Journal of Science and Technology
ISSN: 2456-5660 Volume 7, Issue 01 (JAN-FEB 2022)

www.jst.org.in DOI: https://doi.org/10.46243/jst.2022.v7.i01.pp92-102

Influence of fertigation and organic sources of nutrients on chlorophyll content and soil microbial population of Tuberose

*Senthil Kumar, S and **S.Ganesh
*Ph.D Scholar, **Professor (Horticulture)
School of Agriculture and Animal Sciences
Gandhigram Rural Institute (Deemed to be University)
Gandhigram- 624302, Dindigul, Tamil Nadu. India
**Email:* ssenthilhort@yahoo.co.in

To Cite this Article
Senthil Kumar. S, S.Ganesh, "**Influence of fertigation and organic sources of nutrients on chlorophyll content and soil microbial population of Tuberose**", *Journal of Science and Technology, Vol. 07, Issue 01, Jan-Feb 2022.*

Article Info
Received: 31-01-2022 *Revised: 12-02-2022* *Accepted: 19-02-2022* *Published:26-02-2022*

ABSTRACT

An experiment was conducted to investigate the effect of fertigation, microbial consortium and biostimulants on chlorophyll content and soil microbial population in Tuberose cv. Prajwal at T.Pudhupatti village, Dindigul District of Tamil Nadu during 2015-16 and 2016-17. The experiment was laid out in randomized block design (RBD) with nineteen treatments including each three levels of water-soluble fertilizers viz., 125, 100 and 75 per cent of the recommended doses of fertilizers along with microbial consortium, foliar spray of panchagavya and humic acid and the treatments were replicated twice. The results revealed that, 100 per cent of 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 chlorophyll "a", chlorophyll "b", total chlorophyll content and soil bacteria, fungi and actinomycets population. The increase of total chlorophyll by the T_9 over soil application of recommended dose of fertilizer was 33 per cent.

Key words: Nutrients, chlorophyll content, microbial population, yield and Tuberose.

INTRODUCTION

Tuberose (*Polianthes tuberosa* L.) is one of the most important ornamental bulbous plants which is valued for multi-purpose uses, as cut flower in floral arrangements, as loose flowers in garlands and *veni* preparations and essential oil in aesthetic and perfumery industry. It is an open field cultivated flower, hardy nature and has wide adaptability to different edaphic and climatic conditions across the country (Jaya Kumari *et al.*, 2020). Tuberose plants possess attractive pearl white flowers with pleasant fragrance and blooms for considerably a long period of time. The spikes are excellent for vase and other floral arrangements.

Intensification of agricultural production to meet growing market demand requires the simultaneous application of irrigation water and fertilizers. Tuberose requires high nutrients for proper growth and development and to enhance the yield and quality of flowers. In recent times, fertigation has confirmed to be the most economical fertilizer application technique for most of the flower crops and has potential for more accurate and timely crop nutrition leading to increased yields, enhanced quality and early crop maturity (Kurakula Divya, 2018). The fertigation allows application of right amounts of plant nutrients uniformly to the wetted root volume zone, where most of the active roots are concentrated and this helps to enhance nutrient use efficiency. It has also been found that fertigation improves the productivity and quality of crop produce along with improved resource use efficiency (Jat *et al.*, 2011). The deterioration of soil fertility through use of chemical fertilizers and increasing production costs brought an urge for organic sources of nutrients as part of nutrient requirement. The use of organic nutrients of microbial consortium and biostimulants (panchagavya and humic acid) improves chlorophyll content in leaves and biological properties of soil besides improving the efficiency of applied nutrients. Microbial consortium is the living cells of microorganisms which when inoculated into the soil, supply essential nutrients to plants, improve soil texture, soil structure and water holding capacity of soil. It involves inoculation of beneficial microorganisms that help nutrient acquisition by plants through fixation of nitrogen, solubilisation and mobilization of other nutrients (Aghera *et al.*, 2019).

Biostimulants (panchagavya and humic acid) are products of natural and organic origin that stimulates plants to achieve their highest growth and yield potential. Panchagavya an organic product has the potential to play vital role to encourage growth and providing immunity in plant system. Humic acids are the part of the humus compounds which plays an important role to balance plant nutrition by improving physical, chemical and biological properties of soil. The direct effect of humic acid on crop growth has been attributed to the increase in chlorophyll content in leaves, the acceleration of the respiration process and

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hormonal growth responses and thereby increasing growth and yield of plant (Jonnada Archana *et al*., 2019).

