

## Original Research Article

### **Influence of organic manures and biofertilizers on growth and flowering behavior of tuberose (*Polianthus tuberosa* L.) cv. Prajwal**

#### **Abstract**

**Aim:** To analyse the effect of organic manures and biofertilizers for growth and flower yield in tuberose (*Polianthes tuberosa* L.) cv. Prajwal

The experiment was performed in pots in completely randomized design (CRD) with 11 treatments having four replications to study the response of organic manures, chemical fertilizers and biofertilizers on growth and flower yield of tuberose (*Polianthes tuberosa* L.) cv. Prajwal. The treatment containing sand + vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.) was significantly superior in terms of plant height (70.50cm), length of leaf (36.98cm), Number of leaf (25.67), spike length (66.58cm), rachis length (27.23cm), diameter of stem (1.096cm), florets number per spike (35), number of opened florets per spike (33.67), spikes number per clump, spike weight (75.33g), bulb number per clump (21), bulb diameter (1.20cm), bulb weight (3.98g). While lowest values of these parameters were observed in control (sand). Minimum days taken to bulb sprouting (21.75 days), days taken to complete bulb sprouting (24.50 days), days taken to spike emergence (93 days) and days taken to opening of first floret (106.75 days) was observed in sand + inorganic manures.

**Key words:** *Azotobacter*, FYM, *Pseudomonas*, Vermicompost.

#### **Introduction**

Tuberose has a great economic potential for cut flower as well as loose flower. Tuberose is grown for various purposes such as making *gajras*, *veni*, artistic garlands, bouquets and religious offerings. The tuberose flowers are also used in cosmetic products, raw material of perfumes and in aromatherapy due to its ability to calm the nerves. Tuberose is semi-hard perennial bulbous plant and is suitable for growing in tropical and subtropical climates. Plant nutrition is an important factor for growth and development, quality of spikes and flowers. Generally, farmers apply inorganic fertilizers in improper dose which adversely affects the soil productivity and fertility status. The usage of organic fertilizers and biofertilizers may open new horizons to preserve or to recover the soil health without reducing the crop yield. Organic manures and biofertilizers supply the nutrients to the plants from sources, to which the plant cannot tap themselves (Srivastava *et al.*, 2014).

Organic manures are eco-friendly which improves soil health in terms of physical, chemical and biological properties. FYM is rich in nutrients and most commonly used manure. Vermicompost is produced through earthworms by feeding on plant residue and biological waste matter. Vermicompost has adequate quantity of N, P, K along with different micronutrients vital for plant growth and development. Biofertilizers contain active microorganisms, which hydrolyze the insoluble phosphate into soluble one and these are safe for human, animal and environment. These are low cost and eco-friendly inputs and have tremendous potential for supplying nutrients, especially N and P which ultimately reduce the chemical fertilizer dose by 25-50% (Vyas *et al.*, 2018). *Azotobacter* is free living, nitrogen-fixing, mesophilic, heterotrophic bacteria and aerobic in nature. It has the ability to synthesize growth promoting substances such as auxins, gibberellins and to some extent vitamins along with ability to fix atmospheric nitrogen in soils. *Azotobacter* utilizes atmospheric nitrogen for its cell protein synthesis. After death of *Azotobacter*, the cell protein is mineralized into soil and it contributes towards the nitrogen availability of plant. *Pseudomonas* is phosphorus solubilizing bacteria having ability to solubilize precipitated forms of P or it mineralizes organic phosphorus. *Pseudomonas* is the producer of plant hormones, having ability to colonize the rhizosphere and act as effective biocontrol agent. The purpose of using sand along with organic manures and biofertilizers is that this region has sandy soil low in organic matter.

Keeping in view the above facts, the present investigation was planned to analyse the effect of organic manures and biofertilizers for growth and flower yield in tuberose (*Polianthes tuberosa* L.).

