had significant influence on the on the number of primary and secondary branches at 60 DAT, 90 DAT and 120 DAT. However at 30 DAT number of primary and secondary branches was not significantly altered by pinching treatment. At 60 DAT, 90 DAT and 120 DAT highest number of primary branches (20.48, 24.43 and 27.58 respectively) was recorded in P₁ (pinching at 30 DAT) treatment, which was significantly superior over P₂ (no-pinching) treatment and 60 DAT, 90 DAT and 120 DAT highest number of secondary branches (25.67, 36.27 and 40.33 respectively) was recorded in P₁ (pinching at 30 DAT) treatment, Which was significantly superior over P₂ (no-pinching) treatment. Number of branches per plant may have increased due to pinching of plant which might have forced the auxiliary buds to thrive well Increasing number of branches per plant which might due to effect of removing apical portion of plant. Similar results were observed in marigold (Sarkar *et al.*, 2018; Singh *et al.*, 2019) ^[16, 17].

Interaction Effect

The interaction effect between PGR and pinching treatment on number of primary branches per plant of Gaillardia showed significant variation at 90 DAT but did not varied significantly at 30 and 60 and 120 DAT. Maximum (26.17) number of primary branches in T₅P₁ (GA₃ @ 200 ppm + pinching) which was followed by treatment T₄P₁ (GA₃ @ 100 ppm + pinching) at 90 DAT and minimum (21.60) number of primary branches recorded in T₃P₂ (Ethephon @ 1000 ppm + no pinching) treatment. At 120 DAT, maximum (45.60) number of secondary branches observed in T₅P₁ (GA₃ @ 200 ppm + pinching) treatment. It was followed by T₅P₂ (43.27) (GA₃ @ 200 ppm + no pinching) treatment and minimum (37.53) number of primary branches recorded in T₁P₂ (Control + no pinching) treatment.

4. Effect of plant growth regulators and pinching on Leaf area (cm²) of Gaillardia

The data on leaf area of gaillardia as influenced by the plant growth regulator and pinching are presented in Table 6.

Effect of plant growth regulators

The plant growth regulators had significant influence on the leaf area at 60 DAT, 90 DAT and 120 DAT. However at 30 DAT, leaf area was not significantly altered by PGR treatments where the average leaf area was 2.37 cm². At 60 DAT treatment T₅ (GA₃ @ 200 ppm) recorded the significantly maximum (14.70 cm²) leaf area and it was at par with T₄ (14.57 cm²). The minimum leaf area (7.58 cm²) was found in T₁ (Control). At 90 DAT and 120 DAT the maximum leaf area (30.77 cm² and 29.47 cm²) was recorded in T₄ (GA₃ @ 100 ppm) which was at par with T₅ (GA₃ @ 200 ppm). The least leaf area (22.83 cm²) was observed in treatment T₃ (Ethephon @ 1000 ppm) at 90 DAT. The treatment T₁ (Control) recorded minimum leaf area (22.20 cm²) at 120 DAT. Increase in leaf area in GA₃ might be due to cell division and cell elongation when favours the increased plant height and number of branches. Similar results were recorded in African marigold and Gaillardia. (Yadav *et al.*, 2013; Kadam *et al.*, 2020) ^[20, 7].

Effect of Pinching

Significantly maximum leaf area per plant at 60 DAT, 90 DAT and 120 DAT was observed in P₁ (Pinching at 30 DAT) i.e. 11.18 cm², 26.92 cm² and 26.11 cm² respectively. While minimum leaf area 10.40 cm², 25.74 cm² and 24.81 cm², respectively was recorded in P₂ (no pinching). In pinching practice, apical dominance of plant, branch and leaf may get more sunlight which increased leaf area due to pinching. (Saleh and Yousif 2013) ^[15] found that leaf area was decreased in non-pinned plants compared with pinned once and pinned twice in Geranium plants.

Interaction Effect:

The interaction effect between PGR and pinching treatment on leaf area of Gaillardia was non-significant at all growth stages.

