Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 3084-3086
Received: 14-05-2020
Accepted: 16-06-2020

Sushree Choudhury
Krishi Vigyan Kendra Ganjam-II Odisha University of Agriculture and Technology, Odisha, India

Debasis Sarangi
Krishi Vigyan Kendra Ganjam-II Odisha University of Agriculture and Technology, Odisha, India

Corresponding Author:
Sushree Choudhury
Krishi Vigyan Kendra Ganjam-II Odisha University of Agriculture and Technology, Odisha, India

Effect of organic manures, inorganic fertilizers and biofertilisers on vegetative and floral characters of tuberose (*Polianthes tuberosa* L.) cv. 'Single'

Sushree Choudhury and Debasis Sarangi

Abstract
An investigation was carried out at carried out at the farmer's field in the village Hinjili of Hinjilikatu block of Ganjam district of Odisha,India. during the period from April, 2017 to March, 2018to find out the effect of organic manures, inorganic fertilizers and biofertilisers on vegetative and floral characters of tuberose (*Polianthes tuberosa* L.) cv. 'Single'. The treatments consist of different levels of NPK i.e 100%, 75% and 50%RDF along with combination of organic fertilizers and bio inoculants.The observations were recorded for growth and flowering parameters. Application of 75%RDF + FYM @1Kg/m^2 + Vermicompost @300g/m^2 + Azospirillum @2g/plant) + PSB @ 2g/plant showed significant influence on spike length (86.31cm),rachis length (25.83cm), number of spikes per plant(2.62), number of floret per spike (39.82), flower yield per plant(129.05g), flower yield per hectare (7.17t) and), fresh weight of cut spikes (24.23g), which was found better over all other treatments.

Keywords: Vermicompost azospirillum, biofertilizer, inm, *Phospho Bacteria*, tuberose

Introduction
Tuberose (*Polianthes tuberosa*) commonly known as Rajanigandha, is an important flower crop grown in India and belongs to family Amaryllidaceae. The flowers liked for their prettiness, elegance and fragrance. This traditional flower crop of India blooms throughout the year, and commercially grown for cut flower, loose flower as well as for perfumery industries., Florets loosely arranged on spike, that can reach up to 30 to 45 cm in length. Flower spikes are useful as cut flowers in vase decoration and bouquets; while individual florets used as loose flower for making veni, garlandmaking, button-holes or crown. It has a delightful fragrance and used for extraction of essential oil. The essential oil extracted from tuberose is one of the most expensive raw materials for perfume, thereby contributing in export earnings. There is a need to increase the productivity of this crop to meet the domestic market demand and to cope up the export potential of fresh flowers and to prepare value added products from tuberose. In this modern era, indiscriminate use of chemical fertilizers, pesticides and herbicides has led to the deterioration of soil health, ground water quality, soil microbial population, atmospheric constituents, quality of the agricultural production and thereby the health of animals, and humans. Continuous use of chemical fertilizers, reduces organic matter, and increases soil acidity, creates micronutrient deficiencies finally make the plant susceptible to pest and disease.

Emphasis is now laid on the use of organic inputs to avoid the above-mentioned problems associated with modern agriculture. Moreover, no single source of plant nutrients, either it is chemical, organic or biofertilizer can meet the entire needs of crop hence integrated use of inorganic and organic manures has become important for higher agricultural produce. The role of organic supplements is all the more important in maintaining and increasing the long run fertility and sustainability of agriculture, as it is ecologically sound and supportive of higher levels of biological production and productivity of crops without depleting the natural base of the soil and earth. The organic manures create no pollution, eco friendly, as they become valuable raw materials in enhancing soil health. During this modern time, the concept of integrated nutrient management (INM) has emerged as an important tool for maintaining soil fertility and productivity of crops. Integrated use of fertilizer, manure and biofertilizer improve the soil health and better growth and yield of crops. In view of the above facts, the present experiment has been carried out to find out suitable INM treatment to get maximum growth, flowering and yield of tuberose under agro-climatic conditions of Ganjam district of Odisha, India

Material method

The present study was carried out at the farmer's field in the village Hinjili of Hinjilikatu block of Ganjam district of Odisha, India. from April, 2018 to March, 2019. Popularly cultivated variety, Calcutta Single was used as planting material. The experiment was laid out in a Randomized Block Design with eight treatments and three replications. Total eight INM combinations were tested Theses are described as, T_1: 100% RDF (Control), T_2: 100% RDF + FYM (2Kg/m^2), T_3: 75% RDF + FYM (2Kg/m^2), T_4: 75% RDF+FYM (1Kg/m^2) + Vermicompost (300g/m^2), T_5: 75%RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2) +Azospirillum (2g/plant) +PSB(2g/plant),T_6: 50% RDF + FYM (2Kg/m^2), T_7: 50% RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2), T_8: 50% RDF+FYM (1Kg/m^2) + Vermicompost (300g/m^2)+Azospirillum (2g/plant) + PSB(2g/plant).

