International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(2): 3527-3530

Received: 20-01-2018
Accepted: 22-02-2018

K Sanjeev Kumar
Department of Plant Pathology, Faculty of Agriculture, Annamalai University, Annamlai Nagar, Tamil Nadu, India

P Balabaskar
Department of Plant Pathology, Faculty of Agriculture, Annamalai University, Annamlai Nagar, Tamil Nadu, India

T Sivakumar
Department of Plant Pathology, Faculty of Agriculture, Annamalai University, Annamlai Nagar, Tamil Nadu, India

Correspondence
K Sanjeev Kumar
Department of Plant Pathology, Faculty of Agriculture, Annamalai University, Annamlai Nagar, Tamil Nadu, India

Effect of *Serratia marcescens*, organic amendments and micronutrient mixture on the incidence of panama wilt (*Fusarium oxysporum* f.sp. *cubense*) of banana

K Sanjeev Kumar, P Balabaskar and T Sivakumar

Abstract
Fusarium wilt also known as panama disease caused by *Fusarium oxysporum* f. sp. *cubense* is one of the major constraints to banana production. The studies on the integrated management of wilt disease revealed that integrated treatment combination consisting of application of FYM (SA) plus *S. marcescens* (SA+ST) plus micronutrient mixture (SA+ST) significantly reduced the panama wilt incidence of banana (7.52 per cent) and increased the plant growth and yield to the maximum when compared to all other treatments and control. Further, the same treatment recorded increased rhizo sphere population of *S. marcescens* and reduced population of *Fusarium oxysporum* f. sp. *cubense*

Keywords: *Serratia marcescens, fusarium oxysporum* f. sp. *cubense*, micronutrient mixture, organic amendments.

Introduction
Banana (*Musa* sp), one of the most important fruit crops is cultivated in 117 countries mostly in the tropics and sub- tropics of south and Central America, Asia and Africa. The crop is affected by number of diseases among which *Fusarium* wilt also known as panama disease caused by *Fusarium oxysporum* f. sp. *cubense* is one of the major constraints to banana production world-wide (Thangavelu *et al*. 2001) [11]. Chemical fungicides are not advocated for controlling the soil borne plant pathogens in view of their prohibitive cost and threat to beneficial soil micro flora. Hence, the interest is now shifting towards biological control. The rhizo sphere microflora are ideal to be used as bio control agents because the rhizo sphere provides the first line defense to root surface against invading pathogen (Raaj makers *et al.* 1995) [6]. Several bio control agents have been investigated for the successful management of wilt of banana. However, there is still a good number of antagonists exist in nature unexploited. Hence, in the present investigation attempts were made to test the efficacy of a new bio control organism viz. *Serratia marcescens* for the management of *Fusarium* wilt of banana. Further, no single method has been proved as effective for the successful management of soil-borne pathogens. Therefore, integration of organic amendments which could serve as a food source for the antagonists and application of micronutrient mixture which could improve the vigour of the plant were thought off in the treatment schedule for the sustainable management *of Fusarium* wilt of banana.

Materials and methods
A field experiment was conducted at Eyyalore village in Cuddalore district of Tamil Nadu during 2017. The field selected for this purpose was an endemic area for the occurrence of *F. oxysporum* f. sp. *cubense.* The banana suckers of cultivar Monthan without *Fusarium* wilt infection was obtained from the wilt free garden and planted with the spacing of 1.8 m x 1.8 m after paring and pralinage practices. Talc based formulation of *S. marcescens,* farm yard manure and micronutrient mixture ($ZnSO_4$ + Boran + $CuSO_4$) were selected for this study besides, the fungicide treatment carbendazim @ 0.1 per cent as soil drench + carbofuran 3% G @ 20g/sucker was included in the treatment schedule for comparison and a suitable control was also maintained. All the agronomical practices were strictly adopted during the cropping period as per the crop production manual for Horticultural crops published by the Department

of Horticulture, Government of Tamil Nadu. The observation on the growth parameters and nematode population were recorded as per the 'International Network for the Improvement of Banana and Plantain' (INIBAP) and the wilt incidence was recorded based on the 1-5 scale (Ploetz *et al.* 1999) [5]. The field experiment was conducted in a randomized block design with three replications for each treatment. The dosage of the antagonist and other treatments were decided based on the results obtained in our earlier studies.

