

## Original Research Article

### **Comparative performance of planting materials and standardization of nutrient requirement for high yield, quality and early spike development in Tuberose (*Agave amica* Medik.) cv. Arka Prajwal? Say the region/country**

#### **Abstract:**

The present investigation study was carried out at Vegetable Research Station (TNAU), Palur, Tamil Nadu during 2021 to 2022. The experiment was laid out in Factorial Randomized Block Design (FRBD) with eight treatments and three replications. Planting materials used for the study were bulbs and bulblets. The eight nutrient combinations were tried with foliar application of micronutrient like zinc sulphate (0.2%), Ferrous sulphate (0.5%), Copper sulphate (0.4%) and Boric acid (0.2%) on 30, 60 and 90 DAP, individually and in combination with 25 t ha<sup>-1</sup> FYM and recommended dose of fertilizer (200:200:200 kg ha<sup>-1</sup> NPK). The control was maintained with RDF. Various biometric observations on growth and flowering attributes of tuberose were observed for all the treatments at different stages. The result of the present investigation revealed that among the interaction effects, B<sub>1</sub>N<sub>8</sub>[RDF + ALL 19 (NPK) + GA<sub>3</sub>@ 200 ppm (2 spray at 30 days intervals) + ZnSO<sub>4</sub> (0.2%) + FeSO<sub>4</sub> (0.5%) + H<sub>3</sub>BO<sub>3</sub> (0.2 %) + CuSO<sub>4</sub> (0.4 %)] recorded the highest plant height (95.12 cm), leaf length (51.85 cm), leaf width (2.4 cm), number of leaves per plants (42.67), rachis length (34.87 cm), number of floret/spikes (46.66), flower duration (18.12 days), floret length (6.92 cm) and floret diameter (4.39 cm) followed by the treatment B<sub>2</sub>N<sub>8</sub> which recorded the highest height (90.44 cm), leaf length (48.48 cm), leaf width (2.2 cm), number of leaves per plants (39.78), rachis length (30.42 cm), number of floret/spikes (44.95), flower duration (19.93 days), floret length (6.45 cm) and floret diameter (4.21 cm). From the interaction effect, the treatment combination B<sub>2</sub>N<sub>1</sub> [control (RDF) 200:200:200 NPK] recorded the lowest plant height (72.36 cm), leaf length (42.81 cm), leaf width (1.12 cm) and number of leaves per plants (43.00), rachis length (25.11 cm), number of floret/spikes (37.00), flower duration (15.23 days), floret length (5.04 cm) and floret diameter (3.02 cm). (Define all abbreviations in the first usage; Say at least 1 strong suggestion from the study)

**Keywords:** Floral parameters, foliar Spray, micronutrient, planting material, tuberose, yield parameters.

## Introduction:

The word "tuberose" is a Latin word, which means swollen, refers to the root system of the plant. Tuberose - *Agave amica* (Medik.) cv. Prajwal which is formerly known as *Polianthes tuberosa* belongs to the family Amaryllidaceae and native to Mexico, is a popular bulbous ornamental crop in India and worldwide due to its pleasant fragrance, attractive spike and high economic value.

Tuberose is mostly grown as a loose flower crop in Tamil Nadu. According to the Ministry of Agriculture and Farmers Welfare in 2021, the total area under tuberose in Tamil Nadu during 2021-22 is around 7,030 hectares and the production is around 68,000 tonnes. Dindigul, Krishnagiri, Dharmapuri, Salem, Vellore, Madurai, Tiruvannamalai, Tirunelveli, and Erode are the main tuberose growing locations in Tamil Nadu. It is one of the most popular mass-market, bloated and bulb-shaped flowers and plays a significant role in both the domestic and international markets. Tuberose can be used as cut flowers and loose flowers for their pleasant fragrance. Farmers appreciate it for its greater financial return, lovely aroma, longer shelf life, adaptability to a wide range of climatic conditions and its capacity to grow in a variety of soil types (Tiwari *et al.*, 2002)

Flowering crops are much reactive to micronutrients (Jatav *et al.*, 2020) and use of micronutrients in plant fertilization acquires momentum due to their ability to improve plant growth, flowering and yield. However, the majority of developing nations in the globe struggle with a lack of micronutrients, especially iron and zinc (Sharma *et al.*, 2014). The optimum quantity, timing and application of the appropriate micronutrients are crucial for the better growth, flowering and quality of tuberose plants. For improved growth and superior flowering in tuberose plants, the right vitamin dosages, timing and application techniques are essential. To correct deficiency symptoms, maintenance of nutritional status enhance growth and produce quality in marginal soils, foliar spray by direct application on aerial plant parts is an efficient way rather than root fertilisation (Otalora *et al.*, 2018). The nutritional deficiencies are reached quickly by foliar application than root application, foliar application is becoming progressively more in demand (Niu *et al.*, 2021). Soil nutrients are not early reachable. This might be due to leaching, soil fixations, blockages and other losses. Foliar fertilization applies the nutrients directly on the leaf, where the plant mostly needs them.

