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Effect of Plant Growth Regulators on Growth, Flowering, Yield and Vaselife of Chrysanthemum (*Dendranthema grandiflora*) under Prayagraj Agro Climatic Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation entitled "Effect of plant growth regulators on growth, flowering, yield and vaselife of chrysanthemum under Prayagraj agro climatic conditions", was carried out during August to December, 2022, in Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment was conducted in Randomized Block Design with ten treatment combinations, with application of three plant growth regulators Brassenosteroid(BA), Triacontanol(TRIA) and Gibberellic acid(GA3) each of 50ppm, 100ppm and 150ppm, which was replicated thrice. It was concluded that the plant growth regulators rendered their significant effect on almost all the growth, flowering and yield characters of

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chrysanthemum. The treatment, T9- GA3@150ppm was found superior in terms of plant height (72.47cm), plant spread(35.33cm), number of branches(11.67), leaf length(9.03cm), days taken for first flower bud initiation(66.30 days), days taken for 50% flowering(113.43 days), number of flowers per plant (48.53), flower diameter(10.20cm), stalk length(13.58cm), duration of flowering days(66 days), flower yield per plant(206.67g), flower yield per hectare(229.63q), vase life of flower(16.33 days). Among the different treatments the highest Gross return is 918,520Rs/ha, Net return is 620,343.35Rs/ha, benefit cost ratio is 3.08 was obtained from the treatment, that is T9-GA3@150ppm.

Keywords: Brassenosteroid; triacontanol; gibberellic acid; plant growth regulators; economics.

1. INTRODUCTION

The chrysanthemum (*Dendranthema grandiflora*), a member of asteraceae family and ranks second in popularity, next to rose. It is commercially cultivated in India for cut and loose flower, also for making garlands and wreaths which are used in marriages, religious offerings and death rituals [1]. The name ‘chrysanthemum’ is derived from Greek words, “chryos” means ‘garden’ and “anthos” means ‘flower’ by Linnaeus in 1753 and is native to Northern hemisphere mainly Europe and Asia [2]. Chrysanthemum is commonly known as “Queen of East and Glory of East”, comprises of about 200 species with diploid chromosome number of 2n=18. The chrysanthemum species have fibrous root system, herbaceous perennial plant growing to 50-150cm tall, with deeply lobed leaves and large flower heads, white, yellow or pink. People use the flowers to make medicine for curing chest pain, high blood pressure and other conditions.

Netherland, Mexico, Italy, Spain and Korea are the largest producers of cut chrysanthemum. In India, the largest chrysanthemum producing states are Andhra Pradesh, Karnataka, Tamil Nadu, West Bengal and Gujarat. It is cultivated in almost all the states with an estimated area of about 16,630 hectares with a total production of 17,937MT as loose flowers and 5,720MT as cut flowers [3]. It is a typical short day plant and is planted during July and August months under North Indian conditions; so that initial long day and subsequent short day condition facilitate proper vegetative growth of the plants. Delayed planting leads to poor flower quality with short stem length and vase life [4].

Plant growth regulators are the compounds that in minor amount modify the physiological processes of plants and ultimately alter the yield and quality of plants. There are various methods of application of plant growth regulators like foliar application, drenching, pre-plant sowing, seed priming, capillary string and injection method. Numerous plant growth regulators have been widely used in flowering plants and their efficiency have been demonstrated for nursery plants, foliage plants and many other ornamental plants [5]. It is also used to overcome the factors limiting the growth and yield to harness maximum benefits [6].

GA3 influences a wide range of developmental process in plants life like germination, breaking dormancy, stem elongation, flowering, sex expression, enzyme induction and flower senescence [7]. It enhance growth activities of plant, stimulates rate of cell division, cell elongation and contributes to internode and stem elongation. It promotes earliness in flowering due to the fact that GA3 application enhance the translocation of food for development of floral primordia [8].

Triacontanol increases cell division rate, which produces large root and shoot mass, activates secondary messengers leading to enhance enzymatic activities, improve protein synthesis, promotes flowering and earlier crop maturity [1]. Exogenous use of TRIA synchronizes several physiological and biological processes and is known to improve crop yield.