Treatment schedule

T_1-Sucker treatment (ST) of *S. marcescens* @ 20 g/sucker
T_2-Soil application (SA) of *S. marcescens* @ 25 g/ plant
T_3-Farm yard manure (FYM)-(SA) @ 7 kg/plant
T_4-Sucker treatment (ST) of micronutrient mixture @ 50g/sucker
T_5-Soil application (SA) of micronutrient mixture @ 100 g/ plant
T_6-$T_1 + T_2$
T_7-$T_3 + T_1$
T_8-$T_3 + T_2$
T_9-Micronutrient mixture (SA+ ST)
T_{10}-$T_3 + T_4$
T_{11}-$T_3 + T_5$
T_{12}-FYM (SA) + T_6+T_9
T_{13}-Carbendazim @ 0.1% as soil drench + Carbofuran 3% G @ 20g/ sucker
T_{14}-Control

The population of antagonists and pathogen in the rhizo sphere soil was estimated following the method of Stanghellini and Hancock (1970) at harvest.

Results and discussion

The results (Table 1) of the field trial conducted at Eyyalore during 2017 showed that the wilt disease incidence was effectively controlled by the combined application of *S. marcescens*, FYM and micronutrient mixture (T_{12}) with the least wilt incidence of 7.52 per cent which was followed by T_{13}, T_6 and T_7 (8.92, 12.48 and 14.32% respectively) in the decreasing order of merit. The maximum wilt incidence was recorded in control (41.21 per cent). The results revealed that different plant colonization pattern and different mechanism of disease suppression elicited by *S. marcescens* might have offered greater protection to the plants against the wilt disease. Someya *et al.* (2000) [8] reported that cyclamen plants treated with *S. marcescens* resulted in reduced damping off incidence under greenhouse conditions. Jaiganesh *et al.* (2007) [4] observed that rice seeds treated with talc-based formulation of *S. marcescens* showed lesser blast incidence.

In the present study, integration of micronutrients and FYM with the bioagents proved very effective in reducing the disease incidence. The integration of micronutrients and FYM with the bioagents further enhanced the disease suppression and recorded the least wilt incidence. As observed in the present study, Sarkar *et al.* (2000) [7] also revealed that combination of micronutrients (Boron, Zinc and Iron) resulted in reduced wilt incidence of sun hemp. The results of the present study clearly revealed that an integration of several strategies like application of bio control agents along with organic amendments and mineral nutrition exerted a synergism which offered protection against *F. oxysporum* f. sp. *cubense* and resulted in minimum wilt incidence in banana. Besides suppressing the wilt incidence, the application of integrated treatments increased the growth and yield significantly when compared to control. The maximum increase in growth parameters *viz.* plant height (250.50cm), pseudo stem girth (44.50 cm), leaf number (23.93), leaf area (4294.38cm^2) and yield (24.81) was observed in treatment with combined application of *S. marcescens*, FYM and micronutrient mixture (T_{12}) followed by T_{13} and T_6 respectively (Table 2). The results of the present study are in line with the observation made by Ezhilarasi (2006) [3] who stated that seed treatment of *S. marcescens* increased the growth and yield of black gram. Combined application of $ZnSO_4$ @ 25 kg/ha + $MnSO_4$ @ 5 kg/ha was significantly superior in enhancing growth, yield and nutrient uptake of banana (Arumugam Shakila, 2000) [1]. Jaiganesh *et al.* (2007) [4] observed that rice seeds treated with talc based formulation of *S. marcescens* recorded higher plant growth and yield. It is reasonable to assume that the plant growth promoting substances produced by *S. marcescens* and application of FYM and micronutrients would have increased the vigour of the plant which resulted in the increased plant growth and yield.

The treatment combination with *S. marcescens*, FYM and micronutrient mixture (T_{12}) showed the best rhizo sphere competence and recorded the maximum population of *S. marcescens* with 39.23 x 10^{-6} cfu g-1 soil followed by T_6 (36.67 x 10^{-6} cfu g-1 soil). The same treatment with FYM plus *S. marcescens* (SA + ST) plus micronutrient mixture (SA + ST) significantly reduced the rhizo sphere population of *F. oxysporum* f. sp. *cubense* to the minimum with 9.01 from 30.15 x 10^{-3} cfu g^{-1} soil. This was followed by the soil application and sucker treatment of carbendazim and carbofuran which recorded a pathogen population of 10.00 x 10^{-3} cfu g^{-1} soil (Table 3). *S. marcescens* was reported as effective rhizo sphere colonizers and were typically, present at higher population in the upper portion of the roots of black gram (Ezhilarasi, 2006) [3]. The observations of the present study are also in agreement with the findings of Ayya ppan (2003) [2]. From the available evidence, it can be concluded that the efficient cononization of the bio-protectant in the rhizosphere might be made possible through the possession and exhibition of good competitive saprophytic activity, enzymatic antagonistic potential and other features.

