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Bio-management of root knot nematode (*Meloidogyne incognita*) in tuberose (*Polianthes tuberose* L.)

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Abstract
The present study on assessment of nematode management in tuberose was conducted by ICAR- Krishi Vigyan Kendra, Madurai during 2014 - 15 and 2015 - 16 at five identified farmers fields in Alanganallur block of Madurai district for an area of 2 ha. The present bio-management was conducted with variety Prajwal. There were four technological options were included in the present assessment such as bulbs were treated with *Trichoderma viride* + *Pseudomonas fluorescens* @ 20 g/kg and carbofuran @ 2.5 kg/ha were applied in the field (TO1), bulbs were treated *Purpureocillium lilacinum* @ 20 g/kg of bulb (TO2) and soil application @ 5 kg/ha and basamid @ 100 g per bed were applied in the each bed and covered with polythene mulch (TO3) and the farmer practices (TO4), application of neem cake @ 250 kg/ha as basal application at the time of last ploughing and indiscriminate application of fertilizers and pesticides spraying were imposed for the present experiment. The present study results revealed that bulbs were treated *Purpureocillium lilacinum* @ 20 g/kg of bulb (TO2) recorded the minimum days taken for flowering (134.15 days) and farmers practices observed the longest days taken for flowering (147.47 days). TO2 recorded the highest values in vegetative and flowering traits such as plant height (116.24 cm), number of leaves per plant (241.05), spike length (93.50 cm), number of florets per spike (41.80) and floret weight (1.52 g) whereas the farmers practices registered the lowest values in all the vegetative and flowers traits (101.26 cm; 228.14; 88.25 cm; 35.50; 1.09 g). Regards yield characters, TO2 recorded the highest yield per ha (11.18 t/ha) and the lowest yield was noticed in farmer practices (7.75 t/ha). In the case of nematode incidence, the lowest incidence was recorded in TO2 (demonstrated plot) of 10.0 per cent whereas the highest incidence was registered in farmers practices (21.0%). In the case of economic traits, TO2 registered the highest net profit of Rs. 5,10,120 with the B:C ratio of 2.55 and the lowest net profit (Rs. 2,79,250) and B:C ratio (1.64) was noticed in farmers practices.

Keywords: tuberose, OFT, yield, root knot nematode, number of florets per spike

Introduction
Tuberose (*Polianthes tuberose* L.) belongs to the family Amarylladiaceaea and originated from Mexico. Tuberose popularly called as 'Rajanigandha' and 'Nilasampangi'. Tuberose is most important commercial flower crops in India and abroad and comes under bulbous ornamentals of tropical and subtropical areas. The flowers remain fresh for days together and impart sweets and lingering pleasant fragrance to the atmosphere (Sadhu and Bose, 1973) [9]. As a loose flower, they are in great demand for making garlands and veni in Southern India. It is being used for worshipping, offerings in religious functions and auspicious days. It is cultivated for its fragrant flowers used in cosmetic industries, preparation of bouquets and spikes as cut flowers. It is an important flower crop of Madurai and neighbouring districts and cultivated in an area of morethan 150 ha. It is propagated through bulbs. Rootknot nematode (*Meloidogyne incognita*) has been reported as one of the important limiting factors affecting commercial cultivation of tuberose (Sunderbabu and Vadivelu, 1988) [11], reduce the flower yield up to 10 per cent (Khan and Parvathareddy, 1992) [3]. Rao *et al.*, (2001) [7] reported that wide spread in almost all the tuberose growing areas of South India. Vegetative propagation of bulbs paves way for the entry of many pathogens. Among them, plant parasitic nematodes and wilt inducing fungus (*Fusarium* sp.) contribute for the drastic reduction in the plant yield. Farmers were unaware about nematode infestation, cultivating tuberose without any application of bioformulations and getting low yield as well as low income. With this background, On Farm Testing (OFT) on Bio-management of rootknot nematode (*Meloidogyne incognita*) in tuberose (*Polianthes tuberose* L.) was conducted at farmers field in Madurai district.

