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Effect of NPK, farm yard manure and vermicompost on vegetative growth, and flowering in tuberose (*Polianthes tuberosa* Linn) cv. Prajwal

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Abstract
An investigation was carried out in the Department of Horticulture, in North Eastern Hill University, Tura Campus, Meghalaya (India) during 2019-2020 to study the response of Tuberose (*Polianthes tuberosa* Linn.) cv. Prajwal to application of FYM and the Vermicompost on vegetative growth, and flowering. The experiment was conducted to examine the performance of tuberose in organic amendments compare to inorganic fertilizer. The experiment consisted of 11 treatments and replicated 3 times in Randomized Block. The treatments were T_1: Control, T_2: Recommended dose of NPK (60:30:45 Kg/ha), T_3: FYM @ 25 tonnes/ha, T_4: FYM @ 50 tonnes/ha, T_5: FYM @ 75 tonnes/ha, T_6: vermicompost @ 10 tonnes/ha, T_7: vermicompost @ 20 tonnes/ha, T_8: vermicompost @ 30 tonnes/ha, T_9: FYM + vermicompost (25 tonnes/ha + 10 tonnes/ha), T_{10}: FYM + vermicompost (50 tonnes/ha + 20 tonnes/ha) and T_{11}: FYM + vermicompost (75tonnes/ha + 30 tonnes/ha). In terms of vegetative growth, result showed that T_{11} significantly produced the earliness to days to 50% plant emergence (19.22 days), highest plant height (87.47 cm), numbers of leaves per clump (90.10), leaf area (207.82 cm^2), number of plants per clump (11.91). In flowering character, earliness in emergence of spike (98.89 days), days to first floret opening (117.66), highest spike length (101.48 cm), rachis length (30.96 cm), highest florets/spike (39.76), floret diameter 4.29 cm, floret length (5.33 cm), number of spike/clump 5.72 and 49.44 per plot and maximum flower spike yield/ha was found maximum in T_{11}. Tuberose responded positively to all the parameters recorded in organic treatments and their combination than inorganic and control treatments. In the light of rising concerns for environmental and ecological impact of chemical inputs in agriculture, these organic amendments can be successfully used for ecofriendly crop production.

Keywords: Farm yard manure, fertilizers, floriculture, manure, tuberose, vermicompost

1. Introduction

Tuberose (*Polianthes tuberosa* Linn.) is one of the most important tropical bulbous flowering plants cultivated for the production of long lasting flower spikes (Singh and Shankar, 2011) [29]. It belongs to family Amaryllidaceae and is native to Mexico (Trueblood, 1973) [34]. The generic name *Polianthes* coined by Linneaeus (1737) [36] is probably derived from Greek word ‘Polios’ meaning hoary or shining white and ‘anthos’ meaning flower in allusion to the blooms of the common tuberose. The common name tuberose is derived from *tuberosa*, this plant being the tuberous hyacinth as distinguished from the bulbous hyacinth. Tuberose is a fragrant night-blooming flower and occupies a very selective and prominent position among the ornamental bulbous flowering plants which are valued much by the aesthetic world for the serene beauty of the bright snow-white flowers and delicacy of its magnificent fragrance to transform an entire area into a nectarine and joyous one. Due to their lingering, delightful fragrance and excellent keeping quality they are adorned with romantic vernacular names such as Gulcheri or Nishigandha (Marathi), Rajnigandha (Bengali and Hindi), Nelasampengi (Telugu), Gul-e-shabu (Urdu), Sugandharaja (Kannada and Tamil) and Gulchadi (Gujrati) (Randhawa *et al*., 2001) [24]. The single type flowers are highly scented and are extensively used for loose flower purpose, essential oil and concrete extraction, making garland and more fragrant etc., while double varieties are used as cut flowers, garden display and for interior decoration.

The crop is a bulbous perennial day neutral crop, perpetuating itself through bulbs. The quality of tuberose flower is affected by various pre- and post-harvest factors such as temperature, relative humidity, irrigation, nutrition and harvesting time (Benschop, 1993) [6]. Tuberose needs warm and humid climate for its luxuriant growth.