The growing demand for tuberose blooms has resulted in a significant increase in the need for bulbs or other commercial planting materials for cultivation. Bulbs, bulblets and seeds can all be used to multiply tuberose. Although it is commercially propagated through bulbs, the tuberose bulbs are more expensive. It costs roughly Rs. 1,12,000 per acre. As an alternative to the more common technique of propagating tuberose through bulbs (1:1), bulblets have a greater multiplication rate (1:8). Therefore, bulblet propagation will lower the cost of planting material with a greater quantity of propagules. Tuberose propagation by bulblets is preferable to tuberose propagation through bulbs (Balan *et al.*, 2022)

### **Materials and methods:**

Field experiments were carried out at Vegetable Research Station (TNAU), Palurduring 2021 to 2022. The experimental site was located at about 11° 48' North latitude and 79° 40' East longitude and an altitude of 13.2 meter at Mean Sea Level. Planting materials of tuberose cv. Prajwal viz., bulbs & bulblets were obtained from the farmer's field at Dharmapuri district, Tamil Nadu. The experiment was carried out in Factorial Randomized Design (FRBD) to study the performance of planting material with eight nutrient combinations replicated three times. Recommended dose of nutrients (NPK@200:200:200 kg ha<sup>-1</sup>) were applied in the form of Urea, Single Super Phosphate and Muriate of Potash respectively. Full dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were applied at the time of planting as basal while N was applied in equal split at the time of planting as basal and 30 and 90 days after planting as top dressing. The nutrients were given with basal application of RDF, foliar spray of micronutrients and GA<sub>3</sub> in different combinations.

### **Treatment details:**

#### **Planting materials**

B<sub>1</sub> - Bulbs

B<sub>2</sub> - Bulblets

#### **Nutrient combination**

N<sub>1</sub> - control (RDF) 200:200:200 NPK

N<sub>2</sub> - RDF + ALL 19 (NPK) + GA<sub>3</sub>@ 200 ppm

N<sub>3</sub> - RDF + ALL 19 (NPK) + FeSO<sub>4</sub> (0.5%) + ZnSO<sub>4</sub> (0.2%)

- N<sub>4</sub> - RDF + ALL 19 (NPK) + ZnSO<sub>4</sub> (0.2%) + H<sub>3</sub>BO<sub>3</sub> (0.2 %)
- N<sub>5</sub> - RDF + ALL 19 (NPK) + ZnSO<sub>4</sub> (0.2%) + CuSO<sub>4</sub> (0.2%)
- N<sub>6</sub> - RDF + ALL 19 (NPK) + FeSO<sub>4</sub> (0.5%) + ZnSO<sub>4</sub> (0.2%) + H<sub>3</sub>BO<sub>3</sub> (0.2 %)
- N<sub>7</sub> - RDF + ALL 19 (NPK) + ZnSO<sub>4</sub> (0.2%) + H<sub>3</sub>BO<sub>3</sub> (0.2 %) + CuSO<sub>4</sub> (0.2%)
- N<sub>8</sub> - RDF + ALL 19 (NPK) + GA<sub>3</sub> @ 200 ppm (2 sprays at 30 days intervals) + ZnSO<sub>4</sub> (0.2%) + FeSO<sub>4</sub> (0.5%) + H<sub>3</sub>BO<sub>3</sub> (0.2 %) + CuSO<sub>4</sub> (0.2%)

Planting materials viz., bulbs and bulblets were used for planting. The size of the bulbs used for the experiment were around 4 cm in diameter and the bulblets were 1 to 2 cm in diameter. Bulblets were raised in protraynursery 45 days before planting. To prevent rot infections, the bulbs and bulblets were further treated with 0.1% Bavistin. The bulblets were also treated with Gibberellic acid at 150 ppm to break dormancy before planting for enhanced germination. Different combinations of media, including vermicompost, FYM, red soil and cocopeat were placed in the protrays. The biometric observations like plant height, leaf length, leaf width, number of leaves, days taken for first flowering, number of spikes per plant, spike length, rachis length, number of flowers per spike, flower length, and flower diameter were recorded. The statistical analysis of the data was done by adopting the standard statistical procedure given by Panse and Sukhatme (1995) at a critical difference of five percent (P = 0.05) probability.

## **Results and Discussion:**

### **i. Effect of treatment combinations on vegetative characters:**

The experimental data of various vegetative parameters like plant height, leaf length, leaf width and number of leaves per plant were recorded and statistically analysed which is shown in Table 1.