5. Effect of plant growth regulators and pinching on internodal length of Gaillardia

The data on internodal length of gaillardia as influenced by the plant growth regulator and pinching are presented Table 7.

Effect of Plant Growth Regulators

Plant growth regulator had significant influence on internodal length of gaillardia. The maximum internodal length (7.26 cm) was observed in treatment T₅ (GA₃ @ 200 ppm) which was followed by T₄ (6.43 cm), T₆ (4.56 cm), T₂ (4.18 cm), T₁ (3.61cm) T₂ (2.58 cm). The shortest internode (2.50 cm) was found in the treatment T₇ (CCC @ 2000 ppm). GA₃ is able to both cell division and cell elongation (Reddy and Sulladmath, 1983a) ^[14]. Owing to the fact increase GA₃ application, increased internodal length and cell enlargement that increases growth of plants and also increases auxin content which enhanced the apical dominance indirectly. Similar results were observed in Gaillardia. (Kadam *et al.*, 2020) ^[7].

Effect of Pinching

Pinching had significant influence on internodal length of gaillardia and the highest internodal length (4.69 cm) was observed in treatment P₁ (Pinching at 30 DAT) while least internodal length (4.20 cm) was observed in no pinching (P₂). The internodal length is highest in the pinched plant was observed than control which may be attributed to the forcing of plant for profuse sprouting by tip cutting. (Devi *et al.*, 2019) ^[1] assessed the pinching effect on internodal length in carnation.

Interaction effect

The interaction effect between plant growth regulators and pinching treatment on internodal length of Gaillardia was non-significant.

Table 1: Effect of plant growth regulators and pinching on plant height of Gaillardia

Treat. combinations	Plant height (cm)											
	30 DAT			60 DAT			90 DAT			120 DAT		
	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean
T ₁	13.63	13.37	13.50	26.63	27.20	26.92	48.93	51.47	50.20	79.90	81.43	80.67
T ₂	14.50	14.12	14.31	25.47	26.70	26.08	42.40	43.57	42.98	66.03	68.00	67.02
T ₃	14.43	12.60	13.52	25.43	26.27	25.85	38.10	40.13	39.12	60.87	63.70	62.28
T ₄	13.23	13.23	13.23	34.60	37.00	35.80	67.47	69.30	68.38	98.80	101.37	100.08
T ₅	15.81	13.50	14.65	42.23	43.47	42.85	76.90	78.47	77.68	105.30	110.27	107.78
T ₆	13.03	14.07	13.55	27.40	27.60	27.50	38.73	40.10	39.42	55.47	58.43	56.95
T ₇	14.23	12.52	13.38	19.81	20.93	20.37	36.13	37.47	36.80	53.67	54.30	53.98
Mean	14.12	13.34	13.73	28.80	29.88	29.34	49.81	51.50	50.65	74.29	76.79	75.54
	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result
T	0.44	-	NS	0.68	1.98	SIG	0.50	1.45	SIG	0.37	1.09	SIG
P	0.27	-	NS	0.36	1.06	SIG	0.27	0.78	SIG	0.20	0.58	SIG
TxP	0.62	-	NS	0.96	-	NS	0.71	-	NS	0.54	1.54	SIG

DAT-Days After Transplanting

PGRs Treatments:		Pinching Treatments:
1) T ₁ -Control	2) T ₂ -Ethephon @ 500 ppm	1) P ₁ -Pinching @ 30 DAT
3) T ₃ -Ethephon @ 1000 ppm	4) T ₄ -GA ₃ @ 100 ppm	2) P ₂ -No pinching
5) T ₅ -GA ₃ @ 200 ppm	6) T ₆ -CCC @ 1000 ppm T ₇ -CCC @ 2000 ppm	

Table 2: Effect of plant growth regulators and pinching on plant spread (E-W) of Gaillardia

