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Jonnada Archana
Department of Floriculture and Landscape Architecture, College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad, India

A Girwani
Department of Floriculture and Landscape Architecture, College of Horticulture, SKLTSHU, Mojerla, Telangana, India

D Vishnu vardhan Reddy
Department of Crop Physiology, College of Agriculture, PJTSAU, Hyderabad, Telangana, India

CH Raja Goud
Department of Entomology, College of Horticulture, SKLTSHU, Hyderabad, Telangana, India

Correspondence
Jonnada Archana
Department of Floriculture and Landscape Architecture, College of Horticulture, SKLTSHU, Rajendranagar, Hyderabad, India

Effect of nutrients and biostimulants on growth and flowering of loose flowers of tuberose (*Polianthes tuberosa* L.) cv. Bidhan Rajini - 1

Jonnada Archana, A Girwani, D Vishnu vardhan Reddy and CH Raja Goud

Abstract
The investigation on tuberose cv. Bidhan Rajini-1 were carried out at the Floriculture Research Station Rajendranagar, Hyderabad, to find out the effect of nutrients and biostimulants on tuberose with reference to growth attribute. The experiment was laid out in Randomized Block Design consisted of four biostimulants *viz.*, Humic acid, Fulvic acid, Potassium humate, Arka Microbial Consortium in combination with nutrients. Various growth characters were recorded after planting. The experiment results showed that among the different treatments, application of 75% recommended doses of fertilizers (RDF) + Humic acid 12% (3ml/l) have shown significant effect on the vegetative growth parameters and maximum plant height and number of leaves, were recorded. In addition, this treatment has also resulted in early spike emergence (65days) and maximum spike length (83.56 cm), maximum chlorophyll content (58.66 Spad units) and promoted maximum duration of flowering (174.6 days) in tuberose cv. Bidhan Rajini-1. On the other hand, application of 100% RDF (200kgs each of NPK) resulted in maximum floret length (6.30cm) and floret diameter (5.28 cm).

Keywords: Biostimulants, foliar spray, humic acid, RDF, tuberose

Introduction
Tuberose (*Polianthes tuberosa* L.) is one of the most important tropical ornamental bulbous flowering plants cultivated for production of long lasting flower spikes. Tuberose is an important commercial cut as well as loose flower crop due to pleasant fragrance, longer vase-life, higher returns and wide adaptability to varied climate and soil conditions. The flowers are attractive and elegant in appearance with sweet fragrance (Patel *et al*., 2006) [9]. Tuberose cultivars are mainly three types - single, semi double and double. Flowers of the Single type (single row of perianth) are commonly used for extraction of essential oil, loose flowers, making garland etc., while that of Double varieties (more than two rows of perianth) are used as cut flower, garden display and interior decoration (Jawaharlal *et al*., 2006) [2]. It is commercially cultivated in India in an area of about 2.43 lakh ha, with production of 15.45lakh MT of loose flowers and 6.91lakh stems of cut flower (NHB, 2016) [5].

Tuberose requires a large quantity of NPK, both in the form of organic and inorganic fertilizers. Nitrogen, phosphorus and potassium have a significant effect on spike production and floret quality. Nutrition is one of the most important aspects in increasing the yield and quality of tuberose spikes. After the green revolution, use of chemical fertilizers and pesticides in plant production has increased, which is dangerous to ecology and environment (Kahkashan *et al*., 2017) [3]. The deterioration of soil fertility through use of chemical fertilizers and increasing production costs due to chemical fertilizers brought an urge for organic sources of nutrients as a part of nutrient requirement. Organic farming is one of the possible solutions for this problem, in recent days, biostimulants have emerged as a supplement to mineral fertilizers and hold a promise to improve yield as well as quality of the crop (Sankari *et al*., 2015) [12].

A mixture of two or more PGRs or these with other substances (amino acids, nutrients, vitamins) is called a “Plant growth promoter or Biostimulant”. Humic and Fulvic acids are part of the humus compounds which plays an important role in balance plant nutrition by improving physical, chemical and biological properties of soil. The indirect effects of humic compounds have been attributed to the improvement of physical, chemical and biological conditions of soil.

