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Influence of plant growth regulators on yield, vase life and economics in gaillardia (*Gaillardia pulchella*)

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Abstract
The experiment was carried out at College of Horticulture, Dapoli, Dist. Ratnagiri during *Rabi* season of the year 2019-20 to assess the influence of plant growth regulators on yield, subsequent economics and vase life in Gaillardia cv. Local double'. The experiment was laid out in Randomized Block Design (RBD) with three replications with nine treatments of plant growth regulator *viz*; T_1- NAA @ 100 ppm, T_2- NAA @ 200 ppm, T_3- GA_3 @ 100 ppm, T_4- GA_3 @ 200 ppm, T_5- CCC @ 1500 ppm, T_6- CCC @ 3000 ppm, T_7- PBZ @ 250 ppm, T_8- PBZ @ 500 ppm and T_9- Control. The highest yield of flowers (5.14 kg per plot and 10.57 t per ha) and highest benefit-cost ratio (2.34) was recorded in the application of GA_3 100 ppm (T_3) treatment. The significantly maximum vase life was observed in the treatment T_5 (CCC @ 1500 ppm) (7.33 days) and which was at par with the treatment T_6 (CCC @ 3000 ppm) i.e 7.00 days and T_7 (PBZ @ 250 ppm) i.e. 6.33 days.

Keywords: Gaillardia, GA_3, yield, vase life, economics

Introduction
Gaillardia is popularly known as "Blanket Flower'' and common name may refer to the resemblance of inflorescence to the brightly patterned blankets made by Native Americans, or to the ability of wild texa blanket the ground with colonies. It belongs to Asteraceae family and native of South-Western United State and Mexico. There are about 12 species, out of which *Gaillardia pulchella* Fouge, and *Gaillardia cristata* are of horticultural importance (Bose and Yadav,1989) [1].

Flowering is a complex process that occurs in response to environmental factors as photoperiod and prevailing climatic conditions. 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.

The area under gaillardia as a commercial flower is increasing because of the possibility of year round cultivation. Hence, developing the package of practices for commercial cultivation of gaillardia will promote the area expansion of flower crops in konkan region. Therefore, an attempt has been made to study the response of *Gaiilardia pulchella* cv. 'Local Double' to the application of some growth substances or plant growth regulators.

Material and Methods
An experiment was carried at College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during *Rabi* season of the year 2019-20. The experiment was designed in Randomized Block Design consisting of three replication with nine plant growth regulator treatments *viz*; T1- NAA @ 100 ppm, T2- NAA @ 200 ppm, T3- GA3 @ 100 ppm, T4- GA3 @ 200 ppm, T5- CCC @ 1500 ppm, T6- CCC @ 3000 ppm, T7- PBZ @ 250 ppm, T8- PBZ @ 500 ppm and T9- Control. The preparatory tillage was done and flat beds of 2.7m X 1.8 m were prepared and one month old seedlings of gaillardia were transplanted at spacing of 45 X 45 cm. The recommended interculture operations 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 yield were recorded on randomly selected five plants. The vase life of the flowers in different treatments was also studied. Statistical analysis of the data was carried out by standard method of analysis of variance as given by Panse and Sukhatme (1985) [5]. The economics was estimated based on the cost of cultivation and returns.

Results and Discussion

The data on flower yield per plant is presented in Table 1 and illustrated in Fig.1. From the data, it is cleared that flower yield per plant in different PGR treatments showed significant variation.

The data indicated that the higher flower yield per plot (5.14 kg) was recorded in the treatment T_3 (GA_3 @ 100 ppm). It was at par with the treatment T_1 (NAA @ 100 ppm) 4.82 kg. The lower flower yield (3.34 kg) was recorded in the treatment T_2 (NAA @ 200 ppm). The yield data is converted on hectare basis (Table 1) revealed the similar trend as the yield per plot. Higher flower yield per ha (10.57 t) was recorded in the treatment T_3 (GA_3 @ 100 ppm) which was at par with the treatment T_1 (NAA @ 100 ppm) 9.91 t per ha. The lowest flower yield 6.88 t per ha was obtained from the treatment T_2 (NAA @ 200 ppm).

The most impressive yield of flowers per plant, plot and hectare was recorded with treatment GA_3 at 100 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 Gupta and Datta (2001) [3], Ramdevputra *et al.* (2009) [6], Ramesh *et al.* (2010) [7].

The lesser flower yield in plant growth retardant treatments is mainly due to late initiation of flowering. This has shortened the flowering duration of those treatments and ultimately the yield has reduced.

The data pertaining to the effect of plant growth regulators on vase life in gaillardia flowers are presented in the Table 1. The result revealed that the significantly maximum vase life was observed in the treatment T_5 (CCC @ 1500 ppm) (7.33 days) and which was at par with the treatment T_6 (CCC @ 3000 ppm) i.e 7.00 days and T_7 (PBZ @ 250 ppm) i.e. 6.33 days. However, the lowest vase life was recorded in the treatment T_3 (GA_3 @ 100 ppm) i.e. 3.67 days.

