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Effect of Fertigation and Organic Nutrients on Yield Attributing Parameters and Yield of Tuberose

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A B S T R A C T

The experiment was carried out in Tuberose cv. Prajwal to investigate the effect of fertigation and organic nutrients on yield attributing parameters and yield during 2015-2016 and 2016-2017. The experiment was laid out in randomized block design with nineteen treatments and replicated twice. The pooled mean of first and second year results revealed that, 100 per cent recommended dose of fertilizer through fertigation along with microbial consortium @ 12.5 kg ha^{-1}, panchagavya @ 3 per cent and humic acid @ 0.4 per cent (T_9) registered the highest number of spikes clump^{-1}, spike length, number of florets spike^{-1}, length of floret, diameter of floret, single flower weight, hundred flower weight and flower yield ha^{-1}. The increase of flower yield ha^{-1} by the T_9 over soil application of recommended dose of fertilizer was 40 per cent.

***Key words*:** Fertigation, Microbial consortium, Biostimulants, Yield, Tuberose

Tuberose (*Polianthes tuberosa* L.) is an important flower crop grown in India and belongs to the family Amaryllidaceae, is an open field cultivated flower that is gaining popularity because of its easy cultivation, higher returns [1], hardy nature and wide adaptability to different edaphic and climatic conditions across the country. The flowers are liked for their prettiness, elegance and fragrance. This flower crop of India blooms throughout the year, and it is valued for multipurpose uses like cut flowers in vase decoration, floral arrangements and boquets, as loose flower for making veni, garland making and essential oil in cosmetic and perfumery industry. Nutrition is one of the most important aspects in increasing the yield and quality of Tuberose flowers. Under commercial cultivation of Tuberose, inadequate plant nutrition mainly causes stunted growth which may lead to decline of plant vigour and eventually lead to reduced productivity and profit. Tuberose requires a large quantity of NPK, both in the form of organic and inorganic fertilizers. After the green revolution, use of chemical fertilizers has increased, which is hazardous to ecology and environment [2]. The deterioration of soil fertility through use of chemical fertilizers and increasing production costs due to chemical fertilizers brought organic sources as a supplement.

Efficient use of applied nutrients is necessary for optimum growth and yield. Fertigation technique to be the most economical technique for fertilizer application in many of the flower and other horticultural crops and has potential for more precise and timely crop nutrition ultimately provides better yield and improved quality. It also reduces the wastage of fertilizers and supplies directly to the root zone of the plants. Moreover, no single source of plant nutrients, either it is chemical, biofertilizer (or) biostimulant can meet the entire needs of crop hence, integrated use of inorganic and organic nutrients has become important for higher horticultural production. The role of organic supplements is more essential in maintaining and increasing the long run fertility and sustainability of soil, as it is ecologically sound and supportive of higher levels of biological production and productivity of crops. Microbial consortium is a carrier based microbial product that contains nitrogen fixing, phosphorus and zinc solubilizing and plant growth promoting microbes in a single carrier and also exploits the synergistic effects of combined microbes [3]. Mixed inoculants (Combination of microorganisms) interact synergistically and yield better and show quick results. Many researches have proved that development of plant growth promoting microbial consortium, could be a feasible technology for increasing the crop productivity with savings in chemical fertilizer to an extent of 25 to 30 per cent.

Biostimulants like panchagavya and humic acid have a significant role in increasing the quality attributes and yield in flower crops. Biostimulants improve metabolic efficiency to induce an increase in yields and enhancement in crop quality, increase the tolerance of plants against abiotic stress and to ease absorption, translocation and nutrient usage. Hence, the present experiment was carried

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out to standardize the fertigation and organic nutrient schedule and also to assess the yield attributing parameters and yield of tuberose.

MATERIALS AND METHODS

The experiment was conducted at T. Pudhupatti village of Reddiyarchatram block, Dindigul District during 2015-16 and 2016-17. The variety of Tuberose was Prajwal as test crop. The experimental trial was laid out in randomized block design (RBD) with 19 treatments and replicated two times. The trial consisted three levels of fertigation viz., 125 per cent, 100 per cent and 75 per cent and was applied at various crop growth stages during the cropping period. Microbial consortium was applied @ 12.5 kg ha^{-1} as soil application and biostimulants namely panchagavya (3-4%) and humic acid (0.4-0.5%) were foliar sprayed at monthly interval. Biometrical observations viz., number of spikes $clump^{-1}$, spike length, number of florets $spike^{-1}$, length of floret, diameter of floret, single flower weight, hundred flower weight and flower yield ha^{-1} were recorded in randomly selected five plants and average values were taken for statistical analysis. Standard cultural practices were adopted throughout the cropping period and the data on various yield attributing and yield parameters were recorded and statistically analyzed.

