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EVALUATION OF INTEGRATED DISEASE MANAGEMENT MODULES ON CROSSANDRA WILT INCITED BY *FUSARIUM INCARNATUM* (DESM.) SACC.

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ABSTRACT

Field experiments were conducted at three villages namely Thiminayakarpatty, Sengottai and Sempatty to evaluate integrated modules for their efficacy, efficiency and consistency in management of crossandra wilt. The experiment at Thiminayakarpatty reveals that all treatments tested are effective in management of wilt incidence, but among all the treatment T_8 (*T. viride (Tv-9)* @ 2.5kg/h as basal application at 20 DAP + soil drenching of carbendazim @ 0.1% at 30 DAP, + soil application of *T. viride* (Tv-9) @ 2.5 kg/ha at 50 DAP + Foliar application(FA) of *P. fluorescens (Pf-18)* @ 1.0 kg/ha at 70 DAP + FA of *B.subtilis(Bs-10)*@1.0kg/ha at 90 DAP) significantly recorded 88.3 per cent disease reduction over control followed by T_{12} and T_2. The treat mental effect on root lesion index, indicated that among all the treatments, T_{12} recorded significantly higher reduction of root lesion index which accounted 70.8 per cent reduction over control, followed by T_6 with root lesion index reduction of 66.7 per cent. The similar trend in disease reduction, plant growth parameters and flower yield was also observed in other field trials at Sengottai and Sempatty villages of Thamilanadu, India indicating T_8 as best module for management of crossandra wilt.

INTRODUCTION

Crossandra (Fire cracker) is an important commercial flower, mainly grown in India, Tropical Africa and Madagascar (Bailey, 1963). The flowers are commonly used for hair adornment. Though not fragrant, these flowers are very popular because of their attractive bright colour, light weight and good keeping quality. The crop is frequently affected by various fungal diseases. Among the various fungal diseases wilt disease caused by *Fusarium* spp. is one of the major problem in crossandra production and limits the crop cultivation. Management of this disease has become very difficult due to its soil borne and complex nature. Management of this disease through chemicals and by the use of resistant varieties are possible to some extent. But the hazardous impact of agrochemicals on the environment, development of resistant mutants, escalating cost of pesticides and frequent breakdown of resistant varieties strongly demand a sustainable and an alternative management approach to disease control.

Many scientists reported that different methods such as use of biological agents/chemicals/bio technological/Physical and cultural methods are available to control/manage the plant diseases but management of complex diseases like wilt of Crossandra with use of any single available method is almost impossible. So more comprehensive, broad spectrum, holistic approach is needed and this can be achieved by coordinated use of multiple tactics in ecologically safe and economically feasible way. Integrated approach for the management of disease involves the use of two or more methods in a compatible manner to reduce disease incidence with minimal hazards on environment and maximization of economic profit. Biocontrol agents, organic amendments, and chemicals etc, can be combined to develop an efficient, eco-friendly, compatible and profitable disease management strategy that conserves natural resources and beneficial microbes.

Many workers successfully managed the plant diseases with integration of bio control agents, organic amendments and chemical fungicides in most efficient and eco-friendly way without effecting environment. Animisha *et al.*, (2012) showed that chickpea wilt incited by *Fusarium oxysporum* can be effectively controlled by integration of *T.viride*, carbendazim and neem cakes. Mahesh *et al.,* (2010) observed that combined application of carbendazim, *T.viride* and *Pseudomonas fluoresence* are superior in management of Pigeonpea wilt disease incited by *Fusarium udum var.cajani.*

So keeping all the factors in view, possible attempts were made to evaluate the different integrated modules to manage the crossandra wilt complex under field conditions.

MATERIALS AND METHODS

Field experiments with the following treatments were laid out at three locations namely Thiminayakarpatty, Sengottai and Sempatty villages of Dindugal, district during 2014-15 where the crop is grown every year. The experiments were laid out using Randomized block design (RBD) with plot size of 5 x 5

m^2 and spacing of 30 x 50 cm. The experiment was conducted with 13 treatments and each treatment replicated thrice. All the treatments were applied as per scheduled of treatments starting from 20 DAP. All normal agronomical practices were followed at regular intervals. Natural wilt incidence, lesion index and growth parameters *viz.*, shoot and root length, flower yield were recorded.