Brassenosteroid plays an important role in plant development by promoting cell elongation and division, including regulation of plant height, vascular differentiation, flower development, root development, biotic and abiotic stress response. It stimulates a variety of physiological process including changes in enzymatic activities, membrane potential, photosynthetic activity, DNA, RNA protein synthesis and the balance of other endogenous phytohormones. It promotes cell division and cell expansion, and plays a role in etiolation and reproduction.

Considering the significance and widespread use of plant growth regulators in the floriculture business, the goal of the experiment was to study the effect of plant growth regulators like brassenosteroid, triacontanol and gibberellic acid on growth, flowering, yield and vaselife of chrysanthemum under Prayagraj agro-climatic conditions.

2. MATERIALS AND METHODS

A field experiment entitled "Effect of plant growth regulators on growth, flowering, yield and vaselife of chrysanthemum under Prayagraj agro climatic conditions", was carried out in Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, during August to December, 2022. The chrysanthemum seedlings of *Penguin* variety were transplanted in the open field with a planting distance of (30x30) cm and had six plants per plot. The experiment was laid out in Randomized block design with ten treatments and three replications. The experiment include foliar application of plant growth regulators, Brassenosteroid (BA), Triacontanol (TRIA) and Gibberellic acid (GA3), which were applied with concentrations of BA@50,100,150ppm; TRIA@50,100,150ppm and GA3@50,100,150ppm at 30,60,90 and 120DAP whereas water was sprayed on control plants. Single pinching done after 30DAP. Three plants were selected randomly from each treatment per replication and their observations were recorded at 30 days interval. Data were statistically analysed by the method suggested by Fisher and Yates, 1963.

3. RESULTS AND DISCUSSION

Data in Table 1 indicates significant differences regarding the growth and floral parameters like plant height(cm), plant spread(cm), number of branches per plant, leaf length(cm), days taken to first flower bud initiation, days taken for 50% flowering and number of flowers per plant treated with different BA, TRIA and GA3 concentrations.

Plants attained maximum height (72.47cm), after 120 days of transplanting in the treatment T9-GA3@150ppm followed by the treatment T8-GA3@100ppm (70.20cm) and the minimum was recorded in T0-control (63.33cm). GA3 induce m RNA synthesis pertaining to hydrolytic enzymes, which promotes mitotic activity in apical meristem and increase cell division and cell elongation, leading to increased length of internodes, in turn increases the plant height [1]. These findings are in conformity with Aparna et al*.* [4] and Kuri et al*.* [9].

A similar trend was observed regarding the plant spread (average of North-South and East- West), where maximum plant spread was observed in the treatment T9-GA3@150ppm (35.33cm) followed by the treatment T8-GA3@100ppm (34.67cm) and the minimum was recorded in T0-control (30cm). The application of plant growth regulators enhance cell division with rapid internode elongation and is confined in the sub-apical meristem, which increases the plant spread [10]. Similar results were documented by Patel et al. [2] and Mishra et al. [8].

Number of branches was recorded with significant variations among different treatments. Maximum number of branches was recorded in the treatment T9-GA3@150ppm (11.67), followed by the treatment T8-GA3@100ppm (10.40) and the minimum was found in T0-control (6.63). GA3 plays a role in shoot growth by more utilization of photosynthesis towards internodal elongation. Stimulation of branching by GA3 due to breakage of apical dominance was observed by Kumar et al. [10]. These findings are in agreement with Kuri et al. [9] and Mishra et al. [8]. Maximum leaf length was recorded in the treatment T9-GA3@150ppm (9.03cm), followed by the treatment T8-GA3@100ppm (8.63cm) and the minimum was found in T0-control (6.63cm). GA3 promotes cell division and cell elongation, thereby increase the leaf length and leaf area, and enhance sugar translocation [10]. Similar findings were reported with Koley et al. [11].

