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Desai Supal Alpeshkumar
Department of Floriculture and landscape architecture, Navsari Agricultural University, Navsari, Gujarat, India

Dr. Bhavesh patel
Assistant Extension Educationist, Directorate of Extension Education, Navsari Agricultural University, Navsari, Gujarat, India

Naik Pooja Rajeshbhai
Department of Post Harvest Technology, Navsari Agricultural University, Navsari, Gujarat, India

Patel Vipulbhai
Department of Floriculture and landscape architecture Navsari Agricultural University, Navsari, Gujarat, India

Correspondence
Desai Supal Alpeshkumar
Department of Floriculture and landscape architecture, Navsari Agricultural University, Navsari, Gujarat, India

Effect of plant growth enhancers on growth and flowering of tuberose cv. Prajwal

Desai Supal Alpeshkumar, Dr. Bhavesh patel, Naik Pooja Rajeshbhai and Patel Vipulbhai

Abstract
The experiment on "Effect of plant growth enhancers on growth and flowering of tuberose cv. Prajwal" comprised of 13 treatments of three concentrations of each plant growth enhancers i.e. enriched sap of banana pseudostem (5000 ppm, 10,000 ppm and 15,000 ppm), brassinosteroid (0.25 ppm, 0.50 ppm and 0.75 ppm), each GA_3 and BA (50 ppm, 100 ppm and 150 ppm, respectively). The results indicate that the growth parameters were significantly differed with various treatments. Among different concentrations of plant growth enhancers, T_4 (Enriched sap of banana pseudostem at 15,000 ppm) was found significantly highest plant height (74.8 cm), number of leaves (70.20) and leaf area (65.20 cm^2). An advanced rachis emergence (37.53 days) and first florets opening (7 days), significantly higher spike length (103 cm), rachis length (27.2 cm) and vase life (11.20 days) were also recorded with the application of 15,000 ppm Enriched sap of banana pseudostem.

Keywords: plant growth enhancers, enriched sap of banana pseudostem, brassinosteroid, GA_3, BA, tuberose

Introduction
Tuberose (*Polianthes tuberosa* L.) also known as *Rajnigandha*, *Gul-e-chari*, *Nishighandha* is native of Mexico and belongs to the family Asparagaceae. It is one of the most important bulbous plants of tropical and sub-tropical region not only due to its white colour flowers, attractive spike and delightful fragrance, but easy cultivation and wide adaptability to varying soils and agro-climatic conditions. Its flower is a very good source of essential oils which is used in the production of cosmetic and perfumery products (Hussain, 1986) [10]. Increase in flower production, quality flowers and perfection in the form of plants are the important objectives in commercial flower production.

In India, major tuberose cultivating states are Karnataka, Maharashtra, Assam, Rajasthan, Gujarat, Tamil Nadu, Andhra Pradesh and West Bengal. It is well adapted to the climatic condition of Gujarat and is grown on a large scale by the growers of Gujarat. This herbaceous perennial bulbous plant is commercially cultivated under South Gujarat and has gained considerable importance due to its varied uses. The climate of heavy rainfall zone of south Gujarat is also favourable for growing this crop commercially.

The variety Prajwal selected for experiment was found better for maximum stalk length and higher yield of cut spikes in Gujarat. It is a hybrid which bears single flowers floret on tall spikes. It resulted from the cross "Shringar x Mexican Single". The flower buds are slightly pinkish in colour, while the flowers are white. The individual fully opened florets are used as loose flowers whereas whole spike is used as cut flowers. Tuberose inflorescences (spikes) bear 10 to 20 pairs of florets which open from the base upward. Commercially, spikes 2 to 3 feet long are harvested when the basal florets are open. Unopened flower buds scarcely open after harvest, and thus display quality of tuberose spikes is limited (Michael, 1996) [14].