Treatments details

Treatments	Details
T_1	125% recommended dose of fertilizer through fertigation (RDFTF)
T_2	125% RDFTF + Microbial Consortium (MC) @ 12.5 kg ha^{-1}
T_3	125% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 3% +Humic acid @ 0.4%
T_4	125% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 3% + Humic acid @ 0.5%
T_5	125% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 4% + Humic acid @ 0.4%
T_6	125% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 4% + Humic acid @ 0.5%
T_7	100% RDFTF
T_8	100% RDFTF + MC @ 12.5 kg ha^{-1}
T_9	100% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 3% + Humic acid @ 0.4%
T_{10}	100% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 3% + Humic acid @ 0.5%
T_{11}	100% RDFTF + MC @ 12.5 kg ha^{-1} +Panchagavya @ 4% + Humic acid @ 0.4%
T_{12}	100% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 4% + Humic acid @ 0.5%
T_{13}	75% RDFTF
T_{14}	75% RDFTF + MC @ 12.5 kg ha^{-1}
T_{15}	75%RDFTF + MC @ 12.5 kg ha^{-1} +Panchagavya @ 3% + Humic acid @ 0.4%
T_{16}	75% RDFTF + MC @ 12.5 kg ha^{-1}+ Panchagavya @ 3% + Humic acid @ 0.5%
T_{17}	75% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 4% + Humic acid @ 0.4%
T_{18}	75% RDFTF + MC @ 12.5 kg ha^{-1} + Panchagavya @ 4% + Humic acid @ 0.5%
T_{19}	100% Recommended dose of fertilizer (Soil application)

RDF: NPK 200:200:200 kg ha^{-1}

RESULTS AND DISCUSSION

Yield attributing parameters

Significant differences were observed between the treatments for the yield attributing parameters like number of spikes $clump^{-1}$, spike length, number of florets $spike^{-1}$ (Pooled mean of 2015-16 and 2016-17) (Table 1), length of floret and diameter of floret (Pooled mean of 2015-16 and 2016-17) (Fig 1). Among the various treatments, 100 per cent recommended dose of fertilizer through fertigation along with microbial consortium @ 12.5 kg ha^{-1}, foliar spray of panchagavya @ 3 per cent and humic acid @ 0.4 per cent (T_9) recorded the highest number of spikes $clump^{-1}$ (3.96), spike length (90.68 cm), number of florets $spike^{-1}$ (43.55), length of floret (6.36 cm) and diameter of floret (4.22 cm). The lowest number of spikes $clump^{-1}$ (2.77), spike length (70.85 cm), number of florets $spike^{-1}$ (30.28), length of floret (4.57 cm) and diameter of floret (3.16 cm) were registered in T_{19} (100 per cent recommended dose of fertilizer as soil application).

Table 1 Effect of fertigation and organic nutrients on yield attributing parameters of tuberose var. Prajwal

Treatments	No. of spikes $clump^{-1}$	Spike length (cm)	No. of florets $spike^{-1}$
T_1	3.14	76.50	34.05
T_2	3.31	79.93	36.21
T_3	3.77	87.40	41.02
T_4	3.74	86.93	40.63
T_5	3.68	85.81	39.91
T_6	3.66	85.36	39.58
T_7	3.20	77.63	34.77
T_8	3.39	81.07	36.95
T_9	3.96	90.68	43.55
T_{10}	3.93	90.14	43.13
T_{11}	3.86	89.01	42.37
T_{12}	3.84	88.57	41.80
T_{13}	3.04	75.29	33.02
T_{14}	3.25	78.78	35.48
T_{15}	3.59	84.21	38.80

T_{16}	3.56	83.82	38.78
T_{17}	3.49	82.65	38.00
T_{18}	3.47	82.15	37.75
T_{19}	2.77	70.85	30.28
SEd	0.057	1.50	0.66
CD (0.05)	0.126	3.29	1.45