The minimum days taken for first flower bud initiation was observed in the treatment T9-GA3@150ppm (66.30 days), followed by the treatment T8-GA3@100ppm (68.67 days) and the maximum days taken for first flower bud initiation was in T0-control (77.67 days). GA3 application enhance food translocation for the development of floral primordia, which leads to early flowering. This is due to increase photosynthesis and respiration along with enhanced fixation by GA3 that leds to flower bud initiation [8]. These findings are in conformity with Mounika et al. [3]. The minimum days taken for 50% flowering was found in the treatment T9-GA3@150ppm (113.43 days), followed by the treatment T8-GA3@100ppm (114.20 days) and the maximum days taken for 50% flowering was

Table 1. Effect of plant growth regulators on growth and floral parameters of chrysanthemum

Treatments	Plant height (cm)	Plant spread (cm)	Number of branches	Leaf length (cm)	Days taken to first flower bud initiation (days)	Days taken for 50% flowering(days)	Number of flowers per plant
T0-Control	63.33	30.00	6.63	6.63	77.67	120.43	40.73
T1-BA@50ppm	65.60	30.50	7.40	6.70	76.00	119.00	42.7
T2-BA@100ppm	67.27	32.00	9.33	7.53	73.67	117.20	44.93
T3-BA@150ppm	66.93	31.23	9	7.37	75.67	118.67	43.73
T4-TRIA@50ppm	67.30	32.67	9.60	7.60	74.67	116.30	45.87
T5-TRIA@100ppm	68.40	33.67	10	7.87	72.93	115.63	46.97
T6-TRIA@150ppm	69.10	34.10	10.33	8.07	70.43	115	47.30
T7-GA3@50ppm	67.80	32.80	9.73	7.67	72.53	116.10	46.53
T8-GA3@100ppm	70.20	34.67	10.40	8.63	68.67	114.20	47.63
T9-GA3@150ppm	72.47	35.33	11.67	9.03	66.30	113.43	48.53
F-Test	S	S	S	S	S	S	S
S. Ed	1.26	0.95	0.60	0.35	1.31	1.46	1.32
CD@5%	2.67	2.00	1.27	0.74	2.77	3.10	2.80

Table 2. Effect of plant growth regulators on floral parameters of chrysanthemum

Treatments	Flower diameter(cm)	Flower stalk length (cm)	Duration of flowering days(days)	Flower yield per plant(g)	Flower yield per hectare(q)	Vase life (days)
T0-Control	5.60	8.93	55.50	159.33	177.03	9.00
T1-BA@50ppm	6.27	9.63	56.00	164	182.22	10.17
T2-BA@100ppm	7.79	11.20	59.67	170.67	189.62	12.77
T3-BA@150ppm	6.81	10.50	57.57	167.33	185.92	11.20
T4-TRIA@50ppm	7.00	12.34	58.33	177.67	197.40	12.20
T5-TRIA@100ppm	7.95	12.70	60.00	188.33	209.25	13.00
T6-TRIA@150ppm	9.07	13.10	61.97	191	212.22	14.07
T7-GA3@50ppm	8.50	12.39	60.77	184	204.44	13.17
T8-GA3@100ppm	9.73	13.20	62.53	196.33	218.14	15.10
T9-GA3@150ppm	10.20	13.58	66.00	206.67	229.63	16.33
F-Test	S	S	S	S	S	S
S. Ed	0.27	0.75	1.86	10.00	11.11	0.75
CD@5%	0.58	1.60	3.94	21.18	23.53	1.59

Table 3. Effect of plant growth regulators on economics of different treatments of chrysanthemum

Treatments	Gross return(Rs/ha)	Net return(Rs/ha)	Benefit cost ratio
T0-Control	708,120	411,730	2.38
T1-BA@50ppm	728,880	429,270	2.43
T2-BA@100ppm	758,480	455,615	2.50
T3-BA@150ppm	743,680	437,595	2.42
T4-TRIA@50ppm	789,600	492,474	2.65
T5-TRIA@100ppm	837,000	539,130	2.80
T6-TRIA@150ppm	849,080	550,474	2.84
T7-GA3@50ppm	817,760	520,772.78	2.75
T8-GA3@100ppm	872,560	574,976.75	2.93
T9-GA3@150ppm	918,520	620,343.35	3.08

found in T0-control (120.43 days). GA3 application enhance the translocation of food material for the development of floral primordia which leads to early flowering [3]. Similar results were reported by Patel et al. [2] and Mishra et al. [8].