It grows well in the open field where temperature ranges from 20-30 °C (Arora, 2011) [3]. Very low temperature and frost damage the tuberose plant. Tuberose is insensitive to photoperiod, exposure to day length of approximately 16 hours promoted the vegetative growth of the plant and enhanced the emergence of spike by 10 days. The rate of first floret emergence is directly influenced by the temperature of 21-22 °C (Khan *et al*., 2007) [13]. Warm temperature promotes flower initiation, while irrigation improves quality and yield of flowers (Franklin *et al*., 2010) [9].

It can be grown on almost all types of soil, however, the production of tuberose is effected by physical and chemical properties of soil (Noghani *et al*., 2012) [19]. Tuberose is heavy feeder of nutrients and requires a high amount of organic and inorganic fertilizers to maintain sustainable growth and flowering over a long period (Amarjeet *et al*., 1996) [2]. There are many factors which affect plant growth such as size of bulb and bulblets, depth of planting, optimum level of fertilizer and appropriate concentration of growth regulating chemicals. The number of florets per spike, flower quality, daughter bulb production etc., are related to application of appropriate level of fertilizer and growth regulating chemicals. Nitrogen, phosphorus and potassium have a significant effect on spike production as well as duration of flowering (Singh *et al*., 2004) [31]. The chemical fertilizers alone are not sustainable on long-term basis for increasing crop production. The excessive use of chemical fertilizers and the negligence shown to soil conservation have not only caused exhaustion of soil and its nutrient reserve but also resulted in soil health problems which are not conclusive for achieving consistent increase in agricultural production. A recent trend in farming with organic inputs has resulted in renewed interest in organic farming which is beneficial for improving quality, production and in preventing soil deterioration. The indiscriminate application of chemical fertilizer alters the soil fertility, causes pollution of soil and water bodies. So, it is necessary to reduce the dose of chemical fertilizers and supplement it with low cost input organic fertilizer. The use of cost effective and eco-friendly organic fertilizers has currently attained special significance in crop production to address the sustainability problem and tremendous success has been achieved in several economic crops.

2. Materials and Methods

The experimental site is located at the experimental farm of the Department of Horticulture, NEHU, Tura Campus, Chasingre, West Garo Hills, Meghalaya. The prevalent climate of the region is sub-tropical, experiences a relatively high temperature in summer and cool winter. The maximum temperature recorded during the experimental period was 37.85 °C and the minimum temperature was 13.30 °C. The maximum and minimum relative humidity (R.H) observed during the course of study was 89.76 per cent and 55.86 per cent. Total rainfall was 148.47mm which occurs mostly during the monsoon season. A detailed of meteorological data collected during the period of investigation is presented in Table 1.

The bulbs of tuberose cv. Prajwal used for the experiment were procured from the germplasm being maintained at Kahikuchi Horticultural Research Station, Assam Agricultural University. The experiment was laid out in Randomized Block Design (RBD) with eleven treatments and replicated three times. The detailed information regarding different treatments is as follows: T_1= Control, T_2= Recommended dose of NPK, T_3= FYM 25 tonnes/ha, T_4= FYM 50 tonnes/ha, T_5= FYM 75 tonnes/ha, T_6= Vermicompost 10 tonnes/ha, T_7= Vermicompost 20 tonnes/ha, T_8= Vermicompost 30 tonnes/ha, T_9= FYM+ Vermicompost (25 tonnes/ha + 10 tonnes/ha), T_{10}=FYM+ Vermicompost (50 tonnes/ha + 20 tonnes/ha), T_{11}= FYM+ Vermicompost (75 tonnes/ha+ 30 tonnes/ha) respectively.

3. Result and Discussion

3.1 Vegetative Parameters

3.1.1 Days to plant emergence (days)

From the data shown in Table 1 the earliest days to sprouting of bulbs (7.33 days) were recorded in treatment T_9 which was statistically at par with treatment T_6 (8.11 days), while the most delayed sprouting (14.66 days) was recorded under treatment T_1 which was found to be significantly different from all the treatments. The results were in accordance with the findings of Hadwani *et al*. (2013) [10] that application of FYM @ 30 tonnes per ha + PSB @ 2 g per m^2 + *Azotobacter* @ 2 g per m^2 resulted in early sprouting of bulb of tuberose cv. Double. Early sprouting of bulb in cv. Suvasini and cv. Prajwal (5.67 days and 6.67 days, respectively) was also reported by Lalthawmliana *et al*. (2013a).