## Materials and methods

**Planting material and Biofertilizers:** The study was conducted in Botanical Garden, CCSHAU, Hisar, Haryana. In this experiment uniform sized bulb of tuberose cv. Prajwal were treated with *Azotobacter* (200 ml) and *Pseudomonas* sp. (200 ml) for one hour. The experiment was laid out in Completely Randomized Design (CRD) with total 11 treatments viz., T<sub>1</sub>: Sand (control), T<sub>2</sub>: Sand + Inorganic manure, T<sub>3</sub>: Sand + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.), T<sub>4</sub>: Sand + FYM (1:1), T<sub>5</sub>: Sand + FYM (1:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.), T<sub>6</sub>: Sand + FYM (2:1), T<sub>7</sub>: Sand + FYM (2:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.), T<sub>8</sub>: Sand + vermicompost (3:1), T<sub>9</sub>: Sand + vermicompost (3:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.), T<sub>10</sub>: Sand + vermicompost (4:1), T<sub>11</sub>: (Sand + vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)) having 4 replications each. Organic manures which are light in weight in comparison to sand and having sufficient nutrient contents, due to which, different treatment combinations were tested on volume basis instead of weight basis.

**Inorganic manures:** Half dose of nitrogen (20g N /m<sup>2</sup>), full dose of P<sub>2</sub>O<sub>5</sub> (10g / m<sup>2</sup>) and K<sub>2</sub>O (10g /m<sup>2</sup>) was applied at the time of planting and remaining half dose of nitrogen was applied through top-dressing method at the time of spike emergence. The data of plant and flower characters were recorded: days taken to sprouting, days taken to complete

sprouting, plant height (cm), length of leaf (cm), No. of leaf, days taken to spike emergence, days taken to opening of first floret, spike length (cm), rachis length (cm), diameter of stem (cm), florets number per spike, number of opened florets per spike, spikes number per clump and weight of spike (g). The data for bulb characters were recorded: - bulb number per clump, bulb weight and bulb diameter.

**Statistical Analysis:** Observations was recorded and subjected to statistical analysis (Panse and Sukhatme, 1987) as per the design of the experiment (one factorial CRD) and tested for critical difference at 5% level of significance for plant growth, flower parameters and bulb characters. The data of tuberose and samples was analyzed through descriptive statistics.

## Result and discussion

**Vegetative growth characters:** The data in Table1 clearly shows minimum days taken to bulb sprouting (21.75) and complete bulb sprouting (24.50) were recorded in treatment T<sub>2</sub> (Sand + Inorganic manure), and was found at par with treatment T<sub>5</sub>, T<sub>9</sub>. The maximum days taken to bulb sprouting (27.75) and complete bulb sprouting (30.25) were recorded in treatment T<sub>1</sub> (Sand) which were recorded at par with T<sub>10</sub> and T<sub>6</sub>. Earliness in bulb sprouting and complete bulb sprouting were recorded in T<sub>2</sub> (sand + inorganic manures) the probable reason for earliness in bulb sprouting might be due to early absorption of essential nutrients through the surface of bulbs or through primary roots, which might have stimulated early sprouting. Similar results were reported by Kumar *et al.* (2015a) and Singh *et al.* (2014) in tuberose.

**Table 1: Influence of organic manures and biofertilizers on plant growth characters of tuberose**

Treatments	Days taken to sprouting	Days taken to complete sprouting	Plant height (cm)	Length of leaves (cm)	No. of leaves per clump
T <sub>1</sub>	27.75	30.25	59.65	30.31	15.00
T <sub>2</sub>	21.75	24.50	62.42	33.04	19.33
T <sub>3</sub>	25.00	27.75	60.67	32.02	15.75
T <sub>4</sub>	23.00	28.75	65.24	34.18	19.25
T <sub>5</sub>	22.75	25.00	68.60	36.72	24.50
T <sub>6</sub>	27.00	30.00	61.36	31.10	15.50
T <sub>7</sub>	25.75	28.00	68.43	32.31	20.67
T <sub>8</sub>	25.50	28.25	63.78	33.26	15.67
T <sub>9</sub>	22.75	24.75	68.15	33.66	19.25
T <sub>10</sub>	26.25	29.00	67.48	35.63	17.33
T <sub>11</sub>	25.50	28.25	70.50	36.98	25.67
<b>C.D. at 5%</b>	<b>1.99</b>	<b>1.37</b>	<b>1.29</b>	<b>1.71</b>	<b>1.44</b>