The result clearly revealed that that there was maximum vase life found in the flowers which were treated by the treatment CCC. Increased vase life might be due to reduced physiological weight loss and lesser water uptake by flowers. Restricted respiration due to inhibitory action of retardant might have increased the vase life. Similar findings were also obtained by Saiyad (2009) [8], Moon *et al.* (2017) [4].

The economics has been worked out for each treatment and presented in Table 2. The expenditure i.e. cost of production ranged from Rs. 174027.90/ ha in T_9 (Control) to Rs. 21232.90/ha in T_8 (PBZ @ 500 ppm). The maximum gross return (Rs. 634200/ha) was obtained in treatment T_3 (GA_3 100 ppm). It was followed by the treatment T_1 (NAA @ 100 ppm) (Rs. 594600/ha).

The lower cost of production in control treatment is mainly due to less expenditure on the plant growth regulators and labours required for spraying PGR. Whereas, the higher cost of production in PBZ treatments is mainly due to more price of paclobutrazol as compare to other plant growth regulators.

The highest benefit-cost ratio (2.34) was obtained in T_3 GA_3 100 ppm followed by T_1 (NAA @ 100 ppm) 2.16, T_9 (Control) 1.95, T_4 (GA_3 @ 200 ppm) 1.85, T_7 (PBZ @ 250 ppm) 1.67, T_6 (CCC 1500 ppm) 1.57, T_8 (PBZ @ 500 ppm) 1.24, T_2 (NAA @ 100 ppm) 1.19. The lowest benefit-cost ratio (1.16) was obtained in T_5 (CCC 1500 ppm). The production cost of GA_3 treatment is comparatively less than the CCC and PBZ treatments, that reflects with higher B:C ratio.

From the present investigation it is inferred that the application of GA_3 100 ppm was found best for economic flower production of gaillardia under Konkan agro-climatic conditions.

Table 1: Effect on plant growth regulators on flower yield and vase life in Gaillardia

Treatments		Yield per plot (kg) (Net Plot Size: 2.7 x 1.8 m)	Yield per ha (t)	Vase life (days)
T_1	NAA 100 ppm	4.82	6.00	9.91
T_2	NAA 200 ppm	3.34	5.33	6.88
T_3	GA_3 100 ppm	5.14	3.67	10.57
T_4	GA_3 200 ppm	4.40	4.33	9.06
T_5	CCC 1500 ppm	3.43	7.33	7.06
T_6	CCC 3000 ppm	4.27	7.00	8.79
T_7	PBZ 250 ppm	4.49	6.33	9.24
T_8	PBZ 500 ppm	4.15	5.67	8.54
T_9	Control	4.48	5.33	9.22
Range		3.34-5.14	6.88-10.57	3.67-7.33
Mean		4.28	8.81	5.67
S. Em. ±		0.18	0.37	0.40
C. D. at 5%		0.53	1.09	1.21

Table 2: Effect on plant growth regulators on production economics (B:C ratio) in Gaillardia.

Treatments		Yield t/ha	Expenditure Rs/ha	Gross Return Rs./ha	Net profit Rs./ha	B:C ratio
T_1	NAA 100ppm	9.91	174736.14	594600	406520.33	2.16
T_2	NAA 200ppm	6.88	175413.50	412800	223995.56	1.19
T_3	GA_3 100ppm	10.57	176505.90	634200	444226.69	2.34
T_4	GA_3 200ppm	9.06	177001.90	543600	353095.97	1.85
T_5	CCC 1500ppm	7.06	182312.90	423600	227413.20	1.16
T_6	CCC 3000ppm	8.79	190599.00	527400	322347.07	1.57
T_7	PBZ 250ppm	9.24	193111.90	554400	346658.27	1.67
T_8	PBZ 500ppm	8.54	212372.90	512400	284049.00	1.24
T_9	Control	9.22	174027.90	553200	365878.15	1.95

Selling rate of flowers: Rs. 60/kg

Cost of PGR: 1. GA_3: Rs. 183 /gm. 2. NAA: Rs.1300/lit 3. CCC: Rs. 1166/lit 4. PBZ: Rs.7460/lit

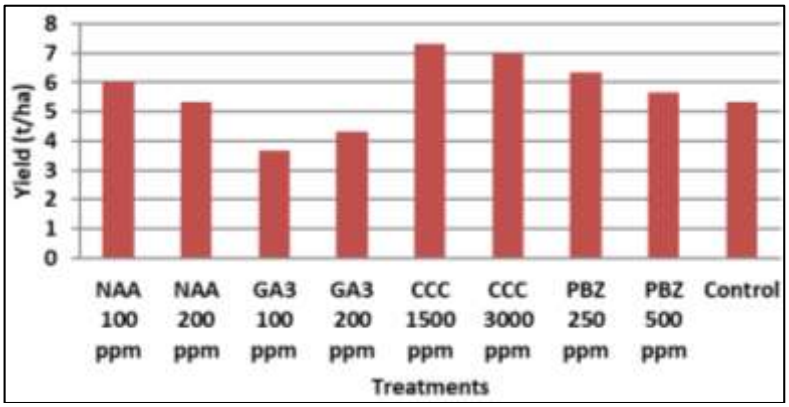

Fig 1: Effect on plant growth regulators on flower yield in Gaillardia

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