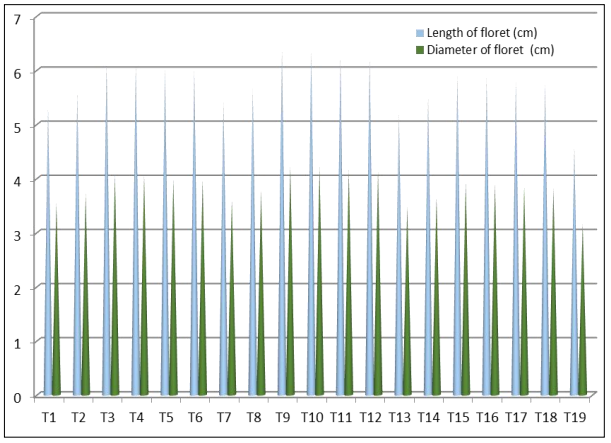

Fig 1 Effect of fertigation and organic nutrients on length and diameter of floret of tuberose (*Polianthes tuberosa* L.) var. Prajwal

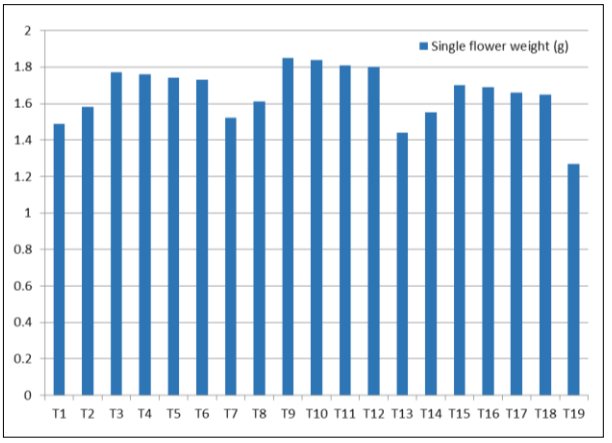

Fig 2 Effect of fertigation and organic nutrients on single flower weight of tuberose (*Polianthes tuberosa* L.) var. Prajwal

Single flower weight

Single flower weight of pooled mean of 2015-16 and 2016-17 was significantly increased by optimum level of fertigation along with microbial consortium and foliar spray of panchagavya and humic acid (Fig 2) The highest single flower weight (1.85 g) was recorded in 100 per cent recommended dose of fertilizer through fertigation along with microbial consortium @ 12.5 kg ha^{-1}, foliar spray of panchagavya @ 3 per cent and humic acid @ 0.4 per cent. The lowest single flower weight (1.27 g) was recorded in 100 per cent recommended dose of fertilizer through soil application (T_{19}).

Yield parameters

Hundred flower weight and estimated flower yield ha^{-1} of pooled mean of 2015-16 and 2016-17 were significantly increased by optimum level of fertigation along with microbial consortium and foliar spray of panchagavya and humic acid (Table 2). The highest hundred flower weight (182.78 g) and estimated flower yield ha^{-1} (15.87 t) were registered in 100 per cent recommended dose of fertilizer through fertigation along with microbial consortium @ 12.5 kg ha^{-1}, foliar spray of panchagavya @ 3 per cent and humic acid @ 0.4 per cent (T_9) whereas, the lowest hundred flower weight (125.38 g) and estimated flower yield ha^{-1} (11.38 t) were recorded in 100 per cent recommended dose of fertilizer through soil application (T_{19}).

Table 2 Effect of fertigation and organic nutrients on hundred flower weight and estimated flower yield of tuberose (*Polianthes tuberosa* L.) var. Prajwal

Treatments	Hundred flower weight (g)	Estimated flower yield (t ha^{-1})
T_1	147.20	12.68
T_2	156.61	13.44
T_3	175.83	15.18
T_4	174.93	15.06
T_5	171.66	14.82
T_6	170.46	14.72
T_7	150.36	12.94
T_8	159.45	13.71
T_9	182.78	15.87
T_{10}	181.81	15.78
T_{11}	179.51	15.52
T_{12}	178.48	15.44
T_{13}	141.98	12.41
T_{14}	153.05	13.19
T_{15}	167.32	14.46
T_{16}	165.96	14.35
T_{17}	163.21	14..07
T_{18}	161.96	13.95
T_{19}	125.38	11.38
SEd	3.12	0.27
CD (0.05)	6.51	0.56

The balanced nutrient application ensures better nutritional status of the plants which was favoured by the treatments. Particularly in plants which received 100 per cent recommended dose of fertilizer through fertigation along with microbial consortium @ 12.5 kg ha^{-1}, foliar application of panchagavya @ 3 per cent and humic acid @ 0.4 per cent [4-5]. Increase in length and diameter of floret could be due to the increased photosynthetic activity which in turn might have favoured an increased accumulation of dry matter and also efficient partitioning of photosynthates towards the sink, while phosphorus is found to be involved in the formation of floral primordia resulting in increased flower length and flower diameter [6].