Its direct effect on plant growth has been attributed to the increase in chlorophyll content, the acceleration of the respiration process, hormonal growth responses, increasing growth and yield of plant or a combination of these processes. Arka microbial consortium (AMC) is a carrier based product released from IIHR Bengaluru is recommended for media preparation, seed treatment, and soil application. AMC contains N fixing, P & Zn solubilizing and plant growth promoting microbes as a single formulation.

Materials and Methods

The present investigation was carried out during 2017-2018 on the effect of nutrients and biostimulants on growth and flowering of loose flowers of tuberose (*Polianthes tuberosa* L.) cv. Bidhan Rajini – 1. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments replicated thrice. The field lay out and randomizations of treatments of plot of size 2 × 2m (4 m2) was used per treatment carried out as per the statistical methods given by Panse and Sukhatme (1954) [8]. The experiment was conducted in the field at Florticultural Research Station, Rajendranagar, Hyderabad. The soil of the experimental field was sandy clay loam. Organic manures like farm yard manure (FYM), and vermicompost were applied as soil application through basal dressing as per the treatment schedule. The recommended dose of fertilizers *viz*., NPK 30:20:30 g per m2 was applied as per the treatment. For the plots with 75% RDF the fertilizers were applied at the rate of 101.83g N, 375g P, 120g K uniformly for individual plots, and for the plots with 50% RDF the fertilizers were applied at the rate of 58.35g N, 250g P, 80g K for individual plots. Prophylactic plant protection measures were adopted as and when required for control of common pests and diseases during investigation period.

Different biostumulants used in this experiment were procured from standard approved companies. Where as Arka microbial consortia (AMC) is procured from IIHR Banglore. Foliar spray of bio stimulants is done at monthly intervals. Humic acid and fulvic acid were sprayed at 3ml/lit of water and it is prepared by adding 3ml of bio stimulants in one liter of water, whereas potassium humate @ 2g/lit of water, prepared by adding 2gm of in one liter of water and Arka microbial consortium (AMC) @ 2ml/lit of water is applied, prepared by adding 2ml of AMC in one lit of water. Observations on growth parameters were recorded and the mean data were subjected to statistical scrutiny. The treatment details are furnished below:

Treatment details

T1- 100% RDF (200kg NPK + FYM 25 tonnes per hectare)
T2- 75% RDF + Fulvic acid 10% @ 3ml/l
T3- 50% RDF + Fulvic acid 10%@ 3ml/l
T4- 75% RDF + Humic acid 12%@ 3ml/l
T5 - 50% RDF + Humic acid 12%@ 3ml/l
T6- 75% RDF + Potassium humate 95% @ 2gm/l
T7- 50% RDF + Potassium humate 95% @ 2gm/l
T8- 75% RDF + Arka microbial consortium
T9- 50% RDF + Arka microbial consortium

After the treatment application, biometric evaluations of the plant growth were performed plant height at 1st spike emergence and at harvest, length of spike was recorded using scale and length and daiameter of the floret was measured in a fully developed floret using vernier callipers and number of leaves at 1st spike emergence, days taken for 1st spike emergence, and duration of flowering was recorded. On the other hand total chlorophyll was recorded by using SPAD meter (SPAD 502) and the SPAD values were recorded at 270 DAP on the fully expanded leaf

The collected replicated data was subjected to standard statistical analysis for Randomized Block Design (RBD) (Panse and Sukhatme, 1954) [8]. Least significant difference was used to compare means and Critical Difference (C.D.) was used to compare for differences.

Results and Discussion

The effect of nutrients and biostimulants on growth and flowering was assessed on tuberose cv. Bidhan Rajini-1 and the results of the experiments are presented in Table 1 and 2.