3.1.2. Days to 50% plant emergence (days)

The data on average days to 50% plant emergence presented in Table 1 revealed that the minimum days taken to 50% plant emergence was recorded in T_{11} (19.32 days) which was at par with treatment T_3 (19.34 days), T_7 (20.00 days), T_8 (20.00 days), T_4 (21.00 days) and T_6 (21.00 days), whereas maximum days to 50% plant emergence was recorded in T_1 (24.33 days) which was at par with treatments T_2 (24.32 days), T_{10} (23.67 days), T_5 (21.67 days) and T_9 (21.67 days). The results were in accordance with the findings of Chaturvedi *et al*. (2014a) [7] who reported minimum number of days taken for 50% sprouting in cv. Local (12.46 days).

Table 1: Effect of NPK, FYM and vermicompost on days to plant emergence, days to 50% plant emergence of tuberose (*Polianthes tuberosa* L.) cv. Prajwal

Treatments	Days to plant mergence (Days)	Days to 50% plant emergence (Days)
T_1	14.66	24.33
T_2	11.33	24.32
T_3	13.00	19.34
T_4	11.33	21.00
T_5	10.77	21.67
T_6	8.11	21.00
T_7	11.39	20.00
T_8	9.00	20.00
T_9	7.33	21.67
T_{10}	10.77	23.67
T_{11}	9.55	19.32
Mean	10.66	21.48
C.D (5%)	1.54	3.20
SE(d)	0.73	1.52

3.1.3. Plant height (cm)

At 30 days after planting, the results revealed that maximum plant height (14.26 cm) was recorded in treatment T_5 which was at par with treatments T_{11} (13.67 cm), T_{10} (12.83 cm), T_8 (12.74 cm), T_4 (12.68 cm), T_3 (12.25 cm) and T_9 (12.25 cm), whereas minimum plant height (10.14 cm) was observed in treatment T_1 (Shown in Table 2). At 210 DAP the maximum plant height (87.47 cm) was observed in treatment T_{11} and it was significantly superior over all the treatments. The minimum plant height (46.93 cm) was observed in treatment T_1. These showed that combination of FYM and vermicompost had positive effect on increasing plant height which was in line with Ramachandrudu and Thangam (2009a) [22] reported maximum plant height of 65.13 cm in cv. Prajwal (65.13 cm) and Lalthawmliana *et al*. (2013b) with 48.63 cm plant height in cv. This increase in plant height might be due to the fact that FYM and vermicompost are rich sources of plant macronutrients (NPK), vital micronutrients (Fe, B, Zn and Mn) and secondary nutrients (Ca, Mg) which release these nutrients at a slow rate which helped in vegetative growth (Joshi and Prabakarshetty, 2005) [11].

Table 2: Effect of NPK, FYM and vermicompost on plant height of tuberose (*Polianthes tuberosa* L.) cv. Prajwal

Treatments	Plant height				
	30 DAP	**90 DAP**	**120 DAP**	**180 DAP**	**210 DAP**
T_1	10.14	30.71	41.41	44.04	46.93
T_2	11.68	41.64	50.61	65.21	66.38
T_3	12.25	42.87	53.44	60.92	62.37
T_4	12.68	45.51	59.75	66.47	73.92
T_5	14.26	51.63	64.91	75.52	81.18
T_6	10.18	36.16	41.96	47.96	51.41
T_7	10.81	37.92	44.23	53.34	53.52
T_8	12.74	47.49	63.97	73.35	78.48
T_9	12.25	43.60	59.31	68.26	72.96
T_{10}	12.83	50.25	64.35	71.54	77.90
T_{11}	13.67	52.16	65.21	78.72	87.47
Mean	12.14	43.63	55.38	64.12	68.41
C.D (5%)	2.36	4.90	5.14	3.41	2.20
SE(d)	1.12	2.33	2.44	1.62	1.05
C.V (%)	11.35	6.50	5.41	5.32	6.18