#### **a. Planting materials:**

The effect of planting materials had significantly influenced the vegetative parameters of tuberose cv. Prajwal. Among the planting materials used in the study, bulbs (B<sub>1</sub>) had recorded highest mean plant height (85.49 cm), leaf length (47.65 cm), leaf width (2.01 cm), number of leaves per plants (49.33) followed by bulblets (B<sub>2</sub>) with plant height (81.06 cm), leaf length (45.82 cm), leaf width (1.85 cm) and number of leaves per plants (48.02). The results illustrate that plant height increased with the increase in bulb size. Similar finding was

observed by Mahanta *et al.*, (1998) who observed taller plants in tuberose which might be due to the presence of more stored photosynthates in larger bulbs. The initial plant growth and the Vigor are determined by the amount of food supplied to the growing plant by the corm (Hossian. *Met al.*, 2011)

#### **b. Nutrient combinations**

The effect of nutrient combinations showed significance difference on vegetative parameters. Among the treatments, N<sub>8</sub> [RDF + ALL 19 (NPK) + GA<sub>3</sub>@ 200 ppm (2 sprays at 30 days intervals) + ZnSO<sub>4</sub> (0.2%) + FeSO<sub>4</sub> (0.5%) + H<sub>3</sub>BO<sub>3</sub> (0.2 %) + CuSO<sub>4</sub> (0.4)] recorded highest mean plant height (92.78 cm), leaf length (50.16 cm), leaf width (2.30 cm) and number of leaves per plants (56.69) while N<sub>1</sub>[control (RDF) 200:200:200 NPK ] recorded lowest mean plant height (73.18 cm), leaf length (44.32 cm), leaf width (1.16 cm) and number of leaves per plants (40.65). From the findings it is clearly understood that micronutrient treatments (0.5% FeSO<sub>4</sub> + 0.2% ZnSO<sub>4</sub> + 0.1% H<sub>3</sub>BO<sub>3</sub>) have positively influenced the vegetative characters. This might be due to the effect of Fe<sup>2+</sup> which regulate the development of chloroplast, formation of chlorophyll, photosynthesis and respiration activities (Bachman and Miller *et al.*, 1995). The increase in plant growth by the application of micronutrient treatment (0.5% FeSO<sub>4</sub> + 0.2% ZnSO<sub>4</sub> + 0.1% H<sub>3</sub>BO<sub>3</sub>) might be due to the activity of Zn<sup>2+</sup> which improves auxin synthesis and chlorophyll content (El-Bakry *et al.*, 2010).

#### **c. Interaction effect:**

The interaction effect between planting materials and nutrient combinations showed highly significant influence on vegetative parameters. The treatment combination of B<sub>1</sub>N<sub>8</sub> recorded highest plant height (95.12 cm), leaf length (51.85 cm), leaf width (2.4 cm) and number of leaves per plants (42.67) followed by the treatment B<sub>2</sub>N<sub>8</sub> which recorded the maximum plant height (90.44 cm), leaf length (48.48 cm), leaf width (2.2 cm) and number of leaves per plants (39.78). From the interaction effect, the treatment combination B<sub>2</sub>N<sub>1</sub> recorded the lowest plant height (72.36 cm), leaf length (42.81 cm), leaf width (1.12 cm) and number of leaves per plants (43.00).

Micronutrients like zinc and boron which might have benefited in nitrogen assimilation and protein synthesis, as well as working as catalytic agents in enzyme activation. Chaturvedi *et al.*, (1986) obtained similar increase in plant growth in gladiolus by spraying Agromin containing micronutrients such as B, Zn, Cu, Mn, Mg, and Mo. The combination of bulb with micronutrient (0.5% Cu + 0.5% ZnSO<sub>4</sub> + 0.5% FeSO<sub>4</sub> + 0.1% Boric acid) obtained the

highest number of leaves/plants, leaf length, and leaf width. According to Hatwaret *et al.*, (2003), the application of micronutrients increased the photosynthetic and other metabolic activities which enhanced the numerous plant metabolites important for cell division and elongation. Banu *et al.*, (2022) conducted an experiment with 45 × 20 cm spacing and 0.5% N + 0.5% ZnSO<sub>4</sub> + 0.5% FeSO<sub>4</sub> + 0.1% Boric acid on tuberose and the results of the experiment showed that plant spacing and foliar nutrition had a substantial impact on the growth leading to yield of tuberose.

**ii. Effect of treatment combinations on flowering characters:**

The data on flowering parameters as influenced by different planting material and foliar nutrition in tuberose are represented in Table.2

**a. Planting materials:**

The effect of planting materials had significantly influenced the flowering parameters of tuberose cv. Prajwal. Among the planting materials used in the study, the bulbs (B<sub>1</sub>) recorded the less number of days for first flowering (98.81 days) whereas the bulblets (B<sub>2</sub>) took more of days for first flowering (101.07 days). Likewise, bulb recorded the highest mean rachis length (31.93 cm), number of floret/spike (44.55), flower duration (17.31 days), floret length (6.12 cm), floret diameter (3.78 cm) whereas bulblets recorded lesser rachis length (26.94 cm), number of floret/spike (40.70), flower duration (16.43 days), floret length (5.72 cm) and floret diameter (4.21 cm).

