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Effect of growth regulators on production of tuberose (*Polianthes tuberosa* L.) spikes cv. Prajwal

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Abstract
Tuberose (*Polianthes tuberosa* L.) is one of the important loose and cut flower cultivated commercially due to pleasant fragrance, longer vase-life of spikes, higher not returns and wide adaptability to varied climate and soil. In this view to study the effect of different growth regulators on production of spikes and flowers in tuberose was carried out at Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during 2017 to 2019. The experiment was laid in Randomized Block Design with four replication. It consist of seven treatments *viz.*, G_1- Gibberellic acid 50 ppm, G_2- Gibberellic acid 100 ppm, G_3- Cycocel 4000 ppm, G_4- Cycocel 5000 ppm, G_5- Tricontanol 4 ppm, G_6- Tricontanol 6 ppm and G_7- Control. During the period of investigation, plant height (75.09 cm), number of leaves (24.20), leaf area (72.64 cm^2), LAI (2.42) and dry matter content were maximum in foliar application of GA_3 @ 100 ppm. The earliest commencement of flowering (73.24), days for 50 percent flowering (75.51), duration of flowering (22.74),spike length(106.1 cm),rachis length(47.58 cm), fresh weight of 100 flowers (258.65 g), length of floret(9.02 cm) and diameter of floret(6.00 cm)was observed maximum in CCC @ 5000 ppm. Maximum number of florets per clump (47.88) were recorded maximum in GA_3 @ 100 ppm. Maximum number of spikes per plant (1.98), per plot (39.50), flower yield per plot (2.34 kg) and per hectare (129.92 q) was recorded in CCC @ 5000 ppm. Among the various growth CCC@ 5000 ppm was found effective in improving yield of spikes and even highest B:C ratio (2.10).

Keywords: Tuberose, plant growth regulators

1. Introduction

Flowers have been considered as the symbol of grace and elegance and a feast for our eyes on happy and sad occasions. The Global floriculture market is expected to reach $77.30 billion by 2026 growing at a CAGR of 8.8% during 2018 to 2026 (Anon., 2019) [3]. As far as flower trade is concerned i.e., for cut and loose flowers, these are growing very well in our state because these cut flowers are used for vase decoration and now-a-days there is a craze for indoor decoration. As far as loose flowers are concerned these are mainly used for preparation of Gajara, Veni, garland and bouquets and demand of flowers for these purposes is unending. Taking into consideration the different points i.e. bio-aesthetic planning, floral garden, indoor decoration, social functions and religious functions the demand for floricultural plants is increasing day by day and to meet out the same there is a good scope for growing and raising of ornamental or floricultural plants.

Besides regular package of practices there is a still scope to increase flower production with best quality tuberose spikes and floret quality by using the advance techniques like use of plant growth regulators *viz*., gibberellins, growth retardants etc. The application of gibberellins has brought a sort of revolution for the floriculture industry. Gibberellins are the plant growth regulators that are known to stimulate physiological responses in plants and alter the source-sink metabolism through their effect on photosynthesis and sink formation (Iqbal *et al.* 2011) [11]. Studies have indicated that GA signalling is involved in maintaining source-sink relation, phloem loading with sucrose, long distance transport of sucrose by phloem cells of plant's vascular system and metabolism in sink organs by unloading of sucrose from phloem to sink organs or tissues influencing overall performance or growth of plants. Gibberellic acid treatments are known to play important role in promoting diverse processes throughout the development of plant; induced early flowering, increased height of plant, number of leaves yield and quality in different flowering crops (Kumar *et al.* 2003; Tyagi and Kumar 2006; Janowska and Andrzejak 2010; Emami *et al.* 2011 and Sure *et al.* 2012) [17, 28, 14, 8, 25].