3.1.4. Number of plants per clump
The data presented in Table 3 revealed that treatment T_{11} had the maximum number of plants per clump (2.66) after 60 DAP which was at par with treatments T_{10} (2.61), T_8 (2.46), T_5 (2.44), T_4 (2.41), and T_9 (2.39), while the minimum number of plants per clump (2.11) was noticed in treatment T_1 which was at par with treatments T_6 (2.13), T_7 (2.16), T_3 (2.25), and T_2 (2.33). The maximum number (11.91) of plants per clump was observed at 180 DAP in treatment T_{11} (FYM @ 75 tonnes/ha + vermicompost @ 30 tonnes/ha). The number of tillers increased with age till 180 DAP followed by a decline due to some tillers died at later stages of growth. After 210 DAP the maximum number of plants per clump (9.83) was in treatment T_{11} and it was significantly superior over all the treatments while the minimum (4.58) was observed in treatment T_1 which was at par with treatments T_6 (5.13) and T_7 (5.36). These results were in agreement with Tripathi *et al*. (2012a) [33] reported highest number of tillers per clump (18.95) in tuberose cv. Single treated with 75% recommended dose of NPK + 500 quintal FYM per ha + 250 quintal vermicompost/ha.

Table 3: Effect of NPK, FYM and vermicompost on number of plants per clump of tuberose (*Polianthes tuberosa* L.) cv. Prajwal

Treatments	Plants per clump				
	60 DAP	**90 DAP**	**120 DAP**	**180 DAP**	**210 DAP**
T_1	2.11	2.25	3.66	4.83	4.58
T_2	2.33	3.33	4.83	8.94	7.33
T_3	2.25	3.58	5.66	8.16	6.52
T_4	2.41	5.16	7.06	9.80	7.86
T_5	2.44	5.43	8.24	10.33	8.77
T_6	2.13	2.83	4.61	5.64	5.13
T_7	2.16	3.05	4.66	6.00	5.36
T_8	2.46	5.96	8.27	9.83	7.76
T_9	2.39	4.49	8.00	9.50	7.66
T_{10}	2.61	6.40	8.48	10.16	8.17
T_{11}	2.66	7.33	10.61	11.91	9.83
Mean	2.36	4.53	6.74	8.65	7.18
C.D (5%)	0.32	1.48	1.63	1.03	0.88
SE(d)	0.15	0.70	0.77	0.49	0.42
C.V (%)	7.92	19.07	14.10	6.99	7.20

3.1.5 Number of leaves per clump
The maximum number of leaves (8.78) was recorded in treatment T_{11} after 30 DAP which was significantly superior over all the treatments. The minimum number of leaves (4.56) was observed in treatment T_1 which was at par with treatments T_7 (4.75), T_6 (5.07) and T_2 (5.43). The number of the leaves/clump continued to increase till 180 DAP and declined in subsequent months. The maximum leaves/clump was recorded in T_{11} (90.10) at 180 DAP with FYM @ 75 tonnes/ha + vermicompost @ 30 tonnes/ha (Table 4).

However, after 210 DAP when plant transcended towards senescence the number of leaves per clump was reduced to maximum (81.40) in treatment T_{11} which was significantly superior over all the treatments whereas the minimum was recorded in T_1 (54.43) which was significantly different from all the treatments.

The results recorded were in in line with Tripathi *et al*. (2012b) [33]; Kabir *et al*. (2011) [12]; Munikrishnappa *et al*. (2011) [18] and Shankar *et al*. (2010a) [27] who reported the maximum number of leaves with the application of vermicompost in tuberose. The increased number of leaves per clump could be attributed to the solubilization effect of plant nutrients by addition of vermicompost leading to increased uptake of NPK (Abusaleha and Shanmungavelu, 1988) [1] and also due to the increased availability of nitrogen, which is an important constituent of chlorophyll and protein, thus causing more growth (Atiyeh *et al*., 2001) [4].