The treatmental details are as follows

T_1 SA of *P.f* (Pf-18) @ 2.5 kg/ha at 20 DAP + Module B

T_2 SA *T.v* (Tv-9) @ 2.5 kg/ha at 20 DAP + Module B

T_3 SA of *B.s* (Bs-10) @ 2.5 kg/ha at 20 DAP + Module B

T_4 SA of Neem cake @ 250 kg/ha at 20 DAP + Module B

T_5 SD of carbendazim @ 0.1% at 20 DAP + Module B

T_6 SA of Phorate10G @ 10 kg/ha at 20 DAP + Module B

T_7 SA of *P.f* (Pf-18) @ 2.5 kg/ha at 20 DAP + Module C

T_8 SA *T.v* (Tv-9) @ 2.5 kg/ha at 20 DAP + Module C

T_9 SA of *B.s* (Bs-10) @ 2.5 kg/ha at 20 DAP + Module C

T_{10} SA of Neem cake @ 250 kg/ha at 20 DAP + Module C

T_{11} SD of carbendazim @ 0.1% at 20 DAP + Module C

T_{12} SA of Phorate10G @10 kg/ha at 20 DAP + Module C

T_{13} Control

Module B = FA of carbendazim @ 0.1% at 30 DAP + SA of *T.v* (Tv-9) @ 2.5 kg/ha at 50 DAP and FA of *P.f* (Pf-18) @ 1.0 kg/ha at 70 DAP + FA of *B.s* (Bs-10) @ 1.0 kg/ha at 90 DAP

Module C= SD of carbendazim @ 0.1% at 30 DAP + SA of *T.v* (Tv-9) @ 2.5 kg/ha at 50 DAP + FA of *P.f* (Pf-18) @ 1.0 kg/ha at 70 DAP + FA of *B.s* (Bs-10) @ 1.0 kg/ha at 90 DAP

RESULTS AND DISCUSSION

The integrated modules are evaluated for their efficacy, efficiency and consistency in management of crossandra wilt at three different locations viz: Thiminayakarpatty, Sengottai and Sempatty. The results of experiment at Thiminayakarpatty reveals that among the thirteen treatments tested, all the treatments were effective in management of wilt incidence, but the treatment T_8 (SA of Tv (Tv-90 @ 2.5kg/ha at 20 DAP plus Module C) significantly recorded 88.3 per cent disease reduction over control followed by T_{12} and T_2, which accounted for 85.3 and 83.5 per cent reduction of wilt incidence over control and statistically on par with each other. Minimum disease incidence reduction of 68.5 per cent was observed in T_4. Observations also made to study the treatmental effect on root lesion index, indicated that among all the treatments, T_{12} recorded significantly higher reduction of root lesion index which accounted 70.8 per cent reduction over control, followed by T_6 with root lesion index reduction of 66.7 per cent, whereas T_1 and T_3 recorded minimum reduction of 45.8 per cent root lesion index when compared to control (Table 1)

Treatment T_8 was found to record the maximum shoot length of 63.8 cm and root length of 35.3 cm of crossandra which accounted for 25.8 and 33.7 per cent increased growth over control. The treatment T_4 was found to be least effective in respect of growth parameters. Crossandra flower yield was highest in the treatment T_8 which recorded 2388kg/ha of flower yield, which accounted 27.6 per cent increased yield over control with C:B ratio of 1:4.03 followed by T_{12} with C:B ratio of 1:3.99 where as minimum increased yield of 14.1 per cent over control was recorded with T_4 at Thiminayakarpatty. The similar trend in disease reduction, plant growth parameters and flower yield were observed in other two field trials at Sengottai and Sempatty villages (Table 2 and 3).

