Studies on the efficacy of nutrients and biostimulants on flowering and yield attributes in tuberose (*Polianthes tuberosa* L.) cv. Bidhan Rajini – 1.

Comment [D1]: Precise title should be preferred

ABSTRACT

The present investigation was carried out at the Floriculture Research Station Rajendranagar, Hyderabad, to study the efficacy of nutrients and biostimulants on flowering and yield attributes in tuberose cv. Bidhan Rajini-1. The experiment consisted of four biostimulants *viz.*, Humic acid, Fulvic acid, Potassium humate, Arka Microbial Consortium in combination with nutrients was laid out in Randomized Block Design replicated thrice. Further regarding the flower yield contributing parameters, the application of 75% RDF along with Humic acid-12% (3ml/l) resulted in maximum number of spikes per clump (3.30), number of florets per spike (66.0), weight of individual florets (2.56gm) and 100 flowers weight (256.6gm), loose flower yield plot^{-1} (17.67kgs) and flower yield ha-1(44 t) followed by 100% RDF (200kg each of NPK).

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Keywords: Biostimulants, Humic acid, Tuberose, RDF, Arka Microbial Consortium.

1. INTRODUCTION

Tuberose (*Polianthes tuberosa*) is considered as one of the most popular flowering plants of tropical and sub-tropical regions belongs to the family Amaryllidaceous, a native of Mexico, produces attractive, elegant and fragrant white flowers (Amin *et al.,* 2017). Today, it is widely cultivated in India, Bangladesh, France, Italy, South Africa, the United States, and many tropical and subtropical regions (Mazed *et al.,* 2015). Among the ornamental bulbous plants which are valued much for their aesthetic, beauty and fragrance of flowers, the tuberose occupies a very selective and special position for flower loving people, because of their prettiness, elegance and sweet pleasant fragrance. While individual florets, on the other hand, are used to make veins, wreaths, buttonholes, or crowns. It has a great potential for cut flower trade and essential oil industry (Sadhu and Bose, 1973). The natural flower oil of tuberose is one of the most expensive perfume ingredients (Singh *et al.,* 2009). It is among a few flowers, which has got good export potential.

Tuberose is a gross feeder and requires a large quantity of NPK, both in the form of organic and inorganic fertilizers (Amarjeet and Godara,1998). Fertilizers have great influence on growth, building and flower production in tuberose (Polara *et al.,* 2004). Nitrogen, phosphorus and potassium have a significant effect on spike production and floret quality (Singh *et al.,* 2004).

A plant biostimulant is any substance or microorganism applied to plants with the aim to enhance nutrition efficiency, abiotic stress tolerance and/or crop quality traits, regardless of its nutrients content. Bio stimulants have been gaining interest in sustainable agriculture because their application activates several physiological processes that enhance nutrient use efficiency, stimulating plant development (Kunicki *et al.,* 2010). Bio stimulants are extracts obtained from organic raw materials containing bioactive compounds. The most common components of the bio stimulants are mineral elements, humic substances (HSs), vitamins, amino acids, chitin, chitosan, and poly and oligosaccharides (Berlyn & Russo 1990; Hamza & Suggars 2001; Kauffman *et al.,* 2007).

Comment [D4]: Add objectives and probable recommendations

2. MATERIALS AND METHODS

The present investigation was carried out at Floricultural Research Station, Rajendranagar, Hyderabad on the efficacy of nutrients and biostimulants on flowering and yield attributes in 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 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 gm^{-2} 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.

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. After the treatment application biometric evaluation of flowering and yield parameters are done.

Length of rachis (cm): The rachis length was measured from point of emergence of the first flower in the spike to the tip of the spike and the mean was expressed in cm.

Days to complete opening of the florets in a spike (days): It is measured by the counting the days taken from the date of opening of first pair of florets in spike to the opening of last pair of florets in the individual spike and expressed in days.

Number of spikes per clump: The total number of spikes harvested during the period of observation was counted in each clump at every harvest and the mean was expressed in numbers.