The role of plant growth enhancers in ornamental bulbous plants has received considerable attention. Plant growth substance play a vital role in overall performance including growth, flowering and yield of tuberose. Enriched sap of banana pseudo stem contains gibberellic acid (110.2- 205.0 ppm) and cytokinin (137.8-244.3 ppm). The stimulation of gibberellic acid, which is known to be one of the endogenous growth enhancers, could be attributed to its unique roles in plant growth and promote flowering as reported by many investigators. Gibberellic acid improves the quality and yield, increase cell elongation and cell division,

delayed senescence, break seed dormancy, initiation root, stimulate flowering, height of plant, number of leaves, chlorophyll content, reduce the juvenile period required for flowering. The effect of cytokinins especially BA (benzyl adenine) for cell divisions, leaf growth, increase stem diameter, root and bud differentiation, delays senescence and apical dominance in the plant. Leaves with proper concentrations of cytokinins remain green and healthy. Cytokinins and gibberellins tend to retard flower senescence (Halevy and Mayank, 1981) [8]. Brassinosteroids increase resistance against unfavorable environmental factors, stress and diseases including salt, drought, temperature extremes and pathogens, it also increase flowering and improve growth and yield. It stimulates seed germination, vascular differentiation and apical dominance. Keeping in view the above facts, an investigation entitled "Effect of plant growth enhancers on growth, flowering and yield of tuberose cv. Prajwal".

Materials and Methods

An experiment entitled "Effect of plant growth enhancers on growth and flowering of tuberose cv. Prajwal" was conducted at the Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during March, 2017 to March, 2018.

The climate of South Gujarat, where the experiment site is situated, is typically tropical characterized by fairly hot summer, moderately cold winter and warm humid monsoon. Generally, monsoon in this region commences in the second week of June and retreats by the end of September. Pre-monsoon rains in the last week of May or in the first week of June are not uncommon. Most of the precipitation is received from South West monsoon, concentrating in the month of July and August. The winter season sets in usually towards the end of October. The lowest temperature of season is recorded either in December or January and hence these two months are the coldest months of the season. From the February onwards the temperature starts rising and reaches the maximum in the month of the summer season.

Treatment Details

T_1 - Control (No spray)	T_8 - GA3 @ 50 ppm
T_2 - Enriched sap of banana pseudostem @ 5000 ppm	T_9 - GA3 @ 100 ppm
T_3 - Enriched sap of banana pseudostem @ 10,000 ppm	T_{10} - GA3 @ 150 ppm
T_4 - Enriched sap of banana pseudostem @ 15,000 ppm	T_{11} - BA @ 50 ppm
T_5 - BR @ 0.25 ppm	T_{12} - BA @ 100 ppm
T_6 - BR @ 0.50 ppm	T_{13} - BA @ 150 ppm
T_7 - BR @ 0.75 ppm	

GA_3 50, 100, 150 ppm was prepared by dissolving 50, 100 and 150 mg GA_3 respectively in 10 ml of absolute alcohol and made 1 liter of final volume in distilled water. Similarly, BA 50, 100, 150 ppm solution was prepared. For preparation of 5000, 10,000 and 15,000 ppm of enriched sap of banana pseudostem solution, 5, 10 and 15 ml of enriched sap of banana pseudostem was respectively dissolved in distilled water by making final volume of 1 liter. For preparation of 0.25, 0.50 and 0.75 ppm of BR solution, 0.46, 0.93 and 1.40 ml of brassinosteroid (0.04% w/w) was respectively dissolved in distilled water by making final volume of 1 litre. The treatments were applied as foliar spray at 60, 90 and 120 days after sprouting. The treatments were applied as foliar spray at 60, 90 and 120 days after sprouting.

Results and Discussion

From various treatments, significantly maximum plant height (74.8 cm) was recorded under Enriched sap of banana pseudostem 15,000 ppm which was statistically at par with T_{10}, T_{13}, T_6, T_3, T_{12}, T_5 and T_{11}, while minimum plant height *i.e.* 55.2 cm was recorded with BR 0.75 ppm.