Animisha *et al.* (2012) showed that chickpea wilt incited by *Fusarium oxysporum* can be effectively controlled by integration of *T. viride*, carbendazim and neem cakes. Mahesh *et al.* (2010) observed that combined application of carbendazim, *T. viride* and *P. fluorescens* were superior in management of Pigeon pea wilt disease incited by *Fusarium udum var cajani.* Dubey *et al.* (2013) reported that the combination of PBP 4G (*T. viride*) for soil application and Pusa 5SD (*T.harzianum*) for seed treatment together with fungicide carboxin, provided the highest seed germination, shoot and root lengths and grain yield with the lowest incidence of wilt in chickpea under field conditions. Soil application of EPC5+Pf1+Tv at 30 g per palm along with 5 kg FYM recorded a higher number of nuts (48 nuts/palm) compared to control (35.5 nuts/palm) in field trial. The quality and quantity of nuts were enhanced in endophytic bacteria EPC5 combined with Pf1+Tv treated palms compared to the chemical check and the control (Rajendran., 2006). Govindappa *et al.* (2011) reported that application of biocontrol agents *viz., T. harzianum, B. subtilis* and *P. fluorescens* reduced the *Fusarium* wilt incidence of safflower both under greenhouse and field conditions. Nikam *et al.* (2007) reported that the soil borne diseases of crops incited by species of *Fusarium* were cost-effective to be managed through integration of microbial antagonist, fungi toxi-cants or organic amendment. Different mechanisms have been suggested as being responsible for their combined or single effect on and fungal inhibition and yield improvement. *T. harzianum* caused a drastic decrease in the rhizosphere population of *F. oxysporum* f. sp. *ciceris* and increased the number of functional nodules in the chickpea roots (Khan *et al.*, 2004). Similar results reported by Mukesh *et al.,* (2015) Rashmi Pente *et al.* (2015) with *Trichoderma spp.*

The wilt disease caused by *F. incarnatum* is a major constraint to crossandra production and there was no substantial host plant resistance to *Fusarium* wilt in the crossandra. The present study concluded that the use of suitable microbial antagonist, fungicide, and oil cakes in an appropriate combination could be the key measures for a rational integrated management of crossandra wilt in sustainable cropping systems. In this approach, a fungicide possibly eliminates the soil borne inoculums, organic amendments improves soil health as well as acts as fungi static compounds, whereas biocontrol agent takes care of the soil borne inoculum and increases crop productivity by improving nutrients as well as growth-promoting compounds status.

Since crossandra is being a biannual crop by adapting the integrated approach namely soil application of *T. viride (Tv-9)* @ 2.5kg/h as basal application at 20 DAP plus soil drenching of carbendazim @ 0.1% at 30 DAP plus soil application of *T. viride* (Tv-9) @ 2.5 kg/ha at 50 DAP plus foliar application

Table 1: Effect of different combination of bioagents, organic amendments and chemicals on the incidence of crosssandra wilt, plant growth parameters and yield under field conditions at Thiminayakarpatty village