Materials and Methods

The present On Farm Testing (OFT) was conducted at Krishi Vigyan Kendra, Agricultural College and Research Institute, Madurai during 2014 – 15 & 2015 – 16 with the aim of management of nematode population in tuberose through biomanagement suitable for Madurai district. The assessment was conducted at five identified farmers' fields at Alanganallur block of Madurai district. The present field experiment was conducted in an area of 2 ha with the variety Prajwal. The tubers of Prajwal variety were purchased from Indian Institute of Horticultural Research (IIHR), Bengaluru whereas *Purpureocillium lilacinum* from Horticultural Research Station, Ooty and distributed the identified beneficiary farmers of Alanganallur block. Before conducting the assessment, trainings were imparted to the beneficiaries regarding package of practices and nematode management in tuberose. The field was thoroughly ploughed and applied well decomposed farmyard manure @ 25 t/ha. During last ploughing, application of recommended dose of fertilizers @ 200:200:200 NPK kg/ ha and formed raised beds with the size of 50 feet length, 4 feet width and 15 - 20 cm height. Soil application of *P. lilacinum* + *Pseudomonas fluorescens* @ 2.5 kg/ha enriched with farmyard manure @ 1t on 30 days after planting. The basamid @ 100 g per bed were applied in the each bed and covered with polythene mulch (TO1). The bulbs were treated *Purpureocillium lilacinum* @ 20 g/kg of bulb (TO2) and soil application @ 5 kg/ha. The bulbs were treated with *Trichoderma viride* + *Pseudomonas fluorescens* @ 10 g/kg and carbofuran @ 2.5 kg/ha were applied in the field (TO3) and farmer practices (TO4) was application of neem cake @ 250 kg/ha as basal application at the time of last ploughing and indiscriminate application of fertilizers and pesticides spraying were imposed for the present assessment. The bulbs were planted at a spacing of 30 x 30 cm. The recommended cultivation practices were followed as per the crop production guide, 2014 (Anonymous, 2014) [1]. Regular field visits were made by the team of KVK scientists. The observations *viz.*, plant height (cm), days taken for flowering (days), number of leaves per plant, number of spikes per plant, spike length (cm), number of flowers per spike, floret weight (g), yield per plant (g) and yield per ha (t/ha) were recorded and analysed statistically as per the method was suggested by Panse and Sukhatme (1967) [5]. The gross returns, gross cost, net returns and benefit cost ratio (B:C ratio) were worked out.

Results and Discussion

The vegetative and yield parameters of the tuberose are presented in Table 1. The present study results revealed that among the four technology options, TO4 (bulbs were treated *Purpureocillium lilacinum* @ 20 g/kg of bulb and soil application @ 5 kg/ha) recorded the highest values in growth and yield characters. TO2 (*Purpureocillium lilacinum* @ 5 kg/ha) recorded the minimum days taken for flowering (134.15 days), whereas late flowering was noticed in farmers practices (TO4) of 147.47 days. Vegetative traits such as plant height, number of leaves per plant recorded the highest in TO2 (116.24 cm; 241.05) whereas farmer practices found the lowest in vegetative traits (101.26 cm; 228.14). This might be due to the bulbs treated with bioformulations such as *Pseudomonas fluorescens* and *Purpureocillium lilacinum*as as well as soil application which increases the height of the plant and also early flowering. The influence of nematode infection probably caused reduction in plant height in farmer practices.

In the case of flowering traits, TO2 recorded the highest in spike length (93.50 cm), number of florets per spike (41.80) and floret weight (1.52 g) followed by TO3 (92.45 cm; 39.90; 1.33 g). The lowest values were observed in farmers practices (88.25 cm; 35.50; 1.09 g). This might be influence of nematode infection caused reduction in spike length and number of florets per spike. This is in according with the findings of Saha and Khan, (2016) [10]. They stated that the lowest spike length and number of florets per spike were noticed under West Bengal condition. Rao *et al.,* (2004) [8] stated that spike length recorded the lowest in untreated bulbs in bioformulations (control).