Table 1: Efficacy of application of *S. marcescens*, FYM and micronutrient mixture on the incidence of *Fusarium* wilt of banana

Tr. No.	Treatments	Wilt incidence (%)	Percent reduction
1.	*S. marcescens*-sucker treatment (ST) @ 20g/sucker	18.21 (25.26)	55.81
2.	*S. marcescens*-soil application (SA) @ 25g/plant	19.84 (26.45)	51.86
3.	Farm Yard Manure (FYM)-(SA) @ 7kg/plant	36.75 (37.31)	10.82
4.	Micronutrient mixture-(ST) @ each 50g/sucker	27.42 (31.57)	33.46
5.	Micronutrient mixture-(SA) @ each 100g/plant	31.62 (34.21)	23.27
6.	*S. marcescens* (ST + SA)@ 25g/plant + 20g/sucker	12.48 (20.68)	69.72
7.	FYM (SA) + *S. marcescens* (ST)	14.32 (22.23)	41.21
8.	FYM (SA) + *S. marcescens* (SA)	15.71 (23.35)	61.88

9.	Micronutrient mixture-(SA + ST)	17.62 (24.81)	57.24
10.	FYM (SA) + Micronutrient mixture (SA)	21.43 (27.57)	47.99
11.	FYM (SA) + Micronutrient mixture (ST)	23.25 (28.82)	43.58
12.	FYM (SA) + T_6 + T_9	7.52 (60.13)	81.75
13.	Carbendazim @ 0.1% as soil drench + Carbofuran 3% G @ 20g/sucker	8.92 (70.81)	78.35
14.	Control	41.21 (39.93)	-
	S Ed CD (p=0.05)	0.52 1.12	-

Data in parentheses indicate angular transformed values.

Table 2: Efficacy of application of *S. marcescens*, FYM and micronutrient mixture on the biometrics of banana

Tr. No.	Treatments	Plant height (cm)	Pseudo stem girth (cm)	No. of leaves/plant	Leaf area/leaf (cm^2)	Yield/Plant (Kg)
1.	*S. marcescens*-sucker treatment (ST) @ 20 g/sucker	238.57	40.25	17.50	3650.72	19.25
2.	*S. marcescens*-soil application (SA) @ 25 g/plant	236.25	36.02	17.20	3600.43	18.52
3.	Farm yard Manure (FYM)-(SA) @ 7kg/plant	230.71	33.72	15.21	3400.62	17.50
4.	Micronutrient mixture-(ST) @ each 50 g/sucker	236.31	30.04	14.32	3310.61	17.00
5.	Micronutrient mixture-(SA) @ each 100 g/plant	238.45	32.45	14.84	3380.48	18.02
6.	*S. marcescens* (ST + SA) @ 25 g/plant + 20 g/sucker	243.57	42.41	19.30	4001.22	22.00
7.	FYM (SA) + *S. marcescens* (ST)	241.18	41.09	18.45	4000.33	21.01
8.	FYM (SA) + *S. marcescens* (SA)	240.52	40.12	18.24	3970.52	20.50
9.	Micronutrient mixture – (SA + ST)	240.00	36.25	16.61	3880.30	20.00
10.	FYM (SA) + Micronutrient mixture (SA)	238.85	35.05	17.78	3600.47	18.62
11.	FYM (SA) + Micronutrient mixture (ST)	239.00	36.06	17.94	3620.39	19.00
12.	FYM (SA) + T_6 + T_9	250.50	44.50	23.93	4294.38	24.81
13.	Carbendazim @ 0.1% as soil drench + Carbofuran 3% G @ 20 g/sucker	248.71	43.36	22.45	4145.24	23.32
14.	Control	200.93	31.46	15.30	3101.29	10.28
	S Ed	0.79	0.21	0.12	7.55	0.15
	CD (p=0.05)	1.68	0.58	0.49	15.22	0.47