Treat. combinations	Plant spread (E-W) in cm											
	30 DAT			60 DAT			90 DAT			120 DAT		
	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean
T ₁	14.37	13.50	13.93	33.60	32.20	32.90	63.73	61.40	62.57	69.50	67.30	68.40
T ₂	14.47	13.97	14.22	26.50	26.43	26.47	47.43	43.73	45.58	61.37	58.93	60.15
T ₃	15.90	15.20	15.55	28.37	25.33	26.85	50.20	50.00	50.10	62.13	58.90	60.52
T ₄	15.70	15.17	15.43	33.73	32.30	33.02	59.77	58.50	59.13	66.77	66.00	66.38
T ₅	14.50	13.43	13.97	34.27	33.60	33.93	64.80	61.60	63.20	70.60	67.83	69.22
T ₆	16.20	15.73	15.97	31.23	30.43	30.83	54.10	52.07	53.08	63.93	62.13	63.03
T ₇	13.17	14.50	13.83	34.40	33.17	33.78	55.30	54.57	54.93	63.80	62.47	63.13
Mean	14.90	14.50	14.70	31.73	30.50	31.11	56.48	54.55	55.51	65.44	63.37	64.40
	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result
T	0.62	-	NS	0.62	1.80	SIG	0.52	1.50	SIG	0.47	1.37	SIG
P	0.33	-	NS	0.33	0.96	SIG	0.28	0.80	SIG	0.25	0.73	SIG
TxP	0.87	-	NS	0.87	-	NS	0.73	-	NS	0.67	-	NS

PGRs Treatments:		Pinching Treatments:
1) T ₁ -Control	2) T ₂ -Ethephon @ 500 ppm	1) P ₁ -Pinching @ 30 DAT
3) T ₃ -Ethephon @ 1000 ppm	4) T ₄ -GA ₃ @ 100 ppm	2) P ₂ -No pinching
5) T ₅ -GA ₃ @ 200 ppm	6) T ₆ -CCC @ 1000 ppm 7) T ₇ -CCC @ 2000 ppm	

Table 3: Effect of plant growth regulators and pinching on plant spread (N-S) of Gaillardia

Treat. combinations	Plant spread (N-S) in cm											
	30 DAT			60 DAT			90 DAT			120 DAT		
	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean
T ₁	17.00	17.33	17.17	35.20	33.20	34.20	65.33	63.03	64.18	71.60	68.60	70.10
T ₂	15.33	15.03	15.18	29.15	28.53	28.84	48.53	46.10	47.32	62.27	61.00	61.63
T ₃	16.93	16.30	16.62	30.10	27.83	28.97	51.80	51.13	51.47	63.17	60.50	61.83
T ₄	16.03	16.50	16.27	35.17	34.10	34.63	61.63	60.00	60.82	67.93	67.07	67.50
T ₅	16.40	15.67	16.03	35.97	35.07	35.52	66.20	63.27	64.73	72.13	69.40	70.77
T ₆	16.57	17.10	16.84	33.57	32.00	32.78	55.30	53.70	54.50	64.83	63.37	64.10
T ₇	16.33	16.20	16.27	35.90	34.53	35.22	56.17	55.57	55.87	64.93	63.63	64.28
Mean	16.37	16.30	16.34	33.58	32.18	32.88	57.85	56.11	56.98	66.70	64.80	65.75
	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result
T	0.50	-	NS	0.61	1.76	SIG	0.43	1.24	SIG	0.42	1.23	SIG
P	0.27	-	NS	0.32	0.94	SIG	0.23	0.66	SIG	0.23	0.66	SIG
TxP	0.70	-	NS	0.86	-	NS	0.61	-	NS	0.60	-	NS

PGRs Treatments:	Pinching Treatments:
1) T ₁ -Control	2) T ₂ -Ethephon @ 500 ppm
3) T ₃ -Ethephon @ 1000 ppm	4) T ₄ -GA ₃ @ 100 ppm
5) T ₅ -GA ₃ @ 200 ppm	6) T ₆ -CCC @ 1000 ppm 7) T ₇ -CCC @ 2000 ppm