Cycocel which is growth retardant plays an immense role in enhancing the flower stalk production and quality of flowers in tuberose (Ponnuswami and Sowmeya, 2015). Also exogenous application of triacontanol regulates directly or indirectly several physiological and biochemical process. The promotive effect of triacontanol has been reported in crops such as beans, cucumbers, lettuce, sweet corn, tomato, maize and cotton etc. (Ries and Houtz 1983) [21]. Triacontanol stimulates cell division, photosynthesis, reducing sugars, mobilization of photosynthates, amino acids and chlorophyll content etc. (Setia *et al*, 1991) [24].

Agro-climatic conditions and soils of Konkan region are congerial for cultivation of tuberose therefore to promote production. At present limited research work has been carried out on use of growth regulators in tuberose under Konkan-agroclimatic condition. Study on application of growth regulators is necessary.

Therefore the research was undertaken with the objective to study the effect of different growth regulators on production of spikes and flowers of tuberose.

Material and Methods

The experiment was conducted at the Nursery no.4 block of floriculture at Department of Horticulture, College of Agriculture, Dr. Balasaheb Sawant Krishi Vidyapeeth, Dapoli, Dist-Ratnagiri (M.S) during 2017-18 and 2018-19 respectively. The experiment was carried out in Randomized Block design with four replications. The treatment consisted of *viz*., G_1- Gibberellic acid 50 ppm, G_2- Gibberellic acid 100 ppm, G_3- Cycocel 4000 ppm, G_4- Cycocel 5000 ppm, G_5- Tricontanol 4 ppm, G_6- Tricontanol 6 ppm, G_7- Control. Tuberose bulbs of size 2.5-3.0 cm were utilized as planting material in the experimental block. The tuberose bulbs were procured from University of Agricultural Sciences, Dharwad, Karnataka. The statistical analysis of the data was done by standard methods of analysis of variance as given by Panse and Sukhatme (1985) [19].

Results and Discussion

The effect of different plant growth regulators on tuberose cv. Prajwal were studied for three consecutive years 2017-18 a 2018-19 and 2019-20 to check the performance with respect to growth, flowering and yield parameters.

During the present investigation effect of several plant growth regulators *viz.* GA_3 (50 and 100 ppm), cycocel (4000 and 5000 ppm) and tricontanol (4 and 6 ppm) along with the control was studied in tuberose cv. Prajwal to obtain quality spikes and flowers. The maximum plant height was observed in GA_3 @ 100 ppm (75.09 cm) and minimum plant height was observed in CCC @ 5000 ppm (69.21cm), maximum number of leaves was found in GA_3 @ 100 ppm (24.20) and minimum number of leaves were found in CCC @ 5000 ppm (21.20), maximum average leaf area (72.64 cm^2) was registered in GA_3 @ 100 ppm and minimum average leaf area (67.04 cm^2) was registered in CCC @ 5000 ppm, maximum leaf area index (2.42) was observed in GA_3 @ 100 ppm and minimum leaf area index (2.23) was observed in CCC @ 5000 ppm, maximum dry matter content in spike (14.34 g) was observed in GA_3 @ 100 ppm and minimum dry matter content in spike (12.78 g) was observed in CCC @ 5000 ppm and maximum dry matter content of leaves per plant (9.94 g) in GA_3 @ 100 ppm while minimum dry matter content of leaves per plant (8.54 g) in CCC @ 5000 ppm.