Hence, the present research work has been undertaken to study the effect of fertigation, microbial consortium, panchagavya and humic acid on chlorophyll content and soil microbial population 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 of three levels of fertigation *viz*.,125 per cent, 100 per cent and 75 per cent of recommended dose of fertilizer and was applied at various crop growth stages during the cropping period. The microbial consortium was applied @ 12.5 kg ha^{-1} as soil application and bio-stimulants namely panchagavya (3 and 4 per cent) and humic acid (0.4 and 0.5 per cent) were foliar sprayed at monthly intervals. Chlorophyll content such as chlorophyll "a", chlorophyll "b" and total chlorophyll in leaf were analysed and expressed in mg g^{-1}. The microbial population viz., bacteria (x 10^6 CFU g^{-1}), fungi (x 10^4 CFU g^{-1}) and actinomycetes (x 10^3 CFU g^{-1}) were recorded and statistically analysed

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

Chlorophyll 'a', 'b' and total chlorophyll

Results of the experiment revealed that all the fertigation treatments in combination with the microbial consortium and bio-stimulants significantly increased the chlorophyll 'a', 'b' and total chlorophyll content over control (Table 1). The highest chlorophyll 'a' (0.512 mg g^{-1} and 0.572 mg g^{-1} in first and second year respectively), chlorophyll 'b' (0.352 mg g^{-1} and 0.403 mg g^{-1}) and total chlorophyll (0.828 mg g^{-1} and 0.932 mg g^{-1}) were recorded at 100 per cent recommended dose of fertilizer through fertigation + microbial consortium @ 12.5 kg ha^{-1} + panchagavya @ 3 per cent + humic acid @ 0.4 per cent (T_9). The lowest chlorophyll 'a' (0.403 mg g^{-1} and 0.433 mg g^{-1}), chlorophyll 'b' (0.276 mg g^{-1} and 0.307 mg g^{-1}) and total chlorophyll (0.639 mg $g^{-1}$and 0.699 mg g^{-1}) were registered at 100 per cent recommended dose of fertilizer through soil application (T_{19}).

Table 1. Effect of fertigation, microbial consortium and biostimulants on chlorophyll 'a', 'b' and total chlorophyll on Tuberose cv. Prajwal

Treatments	Chlorophyll 'a' content (mg g^{-1})		Chlorophyll 'b' content (mg g^{-1})		Total chlorophyll content (mg g^{-1})	
	First year -2015-16	Second year - 2016-17	First year - 2015-16	Second year- 2016-17	First year - 2015-16	Second year - 2016-17
T_1	0.430	0.465	0.293	0.325	0.687	0.749
T_2	0.458	0.501	0.315	0.352	0.734	0.81
T_3	0.493	0.548	0.34	0.385	0.796	0.892

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T_4	0.492	0.546	0.338	0.383	0.793	0.887
T_5	0.490	0.543	0.336	0.38	0.788	0.883
T_6	0.488	0.541	0.335	0.379	0.784	0.881
T_7	0.440	0.476	0.300	0.334	0.703	0.770
T_8	0.467	0.512	0.322	0.362	0.749	0.830
T_9	0.512	0.572	0.352	0.403	0.828	0.932
T_{10}	0.510	0.570	0.350	0.402	0.821	0.928
T_{11}	0.507	0.566	0.350	0.400	0.818	0.925
T_{12}	0.506	0.564	0.348	0.397	0.814	0.920
T_{13}	0.419	0.449	0.285	0.317	0.666	0.725
T_{14}	0.449	0.488	0.307	0.343	0.716	0.788
T_{15}	0.478	0.530	0.331	0.372	0.767	0.854
T_{16}	0.477	0.526	0.329	0.369	0.762	0.849
T_{17}	0.474	0.522	0.328	0.368	0.761	0.846
T_{18}	0.472	0.520	0.326	0.367	0.755	0.843
T_{19}	0.403	0.433	0.276	0.307	0.639	0.699
SEd	0.009	0.011	0.005	0.008	0.013	0.016
CD (p=0.05)	0.018	0.022	0.011	0.016	0.026	0.034

The physiological parameters like chlorophyll ‘a’, ‘b’ and total chlorophyll directly indicate the efficiency of the plant in terms of yield and quality of flower. In the present study, it was found that treatment combination of fertigation along with microbial consortium and biostimulants (panchagavya and humic acid) proved significantly higher levels of all chlorophyll content in both the years of experiment in Tuberose.