	Treatment	Root lesion index*	% decrease over control	Wilt incidence (%)* at 210 DAP	Disease reduction over control (%)	Shoot Length (cm)* at 210 DAP	% increase over control	Root Length (cm)* at 210 DAP	% increase over control	Flower yield kg/ha	Yield increase over control	C:B ratio
T_1	SA of *P.f luorescens* (*Pf*-18) @ 2.5 kg/ha at 20 DAP + Module A	1.3(6.54)**	45.8	11.2(19.49)	75.2	59.4(58.42)	17.2	32.1(34.49)**	21.6	2184 (46.74)***	16.7	1: 3.69
T_2	SA of *T. viride (Tv-9)* @ 2.5 kg/ha at 20 DAP + Module A	1.1(6.01)	54.2	7.4(15.81)	83.5	62.2(52.07)	22.7	34.5(35.95)	30.7	2328 (48.26)	24.4	1 :3.93
T_3	SA of *B. subtilis (Bs-10)* @ 2.5 kg/ha at 20 DAP + Module A	1.3(6.54)	45.8	13.1(21.18)	70.9	58.3(49.77)	15.0	31.8(34.30)	20.5	2172 (46.61)	16.0	1 :3.67
T_4	SA of Neem cake @ 250 kg/ha at 20 DAP + Module B	1.1(6.01)	54.2	14.2(22.08)	68.5	56.7(48.84)	11.8	30.5(33.50)	15.5	2136 (46.22)	14.1	1 :3.58
T_5	SD of carbendazim @ 0.1% at 20 DAP + Module B	0.9(5.44)	62.5	10.4(18.83)	76.8	58.5(49.89)	15.4	33.4(35.28)	26.5	2280 (47.75)	21.8	1 :3.85
T_6	SA of Phorate10G @ 10 kg/ha at 20DAP + Module B	0.8(5.13)	66.7	8.9(17.32)	80.3	62.5(52.24)	23.3	34.3(35.83)	29.9	2316 (48.13)	23.7	1 :3.89
T_7	SA of *P. f* (*Pf*-18 @ 2.5 kg/ha at 20 DAP + Module C	1.2(6.28)	50.0	10.0(18.38)	77.9	61.4(51.59)	21.1	33.2(35.16)	25.8	2352 (48.50)	25.6	1 :3.97
T_8	SA of *T. v (Tv-9)* @ 2.5 kg/ha at 20 DAP + Module C	1.0(5.73)	58.3	5.3(13.27)	88.3	63.2(52.66)	24.7	35.3(36.43)	33.7	2388 (48.87)	27.6	1 :4.03
T_9	SA of *B. s (Bs-10)* @ 2.5 kg/ha at 20 DAP + Module C	1.2(6.28)	50.0	11.8(20.03)	73.8	60.6(51.12)	19.5	32.5(34.73)	23.1	2220 (47.12)	18.6	1 :3.75
T_{10}	SA of Neem cake @ 250 kg/ha at 20 DAP + Module C	1.0(5.73)	58.3	12.6(20.77)	72.0	58.1(49.66)	14.6	32.0(34.43)	21.2	2184 (46.74)	16.7	1 :3.66
T_{11}	SD of carbendazim @ 0.1% at 20 DAP + Module C	1.2(6.28)	50.0	8.0(16.45)	82.1	61.8(51.83)	21.9	33.9(35.58)	28.4	2340 (48.38)	25.0	1 :3.95
T_{12}	SA of Phorate10G @ 10 kg/ha at 20DAP + Module C	0.7(4.79)	70.8	6.6(14.86)	85.3	63.8(53.02)	25.8	34.9(36.19)	32.2	2376 (48.75)	26.9	1 :3.99
T_{13}	Control	2.4(8.90)	-	44.9(42.04)	-	50.7(45.38)	-	26.4(30.89)	-	1872 (43.25)	-	1:3.26
CD (P=0.05)		0.07	-	1.70	-	0.47	-	0.33	-	7.11	-	-
SE(m)±		0.02	-	0.58	-	0.16	-	0.11	-	2.42	-	-

*Mean of three replications, **Figure in the parentheses are arc sine transformed values, ***Figure in the parentheses are square root transformed values.
Module B = FA of carbendazim @ 0.1% at 30 DAP + SA of *T.v* @ 2.5kg/ha at 50 DAP + FA of *P.f* @ 1.0 kg/ha at 70 DAP + FA of *B.s* @ 1.0 kg/ha at 90 DAP
Module C = SD of carbendazim @ 0.1% at 30 DAP + SA of *T.v* @ 2.5kg/ha at 50 DAP + FA of *P.f* @ 1.0 kg/ha at 70 DAP + FA of *B.s* @ 1.0 kg/ha at 90 DAP

Table 2: Effect of different combination of bioagents, organic amendments and chemicals on the incidence of crosssandra wilt, plant growth parameters and yield under field conditions at Sengottai village