The correlation between the size of bulb and flowering of tuberose are vital as size of bulb influence the amount of enzymes and nutrient for the flowering of tuberose (Tehranifar and Akbari, 2012). Similar finding was observed by Singh (2000) who reported that larger corms produced more florets in gladiolus. It was concluded that the large sized bulbs performed better and produced highest number of florets per spike which might be due to availability of more food reserve.

**b. Nutrient combination:**

The effect of nutrient combination showed significance difference in flowering parameters. Among the treatments, N<sub>8</sub> [RDF + ALL 19 (NPK) + GA<sub>3</sub>@ 200 ppm (2 sprays at 30 days intervals) + ZnSO<sub>4</sub> (0.2%) + FeSO<sub>4</sub> (0.5%) + H<sub>3</sub>BO<sub>3</sub> (0.2 %) + CuSO<sub>4</sub> (0.4)] took less number of days for first flowering (81.12 days) from the findings of micronutrient treatments (0.5% FeSO<sub>4</sub> + 0.2% ZnSO<sub>4</sub> + 0.1% H<sub>3</sub>BO<sub>3</sub>) had a positive influence on day taken for first flowering of tuberose and it might be due to Fe<sup>2+</sup> which has a major role in

stimulating the metabolic activity and speed up the reproductive activity. This was in agreement with the findings of Singh *et al.* (2015) in liliium. More days were taken for first flowering (122.96 days) in the control [N<sub>1</sub>- control (RDF) 200:200:200 NPK]. The nutrient combination N<sub>8</sub> recorded the highest mean rachis length (34.87 cm), number of floret/spike (45.80), flower duration (19.02 days), floret length (6.09 cm), floret diameter (4.30 cm). Spraying of GA<sub>3</sub> increased the rachis length by elongating the internodal length and this might be due to induction of cell division and cell elongation by the growth hormone. This is in agreement with the findings by Da Silva *et al.* (2018). N<sub>1</sub>-control recorded less compare to other nutrient combination, rachis length (26.21 cm), number of floret/spike (38.77), flower duration (15.12 days), floret length (5.58 cm) and floret diameter (3.11 cm).

**c. Interaction effect:**

The interaction effects between planting materials and nutrient combinations showed highly significant influence on flowering parameters. The treatment combination B<sub>1</sub>N<sub>8</sub> recorded less number of days taken for first flowering (79.92 days) followed by B<sub>2</sub>N<sub>8</sub> (82.32 days). From the interaction effect, the treatment combination B<sub>2</sub>N<sub>1</sub> recorded more number of days for first flowering (124.61 days). The treatment combination B<sub>1</sub>N<sub>8</sub> recorded the highest rachis length (34.87 cm), number of floret/spike (46.66), flower duration (18.12 days), floret length (6.92 cm) and floret diameter (4.39 cm) followed by B<sub>2</sub>N<sub>8</sub> with rachis length (30.42 cm), number of floret/spike (44.95), flower duration (19.93 days), floret length (6.45 cm) and floret diameter (4.21 cm). Among the interaction effect, the treatment combination B<sub>2</sub>N<sub>1</sub> recorded lowest rachis length (25.11 cm), number of floret/spike (37.00), flower duration (15.23 days), floret length (5.04 cm) and floret diameter (3.02 cm)

This might be due to application of micronutrients at their optimum quantities significantly improved flowering characteristics. Similar finding was observed by Ahmad *et al.*, (2021) in under foliar treatment mixture with Fe, Zn and B in tuberose flowering characteristics were found to be improved. This might be due to cell elongation, IAA synthesis, cell maturation, sugar translocation and protein synthesis caused by different micronutrients which improved the weight and size of gladiolus (Sharma and Khare, 2014). According to the research by Jain *et al.*, (2014) combination of (Zn 0.8 % + Fe 0.8 % + B 0.2 % + Cu 0.4 %) induced the early flowering and increased the floret length of tuberose.

TABLE:1 Effect of planting materials and nutrient combinations on vegetative characters of tuberose *Agave amica* (Medik.)