Enriched sap of banana pseudostem contain some biochemical such as gibberellic acid, NAA, cytokinin, chemicals i.e. N, P, K, Ca, Mg, S, micronutrients (Mn, Cu, Zn, Zn) and beneficial microbes (PSB, Rhizobium, Azotobacter and Fungus). The most pronounced effect of Gibberellins on the plant growth is an elongation of internodes. This increase in plant height might be due to increased meristimatic activity due to enhance cell division and cell elongation. Cytokinins are involved with plant growth and development through stimulating and accelerating cell division and/or cell enlargement or both, Sajid *et al*. (2015) [23] on gladiolus; Asil *et al*. (2011) [4] in tuberose. The result was supported by Bhattuchajee *et al*. (2002) [5] on *Corchourus olitrorius* L.; Soad *et al*. (2010) [28] on croton; Padmalatha *et* al. (2013) [17], Sable *et al*. (2015) [22].

Effect of nitrogen increased the efficiency of metabolic process of the plant and vegetative growth of the plant. Similar findings were observed by Rathod *et al.* (2017) [21] in pomegranate cv. Bhagva.

Maximum number of leaves per plant (70.20) and leaf area (65.20 cm^2) were recorded with the application of 15000 ppm Enriched sap of banana pseudostem, whereas minimum number of leaves and leaf area were observed in 0.75 ppm BR *i.e.* 20.20 and 50.60 cm^2, respectively.

Increase in number of leaves might be due to gibberellins cause stem elongation which results from rapid elongation of internodes due to cell division and cell elongation leading to the production of more number of leaves, Padmalatha *et* al. (2013) [17] and Sable *et* al. (2015) [22] in gladiolus; Singh and Shankar (2011) [26] in tuberose. Significantly, maximum leaf area might be due to its action on cell division and cell enlargement. The same findings were observed by Singh and Barad (2001) [27] and Padaganur *et al*. (2004) [16] in tuberose.

The marked improvement in growth attributes *i.e.* plant height, number of leaves per plant and leaf area of the crop by Enriched sap of banana pseudostem might be due to increasing auxin level of tissue or enhance the conversion of tryptophan to IAA leading to the enhanced activity of cell division and cell elongation through the effect of gibberellic acid and cytokinin singly or due to combine effect of both. This kind of results was observed by Jadhav *et al.* (2015) [11] in gladiolus cv. American Beauty, (Anon., 2016) [3] in brinjal and chillies seedlings, Palagani and Singh (2017) [15] in gerbera and Rathod *et al.* (2017) [21] in pomegranate cv. Bhagva.

Early rachis emergence (37.53 days) and first floret opening (7 days) in tuberose cv. Prajwal were found in 15000 ppm Enriched sap of banana pseudostem, whereas 0.75 ppm BR

resulted in more days for rachis emergence (52.07 days) and first floret opening (14.27 days). This might be due to reduction in juvenile period due to gibberellins and convention of apical meristem into flowering primodia instead of production of leaves at the determination of juvenile phase, Krishnamoorthy (1975) [12], Rajput *et al*. (2011) [20] in golden rod and Wagh *et al*. (2012) [29] in tuberose.

The significantly maximum spike length and rachis length *i.e.* 103 cm and 27.2 cm, respectively was obtained with the application of Enriched sap of banana pseudostem 15000 ppm, whereas minimum value of spike length *i.e.* 78 cm and rachis length *i.e.* 19.1 cm were recorded in 0.75 ppm BR. Increased spike length might be due to rapid internode elongation as a result of increased cell division and cell elongation in intercalary meristem, Kumar *et al*. (2011) [13] and Shanker *et al*. (2011) [25] in tuberose. Gibberellic acid promotes vegetative growth and increases the photosynthetic and metabolic activities causing more transport and utilization of photosynthetic products (Halevy and Shild, 1970) [9] and Dogra *et al*. (2012) [7] in gladiolus. The present findings thus agreed with (Anon., 2014) [2] on banana cv. Grand Nain and Chaudhary *et al.* (2016) [6] in gladiolus cv. American Beauty.