Table 4: Effect of plant growth regulators and pinching on number of primary branches of Gaillardia

Treat. combinations	Number of primary branches											
	30 DAT			60 DAT			90 DAT			120 DAT		
	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean
T ₁	10.93	12.43	11.68	19.83	18.33	19.08	24.30	22.63	23.47	25.47	25.30	25.38
T ₂	11.87	10.95	11.41	21.53	21.30	21.42	24.56	22.73	23.65	27.67	27.20	27.43
T ₃	10.43	10.87	10.65	19.43	18.93	19.18	23.43	21.60	22.52	26.80	26.40	26.60
T ₄	12.67	11.73	12.20	22.17	21.70	21.93	26.16	24.90	25.53	29.33	29.23	29.28
T ₅	12.6	12.43	12.52	23.13	22.27	22.70	26.17	24.07	25.12	30.57	30.10	30.33
T ₆	12.5	11.77	12.14	17.63	16.97	17.30	23.23	22.27	22.75	26.63	26.33	26.48
T ₇	12.47	12.23	12.35	19.60	18.67	19.13	23.17	22.73	22.95	26.60	26.33	26.47
Mean	11.92	11.77	11.85	20.48	19.74	20.11	24.43	22.99	23.71	27.58	27.27	27.43
	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result
T	0.28	-	NS	0.28	0.81	SIG	0.35	1.03	SIG	0.30	0.88	SIG
P	0.15	-	NS	0.15	0.43	SIG	0.19	0.53	SIG	0.16	-	NS
TxP	0.39	-	NS	0.40	-	NS	0.50	0.77	SIG	0.43	-	NS

PGRs Treatments:	Pinching Treatments:
1) T ₁ -Control	2) T ₂ -Ethephon @ 500 ppm
3) T ₃ -Ethephon @ 1000 ppm	4) T ₄ -GA ₃ @ 100 ppm
5) T ₅ -GA ₃ @ 200 ppm	6) T ₆ -CCC @ 1000 ppm 7) T ₇ -CCC @ 2000 ppm

Table 5: Effect of plant growth regulators and pinching on number of secondary branches of Gaillardia

Treat. combinations	Number of secondary branches											
	30 DAT			60 DAT			90 DAT			120 DAT		
	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean
T ₁	12.87	14.87	13.87	25.13	24.73	24.93	34.27	34.20	34.23	38.00	37.53	37.77
T ₂	15.37	15.07	15.22	25.30	24.27	24.78	37.37	36.50	36.93	39.27	38.80	39.03
T ₃	13.67	13.47	13.57	25.30	24.07	24.68	34.53	34.10	34.32	38.67	38.20	38.43
T ₄	14.07	14.67	14.37	27.20	25.97	26.58	38.70	36.50	37.60	43.17	42.00	42.58
T ₅	15.27	15.17	15.22	29.10	25.67	27.38	40.60	38.83	39.72	45.60	43.27	44.43
T ₆	12.67	14.10	13.39	23.30	22.83	23.07	34.00	32.80	33.40	38.70	38.07	38.38
T ₇	14.93	14.21	14.57	24.37	23.80	24.08	34.43	33.50	33.97	38.90	37.93	38.42
Mean	14.12	14.51	14.31	25.67	24.48	25.07	36.27	35.20	35.74	40.33	39.40	39.86
	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result
T	0.41	-	NS	0.41	1.20	SIG	0.36	1.05	SIG	0.21	0.61	SIG
P	0.22	-	NS	0.22	0.64	SIG	0.19	0.56	SIG	0.11	0.32	SIG
TxP	0.58	-	NS	0.58	-	NS	0.51	-	NS	0.30	0.86	SIG

PGRs Treatments:	Pinching Treatments:
1) T ₁ -Control	2) T ₂ -Ethephon @ 500 ppm
3) T ₃ -Ethephon @ 1000 ppm	4) T ₄ -GA ₃ @ 100 ppm
5) T ₅ -GA ₃ @ 200 ppm	6) T ₆ -CCC @ 1000 ppm 7) T ₇ -CCC @ 2000 ppm