Regarding yield traits results revealed that TO2 recorded the highest yield per plant (89.45 g) and the lowest yield was found in farmers practices (60.25 g). Bulbs treated with *Purpureocillium lilacinum* (TO2) recorded the highest yield of 11.18 t/ha followed by TO3 (9.25 g/ha) whereas the lowest yield per ha was observed in farmers practice (7.75 t/ha). This might be due to high production of florets per spike, spike length and weight. This is in accordance with the findings of Ranchana *et al.*, (2013) [6] and Madhumathi *et al*., (2018) [4] in tuberose. Kavitha and Thirukumaran (2020) [2] reported that infestation of nematode very less in *Paecilomyces lilacinus* application as well as bulbs treated with bioformulations before planting recorded the higher yield per ha of 19.65 t/ha under Kanyakumari condition.

Regarding nematode infestation results revealed that TO2 proved significantly effective against *Meloidogyne incognita* infesting tuberose. Among the treatments, TO2 registered the lowest incidence of nematode infestations (10.0fe%) followed by TO3 of 12.0 per cent, whereas farmer practices recorded the incidence of 21.0 per cent.

Table 1: Bio-management of root knot nematode in tuberose

Sl. No.	Parameters	T01 Carbofuran	T02 *Purpureocillium lilacinum* @ 5kg/ha	T03 Basamid + Polythene Mulch	TO4 Farmer's Practice	SEd	CD (P=0.05%)	CV (%)
1.	Days taken for flowering (days)	137.25	134.15	138.42	147.47	2.996	7.332	2.63
2.	Plant height (cm)	110.82	116.24	112.58	101.26	1.709	4.183	1.90
3.	Number of leaves per plant	233.47	241.05	235.60	228.14	2.876	7.039	1.50
4.	Spike length (cm)	91.90	93.50	92.45	88.25	1.766	4.321	2.36
5.	Number of florets per spike	38.50	41.80	39.90	35.50	0.882	2.173	2.79
6.	Weight of floret (g)	1.20	1.52	1.33	1.09	0.03	0.08	1.04
7.	Yield per plant (g)	78.54	89.15	81.52	60.25	1.689	4.133	2.67
8.	Yield (t/ha)	8.25	11.18	9.25	7.75	0.266	0.653	3.59
9.	Root Knot Index/ Gall index	2.5 (50.0)	3.1 (38.0)	3.5 (30.0)	5.0			
10.	Soil nematode population	104 (53.6)	125 (44.1)	167 (22.4)	224			

Figures in the parentheses are per cent decrease over control

Economics

The cost economics of nematode management in tuberose are presented in Table 2. The highest net returns was noticed in TO2 (Rs. 5, 10, 120) with the benefit cost ratio of 2.55, followed by TO3 (4, 87, 000; 2.01) where as the lowest net returns and B:C ratio was observed in farmers practices (TO4) (Rs. 2,79,250; 1.64). This may be due to higher yield obtained under TO2 when compared to farmers practice. TO2 recorded the highest yield per ha which was 44.0 per cent increases in yield over the farmers practice.

Table 2: Cost economics of nematode management in tuberose

Sl. No.	Parameters	T01 Carbofuran	T02 *Purpureocillium lilacinum* @ 5 kg/ha	T03 Basamid + Polythene Mulch	TO4 Farmer's Practice
1.	Yield (t/ha)	8.25	11.18	9.25	7.75
2.	Gross cost (Rs.)	3,16,000	3,28,380	3,35,000	3.07,000
3.	Gross income (Rs.)	6,18,750	8,38,500	6,93,750	5,06,250
4.	Net returns (Rs.)	3,02,750	5,10,120	4,87,000	2,79,250
5.	BCR	1.95	2.55	2.01	1.64

Conclusion

The present study it was concluded that TO2 (*Purpureocillium lilacinum* @ 5 kg/ha) recorded the highest yield of 11.18 t/ha and exhibited the highest net returns of Rs.5,10,120 with the benefit cost ratio of 2.55 over the farmers practices. The adoption of this technology option 2 recorded the highest yield per ha which was 44.0 per cent increases in yield over the farmers practice. Farmers were very much convinced about the bioformulation methods to reduce the nematode population in the tube rose and this technology will be proposed as frontline demonstration in the ensuing season at Madurai district.

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