	Treatment	Root lesion index*	% decrease over control	Wilt incidence (%)* at 210 DAP	Disease reduction over control (%)	Shoot Length (cm)* at 210 DAP	% increase over control	Root Length (cm)* at 210 DAP	% increase over control	Flower yield kg/ha	Yield increase over control	C:B ratio
T_1	SA of *P.fluorescens* (*Pf*-18) @ 2.5 kg/ha at 20 DAP + Module A	1.4(1.54)**	45.4	11.8(3.57)	75.0	56.6(7.59)	17.2	31.1(5.67)**	21.6	2151 (46.38)***	15.3	1: 3.65
T_2	SA of *T.viride (Tv-9)* @ 2.5 kg/ha at 20 DAP + Module A	1.2(1.47)	53.8	7.8(2.96)	83.5	59.3(7.76)	22.7	33.5(5.87)	30.7	2293 (47.89)	22.9	1 :3.89
T_3	SA of *B.subtilis (Bs-10)* @ 2.5 kg/ha at 20 DAP + Module A	1.4(1.54)	45.4	13.8(3.84)	70.8	55.6(7.52)	15.1	30.8(5.64)	20.5	2139 (46.26)	14.7	1 :3.62
T_4	SA of Neem cake @ 250 kg/ha at 20 DAP + Module B	1.2(1.47)	53.8	14.9(3.99)	68.3	54.0(5.42)	11.9	29.6(5.53)	15.6	2104 (45.87)	12.8	1 :3.54
T_5	SD of carbendazim @ 0.1% at 20 DAP + Module B	0.9(1.40)	62.2	10.9(3.45)	76.8	55.8(7.53)	15.4	32.4(5.78)	26.6	2246 (47.39)	20.4	1 :3.80
T_6	SA of Phorate10G @ 10 kg/ha at 20DAP + Module B	0.8(1.36)	66.4	9.3(3.22)	80.2	59.6(7.78)	23.3	33.3(5.85)	30.0	2281 (47.76)	22.3	1 :3.85
T_7	SA of *P.f* (*Pf*-18 @ 2.5 kg/ha at 20 DAP + Module C	1.3(1.50)	49.6	10.5(3.39)	77.7	58.5(7.72)	21.2	32.2(5.76)	25.8	2317 (48.13)	24.2	1 :3.92
T_8	SA of *T.v (Tv-9)* @ 2.5 kg/ha at 20 DAP + Module C	1.1(1.43)	58.0	5.6(2.56)	88.2	60.2(7.83)	24.7	34.2(5.94)	33.8	2352 (48.50)	26.1	1 :4.00
T_9	SA of *B.s(Bs-10)* @ 2.5 kg/ha at 20 DAP + Module C	1.3(1.500	49.6	12.4(3.66)	73.7	57.8(7.67)	19.6	31.5(5.70)	23.1	2187 (46.76)	17.2	1 :3.72
T_{10}	SA of Neem cake @ 250 kg/ha at 20 DAP + Module C	1.1(1.43)	58.0	13.2(3.77)	71.9	55.4(7.51)	14.7	31.0(5.66)	21.3	2151 (46.38)	15.3	1 :3.62
T_{11}	SD of carbendazim @ 0.1% at 20 DAP + Module C	1.3 (1.50)	49.6	8.4(3.07)	82.2	58.9(7.74)	22.0	32.9(5.82)	28.4	2305 (48.01)	23.5	1 :3.90
T_{12}	SA of Phorate10G @ 10 kg/ha at 20DAP + Module C	0.7(1.32)	70.6	6.9(2.82)	85.3	60.8(7.86)	25.9	33.9(5.90)	32.2	2340(48.38)	25.4	1 :3.96
T_{13}	Control	2.5(1.87)	-	47.1(6.94)	-	48.3(7.02)	-	25.6(5.16)	-	1866 (43.20)	-	1:3.23
CD (P=0.05)		0.02	-	0.36	-	0.09	-	0.04	-	11.29	-	-
SE(m)±		0.01	-	0.12	-	0.03	-	0.01	-	3.84	-	-

*Mean of three replications, **Figure in the parentheses are arc sine transformed values, ***Figure in the parentheses are square root transformed values.
Module B = FA of carbendazim @ 0.1% at 30 DAP + SA of *T.v* @ 2.5kg/ha at 50 DAP + FA of *P.f* @ 1.0 kg/ha at 70 DAP + FA of *B.s* @ 1.0 kg/ha at 90 DAP
Module C = SD of carbendazim @ 0.1% at 30 DAP + SA of *T.v* @ 2.5kg/ha at 50 DAP + FA of *P.f* @ 1.0 kg/ha at 70 DAP + FA of *B.s* @ 1.0 kg/ha at 90 DAP

Table 3: Effect of different combination of bioagents, organic amendments and chemicals on the incidence of crosssandra wilt, plant growth parameters and yield under field conditions at Sempatty village