VEGETATIVE CHARACTERS												
	Plant height (cm)			Leaf length (cm)			Leaf width (cm)			No. of leaves per plant		
Planting Material Nutrient combinations	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean
N <sub>1</sub>	74.01	72.36	<b>73.18</b>	45.83	42.81	<b>44.32</b>	1.21	1.12	<b>1.16</b>	42.21	39.09	<b>40.65</b>
N <sub>2</sub>	76.46	73.28	<b>74.87</b>	46.01	43.76	<b>44.88</b>	1.92	1.77	<b>1.80</b>	43.31	41.46	<b>42.39</b>
N <sub>3</sub>	84.65	79.77	<b>82.21</b>	47.71	44.89	<b>46.30</b>	2.00	1.83	<b>1.90</b>	46.43	47.23	<b>46.83</b>
N <sub>4</sub>	89.02	81.31	<b>85.17</b>	46.12	45.94	<b>46.03</b>	2.11	1.92	<b>2.01</b>	49.23	48.75	<b>48.99</b>
N <sub>5</sub>	79.74	76.93	<b>78.33</b>	46.83	45.26	<b>46.04</b>	1.96	1.80	<b>1.80</b>	45.54	45.76	<b>45.65</b>
N <sub>6</sub>	93.44	88.65	<b>91.04</b>	50.02	48.10	<b>49.06</b>	2.30	2	<b>2.15</b>	56.38	54.02	<b>55.20</b>
N <sub>7</sub>	91.47	85.72	<b>88.59</b>	46.85	47.36	<b>47.10</b>	2.20	2.10	<b>2.20</b>	53.49	52.55	<b>53.02</b>
N <sub>8</sub>	95.12	90.44	<b>92.78</b>	51.85	48.48	<b>50.16</b>	2.40	2.20	<b>2.30</b>	58.04	55.34	<b>56.69</b>
<b>Mean</b>	<b>85.49</b>	<b>81.06</b>	<b>83.27</b>	<b>47.65</b>	<b>45.82</b>	<b>46.74</b>	<b>2.012</b>	<b>1.855</b>	<b>1.89</b>	<b>49.33</b>	<b>48.02</b>	<b>48.67</b>
	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>
SE (d)	0.435	0.870	1.231	0.314	0.629	0.890	0.016	0.033	0.047	0.305	0.611	0.864
CD@0.05	0.888	1.777	2.514	0.643	1.286	1.818	0.043	0.068	0.097	0.624	1.248	1.766

Source of TABLE!

TABLE:2 Effect of planting materials and nutrient combinations on flowering characters of tuberose *Agave amica* (Medik.)

FLOWERING CHARACTERS																		
PM NC	No of days taken for flowering			Rachis length (cm)			No. of floret/spike			Flower duration (days)			Floret length (cm)			Floret diameter (cm)		
	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean
N <sub>1</sub>	121.32	124.61	<b>122.96</b>	27.32	25.11	<b>26.21</b>	40.54	37.00	<b>38.77</b>	15.01	15.23	<b>15.12</b>	6.12	5.04	<b>5.58</b>	3.21	3.02	<b>3.11</b>
N <sub>2</sub>	114.54	116.87	<b>115.54</b>	28.47	25.32	<b>28.47</b>	42.68	38.06	<b>40.37</b>	15.23	15.87	<b>15.55</b>	6.37	5.10	<b>5.73</b>	3.35	3.18	<b>3.26</b>
N <sub>3</sub>	109.59	112.30	<b>110.94</b>	33.21	26.00	<b>33.21</b>	44.92	39.71	<b>42.31</b>	16.08	16.54	<b>16.31</b>	6.40	5.66	<b>6.03</b>	3.70	3.67	<b>3.68</b>
N <sub>4</sub>	90.63	95.87	<b>93.25</b>	33.45	26.32	<b>33.45</b>	45.00	40.56	<b>42.78</b>	16.77	17.99	<b>17.38</b>	6.48	6.00	<b>6.24</b>	3.82	3.77	<b>3.80</b>
N <sub>5</sub>	95.42	97.55	<b>96.48</b>	29.54	25.89	<b>29.54</b>	44.65	38.93	<b>41.79</b>	15.86	16.12	<b>15.99</b>	6.35	5.18	<b>5.76</b>	3.65	3.23	<b>3.44</b>
N <sub>6</sub>	86.67	89.54	<b>88.10</b>	34.98	28.45	<b>34.63</b>	46.23	43.42	<b>44.82</b>	17.45	18.83	<b>18.14</b>	6.66	6.32	<b>6.05</b>	4.15	4.02	<b>4.08</b>
N <sub>7</sub>	92.43	89.54	<b>90.98</b>	33.98	28.02	<b>33.98</b>	45.72	43.02	<b>44.37</b>	16.93	18.03	<b>17.48</b>	6.48	6.05	<b>6.45</b>	3.95	3.95	<b>3.95</b>
N <sub>8</sub>	79.92	82.32	<b>81.12</b>	34.87	30.42	<b>34.87</b>	46.66	44.95	<b>45.80</b>	18.12	19.93	<b>19.02</b>	6.92	6.45	<b>6.099</b>	4.39	4.21	<b>4.30</b>
Mean	<b>98.81</b>	<b>101.07</b>	<b>99.94</b>	<b>31.934</b>	<b>26.941</b>	<b>29.43</b>	<b>44.551</b>	<b>40.707</b>	<b>42.62</b>	<b>16.43</b>	<b>17.31</b>	<b>16.87</b>	<b>6.12</b>	<b>5.72</b>	<b>6.09</b>	<b>3.78</b>	<b>3.63</b>	<b>3.7</b>
	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>
SE (d)	0.583	1.167	1.651	0.259	0.518	0.733	0.243	0.487	0.689	0.094	0.188	0.267	0.053	0.106	0.150	0.024	0.048	0.068
CD@0.05	1.192	2.385	3.373	0.529	1.058	1.497	0.497	0.995	1.407	0.192	0.385	0.545	0.108	0.217	0.307	0.049	0.099	0.140