The experimental area was ploughed thoroughly with tractor drawn disc plough and cultivator to bring it to a fine tilth and divided in small plots of 2.0 X 3.0 m size. Organic manures such as Farm yard manure, vermi compost was incorporated in the soil according to the treatment combinations of respective plots during land preparation. In case of chemical fertilizers half dose of nitrogen and full dose of phosphorus and half potash were applied as basal dose. The remaining half dose of nitrogen and potash were applied in two spilt doses at interval of 30 and 60 days after planting of bulbs. After application of manures and fertilizers uniform sized bulbs of 2-3 cm were planted on raised bed with a spacing of 45 x 45 cm at a uniform depth of 4cm. Azospirillum and Phosphate solubilizing bacteria (PSB) was added to little quantity of vermicompost and applied at the base of each plant at 3-4 leaf stage. Standard cultural practices were adopted throughout the cropping period and the data on various growth and flowering parameters was recorded and statistically analyzed.

Results and discussion

Effect on plant growth characteristics

The data recorded in Table 1 revealed that Significant influence of treatment combinations was noticed on all the growth parameters. When inorganic manures were applied along with organic manures, the effectiveness of inorganic manures increased. Recommended dose of fertilizers in combination with FYM (2kg/m2) (T_2) had pronounced effect on vegetative characters i.e mean plant height (50.78cm) and mean number of leaves per plant (16.55). However, this is followed by 75%RDF integrated with FYM (1Kg/m^2), Vermicompost (300g/m^2), Azospirillum (2g/plant) and PSB(2g/plant) (T_5). Improvement in vegetative parameters might be due to full dosage of straight fertilizers and its direct availability during early stages of plant growth. The increase in the vegetative growth may due to better flow of various macro and micro nutrients along with plant growth substances into the plant system. Apart from this, FYM applied might have enhanced the effect. FYM increased population of bacteria, actinomycetes, fungi as well as improved physico chemical condition of soil and enhanced nutrient availability through mineralization process (Reddy and Swamy, 2000). The combined effect of 75%RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2)+Azospirillum (2g/plant)+PSB (2g/plant (T_5) has registered maximum spike length (86.31cm) and rachis length (25.83cm). Enhanced spike length and rachis length may be attributed due to the presence and synthesis of Gibberellin in vermicompost and biofertiliser. Gibberillin cause both cell elongation and division that dramatically stimulates internodal elongation. Similar findings have been reported regarding plant height by Gayathri *et al.,* (2004) [1] in statice and Geeta Pandey *et al.*, (2010) [2] in chrysanthemum.

Effect on flowering parameters

The data pertaining to flowering parameters like number of spikes per plant, number of floret per spike, floret length, floret diameter are represented in Table 2. The data shows that significant influence with highest trends for number of spikes per plant(2.62), number of floret per spike (39.82), floret length(4.92cm), floret diameter(3.33cm) were recorded with an application of 75%RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2) +Azospirillum (2g/plant) +PSB (2g/plant) i.e. T_5. An improvement in flowering attributes by chemical and biofertilizer application might be due to the fact that vermi-compost is nutritive fertilizer helps in availability of macro-and micro-nutrients levels in soil to plant system and also improve level of growth promoting substances. As a result, their combined application helped in stimulating the vegetative and reproductive phase of the plants. The results of the study are also in agreement with the findings of Shankar *et al*. (2010) [4], Tripathi *et al* (2012) [6] in tuberose

Effect on yield parameters

The data on loose flower yield per plant, loose flower yield per hectare, fresh weight of cut spikes was presented in Table 3. Significantly highest flower yield per plant (129.05g), flower yield per hectare (7.17t), fresh weight of cut spikes (24.23g) was noticed in treatment T_5: 75%RDF+FYM (1Kg/m^2) + Vermicompost (300g/m^2) +Azospirillum (2g/plant) +PSB(2g/plant). The increase in yield clearly indicates effect of inorganic fertilizer integrated with organic manure and biofertiliser. The inclusion of biofertiliser and vermi-compost with chemical fertilizer greatly helped in improving the yield attributes because of fact that vermi-compost and biofertiliser application most probably increased the level of growth promoting substances and nutrients availability forms in the soil to plant system and therefore helped in enhancing the uptake of nutrients and accumulation of more photosynthates in plant sink, viz. cut spike and loose flowers. Increased yields might be due to increased nitrogen fixing capacity of Azosprillum. Vermicompost serves as a source of humic and fulvic acids, which significantly influences the activity of Azosprillum, also improves the level of growth promoting substances and increases the vegetative growth as well as reproductive growth and flower yield. The obtained results are in accordance with the earlier findings of Yadav *et al*. (2005) [7] in tuberose, and Singh (2007) [5] in rose,