In the drip fertigation, maximum availability of potassium through water soluble fertilizers (19:19:19, 12:61:00 and 00:00:50) for better flower growth in the growing soil might be one of the reasons for the increased flower size and higher flower yield and quality [7-9].

The soil solum is properly mixed with organic manure and biofertilizers for extraction of nutrients along with enough moisture and the fertigation of 100 per cent recommended dose of fertilizer and 75 per cent recommended dose of fertilizer ultimately favours building up of turgor potential inside the plant system in a positive approach. This positive and favourable change might have led to an increased number of flowers and yield. Further, the application of water-soluble fertilizer has a direct positive role in producing more flowers and ultimately the flower yield. This might be due to reduced nutrient losses by leaching and efficient use of nutrients through fertigation, which has been supported by several researchers [10-11].

Higher photosynthesis enhanced food accumulation which might have resulted in enhanced plant growth and subsequently more number of flowers $plant^{-1}$ and ultimately higher flower yield. Beside this, higher flower yield might be attributed due to the increased availability of phosphorus and its greater uptake because the microbial consortium contains the phosphorus solubilizing bacteria that solubilize the phosphorus in soil and made easily available to plants along with addition of inorganic fertilizer through fertigation. Increased yield may also be due to the increased number leaves and other growth parameters [12]. When the organic substances are added to the soil, the microbes breakdown complex nitrogenous compounds slowly and make steady N supply throughout the growth period of the crop. Higher flower production of tuberose was acquired with the addition of organic nutrients in the form of microbial consortium in conjunction with recommended (or) reduced level of NPK (100 per cent or 75 per cent) through inorganic source of nutrients. This might be due to the fact that the continuous and balanced supply of nutrients are ensured under integrated nutrient plant system, which helps to maintain plants health and enhanced soil biological activity, which in turn improves nutrient mobilization from organic matter and soil reserves [13]. The improvement in flower production is due to integrated nutrient management in tuberose [14]. He stated that biofertilizer in the presence of organic manure had positive impact on flower yield of Gerbera. The improvement might be due to the fact that the microorganisms in biofertilizer are mostly chemo-organotrophs and derive carbon and energy from organic matter. The combined application of fertilizers and consortium of biofertilizers significantly enhanced the photosynthesis and yield attributing characters [15].

Panchagavya, an organic product, has the potential to play the role of promoting growth and providing immunity in plant system. It contains essential nutrients, many vitamins and essential amino acids. In T_9 (100 per cent recommended dose of fertilizer through fertigation along with microbial consortium @ 12.5 kg ha^{-1}, foliar spray of panchagavya @ 3 per cent and humic acid @ 0.4 per cent) treatment the increase in flower yield of Tuberose might be due to the increased availability and uptake of nutrients, water, increased activity of gibberlic acid, indole acetic acid and cytokinins present in panchagavya [16-18]. Panchagavya has significantly increased the yield due to the presence of useful microorganisms, nitrogen, calcium, cytokinin, gloucose, minerals, etc. These nutrients might have triggered rapid cell division, proliferation and speedy growth of Tuberose plant and floral primordial.

Humic acid increases the efficiency of biofertilizers, resulted in increased availability of various nutrients in turn to higher yield. This could be associated with more uptake of N, P and K from soil due to chelating action of humic acid, which resulted in development of more number of spikes. The application of humic acid, panchagavya and biofertilizers reduces the requirement of other fertilizers and increases soil aeration and drainage [19].

The reduced number of florets, yield attributing parameters and yield were registered in 100 per cent recommended dose of fertilizer through soil application. It might be due to the non-availability of nutrients throughout the crop period and poor mobilization of straight fertilizers to the plants affecting the photosynthetic efficiency of the plants. This might possibly be due to increased nutrient losses by leaching and less fertilizer use efficiency when it was applied through soil [20-21].

CONCLUSION

From the above study, it can be concluded that 100% recommended dose of fertilizer through fertigation along with basal application of microbial consortium @ 12.5 kg ha^{-1}, foliar spray of panchagavya @ 3% and humic acid @ 0.4% (T_9) at monthly interval is the most effective nutrient combination for enhancing the yield attributing parameters and yield in tuberose. Similarly, 75% recommended dose of fertilizer through fertigation along with microbial consortium @ 12.5 kg ha^{-1}, foliar spray of panchagavya @ 3% and humic acid @ 0.4% (T_{15}) significantly increased the yield than the 100% recommended dose of fertilizer through soil application (T_{19}).

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