Maximum plant height was due to the gibberellins which increased the auxin content of tissues or enhance auxin effectiveness by increasing the effective sites which it might act. These results are in close association with the Amin *et al.* (2017) [1] who observed that higher concentration of GA_3 played significant role in increasing plant height. It gives the clear picture that foliar application of gibberellins and triacontanol stimulates photosynthesis, translocation of photosynthates and chlorophyll content of the plants which might have resulted in the increased leaf production per plant. Amin *et al*. (2018) who observed that treatment GA_3 promoted increase in the number of leaves per plant, Samant (2000) [23] reported that the sprays of triacontanol significantly influenced the number of leaves per plant in gaillardia as well as similar results were reported in tuberose with foliar spray by TRIA 6 ppm by Fernandes (2003) [9]. Maximum leaf area reported by Padaganur *et al.* (2004) [18] who reported that application of GA_3 has shown the significant effect in tuberose (cv. Single) application of GA_3 150 ppm has shown increase in leaf area (2009.06 cm^2) of tuberose while minimum leaf area (706.73 cm^2) was observed with application of paclobutrazol 1500 ppm. Gibberellins helped for active photosynthesis and resulted in development of maximum leaf area. Sable *et al.* (2015) [22] observed the effect of plant growth regulators on gladiolus. Suseela *et al.* (2018) [26] reported that maximum leaf area (5.10 cm^2) in foliar application of GA_3 250 ppm in tuberose while minimum leaf area (1.89 cm^2) was recorded in foliar application of PBZ 100 ppm. Dry matter production of tuberose with foliar application of growth regulators indicated that giberellic acid and tricontanol has played vital role in increasing the vigour due to which maximum dry matter was obtained where as foliar application of CCC has retarded the vigour of plant due to which minimum dry matter was recorded. Similar results were reported by Fernandes (2003) [9] who studied the various treatments tried, both at high and low concentration, GA at 20 ppm recorded the maximum dry weight of the leaves per plant (21.47 g) and was significantly superior over rest of the treatments.

The minimum days required for commencement of flowering (73.24) was observed in CCC @ 5000 ppm and maximum days required for commencement of flowering (82.71) was observed in control, minimum days required for 50 percent flowering (75.51) in CCC @ 5000 ppm and maximum days required for 50 percent flowering (90.06) in control, duration of flowering was observed maximum (22.74) in CCC @ 5000 ppm and minimum (17.74) in control, maximum highest spike length (106.1 cm) was registered in CCC @ 5000 ppm and minimum highest spike length (100.3 cm) was registered in control, highest rachis length (47.58 cm) was obtained maximum in CCC @ 4000 ppm and minimum rachis length (36.84 cm) was obtained in control, maximum fresh weight of 100 flowers (258.65 g) was recorded in CCC @ 5000 ppm and minimum fresh weight of 100 flowers (215.85 g) was recorded in control, length of floret was recorded maximum (9.02 cm) in CCC @ 5000 ppm and minimum length of floret (7.42 cm) was recorded in control, maximum diameter (6.00 cm) was recorded in CCC @ 5000 ppm and minimum diameter (5.38 cm) was recorded in control, Maximum number of florets per clump (47.88) were recorded in GA_3 @ 100 ppm and minimum number of florets per clump (39.92) were recorded in control.

Similarly Bhattacharjee and Mukherjee (1979) [6] who noticed significantly early flowering by CCC treatment (1000, 2500 and 5000 ppm) to tuberose bulb also Gowda *et al*. (1991) [10]

reported early flowering (128 days) with CCC (2000 ppm) over control (148 days) in Dahlia cv. Local. Joshi (1999) who reported that triacontanol had a promotory effect on the days required for 50 per cent flowering in gladiolus cv. Tradehorn. This result supports the results reported by Bhattacharjee and Mukherjee (1979) [6] that longevity of spike in the field increased with CCC treatment in tuberose. Jana and Biswas (1979) [13] who have reported that CCC (500, 1000 ppm) significantly increased the spike length in tuberose. Also Jacob *et al*. (1991) [12] observed increased length of spike in plants treated with CCC (1000, 1500 and 2000 ppm) over untreated plants in tuberose. Rangwala (1987) [20] who noticed significant increase in the length of rachis with CCC (1500 ppm) over control in tuberose during two years trial under Dharwad condition. Similarly, Jacob *et al.* (1991) [12] observed significant increase in length of rachis (18.90 cm) with CCC (1500 ppm) in tuberose. Rangwala (1987) [20] who recorded maximum fresh weight of flowers with CCC (1000 ppm) over control in tuberose during two years of investigation under Dharwad condition. Karuppaia (2019) [15] who reported in crossandra that maximum length of individual flower (5.2 cm) by Maleic hydrazide (MH) 500 ppm + ferrous sulphate 0.5% foliar spray on 3rd, 6th and 9th MAP. Also the second best treatment was GA_3 100 ppm where Padaganur *et al.* (2004) [18] observed that application of GA_3 150 ppm has shown significantly maximum length of florets (5.69 cm). These results are in contrast with Bose *et al.* (1980) [7] who did not observe any significant increase in the length and diameter of flowers with CCC (10, 100 and 1000 ppm) in *Hippeastrum hybridum* Hort. Also Rangwala (1987) [20] reported maximum diameter of flower with CCC during second year under Dharwad condition.