Chlorophyll is an important pigment responsible for harvesting solar energy and converting into chemical energy, exhibiting a differential pattern in their accumulation in plants cultivated under different systems of fertilization. Chlorophyll content has a direct bearing on photosynthetic activity which may result in synthesis of more carbohydrates. Chlorophyll is the most important green pigment found in green leaves and is certainly determining the photosynthetic efficiency and productivity of crops. Remarkably K also played an important role in the synthesis of chlorophyll by taking part in various enzyme activities. K influences the total chlorophyll and carotenoids contents of the leaves and it might also directly or indirectly increases crop yield through increased photosynthesis. In the present investigation, the highest chlorophyll ‘a’ (0.512 mg g^{-1} and 0.572 mg g^{-1} in first and second year respectively), chlorophyll ‘b’ (0.352 mg g^{-1} and 0.403 mg g^{-1}) and total chlorophyll (0.828 mg g^{-1} and 0.932 mg g^{-1}) were recorded at 100 per cent recommended dose of fertilizer through fertigation along with microbial consortium @ 12.5 kg ha^{-1}, foliar

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spray of panchagavya @ 3 per cent and humic acid @ 0.4 per cent. The increase in chlorophyll was due to the absorption of adequate quantities of required nutrients regularly which subsequently improved the chlorophyll biosynthesis in vegetative growth of Tuberose as elucidated by Kabariel (2015). The results are in conformity with Aghera *et al*. (2019) in Tuberose, Bhalla *et al*. (2006), Pandey *et al*. (2013), Panusuriya (2018) in Gladiolus and Jadhav *et al*, (2014) in Marigold. This result is also in agreement with the findings of Raghavendra (2000) and also such increase might be due to higher photosynthetic rate as a result of more absorption of available nutrients, which cause an increase in development of growth and photosynthetic efficiency (Abdel- Nazeer and El-Shazly, 2001). The foliar application of humic acid sprayed on the leaves and aerial parts of plants might have translocated to the other parts of the plants, including roots. The root leachates containing very low concentration of humic acid might have helped in the chelation of metal ions in soil making them available in absorbable and usable for plant growth and development. This might have attributed for an increased chlorophyll content in the leaves and thus photosynthetic efficiency causing more perfectional influx of photosynthetaes to the sink. The results are in accordance with the findings of Sankari *et al.* (2015) in Gladiolus. The increase in chlorophyll content was also associated with more nutrition as reported by Sivakumar (2007) in Mango and Josefina *et al*., (2003) in Citrus.

ENUMERATION OF MICROBIAL POPULATION

Enumeration of bacterial population

The data on microbial population in the soil revealed that the significant variations in bacterial population was found due to different levels of combination of fertigation, microbial consortium and biostimulant treatments while compared to the fertilizer application through the soil treatment during both the years of the experimentation (Fig.1). The highest bacterial population (94.63 x 10^6 CFU g^{-1} and 98.16 x 10^6 CFU g^{-1} respectively) was recorded in the 100 per cent recommended dose of fertilizer through fertigation + microbial consortium @ 12.5 kg ha^{-1} + panchagavya @ 3 per cent + humic acid @ 0.4 per cent (T_9), whereas the lowest bacterial population (68.11 x 10^6 CFU g^{-1} and 70.36 x 10^6 CFU g^{-1}) was registered in the 100 per cent recommended dose of fertilizer through soil application (T_{19}).

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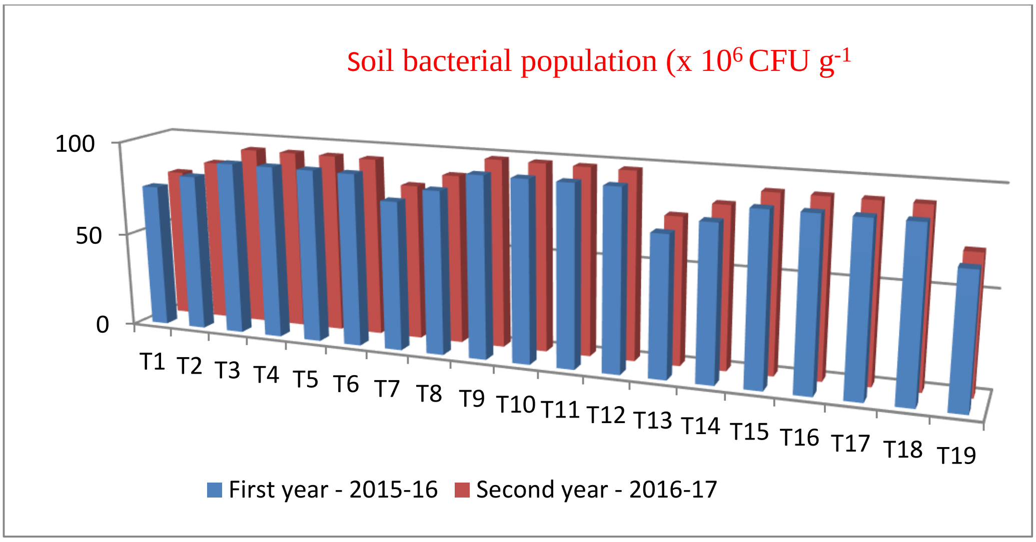