**Plant height (cm), length of leaf (cm) and number of leaf per clump:** It is evident from the data given in Table 1 that plant height, length of leaf, number of leaf differed significantly with various treatments. The maximum plant height

(70.50 cm), length of leaf (36.98 cm) and number of leaf (25.67) were recorded with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)), which was significantly higher over the remaining treatments, however minimum plant height (59.65cm), length of leaf (30.31 cm) and number of leaf (15) were recorded in treatment T<sub>1</sub> (Sand). The rise in height of plant, leaf length, and leaf number because the organic manures and biofertilizers provide nutrients to the plants in the accessible form. They are ample in micronutrients in addition with plant growth encouraging substances viz., enzymes, hormones and humus forming beneficial microbes. Organic matters, on usage to the soil, enhance the physical properties of soil such as aeration, permeability, aggregation and water holding capacity which build up growth, and development of plants. Similar trend reported in Sudhagar *et al.*(2020), Singh *et al.*(2015), Preetham *et al.*(2017) and Kumar (2015a) in tuberose.

**Days taken to spike emergence and opening of first florets:** The perusal of data on days taken to spike emergence and opening to first floret is depicted in Table 2 and different treatments differed significantly among each other. The minimum days taken to spike emergence (93.00) and opening of first floret (106.75) were observed with treatment T<sub>2</sub> (Sand + Inorganic manure), which was statistically at par with T<sub>11</sub> and T<sub>9</sub>. The maximum days taken to spike emergence (103.63) and opening of first floret (119.3) were observed in T<sub>4</sub> (Sand + FYM (1:1), closely followed by T<sub>6</sub> which was significant higher over the other treatment. Earliness in spike emergence and opening of first floret with T<sub>2</sub> (sand + inorganic manures) reverts in early completion of growth phase and have greater stimulation in bulb metabolism which leads to the earliness spike emergence. Similar results were obtain by Kumar *et al.* (2015b), Shirsat *et al.* (2015) in tuberose and Sudhagar *et al.* (2020) in tuberose).

**Table 2: Influence of organic manures and biofertilizers on flowering characters of tuberose**

Treatments	Days taken to spike emergence	Days taken to opening of first floret	Stem diameter (cm)	No. of spikes per clump	No. of florets per spike	No. of opened florets per spike	No. of unopened florets per spike
T <sub>1</sub>	101.00	117.33	0.88	1.25	23.50	17.50	6.00
T <sub>2</sub>	93.00	106.75	0.92	1.00	31.00	28.50	2.50
T <sub>3</sub>	100.95	112.50	0.89	1.75	29.33	27.66	1.67
T <sub>4</sub>	103.63	119.31	0.90	1.25	25.00	21.00	4.00
T <sub>5</sub>	96.75	112.25	0.97	1.75	28.71	27.04	1.67
T <sub>6</sub>	103.00	119.00	0.90	1.00	30.11	25.11	5.00
T <sub>7</sub>	100.75	117.50	0.94	2.00	32.17	29.17	3.00
T <sub>8</sub>	96.13	109.40	0.90	2.25	26.53	21.03	5.50
T <sub>9</sub>	94.03	109.20	0.96	1.75	27.44	23.94	3.5

T <sub>10</sub>	95.50	111.15	0.96	1.75	29.83	28.05	1.78
T <sub>11</sub>	93.50	107.00	1.10	1.00	35.00	33.67	1.33
<b>C.D. at 5%</b>	<b>1.59</b>	<b>1.56</b>	<b>0.04</b>	<b>NS</b>	<b>1.21</b>	<b>1.55</b>	<b>1.06</b>