Maximum number of spike per plant was registered (1.98) in CCC @ 5000 ppm and minimum number of spike per plant was registered (1.66) in control, Maximum number of spikes per plot (39.50) were registered in CCC @ 5000 ppm and minimum number of spikes per plot (32.63) were registered in control, maximum flower yield per plot (2.34 kg) was observed in CCC @ 5000 ppm and minimum flower yield per plot (1.28 kg) was observed in control, maximum flower yield per hectare (129.92 q) was observed in CCC @ 5000 ppm and minimum flower yield per hectare (71.20 q) was observed in control. Effect of growth regulators in tuberose shows that CCC@ 5000 ppm was superior in yield of spikes and flowers yield and maximum net returns (Rs.4,37,500/-) and recorded highest B:C ratio (2.10).

This indicates that CCC and GA_3 plays an important role in production of maximum spikes as compared to TRIA. Also the studies which are conducted in bulbous flowering plant regarding foliar application of GA_3 which helps in translocation of nutrients from source to sink. Also CCC helps in stem elongation and retards the vegetative growth of the plant which enables for early commencement of flowering. These results are in accordance with Bayaskar *et al.* (2018) [5] who reported the effect of cycocel in chrysanthemum. Also Jana and Biswas (1979) [13] found maximum number of flowers per spike in treatment with CCC (2000 ppm) and similar was observed by Rangwala (1987) [20]. The number of flowers per plot may be due to the effect of CCC and GA_3 might have stimulated the source sink relationship i.e, fast translocation of nutrients from soil to the reproductive development which resulted in maximum number of flowers. These results are in close association with the results reported by Jana and Biswas (1979) [13], Rangwala (1987) [20] and Padaganur *et al.* (2004) [18] who reported that application of GA_3 150 ppm has given maximum loose flower yield per plot 3.2 sq.m and per hectare (3.66 kg & 6.35 tonnes) while minimum yield of loose flowers per plot 3.2sq.m and per hectare (1.79 kg & 2.97 tonnes) was observed in control.

Table 1: Effect of plant growth regulators on vegetative parameters in tuberose cv. Prajwal

Treatments	Plant height (cm)	Number of leaves	Average leaf area (cm^2)	Leaf area index	Dry matter of Leaves plant $^{-1}$ (g)	Dry matter of Spike plant $^{-1}$ (g)
	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
GA_3 50 ppm	74.12	23.68	70.98	2.37	9.33	13.77
GA_3 100 ppm	75.09	24.20	72.64	2.42	9.94	14.34
CCC 4000 ppm	71.63	21.24	69.33	2.31	8.59	13.11
CCC 5000 ppm	69.21	21.20	67.04	2.23	8.54	12.78
TRIA 4 ppm	72.94	23.19	70.89	2.36	9.91	13.49
TRIA 6 ppm	73.81	24.14	72.16	2.41	9.71	13.96
Control	72.82	22.56	71.72	2.39	9.09	13.33
S.Em ±	0.62	0.20	0.71	0.02	0.16	0.21
CD at 5%	1.78	0.57	2.11	0.05	0.47	0.60
Cv	1.99	1.99	2.01	2.01	3.76	2.83

Table 2: Effect of plant growth regulators on flowering parameters in tuberose cv. Prajwal