Source of TABLE!

**TABLE:3 Effect of planting materials and nutrient combinations on yield parameters of tuberose *Agave amica* (Medik.)**

Planting Materials Nutrient combinations	Single floret weight (g)			Weight of floret per spike (g)			Yield per plot(kg)		
	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean	B <sub>1</sub>	B <sub>2</sub>	Mean
N <sub>1</sub>	1.49	1.41	<b>1.45</b>	42.81	40.80	<b>41.80</b>	1.28	1.72	<b>1.50</b>
N <sub>2</sub>	1.57	1.49	<b>1.53</b>	44.01	42.32	<b>43.16</b>	1.38	1.89	<b>1.63</b>
N <sub>3</sub>	1.68	1.54	<b>1.61</b>	43.57	44.30	<b>43.93</b>	1.46	2.04	<b>1.75</b>
N <sub>4</sub>	1.77	1.64	<b>1.70</b>	46.26	45.55	<b>45.90</b>	1.62	2.23	<b>1.93</b>
N <sub>5</sub>	1.76	1.68	<b>1.72</b>	44.56	42.66	<b>43.61</b>	1.56	2.16	<b>1.86</b>
N <sub>6</sub>	1.80	1.77	<b>1.77</b>	47.34	46.32	<b>47.14</b>	1.72	2.42	<b>2.07</b>
N <sub>7</sub>	1.60	1.75	<b>1.71</b>	48.00	45.55	<b>46.44</b>	1.57	2.41	<b>1.99</b>
N <sub>8</sub>	1.92	1.81	<b>1.86</b>	49.24	46.24	<b>47.88</b>	1.90	2.51	<b>2.20</b>
Mean	<b>1.70</b>	<b>1.63</b>	<b>1.67</b>	<b>45.76</b>	<b>44.21</b>	<b>44.98</b>	<b>1.56</b>	<b>2.17</b>	<b>1.86</b>
	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>	<b>B</b>	<b>N</b>	<b>B×N</b>
SE(d)	<b>0.012</b>	<b>0.024</b>	<b>0.034</b>	<b>0.268</b>	<b>0.536</b>	<b>0.758</b>	<b>0.014</b>	<b>0.028</b>	<b>0.040</b>
CD@0.05	<b>0.025</b>	<b>0.050</b>	<b>0.070</b>	<b>0.547</b>	<b>1.095</b>	<b>1.549</b>	<b>0.029</b>	<b>0.058</b>	<b>0.082</b>

Source of TABLE!

**iii. Effect of treatment combinations on yield characters:**

The data on yield parameters influenced by different planting materials and nutrient combinations in tuberose are represented in Table. 3

**a. Planting materials:**

The effect of planting materials had significantly influenced the yield parameters of tuberose cv. Prajwal. Among the planting materials used in the study, the bulblets (B<sub>2</sub>) recorded highest mean flower yield per plot (2.17 kg) whereas the bulbs (B<sub>1</sub>) recorded lowest mean yield per plot (1.56 kg). The treatment B<sub>1</sub> recorded the highest mean single floret weight (1.70 g), weight of floret per spike (45.76 g) followed by the treatment B<sub>2</sub> (bulblets) with single floret weight (1.67 g) and weight of floret per spike (44.21 g). Though the flower characters are higher when bulbs were used as planting material, highest yield per plot was

obtained when bulblets were used as planting material. This might be due to accommodation of more bulblets in unit space because of its lesser in size compare to the bulb. This is in accordance with the finding of Balan *et al.*, (2022).