Table 1: Effect of plant growth enhancers on growth and flowering attributes of tuberose cv. Prajwal

Treatments	Plant Height (cm)	Number of leaves per plant	Leaf area (cm^2)	Days to rachis emergence	Days to first floret opening	Spike Length (cm)	Rachis length (cm)	Vase life (days)
T_1 – Control	57.4	35.47	52.10	50.53	13.80	80.00	19.9	8.00
T_2 - Enriched sap of banana pseudostem @ 5000 ppm	59.2	40.27	53.20	49.40	13.40	82.00	20.4	8.53
T_3 - Enriched sap of banana pseudostem @ 10000 ppm	71.6	63.73	62.00	44.60	8.67	95.00	25.1	10.47
T_4 - Enriched sap of banana pseudostem @ 15000 ppm	74.8	70.20	65.20	37.53	7.00	103.00	27.2	11.20
T_5 - BR @ 0.25 ppm	68.9	56.73	60.80	45.87	9.67	92.00	23.4	9.87
T_6 - BR @ 0.50 ppm	72.5	65.27	62.90	42.47	8.27	97.00	25.9	10.60
T_7 - BR @ 0.75 ppm	55.2	20.20	50.60	52.07	14.27	78.00	19.1	7.73
T_8 - GA_3 @ 50 ppm	62.3	46.20	55.00	48.07	12.27	84.00	21.1	9.00
T_9 - GA_3 @ 100 ppm	64.2	48.80	56.30	46.93	11.67	87.00	21.8	9.20
T_{10} - GA_3 @ 150 ppm	73.9	69.20	64.10	39.73	7.40	101.00	26.8	10.93
T_{11} - BA @ 50 ppm	67.4	51.80	58.40	46.33	10.53	89.00	22.3	9.47
T_{12} - BA @ 100 ppm	70.4	60.73	61.20	45.00	9.13	94.00	24.3	10.07
T_{13} - BA @ 150 ppm	73.2	65.80	63.50	41.60	7.87	99.00	26.1	10.53
S. Em. ±	3.16	2.99	3.02	2.46	0.46	5.13	1.30	0.59
C.D. at 5 %	9.23	8.73	8.80	7.19	1.34	14.98	3.79	1.73
CV %	8.18	9.70	8.87	9.40	7.73	9.79	9.64	10.64

Enriched sap of banana pseudostem at 15,000 ppm was recorded significantly higher with respect to vase life (11.20 days), which was statistically at par $T_{10,}$ $T_{13,}$ $T_{6,}$ $T_{12,}$ $T_{5,}$ T_{11} and T_3, while minimum vase life (7.73 days) was observed in BR at 0.75 ppm (T_7).

The beneficial effect of plant growth enhancers on vase life were might be due to PGR especially cytokinins and gibberellins have positive effects on post-harvest life of cut flowers. The maximum increase in spike length might be due to sucrose which increasing vase life of flowers by acting as the main source of food and reparable substance during opening of flower petals and more uptake of water from vase solution which increasing vase life by Shanker and Sharma (2016) [24] in tuberose cv. Double. Gibberellic acid increase flower size and number of florets, which increased stored food material in tissue, which cause increase in vase life of flower indirectly Chaudhary *et al.* (2016) [6] in gladiolus cv. American Beauty. A similar finding was made by Jadhav *et al.* (2015) [11] in gladiolus cv. American Beauty.

The superiority of vegetative growth might have led to the increase in flowering attributes and good quality of flower spikes in tuberose var. Prajwal due to the effect of gibberellic acid and cytokinin singly or due to combine effect of both. The present findings thus agreed with (Anon., 2013) [1] in papaya, (Anon., 2014) [2] in banana cv. Grand Nain, Jadhav *et al.* (2015) [11] and Chaudhary *et al.* (2016) [6] in gladiolus cv. American Beauty; Palagani and Singh (2017) [15] in gerbera; Patel *et al*. (2017) [19, 21] in mango cv. Kesar, Rathod *et al.* (2017) [21] in pomegranate cv. Bhagva and Parmar (2017) [21] in papaya var. Red Lady.

Conclusion

It can be concluded that the foliar application of banana pseudostem @ 15000 ppm sprayed at 60, 90 and 120 days after sprouting was obtained maximum growth and quality flower production.

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