Treatments	Days for commencement of flowering (no.)	Days for 50% flowering (no.)	Flowering Duration (days)	Length of flower spike (cm)	Rachis Length (cm)
	Pooled	Pooled	Pooled	Pooled	Pooled
GA_3 50 ppm	79.24	81.83	19.57	103.0	43.47
GA_3 100 ppm	76.78	82.54	21.00	103.7	44.90
CCC 4000 ppm	74.58	77.95	21.91	103.5	47.58
CCC 5000 ppm	73.24	75.51	22.74	106.1	47.27
TRIA 4 ppm	78.83	81.81	19.23	103.3	45.43
TRIA 6 ppm	78.46	81.50	21.94	104.0	46.06
Control	82.71	90.06	17.74	100.3	36.84
S.Em ±	0.50	0.52	0.58	0.50	0.42
CD at 5%	1.45	1.50	1.69	1.44	1.21
Cv	1.40	1.43	6.26	1.15	2.20

Table 3: Effect of plant growth regulators on flowering parameters in tuberose cv. Prajwal

Treatments	Fresh weight of 100 flowers (g)	Length of flower (cm)	Diameter of flower (cm)	No. of florets per clump
	Pooled	Pooled	Pooled	Pooled
GA_3 50 ppm	225.55	8.07	5.41	44.73
GA_3 100 ppm	231.93	8.63	5.93	47.88
CCC 4000 ppm	249.49	8.82	5.97	45.59
CCC 5000 ppm	258.65	9.02	6.00	47.07
TRIA 4 ppm	243.31	8.19	5.97	44.24
TRIA 6 ppm	247.29	8.26	5.97	46.69
Control	215.85	7.42	5.38	39.92
S.Em ±	2.28	0.133	0.041	0.55
CD at 5%	6.59	0.381	0.11	1.58
Cv	1.61	2.91	1.65	2.70

Table 4: Effect of plant growth regulators on yield parameters in tuberose cv. Prajwal

Treatments	Number of spikes $plant^{-1}$	Number of spikes $plot^{-1}$	Flower yield kg per $plot^{-1}$	Flower yield q ha^{-1}
	Pooled	Pooled	Pooled	Pooled
GA_3 50 ppm	1.88	37.63	1.65	91.91
GA_3 100 ppm	1.95	39.00	1.87	104.13
CCC 4000 ppm	1.92	35.13	1.96	108.77
CCC 5000 ppm	1.98	39.50	2.34	129.92
TRIA 4 ppm	1.89	38.00	1.82	100.84
TRIA 6 ppm	1.91	38.25	2.06	114.41
Control	1.66	32.63	1.28	71.20
S.Em ±	0.04	1.17	0.08	4.87
CD at 5%	0.12	3.36	0.25	13.98
Cv	4.97	7.30	11.01	11.01

Table 5: Economics on effect of growth regulators in tuberose cv. Prajwal

Treatment	Yield of flower (q/ha)	Yield of bulb (q/ha)	Total Input cost (Rs)	Gross return (Rs)	Net Returns (Rs)	B:C ratio
GA3 50 ppm	91.91	387171	387171	682360	295189	1.76
GA3 100 ppm	104.13	389255	389255	731240	341985	1.88
CCC 4000 ppm	108.77	394561	394561	749800	355239	1.90
CCC 5000 ppm	129.92	396900	396900	834400	437500	2.10
TRIA 4 ppm	100.84	387426	387426	718080	330654	1.85
TRIA 6 ppm	114.41	388596	388596	772360	383764	1.99
Control	71.20	385087	385087	599520	214433	1.56