Table 3: Efficacy of application of *S. marcescens*, FYM and micronutrient mixture on the rhizo sphere population of the antagonist and pathogen

Tr. No.	Treatments	Rhizosphere population (g^{-1} of oven dry soil)	
		S. marcescens **(10^{-6} cfu)**	***F. oxysporum*** **f. sp. *Cubense* (10^{-3} cfu)**
1	*S. marcescens*-sucker treatment (ST) @ 20 g/sucker	31.71	22.54
2	*S. marcescens*-soil application (SA) @ 25 g/Plant	32.82	23.92
3	Farm Yard Manure (FYM)-(SA) @ 7 kg/plant	0.00	28.64
4	Micronutrient mixture-(ST) @ each 50 g/sucker	0.00	27.01
5	Micronutrient mixture-(SA) @ each 100 g/Plant	0.00	27.00
6	*S. marcescens* (ST + SA) @ 25 g/plant + 20 g/sucker	36.67	13.78
7	FYM (SA) + *S. marcescens* (ST)	34.25	16.82
8	FYM (SA) + *S. marcescens* (SA)	36.01	18.94
9	Micronutrient mixture-(SA + ST)	0.00	21.02
10	FYM (SA) + Micronutrient mixture (SA)	0.42	24.76
11	FYM (SA) + Micronutrient mixture (ST)	0.39	25.68
12	FYM (SA) + T_6 + T_9	39.23	9.01
13	Carbendazim @ 0.1% as soil drench + Carbofuran 3% G @ 20 g/sucker	0.00	10.00
14	Control	0.00	30.15
	S Ed	0.62	0.19
	CD (p=0.05)	1.21	0.40

References

1. Arumugm Shakila. Studies on nutrition for *in vitro* propagated Banana cv. 'Robusta', Ph. D. Thesis, Annamalai Univesity, India, 2000.
2. Ayyappan S. Evaluation of certain biocontrol agents for the control of fusarial wilt *(Fusarium oxysporum* f. sp. *lycopersici)* and root rot nematode disease complex of tomato. Ph. D. Thesis, Annamalai University. India, 2003.
3. Ezhilarasi A. Effect of *Serratia marcescens* on the management of dry root rot caused by *Macrophomina phaseolina* (Tassi.) Goid. Of black gram. M.Sc (Ag.) Thesis, Annamalai University, India, 2006.
4. Jaiganesh V, Eswaran A, Balabaskar P, Kanna C. Antagonistic activity of *Serratia marcescens* against Pyricularia oryzae. Not. Bot. Hort. Agrobat. Cluj. 2007; 35:48-54.
5. Ploetz RC, Haynes JL, Vazquez A. Responses of new banana accessions in south Florida to Panama disease. Cropprot. 1999; 18:445-449.
6. Raaijmakers JM, Van der Sluis I, Koster M, Bakker PAHM, Weisbeek PJ, Schippers B. Utilization of heterologous siderophores and rhizosphere competence of fluorescent Pseudomonas spp. Can. J Microbiol. 1995; 41:126-135.
7. Sarkar SK, Pradhan SK, Tripathi SN. Influence of boron, zinc and iron on the incidence of sunhemp wilt

(Fusarium udum f. sp. *crotolariae).* J My col. PI. Pathol. 2000; 30:116-118.
8. Someya N, Kataoka N, Komagata T, Hirayae K, Hibi T, Akusu K. Biological control of cyclamen soilborne disease by Serratia marcescens strain B_2. Plant Dis. 2000; 84:334-340.
9. Stanghellini ME, Hancock JG. A quantitative method for the isolation of *Pythium ultimum* from soi. Phytopathology. 1970; 60:551-552.
10. Weller DM. Biological control of soil borne plant pathogens in the rhizosphere with bacteria. Annu. Rev. Phytopath. 1988; 26:379-407.
11. Thangavelu R, Sundararaju P, Sathiamoorthy S, Raghuchandar T, Velazhahan R, Nakkeeran S *et al*. Status of *Fusarium* wilt of banana in India. In: Banana *Fusarium* wilt management: Towards sustainable cultivation. AB. Molina, NH. Nikmasdek, KW. Liew (eds), INIBAP-ASPNET, Los Banos, Laguna, PhIlippines, 2001, 58-63.