**Stem diameter (cm):** The stem diameter varied significantly with application of organic manures and biofertilizers is presented in Table 2. The maximum diameter of stem (1.096 cm) was recorded with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)), which was statistically significant over the remaining treatments. The minimum stem diameter (0.882 cm) was found in T<sub>1</sub> (Sand), which is at par with T<sub>2</sub> (0.916 cm), T<sub>3</sub> (0.889 cm), T<sub>4</sub> (0.896 cm), T<sub>6</sub> (0.897 cm) and T<sub>8</sub> (0.896 cm). Treatments T<sub>2</sub>, T<sub>5</sub>, T<sub>7</sub>, T<sub>9</sub> and T<sub>10</sub> were found at par with each other. Maximum increase in stem diameter (1.10 cm) was with T<sub>11</sub> may be due to protoplasm formation, division and elongation of meristem cells, enhancing the biosynthesis of proteins and carbohydrates which lead to enhancing the growth. Similar results were reported in tuberose by Preetham *et al.* (2017) and Shirsat *et al.* (2015).

**Number of florets per spike and number of opened florets per spike:** The data given in Table 2 presents that florets number per spike and number of opened florets per spike increased with application of organic manures and biofertilizers over T<sub>1</sub> (sand). The maximum florets number per spike (35.00) and number of opened floret per spike (33.67) was recorded with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)) which was statistically higher over the remaining treatments. The minimum florets number per spike (23.50) number of opened florets per spike (17.50) was count with treatment T<sub>1</sub> (Sand). Treatments T<sub>2</sub>, T<sub>6</sub> and T<sub>7</sub> were at par with each other; similarly T<sub>3</sub>, T<sub>5</sub> and T<sub>10</sub> were at par with each other. The increase in florets number per spike and number of opened florets per spike might be because the organic matter and biofertilizers use nutrients to the plants in the transferable form and they are also ample in micronutrients along with having plant growth encouraging substances viz., enzymes, hormones and humus creating beneficial microbes, which increases rachis length as clear from the present investigation, which ultimately produces more number of florets per spike. Similarly, Kumar *et al.* (2012) in their study on tuberose reported that number of florets per spike (32.60). Munikrishnappa *et al.* (2004), Bhalla *et al.* (2007) and Shirsat *et al.* (2015) reported that number of florets per spike significantly increase with organic manures and biofertilizers in tuberose.

**Number of florets unopened per spike:** The unopened florets per spike decreased significantly with application of organic manures and biofertilizers over T<sub>1</sub> (sand) except T<sub>6</sub> and T<sub>8</sub> represented in table 2. The minimum number of florets unopened per spike (1.33) was with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)) which was found at par with T<sub>2</sub> (2.50), T<sub>3</sub> (1.67), T<sub>5</sub> (1.67) and T<sub>10</sub> (1.78). The maximum number of florets unopened per spike (6.00) was notice with treatment T<sub>1</sub> (Sand). Treatments T<sub>4</sub>, T<sub>7</sub> and T<sub>9</sub> were found at par with each other. The decrease in number of florets unopened per spike, because the organic matter and biofertilizers use

nutrients to the plants in the accessible form and they are also ample in micronutrients along with having plant growth encouraging substances viz., enzymes, hormones and humus forming favorable microbes, which improves the flower quality, which ultimately produces less number of florets unopened per spike. Similar findings were reported by Koley and Pal (2011), Kumar (2015a) in tuberose.

**Number of spikes per clump:** The perusal of data presented in table 2 shows that the effect of organic manures and biofertilizers upon number of spikes per clump was non-significant. However increase in number of spikes per clump (2.25) was observe in T<sub>8</sub> and lowest (1.00) in T<sub>2</sub>, T<sub>6</sub> and T<sub>11</sub>.