Treatment	Root lesion index*	% decrease over control	Wilt incidence (%)* at 210 DAP	Disease reduction over control (%)	Shoot Length (cm)* at 210 DAP	% increase over control	Root Length (cm)* at 210 DAP	% increase over control	Flower yield kg/ha	Yield increase over control	C:B ratio
T_1 SA of *P.fluorescens* (*Pf*-18) @ 2.5 kg/ha at 20 DAP + Module A	1.2(6.38)	48.5	10.6(18.99)	74.7	61.4(51.56)	17.1	33.0(35.02)	25.8	2206(46.97)***	16.8	1: 3.74
T_2 SA of *T.viride (Tv-9)* @ 2.5 kg/ha at 20 DAP + Module A	1.0(5.87)	56.5	7.0(15.34)	83.1	64.3(53.28)	22.7	35.4(36.51)	35.2	2351(48.49)	24.5	1 :3.98
T_3 SA of *B.subtilis (Bs-10)* @ 2.5 kg/ha at 20 DAP + Module A	1.2(6.38)	48.5	12.4(20.61)	70.5	60.2(50.89)	15.0	32.7(34.83)	24.6	2194(46.84)	16.2	1 :3.72
T_4 SA of Neem cake @ 250 kg/ha at 20 DAP + Module B	1.0(5.87)	56.5	13.4(21.50)	68.0	58.6(49.93)	11.8	31.3(34.01)	19.5	2157(46.45)	14.2	1 :3.66
T_5 SD of carbendazim @ 0.1% at 20 DAP + Module B	0.9(5.30)	64.4	9.8(18.28)	76.5	60.5(51.02)	15.4	34.3(35.83)	30.9	2303(47.99)	21.9	1 :3.90
T_6 SA of Phorate10G @ 10 kg/ha at 20DAP + Module B	0.8(4.10)	68.3	8.4(16.87)	79.8	64.6(53.46)	23.3	35.2(36.39)	34.4	2339(48.37)	23.9	1 :3.94
T_7 SA of *P.f* (*Pf*-18 @ 2.5 kg/ha at 20 DAP + Module C	1.1(6.13)	52.5	9.5(17.91)	77.4	63.5(52.78)	21.1	34.1(35.71)	30.1	2376(48.74)	25.8	1 :3.99
T_8 SA of *T.v (Tv-9)* @ 2.5 kg/ha at 20 DAP + Module C	1.0(5.59)	60.4	5.0(12.94)	87.8	65.3(53.89)	24.6	36.2(37.00)	38.3	2412(49.11)	27.7	1 :4.09
T_9 SA of *B.s(Bs-10)* @ 2.5 kg/ha at 20 DAP + Module C	1.1(6.13)	52.5	11.2(19.52)	73.4	62.6(52.29)	19.5	33.4(35.27)	27.4	2242(47.35)	18.7	1 :3.80
T_{10} SA of Neem cake @ 250 kg/ha at 20 DAP + Module C	1.0(5.59)	60.4	11.9(20.20)	71.6	60.0(50.77)	14.6	32.9(34.96)	25.4	2206(46.97)	16.8	1 :3.71
T_{11} SD of carbendazim @ 0.1% at 20 DAP + Module C	1.1(6.13)	52.5	7.6(15.97)	81.8	63.9(53.03)	21.9	34.8(36.14)	32.9	2363(48.62)	25.1	1 :3.9
T_{12} SA of Phorate10G @ 10 kg/ha at 20DAP + Module C	0.7(4.68)	72.3	6.2(14.47)	84.9	65.9(54.27)	25.8	35.8(36.76)	36.8	2400(48.99)	27.1	1 :4.03
T_{13} Control	2.4(8.91)	-	42.5(40.68)	-	52.4(46.35)	-	26.2(30.76)		1876(43.12)	-	1:3.30
CD (P=0.05)	0.02	-	0.25	-	0.09	-	0.14		12.27	-	-
SE(m)±	0.01	-	0.08	-	0.03	-	0.05		4.18	-	-

*Mean of three replications, **Figure in the parentheses are arc sine transformed values, ***Figure in the parentheses are square root transformed values.
Module B = FA of carbendazim @ 0.1% at 30 DAP + SA of *T.v* @ 2.5kg/ha at 50 DAP + FA of *P.f* @ 1.0 kg/ha at 70 DAP + FA of *B.s* @ 1.0 kg/ha at 90 DAP
Module C = SD of carbendazim @ 0.1% at 30 DAP + SA of *T.v* @ 2.5kg/ha at 50 DAP + FA of *P.f* @ 1.0 kg/ha at 70 DAP + FA of *B.s* @ 1.0 kg/ha at 90 DAP

of *P. fluorescens (Pf-18)* @ 1.0 kg/ha at 70 DAP plus foliar application of *B. subtilis (Bs-10)* @ 1.0 kg/ha at 90 DAP, apart from controlling wilt disease and nematode most effectively, the yield could be increased remarkably and thereby the farmers/growers can get more income. In addition it may lead to changes in the lively would of small farmers who are all cultivating crossandra in South India.

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