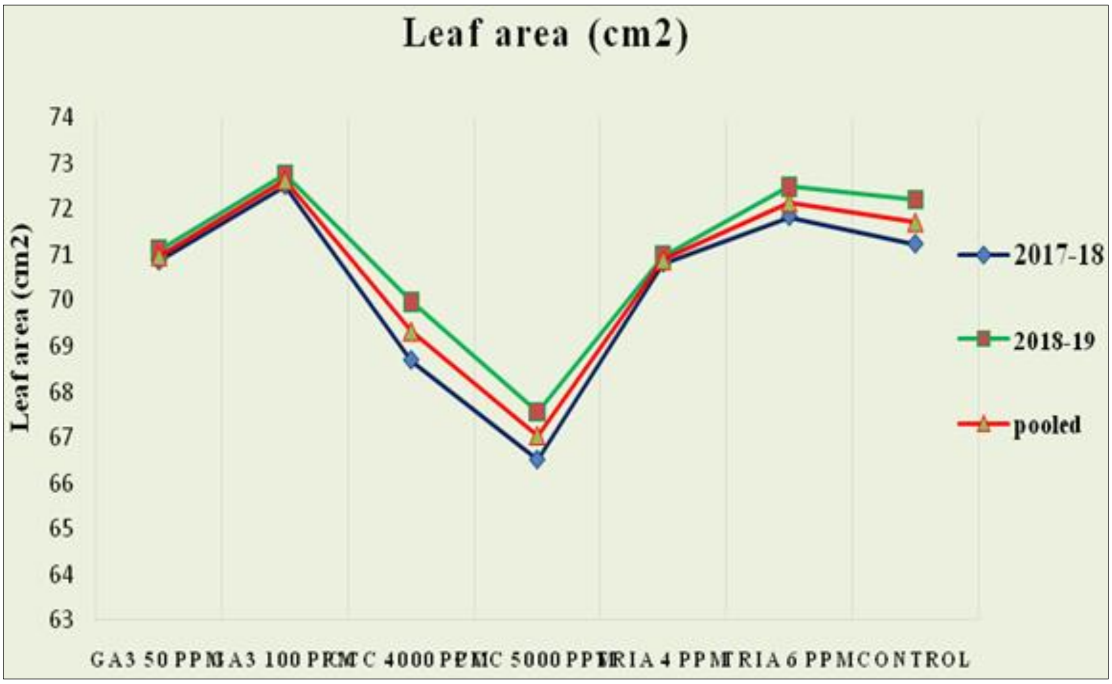

Fig 1: Effect of growth regulators on leaf area in tuberose cv. Prajwal

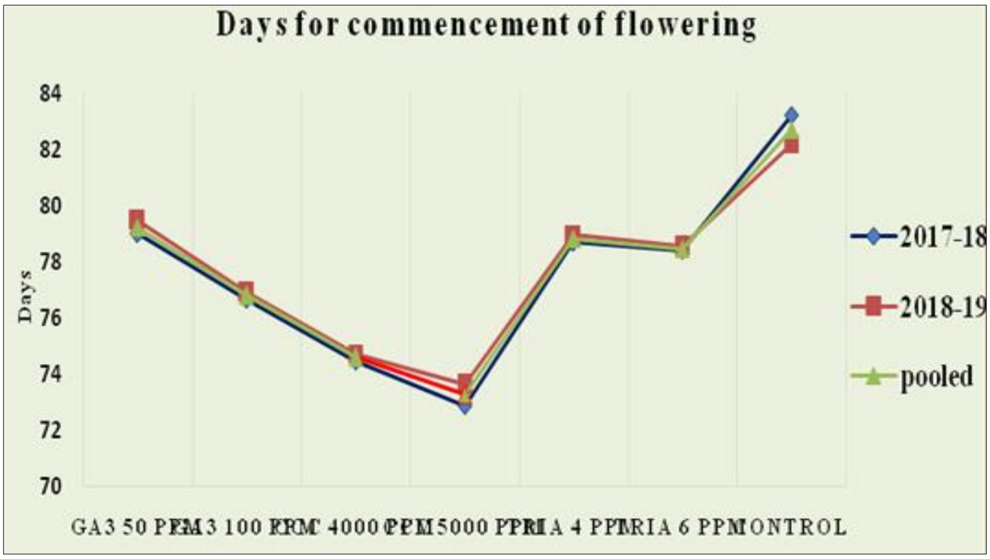

Fig 2: Effect of growth regulators on days for commencement of flowering in tuberose cv. Prajwal