**Length of spike (cm) and Length of rachis (cm):** The mean values presented in table 3 revealed that spike length, rachis length increased with application the organic manures and biofertilizers over T<sub>1</sub> (sand). Maximum length of spike (66.58 cm) and length of rachis (27.23 cm) was recorded with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)), which was significant over other treatments. The minimum length of spike (52.13 cm) and length of rachis (17.90 cm) was recorded with T<sub>1</sub> (Sand) which was at par with T<sub>6</sub> and T<sub>10</sub>. Treatments T<sub>2</sub>, T<sub>9</sub> and T<sub>7</sub> were at par with each other and T<sub>3</sub>, T<sub>4</sub>, T<sub>7</sub> and T<sub>8</sub> were at par with each other. As supply of nutrients through the organic manures and biofertilizers are rich in micronutrients besides having plant growth promoting substances viz., hormones, enzymes and humus forming beneficial microbes, which leads to increase in length of spike and rachis length. Organic sources, on application to the soil, improve the physical properties of soil such as aggregation, aeration, permeability and water holding capacity which promote growth, and development of plants. Similarly, length of spike (70.50 cm) and length of rachis (27.50 cm) reported by Kumar (2015a) in his study on tuberose. Singh *et al.* (2015), Preetham *et al.* (2017) and Suchismita *et al.* (2018) were also reported similar trend in tuberose.

**Table 3: Influence of organic manures and biofertilizers on flowering characters**

Treatments	Spike weight (g)	Length of spike (cm)	Length of rachis (cm)	No. of bulb per clump	Diameter of bulb (cm)	Weight of bulb (g)
T <sub>1</sub>	54.22	52.13	17.90	13.00	1.04	2.12
T <sub>2</sub>	71.96	60.68	22.50	15.50	1.10	2.77
T <sub>3</sub>	55.67	58.25	19.43	14.75	1.05	2.74
T <sub>4</sub>	63.00	59.41	20.77	18.50	1.13	2.44
T <sub>5</sub>	66.67	64.36	21.68	19.00	1.18	2.77
T <sub>6</sub>	60.00	52.20	18.83	16.50	1.07	2.14
T <sub>7</sub>	64.67	59.10	21.03	19.50	1.09	2.43
T <sub>8</sub>	60.71	58.72	20.75	18.00	1.18	2.71
T <sub>9</sub>	62.50	60.33	23.43	19.50	1.18	2.83
T <sub>10</sub>	68.26	52.75	22.54	16.25	1.06	2.60
T <sub>11</sub>	75.33	66.58	27.23	21.00	1.20	3.98
<b>C.D. at 5%</b>	<b>2.45</b>	<b>1.64</b>	<b>1.50</b>	<b>1.29</b>	<b>0.06</b>	<b>0.51</b>

**Spike weight (g):** The spike weight increased significantly with application of organic manures and biofertilizers over T<sub>1</sub> (sand) except T<sub>3</sub> represented in table 3. The maximum spike weight (75.33 g) was found with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)) which was statistically higher over the other treatments. The minimum spike weight (54.22 g) was found with treatment T<sub>1</sub> (Sand) which was found at par with T<sub>3</sub> (55.67). Second most effective treatment in increasing the spike weight (71.96 g) was T<sub>2</sub> which was again superior to T<sub>3</sub> to T<sub>8</sub>. Increase in the spike weight might be due to abundant supply of nutrients, which prolonged the vegetative growth and ultimately uses supply of nutrients towards spike development hence increased the weight of spike. Pradhan *et al.* (2015), Kumar (2015b), Bohra and Nautiyal (2019) recorded similar trend in tuberose.