The plant height was recorded at 1st spike emergence and at harvest and it was observed that the treatments had significant effect on plant height during the period of growth. The results indicated an increasing trend in plant height with the application of 75% recommended doses of fertilizers (RDF) + Humic acid 12% (3ml/l). Among the various treatments, 75% recommended doses of fertilizers (RDF) + Humic acid 12% (3ml/l)(T4) recorded the maximum plant height at 1st spike emergence and at harvest followed by 100% RDF (T1) (Table 1). Increase in plant height might be due to easy absorption of nutrients, which would promote protein synthesis from reserved carbohydrate leading and regulator activity of humic substances which promote growth could be due to both a direct action of soluble humic complexes and an increase of endogenous hormone concentration in the tissues as a consequence of the inhibition of some catabolic enzymes such as IAA oxidase by soluble humic complexes as suggested by Cacco and Dell' Angola (1984) [1]. Similar results regarding the effect of Humic acid on plant height were also reported by Sankari *et al*., (2015) [12] and Pradeep *et al*., (2014) [10] in Gladiolus, Mohammadipour *et al*., (2012) [4] in Marigold.

There was a significant increase in number of leaves at 1st spike emergence stage and maximum number of leaves plant-1 (40.5) was observed in plants treated with 75% RDF + Humic acid 12% (3ml/l), followed by the treatment T2- 75% RDF + Fulvic acid (3ml/l) which recorded a leaf number of (38.2) (Table 1). This might be due to the accelerated mobility of the photosynthate from the source to sink due to the readily available nitrogen source from both inorganic and organic nutrients and in turn it promotes protein synthesis from reserved carbohydrate leading to the production of more number of leaves (Ranchana *et al*., 2017) [11]. This is in concurrence with the findings of Sankari *et al*., (2015) [12], Pradeep *et al*., (2014) [10] in Gladiolus and Ranchana *et al*., (2017) [11] in orchid.

It is evident from the data (Table 1) that the there was a significant reduce in number of day for spike emergence (65.0) by the application 75% RDF + Humic acid 10% (3ml/l) which was followed by 75% RDF + Arka Microbial Consortium (67.73). The induction of early spike emergence might have been influenced by triggering of such metabolic activity and narrowing of the C: N ratio by the significant accumulation of carbohydrates. The movement of nutrients from source to sink would have taken place in a consistent manner and made the nutrient available to all plant parts for quick development of spike emergence. This could also be attributed to the gibberellin like activity of Humic acid as reported by Vaughan *et al*., (1985) [14]. Similar results regarding the effect of Humic acid on early spike emergence were also reported by Palanisamy *et al*., (2015) [6] in gerbera.

There was a significant increase in the spike length. The maximum spike length (83.56 cm) was recorded in the

treatment T4-75% RDF + Humic acid (3ml/l) and this was followed by100% RDF as depicted in (Table 2). This could be due to the slow release of nutrients from soil resulting in greater up take of nutrients, which might have exerted greater spike length. Humus substances could have mobilized the reserve food materials to the sink through increased activity of hydrolyzing and oxidizing enzymes. This would have helped the better availability and utilization of nutrients. This was in conformatory with the findings of Sankari *et al*., (2015) [12], Pradeep *et al*., (2014) [10] in Gladiolus.

Among the different treatments maximum duration of flowering (174.6 days) in plants was observed by the application of 75% RDF + Humic acid 12% (3ml/l) (Table 2). Balanced nutrition is of considerable importance in improving the yield and reducing the duration of flowering, and higher production of auxin and growth substances by humic acid at early phase of growth would have contributed to early flowering and reduction in the duration of flowering. This could also be attributed to the gibberellin like activity of humic acid as reported by Vaughan *et al*., (1985) [14]. Results are in accordance with the findings of Vinutha *et al*., (2017) [13] in chaina aster and Pansuriya *et al*., (2018) [7] in gladiolus.

The analysis of the data revealed that there was significantly increase in the length and diameter of floret of tuberose. The flowers in treatment of 100% RDF has recorded maximum flower length (6.30 cm) and diameter (5.28 cm) (Table 2) and it is followed by the treatment 75% RDF + Humic acid 12% (3ml/l). Increase in flower length and diameter could be due to the increased photosynthetic activity which in turn, might have favoured an increased accumulation of dry matter and also efficient partitioning of photosynthates towards the sink. While phosphorus is found to be involved in formation of floral primordial resulting in increase of flower length and diameter. Results are in accordance with the finding of Yadav *et al*. (2005) in tuberose.