Table 4: Effect of NPK, FYM and vermicompost on number of leaves per clump of tuberose (*Polianthes tuberosa* L.) cv. Prajwal

Treatments	Number of leaves per clump				
	30 DAP	90 DAP	120 DAP	180 DAP	210 DAP
T_1	4.56	35.50	41.37	51.23	54.43
T_2	5.43	38.30	51.83	70.60	72.67
T_3	5.67	40.73	55.80	68.30	66.63
T_4	5.67	40.93	56.43	81.07	74.27
T_5	5.77	41.53	59.47	86.73	76.47
T_6	5.07	31.27	42.07	57.37	60.67
T_7	4.57	36.27	41.53	63.33	64.20
T_8	6.22	42.00	61.07	82.37	74.40
T_9	5.67	40.73	53.20	73.27	74.07
T_{10}	6.10	44.10	64.13	82.13	75.20
T_{11}	8.78	46.37	81.27	90.10	81.40
Mean	5.79	39.79	55.29	73.32	70.40
C.D (5%)	1.08	2.60	5.43	4.07	4.48
SE(d)	0.51	1.23	2.58	1.94	2.13
C.V (%)	10.87	8.81	5.72	5.24	7.71

3.2 Flowering characters

3.2.1 Number of days to spike emergence (days)

The data on number of days taken for spike initiation as influenced by different treatments is presented in Table 5. The least number of days (98.89 days) taken for spike initiation was observed in treatment T_{11} which was found to be significantly differed from all the treatments followed by treatment T_{10} (112.27 days). Whereas, the maximum number of days (129.94 days) taken to spike initiation was observed in treatment T_1 which was at par with treatments T_6 (126.05 days), T_7 (125.75 days), T_3 (125.52 days), T_4 (125.44 days), T_9 (124.16 days) and T_5 (123.50 days). The data pertaining to number of days required for spike emergence indicated that the treatment T_{11} (FYM @ 75 tonnes/ha + vermicompost @ 30 tonnes/ha) significantly reduced the number of days (98.89 days) required for emergence of spike than any other treatments. The results were in conformity with findings of Barman *et al*. (2003) [5] reported early spike emergence with the application of FYM along with biofertilizers. Vasanthi and Kumaraswamy (1999) [35] reported that the flowering of the plant is affected by the balanced uptake of nitrogen and the availability of micronutrients resulting in early flower initiation.

3.2.2 Days to first floret opening (days)

From the data presented in Table 5 the least number of days (117.66 days) taken for the first floret opening in a spike was recorded in treatment T_{11}, while the maximum number of days taken for floret opening (151.33 days) was recorded in treatment T_1 which was at par with treatments T_6 (147.11 days), T_7 (146.69 days), T_3 (145.55 days), T_4 (145.33 days), T_5 (144.75 days) and T_9 (143.50 days). The results revealed that the minimum days to flowering were recorded in treatment T_{11} (117.66 days) integrating FYM @ 75 tonnes/ha + vermicompost @ 30 tonnes/ha. Similar findings were reported by Krishnamoorthy (2014) [14] that Prajwal had least number of days to opening first floret (153 days). The early flowering initiation in combined treatment of organic component might be due to balanced supply of nitrogen from organic sources which promotes the translocation of phytohormones to the apical shoots as reported by Marschner (1983) [17].

3.2.3 Spike length (cm)

The maximum length of spike (101.48 cm) was recorded in T_{11} which was significantly superior over the rest of the treatments (Table 5) and the minimum spike (82.76 cm) length was recorded in T_1. It was observed that spike length increased with the application of FYM and vermicompost. The maximum spike length (101.48 cm) was recorded in T_{11} (FYM @ 75 tonnes/ha + vermicompost @ 30 tonnes/ha). Treatment T_{11} produced plants of maximum height and more number of leaves which might have resulting in longest spike. The results were in accordance to Shankar *et al*. (2010b) [27] reported highest spike length in tuberose cv. Single when treated with vermicompost (1 kg/m^2) and PSB (2 g/bulb). Similar results were also obtained by Singh *et al*. (2006) [30].

3.2.4. Rachis length (cm)

The maximum length of rachis (30.96 cm) was observed in T_{11} (Table 5) which was significantly superior over the rest of the treatments. The minimum length of rachis (22.02 cm) was observed with treatment T_1 which was statistically at par with treatments T_9 (22.59 cm) and T_3 (22.60 cm). The rachis length was significantly influenced by the different treatment in which treatment T_{11} (FYM @ 75 tonnes/ha + vermicompost @ 30 tonnes/ha), showed highest spike length and rachis length (30.96 cm). The maximum vegetative growth of the plant might have resulted in longest rachis length. The results were in line with Prakash *et al*. (2016) [21] who reported cultivar Prajwal had maximum rachis length (31.00 cm) with application of organic supplements.

