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Ravindranath Reddy P
BT College, Madanapalle, Andhra Pradesh, India

Corresponding Author:
Ravindranath Reddy P
BT College, Madanapalle, Andhra Pradesh, India

Studies on the effect of plant hormones on flowering behavior of Gaillardia (*Gaillardia pulchella* L.)

Ravindranath Reddy P

Abstract
Blanket flower (*Gaillardia* spp. Foug.), also known as fire-wheel or Indian blanket, is a native plant that has found its way into the realm of cultivation and extensive production. It's gorgeously coloured flowers are best arranged in copper bowls or simple plain-coloured vases. The successful commercial cultivation of the crop depends on several factors like, genetic, environment and management factors. In recent years, scientists have given due attention to the idea of regulating plant growth, yield and quality with the application of plant growth regulators in various ways. The experiment was conducted at Horticulture farm of B.T. College, Madanapalle, Andhra Pradesh during 2016 The experiment was laid out in Randomized Block Design (RBD) with three replications with two plant growth promoting hormones *viz*; NAA @ 50, 75 and 100 ppm and GA3 @ 50, 75 and 100 ppm, and two plant growth retardants *viz*., CCC @ 500, 1000 and 1500 ppm abd PBZ @150, 200 and 250 ppm with a Control. The Spraying with different growth regulators was done thrice i.e. 30, 45 and 60 days after transplanting. The observations on flowering attributes and yield were recorded on randomly selected five plants. From the present findings, it is concluded that the gibberellic acid treatments were having profound effect of all the growth and flowering characters of gaillardia. The treatment T6 i.e. GA3 200 ppm spray was found best with respect to minimum days required for flower initiation, number of flowers per plant, flower yield per plant.

Keywords: *Gaillardia*, plant hormones, GA3, NAA, CCC, PBZ, flowering

Introduction
Gaillardia is one of the most popular annual flowers in India because of its easy cultivation, wide adaptability to varying soils and climatic conditions with long duration of flowering and attractive flower colour. It's gorgeously coloured flowers are best arranged in copper bowls or simple plain-coloured vases. The successful commercial cultivation of the crop depends on several factors like, genetic, environment and management factors. In recent years, scientists have given due attention to the idea of regulating plant growth, yield and quality with the application of plant growth regulators in various ways. Plant growth regulators (PGRs) are used for controlling many aspects of plant growth and development, including height, flower initiation, and fruit set. Several PGRs interrupt physiological pathways of hormones and enzymes, which disrupts normal growth (Danielson, 2005) [2], which ultimately affect the plant growth, yield and quality of flowers and yield.

Materials and Methods
The experiment was conducted at Horticulture farm of B.T. College, Madanapalle, Andhra Pradesh during 2016 The experiment was laid out in Randomized Block Design (RBD) with three replications with two plant growth promoting hormones *viz*; NAA @ 50,75 and 100 ppm and GA3 @ 50, 75 and 100 ppm, and two plant growth retardants *viz*., CCC@ 500, 1000 and 1500 ppm abd PBZ @150, 200 and 250 ppm with a Control. The flat beds of 3 X 1.5 m were prepared and 30 days old seedlings of gaillardia were transplanted at spacing of 45 X 45 cm. The recommended cultural practices (Manuring, irrigation, weeding and plant protection, etc.) were followed uniformly to experimental plots. The Spraying with different growth regulators was done thrice i.e. 30, 45 and 60 days after transplanting. The observations on flowering attributes and yield were recorded on randomly selected five plants. Statistical analysis of the data was carried out by standard method of analysis of variance as given by Panse and Sukhatme (1995) [6].

Results and Discussion
Significant differences were noticed due to the application of both promoters and retardants.

The data on days required for initiation of flowering after transplanting was presented in Table 1 The data revealed that the significantly early initiation of flowering (61.73 DAT) was observed in treatment T6 (GA3 @ 200 ppm).

Earliest bud initiation and flowering was observed with the application of GA3 might be due to gibberellins which reduces juvenile period and with the termination of juvenile phase, the shoot apical meristem instead of producing leaves and branches start producing buds. The earliness in flowering of gaillardia by GA3 treatments might be due to increased photosynthetic area and respiration which enhanced CO_2 fixation in plants that are associated with early flowering. These results are in close accordance with the Poshiya *et al.* (1995) [8, 9], Patel (1998) [7], Makwana (1999) [5] and Ghadage *et al.* (2013) [4] in gaillardia.