Number of florets per spike: The number of florets produced per spike in each plant was counted and the mean was expressed in numbers.

Individual flower weight (gm): The weight of the individual floret was taken in a fully developed floret from five randomly selected spikes in each replication and the mean was expressed in grams.

Weight of 100 flowers (gm): Weight was measured from randomly selected hundred florets in each replication in each treatment and the mean was expressed in grams.

Loose flower yield per plot (kg): The flowers were harvested at bud stage (pin hole stage) and the flowers picked from individual pickings per plot were summed in each of the experimental plot and expressed in kg.

Loose flower yield per hectare (t/ha): The estimated yield per hectare was arrived as described below and expressed in tonnes.

$$\text{Estimated yield (t)} = \frac{\text{Yield per plot (kg)} \times 10000\ (m^2)}{\text{Plot size}\ (m^2)}$$

3. RESULT AND DISCUSSION

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Flower characters

Nutrients and biostimulants have significant impact on flowering in tuberose, with respect to length of rachis there was a significant increase among the treatments by application of nutrients and biostimulants. The application of 75% RDF + Humic acid (3ml/l) resulted in maximum rachis length (34.63 cm) which was followed by 100% RDF (32.50 cm). The increase in rachis length could also be due to the slow release of nutrients from soil resulting in greater up take of nutrients, which might have exerted greater rachis length. This was in line with the findings of Sankari *et al*., (2015), Pradeep *et al*., (2014). in Gladiolus.

And there was significant effect of treatments on the days to complete opening of the florets in a spike (days). Maximum days (26.56 days) was recorded in the treatment T4- 75% RDF + Arka Microbial consortium (AMC) followed by treatment 75% RDF + Humic acid (24.13 days). The improvement in flowering on spike might be due to the fact that the combined application of Arka Microbial consortium (AMC) along with nutrients might have improved the soil health and flower quality as revealed by Pansuriya *et al.,* (2018) in gladiolus.

whereas there was a significant increase in the number of spikes per clump by the application of 75% RDF + Humic acid 12% (3ml/l) resulted in maximum number of spikes per plant (3.30) which was followed by the treatment 100% RDF (3.00). Humic acid might have increased the carbohydrate accumulation which in turn would have hastened the spike emergence & produce quality flowers as reported by Vaughan *et al.,* (1985).

The number of florets per spikes was maximum (66.0) in the treatment T4 -75% RDF + Humic acid (3ml/l), followed by 100% RDF (64.0). It might be due to presence of growth promoting substances like essential plant nutrients, vitamins, enzymes and antibiotics in Farmyard manure and Humic acid with active phenolic group might have inhibited oxidase activity and promoted the prolonged persistence of IAA in plants that might have contributed to the increased florets per spike in conformity with the findings of Sankari *et al*., (2015) and Pradeep *et al*., (2014).

Yield characters

The individual floret weight (g) was recorded maximum (2.56gm) by the plants by the application of 75% RDF + Humic acid 12% (3ml/l) which was followed by 100% RDF (2.43 gm). Increase in flower weight could be due to the increased photosynthetic activity by the application of nutrients and humic acid which, in turn, might have favoured an increased accumulation of dry matter and also efficient partitioning of photosynthates towards the sink. Results are in line with the findings of Kabariel *et al.,* (2016) in marigold.

There was a significant effect on weight of 100 flower (gm). Maximum weight of flower (256.6gm) was observed in the plants subjected to 75% RDF + Humic acid 12% (3ml/l) followed by plants treated with 100% RDF (243.3gm). The increase in weight of flowers of tuberose may be due to supply of balance amount of nutrients to the plant so that the growing plants are supplied with food, and application of humic substance increases in water holding capacity of soil and increase quality of flower. The results are in confiding with the Harshavardhan *et al*., (2017) in marigold.