The data revealed that nutrients and bio stimulants have significantly influenced the chlorophyll content of leaf. By the application of 75% RDF + Humic acid 12% (3ml/l) maximum chlorophyll content (58.66 spad units) was recorded (Table 2). The humic acid sprayed on the leaves might have translocated to the other parts of the plants, including roots. The root lechates containing very low concentration of humic acid might have helped in the chelation of metal ions in soil making them available in absorbable and usable form for plant growth. Which might have attributed to increased chlorophyll content in the leaves and thus, photosynthetic efficiency causing more perfectional influx of photosynthetaes to the sink. Further, results were in agreement with Sankari *et al*., (2015) [12].

Table 1: Effect of nutrients and biostimulants on plant height at 1st spike emergence (cm), at harvest (cm) and number of leaves at 1st spike emergence and Days taken for 1st spike emergence in tuberose.

	Treatment	Plant height (cm)		Number of leaves at 1st spike Emergenc e	Days taken for 1st spike emergence
		1st spike Emergenc e	At harvest		
T1	100% RDF (200kg NPK + FYM 25 tonnes per hectare)	27.3	47.0	35.6	70.00
T2	75% RDF + Fulvic acid 10% @ 3ml/l	25.4	45.4	38.2	68.33
T3	50% RDF + Fulvic acid 10%@ 3ml/l	21.5	42.0	33.1	74.00
T4	75% RDF + Humic acid 12%@ 3ml/l	29.2	48.8	40.5	65.00
T5	50% RDF + Humic acid 12%@ 3ml/l	23.0	43.5	34.1	72.66
T6	75% RDF + Potassium humate 95% @ 2gm/l	22.9	42.9	33.8	72.00
T7	50% RDF + Potassium humate 95% @ 2gm/l	20.6	41.3	32.0	75.33
T8	75% RDF + Arka microbial consortium	24.0	44.2	34.2	67.73
T9	50% RDF + Arka microbial consortium	21.2	41.5	32.3	71.00
S.Em ±		0.59	0.55	0.82	0.753
C.D. at 5%		1.81	1.66	2.50	2.275

Table 2: Effect of nutrients and biostimulants on length of spike (cm), duration of flowering (days), length of floret (cm), diameter of floret (cm), total leaf chlorophyll content (Spad units) in tuberose.

	Treatment	Length of spike (cm)	Duration of flowering g (days)	Length of floret (cm)	Diameter of floret (cm)	Total leaf chlorop hyll content (Spad units)
T1	100% RDF (200kg NPK + FYM 25 tonnes per hectare)	80.90	22.86	6.30	5.28	53.52
T2	75% RDF + Fulvic acid 10%@ 3ml/l	78.03	22.60	6.03	4.94	56.26
T3	50% RDF + Fulvic acid 10%@ 3ml/l	75.26	19.33	5.63	4.41	48.52
T4	75% RDF + Humic acid 12%@ 3ml/l	83.56	24.13	6.13	5.01	58.66
T5	50% RDF + Humic acid 12%@ 3ml/l	77.33	20.60	5.76	4.74	50.21
T6	75% RDF + Potassium humate 95% @ 2gm/l	76.00	21.70	5.70	4.61	49.36
T7	50% RDF + Potassium humate 95% @ 2gm/l	73.66	19.06	5.33	4.12	45.76
T8	75% RDF + Arka microbial consortium	77.80	26.56	5.83	4.82	52.50
T9	50% RDF + Arka microbial consortium	74.13	21.80	5.43	4.30	47.46
	S.Em ±	0.821	0.691	0.176	0.056	0.727
	C.D. at 5%	2.480	2.087	0.534	0.169	2.197

Conclusion

The present study gave lead for usage of biostimulants in integrated nutrition management. Among the treatments 75% RDF + Humic acid 12% (3ml/l) has shown significant increase in growth and flowering due to better uptake and utilization of nutrients as well as better translocation of photosynthates as influenced by synergistic effects of nutrients and humic acid.

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