Table 1: Effect of application of organic manures, inorganic fertilizers and biofertilisers on growth characteristics of Tuberose. cv. 'Single'

Treatments	Plant height (cm)	No.of leaves per plant	Spike length	Rachis length
T_1: 100% RDF (Control)	40.28	10.66	76.01	18.51
T_2: 100% RDF + FYM (2Kg/m^2)	50.78	16.55	81.63	21.28
T_3: 75% RDF + FYM (2Kg/m^2)	44.65	12.73	81.21	20.93
T_4: 75% RDF+FYM (1Kg/m^2) + Vermicompost (300g/m^2)	46.12	13.26	81.77	22.46

T_5: 75%RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2) +Azospirillum(2g/plant) +PSB(2g/plant)	48.45	15.08	86.31	25.83
T_6: 50% RDF + FYM (2Kg/m^2)	43.34	11.26	77.74	19.14
T_7: 50% RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2)	44.02	12.01	79.85	20.29
T_8: 50%RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2) +Azospirillum(2g/plant) +PSB(2g/plant)	45.94	12.42	80.94	21.01
SEM	0.61	0.24	0.81	0.97
CD 5%	1.86	0.72	2.46	2.95

Table 2: Effect of application of organic manures, inorganic fertilizers and biofertilisers on floral attributes of Tuberose. cv. 'Single'

Treatments	No. of spikes per plant	No. of floret per spike	Floret length	Floret diameter
T_1: 100% RDF (Control)	1.05	25.64	3.87	2.72
T_2: 100% RDF + FYM (2Kg/m^2)	1.82	34.85	4.36	3.18
T_3: 75% RDF + FYM (2Kg/m^2)	1.65	33.53	4.25	3.16
T_4: 75% RDF+FYM (1Kg/m^2) + Vermicompost (300g/m^2)	1.97	35.61	4.47	3.24
T_5: 75%RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2) +Azospirillum(2g/plant) +PSB(2g/plant)	2.62	39.82	4.92	3.33
T_6: 50% RDF + FYM (2Kg/m^2)	1.26	27.8	4.02	2.97
T_7: 50% RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2)	1.39	31.05	4.14	3.04
T_8: 50% RDF+FYM (1Kg/m^2) + Vermicompost (300g/m^2)+Azospirillum (2g/plant) + PSB(2g/plant)	1.41	32.33	4.21	3.06
SEM	0.17	0.92	0.02	0.01
CD 5%	0.53	2.80	0.06	0.03

Table 3: Effect of application of organic manures, inorganic fertilizers and biofertilisers on yield of Tuberose. cv. 'Single'

Treatments	Loose flower yield/plant (g)	Loose flower yield/hectare (t)	Fresh weight of cut spikes (g)
T_1: 100% RDF (Control)	62.29	3.01	14.72
T_2: 100% RDF + FYM (2Kg/m^2)	106.24	5.17	21.32
T_3: 75% RDF + FYM (2Kg/m^2)	98.79	4.52	20.65
T_4: 75% RDF+FYM (1Kg/m^2) + Vermicompost (300g/m^2)	118.3	6.66	22.38
T_5: 75%RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2) +Azospirillum(2g/plant) +PSB(2g/plant)	129.05	7.17	24.23
T_6: 50% RDF + FYM (2Kg/m^2)	76.09	3.82	18.91
T_7: 50% RDF+FYM (1Kg/m^2)+ Vermicompost (300g/m^2)	84.06	4.01	19.52
T_8: 50% RDF+FYM (1Kg/m^2) + Vermicompost (300g/m^2)+Azospirillum (2g/plant) + PSB(2g/plant)	94.85	4.73	19.85
SEM	1.38	0.40	0.94
CD 5%	4.18	1.23	2.88

Conclusion

It can be concluded that application of 75 per cent RDF chemical fertilizer along with FYM (2kg/m2), vermicompost (300g/m2) and biofertilizers (Azospirillum 2g/plant, PSB2g/plant) is the most effective nutrient combination in enhancing the yield as well as the quality of flower stalks in tuberose. This indicates the possibility of reducing the use of chemical fertilizers up to 50% as these are expensive and thus can protect the soil from ill effects of hazardous chemical and improve productivity and also maintains soil sustainability.

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