3.2.5. Floret diameter (cm)
The maximum floret diameter (4.29 cm) was recorded in treatment T_{11} followed by T_{10} (4.28 cm), T_8 (4.24 cm), T_9 (4.23 cm) and T_5 (4.22 cm) which were on par with each other (Table 5). The minimum floret diameter (4.04 cm) was recorded in the treatment T_7 which was at par with treatments T_1 (4.06 cm) and T_3 (4.10 cm). Results showed that treatment T_{11} (FYM @ 75 tonnes/ha + vermicompost @ 30 tonnes/ha) produced significantly larger sized floret (4.29 cm) than other treatments. The results were in accordance with Sateesha *et al*. (2011) [26] that Prajwal had maximum (5.19 cm) floret diameter. Similar was reported by Ramachandrudu and Thangam (2009b) [22] that maximum floret diameter in cv. Prajwal was 3.59 cm.

3.2.6. Floret length (cm)
From the data shown in Table 5 the maximum length of floret (5.33 cm) was recorded in treatment T_{11} which was at par with T_8 (5.32 cm), T_{10} (5.31 cm), T_5 (5.30 cm), T_2 (5.29 cm), T_4 (5.25 cm), T_3 (5.22 cm), T_9 (5.19 cm) and T_7 (5.18 cm) whereas, the minimum length of floret (4.95 cm) was recorded in T_1 which was at par with T_6 (5.11 cm). The results were in accordance to the findings of Chaturvedi *et al*. (2014b) [7] that cv. Prajwal had maximum (5.86 cm) floret length. A similar improvement in floret length was reported by Padaganur *et al*. (2005a) [20] with application of vermicompost with other organic manures or fertilizers.

Table 5: Effect of NPK, FYM and vermicompost on days to spike emergence, days to first floret opening, spike length, rachis length, fresh weight of spike of tuberose (*Polianthes tuberosa* L.) cv. Prajwal

Treatment	DSE (days)	FFO (days)	SL (cm)	RL (cm)	FWS (g)
T_1	129.94	151.33	82.76	22.02	74.66
T_2	119.61	140.14	92.98	28.75	93.33
T_3	125.52	145.55	91.73	22.60	95.55
T_4	125.44	145.33	90.38	25.61	102.44
T_5	123.50	144.75	93.57	29.01	92.77
T_6	126.05	147.11	82.90	26.30	71.77
T_7	125.75	146.69	91.09	25.24	85.11
T_8	116.24	138.15	93.96	28.03	104.72
T_9	124.16	143.50	90.04	22.59	94.66
T_{10}	112.27	131.33	92.79	28.21	107.33
T_{11}	98.89	117.66	101.48	30.96	120.00
Mean	120.67	141.05	91.25	26.30	94.76
C.D (5%)	6.55	7.85	1.87	1.64	7.81
SE(d)	3.12	3.73	0.89	0.78	3.71
C.V (%)	7.16	8.24	8.34	6.63	8.80

DSE: Days to spike emergence; FFO: First floret opening; SL: Spike length; RL: Rachis length; FWS: Fresh weight of spike

3.2.7 Number of florets per spike
The highest number of florets per spike revealed highest number of florets per spike (39.76) was recorded in T_{11} (Table 6) which was significantly superior over the rest of the treatments whereas, the least number of florets per spike (21.48) was recorded in treatment T_6 which was at par with T_9 (21.58), T_7 (22.77) and T_1 (22.88). A similar result was reported by Ranchana (2013) [23] with highest number of florets per spike in cv. Prajwal (43.00) followed by Shringar (42). The finding was also in line with Sreenivas *et al*. (1998) [32] that application of FYM + NPK (recommended dose) gave highest florets/spike.

3.2.8. Number of spikes per clump
The maximum number of spike per plant (1.72) was recorded in treatment T_{11} which was significantly superior over all the treatments (Table 6). The lowest number of spike per plant (1.00) was recorded in T_1 which was at par with T_7 (1.08). The results obtained from the present investigation were in accordance with that of Rao *et al*. (2015) [25] who observed maximum number of spikes per plant in tuberose cv. Hyderabad Double treated with75% RDF and different combination of FYM, vermicompost, *Azospirillum* and phosphate solubilizing bacteria.