Fig. 1. Effect of fertigation, microbial consortium and biostimulants on soil bacterial population of Tuberose cv. Prajwal

Enumeration of Soil fungi population

Enumeration of soil fungi population (for both the years) was significantly increased by higher doses of fertigation along with microbial consortium and foliar spray of panchagavya and humic acid (Fig. 2). The highest fungi population (26.54 x 10^4 CFU g^{-1} and 28.86 x 10^4 CFU g^{-1} respectively) was recorded by the application of 100 per cent recommended dose of fertilizer through fertigation + microbial consortium @ 12.5 kg ha^{-1} + panchagavya @ 3 per cent + humic acid @ 0.4 per cent (T_9), whereas the lowest fungi population (17.76 x 10^4 CFU g^{-1} and 19.24 x 10^4 CFU g^{-1}) was registered at 100 per cent recommended dose of fertilizer application through soil (T_{19}).

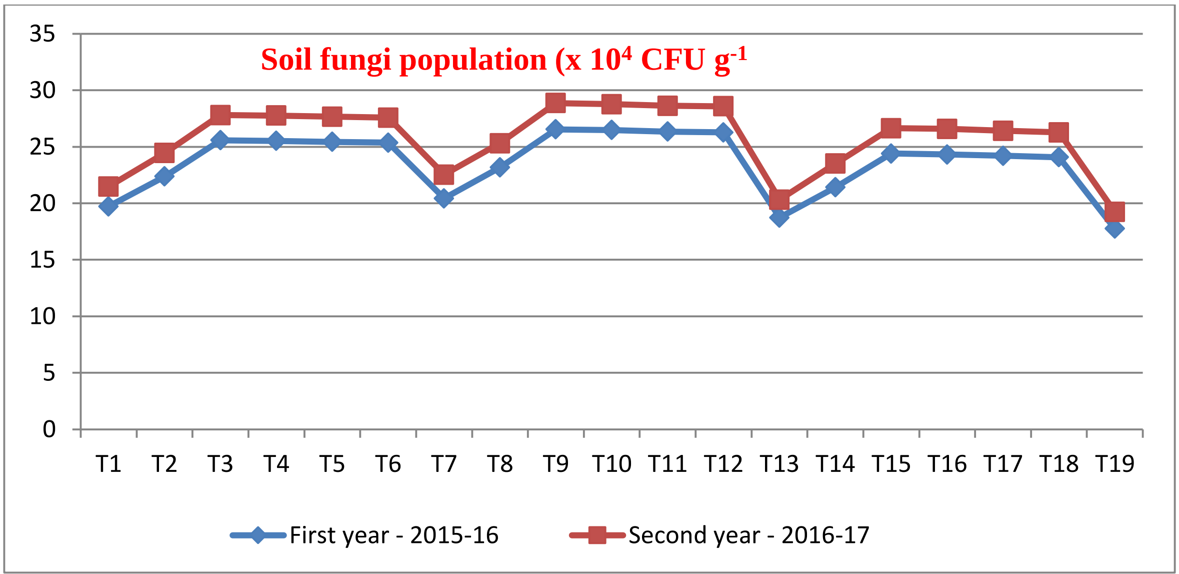

Fig. 2. Effect of fertigation, microbial consortium and biostimulants on soil fungi population of Tuberose cv. Prajwal

Enumeration of Soil actinomycetes population

Significant differences were observed (in both the years) between the treatments for the actinomycetes population in soil (Fig.3). The highest soil actinomycetes (8.14 x 10^3 CFU $g^{-1}$and 8.88 x 10^3 CFU g^{-1} respectively) was recorded in 100 per cent recommended dose of fertilizer through fertigation + microbial consortium @ 12.5 kg ha^{-1} + panchagavya @ 3 per cent + humic acid @ 0.4 per cent (T_9). The lowest soil actinomycetes (5.36 x 10^3 CFU g^{-1} and 5.62 x 10^3 CFU g^{-1}) was registered in 100 per cent recommended dose of fertilizer as soil application (T_{19}).