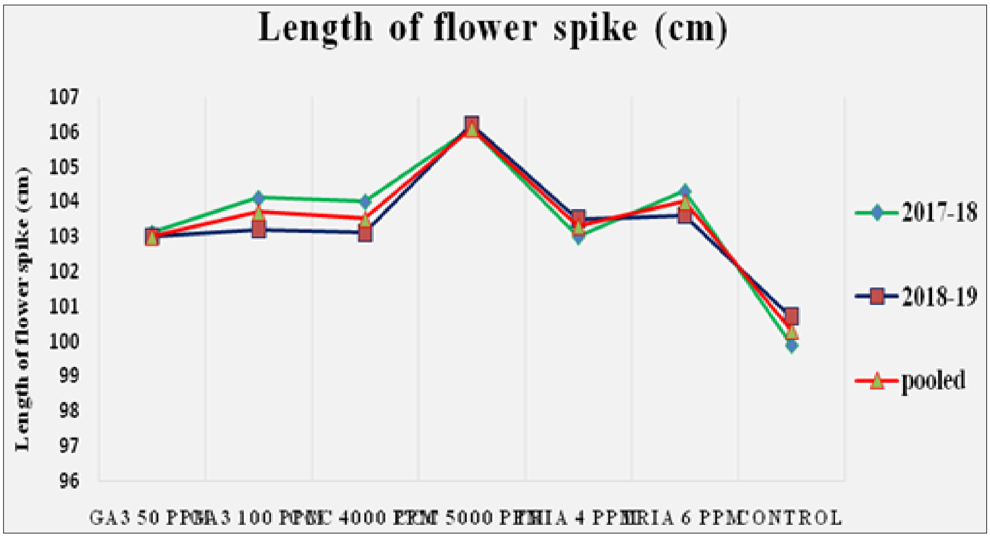

Fig 3: Effect of growth regulators on spike length in tuberose cv. Prajwal

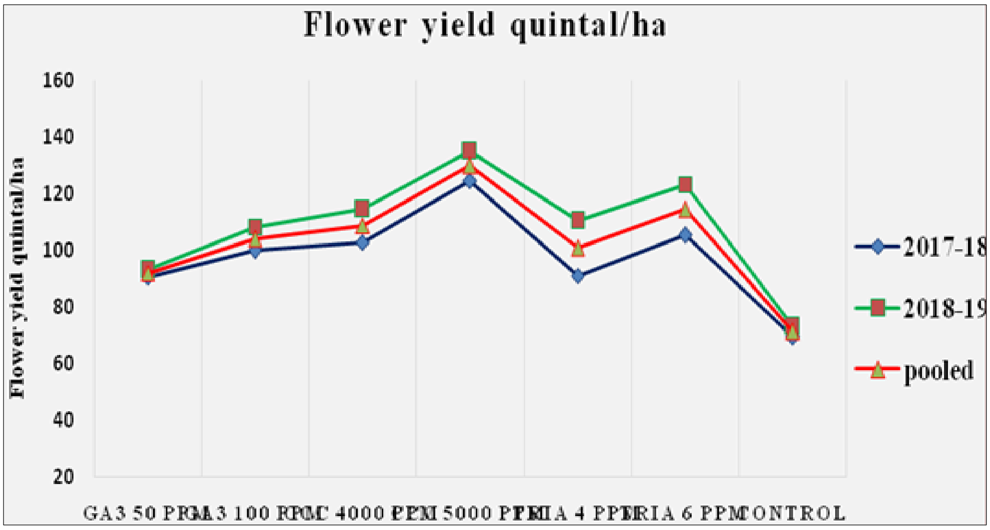

Fig 4: Effect of growth regulators on flower yield q ha-1 in tuberose cv. Prajwal

Conclusion

The number of spikes and flowers in prajwal variety of tuberose was improved by application of various growth regulators. It was observed that application of GA_3 @ 100 ppm improved the vegetative parameters dry matter of leaves which was registered in TRIA@ 6 ppm. While growth retardant CCC @ 5000 ppm has shown the significant results in yield attributes.

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