3.2.9. Number of spikes/plot/ha
From the data presented in Table 6 the maximum number of spikes per plot (16.33) was recorded in T_{11} which was at par with treatment T_5 (15.33). However, the least number of spikes per plot (9.00) was recorded in treatment T_1. Similarly, the yield of the flower spike per hectare in number was found highest in T_{11} (4, 94,400) followed by T_{10} (4, 16,900) and T8 (4,07,200) respectively. Improvements in flower yield with the application of vermicompost in addition to other organic manures were also reported by Padaganur *et al*. (2005b) [20] and Chauhan *et al*. (2005) [8] in marigold.

3.2.10. Field life (days)
The treatment T_{11} (22.17 days) gave maximum field life of flower which was at par with T_2 (21.20 days), T_8 (21.05 days), T_{10} (20.91 days), T_5 (20.41 days), T_9 (20.36 days) and T_4 (19.97 days) respectively (Table 6). Whereas, the minimum field life of flower was found in T_7 (18.00 days) which was at par with T_3 (18.49 days), T_6 (18.51) and T_1 (18.99 days) respectively. The longest field life of flower might be due to high vegetative growth and longest spike length with more number of florets. The results were in conformity with the findings of Shashidhara and Gopinath (2002) [28] reported that application of organic fertilizers gave maximum field life of flower in calendula. The results were also in conformity with the findings of Padaganur *et al*. (2005c) [20] who reported maximum field life of flower in the field due to application of vermicompost in tuberose.

Table 6: Effect of NPK, FYM and vermicompost on floret diameter, floret length, number of florets per spike, field life and number of spike yield/ha in number of tuberose (*Polianthes tuberosa* L.) cv. Prajwal

Treatment	FD (cm)	FL (cm)	FPS	FLL	Yield/ha
T_1	4.06	4.95	22.88	18.99	117000
T_2	4.19	5.29	29.33	21.20	275300
T_3	4.10	5.22	25.91	18.49	397500
T_4	4.20	5.25	29.33	19.97	388800
T_5	4.22	5.30	36.76	20.41	379100
T_6	4.21	5.11	21.48	18.51	278600
T_7	4.04	5.18	22.77	18.00	311600
T_8	4.24	5.32	29.06	21.05	407200
T_9	4.23	5.19	21.58	20.36	370900
T_{10}	4.28	5.31	33.08	20.91	416900
T_{11}	4.29	5.33	39.76	22.17	494400
Mean	4.18	5.22	28.36	20.01	NA
C.D (5%)	0.07	0.19	1.97	2.35	
SE(d)	0.03	0.09	0.94	1.12	
C.V (%)	5.10	6.14	12.63	6.83	

FD: Floret diameter; FL: Floret length; FPS: Floret per spike; FLL; Field Life

4. Conclusion

It can be concluded from the present investigation that among all the treatments, treatment T_{11} (FYM @ 75 tonnes/ha + vermicompost @ 30 tonnes/ha) performed best for the vegetative growth, flowering and yield characters with respect to earliness of days to 50% plant emergence (19.22 days), highest plant height (87.47 cm), number of leaves per clump (90.10), leaf area (207.82 cm^2) and 11.91 number of plants per clump which was reflected by early emergence of spike (98.89 days), days to first floret opening (117.66 days), highest fresh weight of spike of (120.00 g), highest spike length of (101.48 cm), rachis length of (30.96 cm), maximum number of florets/spike (39.76), floret diameter (4.29 cm), floret length (5.33 cm), number of spikes per clump (5.72), per plot (49.44) and per hectare (4, 94,400). Based on the results above, the tuberose cv. Prajwal gave excellent response to FYM, vermicompost and their combination with respect to vegetative, flowering and yield parameters. For ecofriendly and sustainable crop production FYM, Vermicompost and their combination can be suitably and successfully use for the production of tuberose in the light rising concerns for consequences of inorganic fertilizers on environment.

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6. Conflicts of interest

The author declares no conflict of interest.

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