#### **b. Nutrient combinations**

The effect of nutrient combination showed significance difference in yield parameters. Among the treatments, N<sub>8</sub> [RDF + ALL 19 (NPK) + GA<sub>3</sub> @ 200 ppm (2 sprays at 30 days intervals) + ZnSO<sub>4</sub> (0.2%) + FeSO<sub>4</sub> (0.5%) + H<sub>3</sub>BO<sub>3</sub> (0.2 %) + CuSO<sub>4</sub> (0.4)] recorded highest mean single floret yield (1.86 g), weight of floret per plant (47.88 g), flower yield per plot (2.20 kg) This might be due to the fact that, Iron enhanced the flowering parameters, relived the plant from chlorosis and produced healthy green leaves which resulted in higher assimilate synthesis and partitioning of flower growth which may in turn have increased the flower production and ultimately yield. Similar results were also reported by Balkrishnan *et al.*, (2007) in marigold and Ganga *et al.*, (2008) in chrysanthemum and lower value of yield parameter were observed in the N<sub>1</sub>[control (RDF) 200:200:200 NPK] single floret yield (1.45 g), weight of floret per plant (41.80 g) and flower yield per plot (1.50 kg).

#### **c. Interaction effect**

The interaction effects between planting materials and nutrient combination showed highly significant influence on yield parameters. The treatment combination of B<sub>2</sub>N<sub>8</sub> recorded highest flower yield per plot (2.51 kg) followed by B<sub>1</sub>N<sub>8</sub> (1.90 kg). From the interaction effect, the treatment combination B<sub>1</sub>N<sub>1</sub> recorded lesser flower yield per plot (1.28 kg). The treatment combination B<sub>1</sub>N<sub>8</sub> recorded the highest single floret weight (1.92 g), weight of floret per plant (49.24 g) followed by B<sub>2</sub>N<sub>8</sub> with single floret weight (1.81 g) and weight of floret per plant (46.24 g). Among the interaction effect, the treatment combination B<sub>2</sub>N<sub>1</sub> recorded lowest single floret weight (1.41g), weight of floret per plant (40.80 g).

Bulblets are small in size with a slow growth process closer planting was done which accommodated more plants per unit area. Closer planting resulted in more plant population in the current study, but there was insufficient space for trapping solar energy for various metabolic activities Banu *et al.*, (2022). While the closer spacing resulted in significantly higher flower yield/plot and yield per hectare. This could be due to a higher number of plants per unit area. This was in accordance with the findings of Singh *et al.*, (2018). The foliar application of zinc sulphate and borax resulted in increased flower weight and yield from the findings of Karuppaiah (2019) in tuberose. Cost of bulb is

higher compared to the bulblets, where the multiplication rate of bulblets is higher (1:8) compared to the conventional method of propagation through bulbs (1:1) Balan *et al.*, (2022).

### **Conclusion:**

From the above results, it is observed that when tuberose cultivation is commercially propagated through bulbs, the cost of bulbs is higher around Rs. 1,12,000 per acre. When tuberose is propagated through bulblets, the multiplication rate of bulblets is higher (1:8) compared to the conventional method of propagation through bulbs (1:1). The results showed that the performance of bulblets which raised in protray nursery for 45 days before transplanting in the main field are almost similar to the normal bulbs in yield and growth parameters with the cost benefit ratio of bulblets which is higher than cultivation by bulbs. Thus, we can reduce the cost of bulbs required for planting by 50 percent and thereby reduce the cost of production and dependence on costly mother bulbs.

### **Reference:**

1. Bachman, G, and W Miller. 1995. "Iron chelate inducible iron/manganese toxicity in zonalgeranium." *Journal of plant nutrition* 18 (9):1917-1929.
2. Balakrishnan VM, Jawaharlal T, Senthil Kumar, Ganga M. Response of micronutrients on flowering, yield and xanthophylls content in African marigold. *J. Ornam. Hort.*, 2007; 10(3):153-156
3. Balan, S., Aruna, P., Rajamani, K., & Vanitha, K. (2022). Effect of media on the growth of bulblet propagated tuberose plants.
4. Banu, A. A., Aruna, P., Kavitha, M., & Vanitha, K. (2022). Effect of plant spacing and foliar nutrition on growth and physiological parameters of tuberose (*Polianthes tuberose* L.) cultivar Prajwal.
5. Chaturvedi OP, IN Shukla, AR Singh. Effect of agromin on growth and flowering in gladiolus. *Haryana J Hort Sci.* 1986;18(3&4):196–199.
6. Da Silva, PS, CF Barreto, MBM Kirinus, AV Schiavon, MB Malgarim, and P Mello-Farias. 2018. "Effects of Gibberellic acid (GA3) on reduction of rot disease and physico-chemical quality of 'Pinot Noir' grape." *Australian Journal of Crop Science* 12(8):1363-1369.