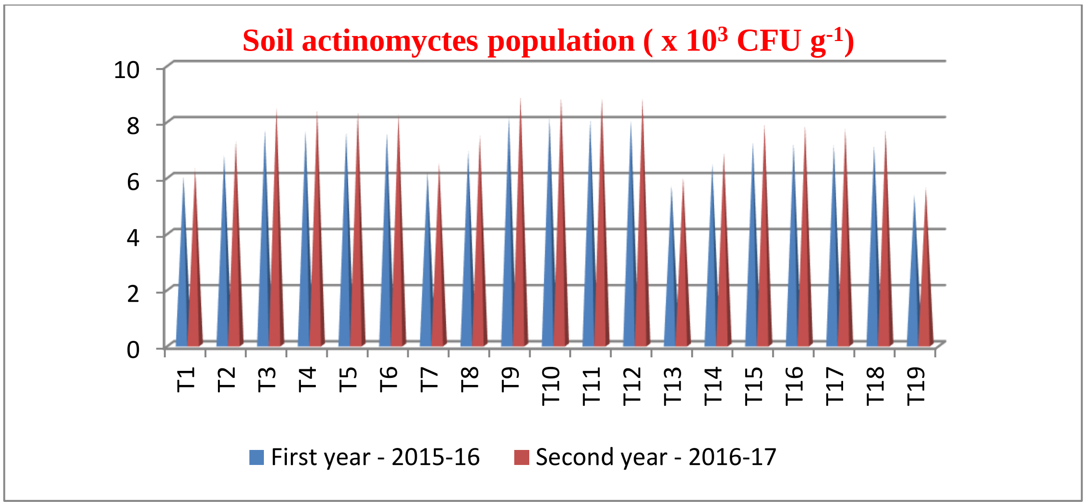

Fig. 3. Effect of fertigation, microbial consortium and biostimulants on soil actinomycetes population of Tuberose cv. Prajwal

The fertility of soil depends not only on its chemical composition but also on the qualitative and quantitative nature of microorganism present in the soil ecosystem. Soil microorganisms in the rhizosphere influence the plant growth in several ways. They play a critical role in the carbon, nitrogen, phosphorus and sulphur cycles and availability of certain trace elements like iron, manganese and copper in the soil. Some of the soil microbes act as antagonists for soil borne pathogens, thus these microbes are support for normal growth of the plants. In addition, the soil microbes influence the permeability, water holding capacity and tilth of the soil.

By the combined application of fertigation along with microbial consortium and foliar application of biostimulants, an increased microbial population of bacteria (94.63 x 10^6 CFU g^{-1} and 98.16 x 10^6 CFU g^{-1} in first and second year respectively), fungi (26.54 x 10^6 CFU g^{-1} and 26.54 x 10^6 CFU g^{-1} and actinomycetes (8.14 x 10^3 CFU g^{-1} and 8.88 x 10^3 CFU g^{-1}) were

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recorded. The treatment T_9 comprising of 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 registered the highest pooled mean value of microbial population in Tuberose. Dkhar and Mishra (1983) stated that fungal and bacterial population in the soils of permanent agriculture is probably due to the function of nitrogen, phosphorus, potassium and organic carbon.

The use of biofertilizers or microbial consortium increases number of microbes in soil which results into better root production, increase uptake of nutrients and water, profuse vegetative growth and higher photosynthesis and better food accumulation, enhanced capacity for absorption of ions and water from the soil resulting into increased yield. Similar findings were also reported by Kumarai Vasantha *et al*. (2014) and Godse *et al*. (2006) in Gladiolus. The enhanced soil microbial activity as indicated by microbial population, microbial diversity and enzymatic activity was mainly due to favourable soil environment, sufficient energy in the form of carbon and protein sources with organic sources of nutrition (Solaippan, 2002). Addition of organic nutrients improved the microbial activity and enhanced the availability of native and applied nutrients which in turn increased the yield in Tuberose.

CONCLUSION

It could be concluded that the application of 100 per cent recommended dose of fertilizer through fertigation + microbial consortium @ 12.5 kg ha^{-1} + panchagavya @ 3 per cent + humic acid @ 0.4 per cent (T_9) is the most effective nutrient combination in enhancing the chlorophyll content of test crop and microbial population.

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