Table 6: Effect of plant growth regulators and pinching on Leaf area (cm²) of Gaillardia

Treat. combinations	Leaf area (cm ²)											
	30 DAT			60 DAT			90 DAT			120 DAT		
	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean	P ₁	P ₂	Mean
T ₁	2.50	2.13	2.32	8.27	6.90	7.58	24.00	21.90	22.95	23.40	21.00	22.20
T ₂	2.17	2.23	2.20	9.23	8.70	8.97	25.50	24.23	24.87	24.67	22.67	23.67
T ₃	2.50	2.37	2.43	8.93	8.03	8.48	23.30	22.37	22.83	22.53	22.17	22.35
T ₄	2.30	2.27	2.28	14.73	14.40	14.57	30.93	30.60	30.77	29.77	29.17	29.47
T ₅	2.60	2.50	2.55	15.30	14.10	14.70	30.40	29.40	29.90	29.33	28.47	28.90
T ₆	2.40	2.03	2.22	10.90	10.40	10.65	28.23	26.40	27.32	27.67	26.10	26.88
T ₇	2.70	2.47	2.58	10.90	10.27	10.58	26.07	25.27	25.67	25.43	24.13	24.78
Mean	2.45	2.29	2.37	11.18	10.40	10.79	26.92	25.74	26.33	26.11	24.81	25.46
	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result	S.Em±	C.D at 5%	Result
T	0.14	-	NS	0.22	0.63	SIG	0.32	0.93	SIG	0.37	1.06	SIG
P	0.08	-	NS	0.12	0.34	SIG	0.17	0.50	SIG	0.20	0.57	SIG
TxP	0.20	-	NS	0.31	-	NS	0.45	-	NS	0.52	-	NS

PGRs Treatments:		Pinching Treatments:	
1) T ₁ -Control	2) T ₂ -Ethephon @ 500 ppm	1) P ₁ -Pinching @ 30 DAT	
3) T ₃ -Ethephon @ 1000 ppm	4) T ₄ -GA ₃ @ 100 ppm	2) P ₂ -No pinching	
5) T ₅ -GA ₃ @ 200 ppm	6) T ₆ -CCC @ 1000 ppm 7) T ₇ -CCC @ 2000 ppm		

Table 7: Effect of plant growth regulators and pinching on Internodal length of Gaillardia

Treatment combinations	Internodal length (cm)		
	P ₁	P ₂	Mean
T ₁	3.63	3.59	3.61
T ₂	4.52	3.84	4.18
T ₃	2.70	2.47	2.58
T ₄	6.75	6.11	6.43
T ₅	7.50	7.02	7.26
T ₆	4.90	4.22	4.56
T ₇	2.86	2.13	2.50
Mean	4.69	4.20	4.45
	S.Em ±	C.D at 5%	Result
T	0.09	0.26	SIG
P	0.05	0.14	SIG
TxP	0.13	-	NS

PGRs Treatments		Pinching Treatments:	
1) T ₁ -Control	2) T ₂ -Ethephon @ 500 ppm	1) P ₁ -Pinching @ 30 DAT	
3) T ₃ -Ethephon @ 1000 ppm	4) T ₄ -GA ₃ @ 100 ppm	2) P ₂ -No pinching	
5) T ₅ -GA ₃ @ 200 ppm	6) T ₆ -CCC @ 1000 ppm		
7) T ₇ -CCC @ 2000 ppm			

Conclusion

The present investigation revealed that, plant growth regulators and pinching had significant effect on vegetative characters of gaillardia (*Gaillardia pulchella* L.). In PGR treatment GA₃ @ 200 ppm spray was found best with respect to vegetative attributes. In pinching treatment (Pinching at 30 DAT) found best with respect to maximum plant spread, higher number of primary and secondary branches, maximum leaf area, maximum internodal length.

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