Maximum flower yield per plot (17.67 kgs) was recorded by the application of 75% RDF + Humic acid 12% (3ml/l) which was followed by 100% RDF (16.03 kgs). The application of nutrients and biostimulants might have formed a sink in a position where it accumulates and draws the available photosynthates to the site which ultimately increased the flower yield per plot as reported by the findings of Palanisamy *et al*., (2015) in gerbera and Sankari *et al*., (2015) in gladiolus.

Maximum flower yield per hectare (44.01 t ha-1) was obtained by the application of 75% RDF + Humic acid 12% (3ml/l) which was followed by 100% RDF (42.42 t ha-1). The maximum flower yield per hectare is due to the available nutrients and by the action of humic substances has increased the production of more number of spikes per clump, more number of florets on spike, larger sized flowers per plant and thus ultimately increased the yield. These investigations are supported by the findings of Shrikanth and Jawaharlal (2014), Palanisamy *et al*., (2015) in gerbera and Sankari *et al*., (2015) in gladiolus.

Table 1 Effect of nutrients and biostimulants on flowering characters of tuberose.

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Comment [D7]: Updated references should be added

	Treatment	Length of rachies (cm)	Days to complete opening of the florets in a spike (days)	Number of spikes per clump	Number of florets per spike
T_1	100% RDF (200kg NPK + FYM 25 tonnes per hectare)	32.50	22.86	2.93	64.0
T_2	75% RDF + Fulvic acid 10%@ 3ml/l	30.33	22.60	3.00	63.50
T_3	50% RDF + Fulvic acid 10%@ 3ml/l	27.90	19.33	2.53	62.21
T_4	75% RDF + Humic acid 12%@ 3ml/l	34.63	24.13	3.30	66.01
T_5	50% RDF + Humic acid 12%@ 3ml/l	29.26	20.60	2.83	63.21
T_6	75% RDF + Potassium humate 95% @ 2gm/l	28.00	21.70	2.70	61.94
T_7	50% RDF + Potassium humate 95% @ 2gm/l	25.50	19.06	2.50	61.63
T_8	75% RDF + Arka microbial consortium	30.06	26.56	2.80	62.62
T_9	50% RDF + Arka microbial consortium	27.83	21.80	2.66	62.10
	S.Em ±	0.759	0.691	0.099	0.394
	C.D. at 5%	2.294	2.087	0.299	1.190

Comment [D8]: Lettering should be added

Table 2: Effect of nutrients and biostimulants on Yield characters of tuberose.

	Treatment	Weight of individual flowers	Weight of 100 flowers	Loose flower yield per plot (kg)	Loose flower yield per hectare (t/ha)
T_1	100% RDF (200kg NPK + FYM 25 tonnes per hectare)	2.43	243.3	16.03	42.42
T_2	75% RDF + Fulvic acid 10%@ 3ml/l	2.30	230.02	15.40	38.46
T_3	50% RDF + Fulvic acid 10%@ 3ml/l	2.06	206.6	12.85	32.74
T_4	75% RDF + Humic acid 12%@ 3ml/l	2.56	256.6	17.67	44.01
T_5	50% RDF + Humic acid 12%@ 3ml/l	2.26	226.6	14.54	36.09
T_6	75% RDF + Potassium humate 95% @ 2gm/l	2.20	220.0	15.04	37.48
T_7	50% RDF + Potassium humate 95% @ 2gm/l	1.90	190.0	11.08	27.75
T_8	75% RDF + Arka microbial consortium	2.28	228.3	14.92	37.86
T_9	50% RDF + Arka microbial consortium	1.96	196.6	12.72	31.85
	S.Em ±	0.040	4.091	0.229	0.608
	C.D. at 5%	0.123	12.35	0.691	1.837

Comment [D9]: Lettering should be added

4. CONCLUSION

Comment [D10]: Rewrite the conclusion

Based on the findings of the present investigation, it is concluded that application of 75% RDF along with Humic acid-12% (3ml/l) resulted in significant increase in flowering and yield attributes in tuberose 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. So the application of 75% RDF along with Humic acid-12% (3ml/l) can be recommended to farmers for better yield.

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