7. El-Baky, A., Ahmed, M. E., Nemr, and M. Zaki. 2010. "Effect of potassium fertilizer and foliar zinc application on yield and quality of sweet potato." *Research Journal of Agriculture & Biological Sciences* 6(4):386-394.
8. Ganga M, Jagadeeswari V, Padmadevi K, Jawaharlal M. Response of chrysanthemum cv. CO.1 to the application of micronutrients. *J Orna. Hort.* 2008; 11(3):220-223.
9. Hatwar GP, Gondane SU, Urkude SM, Gahukar OV. Effect of micronutrients on growth and yield of chilli. *Soils and crops.* 2003; 13:123-125.
10. Hossian, M. J., Amin, M. R., Choudhury, S., & Uddain, J. (2011). Effect of corm size and different doses of phosphorous on the growth, corm and cormel development of gladiolus. *Libyan Agriculture Research Center Journal International*, 2(1), 09-14.
11. Jain, P. A. L. A. K. (2014). *Effect of micronutrients on growth and flowering of tuberose (Polianthes tuberosa L.)* (Doctoral dissertation, M. Sc. Thesis, College of Horticulture, Mandsaur, India).
12. Jatav, H. S., Sharma, L. D., Sadhukhan, R., Singh, S. K., Singh, S., Rajput, V. D., ... & Sukirtee. (2020). An overview of micronutrients: prospects and implication in crop production. *Plant micronutrients: deficiency and toxicity management*, 1-30.
13. Karuppaiah P. Effect of zinc and boron on growth, yield and quality of tuberose (Polianthes tuberosa L.) cv. Prajwal. *Horticulture International Journal.* 2019; 3:10. 15406/hij.2019.03.00104
14. Katiyar, R.S., Garg, V.K. and Singh, P.K., 2005. Foliar spray of Zn and Cu on growth, floral characteristics and yield of gladiolus. *Indian journal of Horticulture.* 62 (3): 272-275.
15. Kumari, R. V., Kumar, D. P., Arunkumar, B. and Mahadevamma M. (2013). Effect of plant density, planting methods and mulches on floral and cormel parameters in gladiolus (*Gladiolus hybridus* L.). *Asian J. Hort.* 8(2): 391-398.
16. Mahanta, P., L. Paswan and A.B. Siddique. 1998. Effect of bulb size on growth and flowering of tuberose (*Polianthes tuberosa* L.) cv. Single. *Annal Agric. Biol. Res.* 3: 35-38.
17. Mudassir, S., Ahmad, R., & Anjum, M. A. (2021). Foliar Application of Micronutrients Enhances Growth, Flowering, Minerals Absorption and Postharvest Life of Tuberose (*Polianthes tuberosa* L.) in Calcareous Soil. *J. Hortic. Sci. Technol*, 4, 41-47.

18. Niu, Junhao, Chang Liu, Mingli Huang, Kezhong Liu, and Dongyun Yan. 2021. "Effects of foliar fertilization: a review of current status and future perspectives." *Journal of Soil Science*
19. Otálora, G., Piñero, M. C., López-Marín, J., Varó, P., & del Amor, F. M. (2018). Effects of foliar nitrogen fertilization on the phenolic, mineral, and amino acid composition of escarole (*Cichorium endivia* L. var. *latifolium*). *Scientia Horticulturae*, 239, 87-92.
20. Panse, V. G., & Sukhatme, P. V. (1954). Statistical methods for agricultural workers. *Statistical methods for agricultural workers*.
21. Sahare, H., Singh, A., Singh, G., Sharma, R., & Kumari, P. (2018). Effect of Thidiazuron with Sucrose Pulsing and Low Temperature Storage with Polyfilm Packaging on Floret Opening and Abscission of Tuberose Cut Spikes. *Journal of Pure and Applied Microbiology*, 12(3), 1385-1392.
22. Sharma, Priti, Prachi Sharma, Vishal Chugh, Harcharan Singh Dhaliwal, and Dharmendra Singh. 2014. "Morphological, Cytological and Biochemical Characterization of wheat *Aegilops longissima* Derivatives BC<sup>1</sup>F<sup>6</sup> and BC<sup>2</sup>F<sup>4</sup> with High Grain Micronutrient." *International Journal of Agriculture, Environment and Biotechnology* 7 (2):191
23. Sharma, U. B., & Khare, R. K. (2014). Effect of bio fertilizers and foliar spray of zinc under different levels of N, P on floral characteristics and economics of *Gladiolus grandiflorus*. *Bhartiya Krishi Anusandhan Patrika*, 29(2), 78-81.
24. Singh, K.P. 2000. Growth, flowering and corm production in gladiolus as affected by different corm sizes. *J. Ornament. Hort.* 3: 26–29
25. Singh, KP. 1996. "Effect of spacings on growth and flowering in tuberose (*Polianthes tuberosa* Linn.) cultivar Shringar." *Indian Journal of Horticulture* 53 (1):76-79.
26. Tiwari, H., M. Kumar, R.K. Naresh, M.K. Singh, S. Malik, S.P. Singh and V. Chaudhary (2018). Effect of organic and inorganic fertilizers with foliar application of gibberellic acid on productivity, profitability and soil health of marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda. *Int. J. Agricult. Stat. Sci.*, 14(2), 575-585

Remove all numbers on the LIST OF REFERENCE and format all journal names in ITALIC format; is the standard rule