**Number of bulbs per clump:** It is obvious from the data presented in the table 3 that number of bulbs per clump rise significantly with implementation of organic manures and biofertilizers on top of T<sub>1</sub>. The maximum bulbs number per clump (21) was found with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)), which was statistically superior over the other treatment in increasing the number of bulbs per clump. The minimum number of bulbs per clump (13) was found with treatment T<sub>1</sub> (Sand). Second most effective treatment in increasing the number of bulbs per clump (19.50) was notice T<sub>7</sub> and T<sub>9</sub> which were at par with T<sub>4</sub> and T<sub>5</sub>. The increase in number of bulbs might be due to the fact that nutrients and various growth hormones helped in increasing the more amount of assimilates that are need for enhancing the number of bulbs. Similar results was reported by Prity *et al.* (2011) in their study that number of bulbs per clump (39.40) was found in organic fertilizer and rich compost @ 10t/ha in tuberose.

**Diameter of bulb (cm):** Data presented table 3 revealed that diameter of bulb varied much with application various treatments. The greatest diameter of bulb (1.20 cm) was found with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)) which was found at par with T<sub>5</sub> (1.18 cm), T<sub>8</sub> (1.18 cm) and T<sub>9</sub> (1.18 cm). The smallest diameter of bulb (1.04 cm) was found with T<sub>1</sub> (Sand) which was at par with T<sub>2</sub> (1.10 cm), T<sub>3</sub> (1.05 cm), T<sub>6</sub> (1.07 cm), T<sub>7</sub> (1.09 cm) and T<sub>10</sub> (1.06 cm). Organic manures and biofertilizers led to improve the vegetative growth of plants so the plants could produce a good quality of bulbs. Furthermore, nutrients had a positive effect on photosynthesis and respiration rates and leaf carbohydrate and the nutrients uptake and transport, consequently produced good plants which can store a large amount of food in the bulb, thus bulb diameter could be increased. Similar results were reported in tuberose by Yadav *et al.* (2005) and Kumar (2015b).

**Weight of bulb (g):** It is apparent from the data shown in the table 3 that weight of bulb increased significantly with application of organic manures and biofertilizers over T<sub>1</sub> (sand) except T<sub>4</sub>, T<sub>6</sub> and T<sub>7</sub>. The maximum weight of bulb (3.98 g) was found with treatment T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.)), which

was significantly highest over the other treatments. The minimum weight of bulb (2.12 g) was found with T<sub>1</sub> (Sand) which was statistically at par with treatment T<sub>4</sub> (2.44 g), T<sub>6</sub> (2.14 g), T<sub>7</sub> (2.43 g) and T<sub>10</sub> (2.60 g). Treatments T<sub>2</sub> to T<sub>5</sub> and T<sub>7</sub> to T<sub>10</sub> were found at par with each other. The increase in bulb weight might be due to the fact that nutrients helped in increasing the more amount of assimilate that are need for increase in bulb weight. Similar results in tuberose by Yadav *et al.* (2005) and Kumar (2015b).

### Conclusion:

Minimum number of days taken for bulbs sprouting (21.75), complete bulb sprouting (24.50), spike emergence (93.00) and opening of first floret (106.75) was observed in T<sub>2</sub> (Sand + Inorganic manures) treatment. height of Plant, length of leaf, number of leaf, spike length, rachis length, stem diameter, number of florets per spike, number of florets opened per spike, spike weight, number of bulbs per clump, diameter of bulb and weight of bulb increased significantly with organic manures and biofertilizers over T<sub>1</sub> (sand). Maximum plant height (70.50 cm), length of leaves (36.98 cm), length of spike (66.58 cm), length of rachis (27.23 cm), stem diameter (1.09 cm), spike weight (75.33 g) diameter of bulb (1.20 cm), weight (3.98 g) of bulb, maximum number of leaves per clump (25.67), number of florets per spike (35.00), number of florets opened per spike (33.67) and number of bulbs per clump (21.00) were obtained in T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.) treatment. Minimum number of florets unopened per spike (1.33) were obtained in T<sub>11</sub> (Sand + Vermicompost (4:1) + Biofertilizers (*Azotobacter* & *Pseudomonas* sp.) treatment.

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