Maximum number of flowers per plant was noted in the treatment T9-GA3@150ppm (48.53), followed by the treatment T8-GA3@100ppm (47.63) and the minimum number of flowers per plant was noted in T0-control (40.73). Due to apical dominance and differentiation of axillary and apical buds developed on primary and secondary branches into floral meristems through diversion of extra energy into branches which leads to produce more number of flowers per plant [3]. These findings are in conformity with Kuri et al. [9] and Kumar et al. [12].

The data regarding floral parameters like flower diameter, flower stalk length, duration of flowering days, flower yield per plant, flower yield per hectare and vase life of flower is shown in the Table 2. Flower diameter was found maximum in the treatment T9-GA3@150ppm (10.20 cm), followed by the treatment T8-GA3@100ppm (9.73 cm) and the minimum is found in the T0-control (5.60 cm). Limited pinching leads to limited production of primary branches on main stem, secondary branches on primary branches and production of lesser number of flower buds leads to the diversion of photo assimilates to the existing flowers in the plants, results in maximum flower diameter [3]. These findings are in line with those of Aparna et al. [4] and Kumar et al. [12] in marigold [13-16].

The maximum flower stalk length was found in the treatment T9-GA3@150ppm (13.58cm), followed by the treatment T8-GA3@100ppm (13.20cm) and the minimum flower stalk length was recorded in T0-control (8.93cm). Foliar application of GA3 promote cell division and cell elongation which results in longer flower stalk length [3]. The maximum duration of flowering days was observed in the treatment T9-GA3@150ppm (66 days), followed by the treatment T8-GA3@100ppm (62.53 days) and the minimum duration of flowering days was observed in T0-control (55.50 days). Enhancement of flowering duration under GA3 treatment, due to early flower induction as a result of replacement part of vernalisation by GA3 [8]. These findings are in strong conformity with Kumar et al. [10].

Flower yield per plant was recorded highest in the treatment T9-GA3@150ppm (206.67g), followed by the treatment T8-GA3@100ppm (196.33g) and the least was recorded in T0-control (159.33g). Plant growth regulators stimulate vegetative growth and induce changes in vegetative morphology and thereby accelerates the flower yield per plant [2]. These reports are in strong conformity with Kuri et al. [9] and Kumar et al. [12]. The flower yield per hectare was observed highest in the treatment T9-GA3@150ppm (229.63q), followed by the treatment T8- GA3@100ppm (218.14q) and the least was observed in T0-control (177.03q). GA3 treatment enhance induction of flower bud break i.e., differentiation of floral primordia in the apical region which leads to increase production of flowers per plant and hence increase the flower yield per hectare [8].

Maximum vase life was recorded in the treatment T9-GA3@150ppm (16.33 days), followed by the treatment T8-GA3@100ppm (15.10 days) and the minimum was recorded in T0-control (9 days). Single pinched plants possess maximum vase life. Due to improvement in lusture and keeping quality of flowers by pinching operation, GA3 maintain high auxin concentration in plant which helps in better development of vascular tissue in flower stalks and maintain continuity of water column and freshness of flowers for long period of time, thus increases vase life [3]. Economics of different treatments is depicted in Table 3, where the treatment T9-GA3@150ppm gained maximum gross return 918,520 Rs/ha, net return 620,343.35Rs/ha and the benefit cost ratio is 3.08 [17-20].

4. CONCLUSION

From the present study, it is concluded that the foliar application of plant growth regulator, i.e., the treatment T9-GA3@150ppm proved to be superior among all other treatments in terms of growth, flowering and yield parameters like plant height, plant spread, number of branches, leaf length, days taken for first flower bud initiation, days taken for 50% flowering, number of flowers per plant, flower diameter, flower stalk length, duration of flowering days, flower yield per plant, flower yield per hectare, vase life, gross return, net return and benefit cost ratio.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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