The data presented in Table 1 revealed that the application of plant growth regulators did not show the significant effect on number of pickings. It was in the range of 8.14 TO 11.22 pickings. Higher number of pickings in control treatment is due to more influence of natural parameters on the untreated plants. The data on flowering duration as influenced by the PGR treatments showed significant differences. The longest flowering duration (132.09 days) was observed in the treatment T6 (GA3 @ 200 ppm) which was statistically superior to the treatment T5 (GA3 @ 150 ppm) having period of flowering duration (127.45 days). The shortest flowering duration (115.82 days) was observed in the treatment T9 (CCC @ 1500 ppm). Gibberellic acid spray recorded a significant longest flowering duration. Advanced bud formation and onset of flowering in GA3 treated plants was attributed to enhanced flowering duration (Dutta *et al.*, 1993) [3]. Prolonged flowering duration owing to GA3 was also documented by Dahiya and Rana (2001) [1] in chrysanthemum. Gibberellic acid had an additive effect on flowering duration due to their early induction of flowering. The lowest flowering duration in CCC and PBZ is mainly due to delayed initiation of flowering and inhibition of GA biosynthesis. The data on number of flowers also showed significant differences among the treatments. Maximum number of flowers (35.43) were recorded under the treatment T6 (GA3 @ 200 ppm) which is followed by T_5 GA3 @ 150 ppm with 33.98 flowers. However the lowest number of flowers were\recorded under the treatment T12 (PBZ @ 250 ppm) with 23.08 flowers.

The data on flower yield per plant is presented in Table revealed that flower yield per plant in different PGR treatments showed significant variation. Highest flower yield per plant (223.98 gm) was recorded in the treatment T6 GA3 @ 200 ppm. The lowest flower yield per plant (139.24 gm) was observed in the treatment T12 (PBZ @ 250 ppm). The most impressive yield of flowers per plant, plot and hectare was recorded with treatment GA3 at 200 ppm. The influence of raising the flower yield was due to increase number of branches which led to increase in the number of flowers. After successful vegetative phase only, the plant could step into reproductive phase with better yield. Similar results were found by Poshiya *et al.* (1995) [8, 9], Ramdevputra *et al.* (2009) [10] and Ramesh Kumar *et al.* (2010) [11]

From the present findings, it is concluded that the gibberellic acid treatments were having profound effect of all the growth and flowering characters of gaillardia. The treatment T6 i.e. GA3 200 ppm spray was found best with respect to minimum days required for flower initiation, number of flowers per plant, flower yield per plant.

Table 1: Effect of plant growth regulators on flowering behavior of *Gaillardia*

Treatments	Earliness in flowering	Number of pickings	Flowering duration (Days)	Number of flowers	Yield per plant (g)
T1 NAA @ 50 ppm	68.01	9.16	124.27	30.65	214.01
T2 NAA @ 100 ppm	67.82	9.91	125.45	30.44	214.24
T3 NAA @ 150 ppm	63.87	9.93	126.88	31.05	215.63
T4 GA3 @ 100 ppm	67.88	9.42	124.11	30.76	214.33
T5 GA3 @ 150 ppm	62.88	10.01	127.45	33.98	217.98
T6 GA3 @ 200 ppm	61.73	11.22	132.09	35.43	223.98
T7 CCC @ 500 ppm	74.01	10.22	122.98	25.98	196,26
T8 CCC @ 1000 ppm	72.88	9.04	121.08	25.98	203.87
T9 CCC @ 1500 ppm	71.25	9.22	115.82	26.87	206.55
T10 PBZ @ 150 ppm	74.04	9.25	122.09	25.24	208.88
T11 PBZ @ 200 ppm	73.77	9.45	121.01	24.87	203.33
T12 PBZ @ 250 ppm	71.98	9.66	117.98	23.08	202.22
T13 Control	69.02	8.14	123.98	28.98	188.24
SEd	0.93	NS	0.96	0.62	1.30
Cd (p = 0.05)	1.88	NS	1.94	1.26	2.63

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