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Integrated Management of *Fusarium* Wilt of Eggplant

V.Govardhan Rao [1*], D.N.Dhutraj [2], K.T.Apet [3], C.V.Ambadkar [4] , K.D. Navgire[5]
1: Department Of Plant Pathology, Dr.Y.S.R Horticultural University, Pulivendula, (A.P), India-516 390
2, 3, 4&5: Department Of Plant Pathology, Vnmkv, Parbhani (Ms), India-431 402
*Corresponding Author
Email Id; Vgrao2007@Gmail.Com

ABSTRACT
Wilt of Eggplant (Solanum melongenae L.) due to Fusarium oxysporum f.sp.melongenae causes much damage to the crop. To manage wilt through integrated approaches an experiment was conducted with twelve treatments considering Seedling root dip of Carbendazim , Trichoderma harzianum soil application, soil application of Neem Seed Cake alone, Trichoderma fortified Neem Seed Cake, Brassica tissue soil incorporation and integration of treatments. The reduction in per cent disease incidence was ranged from 29.70 to 88.49 per cent. However, highest reductions in per cent disease incidence was recorded with the treatment T11(Seedling root dip of Carbendazim + soil application of Trichoderma fortified Neem Seed Cake + Brassica tissue soil incorporation) (88.49 %) followed by T10(Seedling root dip of Carbendazim + Seedling root dip with T.harzianum + Brassica tissue soil incorporation) (79.49 %), T9(soil application of Trichoderma fortified Neem Seed Cake + Brassica tissue soil incorporation) (69.78 %), T6(Seedling root dip of Carbendazim + soil application of Trichoderma fortified Neem Seed Cake) (66.71 %), T7(Seedling root dip of Carbendazim+ Brassica tissue soil incorporation) (62.65%) , T5(soil application of Trichoderma fortified Neem Seed Cake+ Trichoderma harzianum soil application) (55.64 %), T3 (soil application of Trichoderma fortified Neem Seed Cake) (52.88 %), T4(Brassica tissue soil incorporation) (49.79 %), T1(Seedling root dip of Carbendazim) (40.52 %), T8 (soil application of neem seed cake alone) (38.38 %) and T2 (Trichoderma harzianum soil application) (29.70%).However, the per cent increase in yield over the control was ranged from 38.41 to 115.39 per cent among the treatments, and the highest yield increase was noticed with the treatment T11 (115.39 %) followed by T10 (104.74%), T9 (98.27%), T6 (88.65%), T3 (87.77 %), T8 (77.85%), T5 (67.44%), T7 (66.11%), T1 (57.32%), T4 (44.58%) and T2 (38.41%).

***KEY WORDS**: Integrated disease management, eggplant, Fusarium wilt, Fortified organic amendments, Brassica soil incorporation, neem seed cake, Trichoderma harzinum, Carbendazim*

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INTRODUCTION

Eggplant or Brinjal (*Solanum melongena* L.) is a widely grown vegetable crop in asian countries. It occupies the third position amongst vegetable crops in our country. It is a popular and widely consumed vegetable throughout the tropical and sub-tropical regions of the world [1, 3]. Brinjal is growing throughout the India covering an area of 668.72 thousand ha with production of 123.99 thousand tones and productivity of 18.53 M. tones / ha. In Maharashtra, the area, production and productivity of Brinjal were 221.40 thousand ha, 433.28 thousand tones and 19.68 M. tones / ha, respectively during 2016-17 [6, 2].

Among other factors for low productivity of the brinjal crop, disease is one of them. This disease is common in non-flooded high lands where solanaceous vegetables are grown

continuously without crop rotation .In some cases, 100% plants are found to die in Kitchen gardens due to wilt problem (Ali et at. 1994).Wilt disease is also the major limiting factors for eggplant production throughout the world [8]. Wilt is the most important disease for poor yield .Species of *Fusarium* are responsible for vascular wilt and can be a seed borne both internal and external and survive more than 1-2 years in seed. After germination secondary infection of the fungus may be manage by use of Carbendazim, Aliette and Benlate. Carbendazim completely eradicated seed borne infection of *F. solani* and gave maximum reduction in many crops. Organic soil amendment is another important option and eco-friendly approach for controlling soil borne pathogens by developing suppressive soil [13, 20]. Bio-control agent like *Trichoderma harzianum* is reported to have great effect against soil borne pathogens [10, 17, 21]. *Trichoderma harzianum* and *T.viride* were effectively reduced the incidence of eggplant wilt caused by *Fusarium solani*. The most effective treatment was soil solarization integrated with *T.harzianum*, Carbendazim and Neem applications [4]. Considering the above facts the present study was undertaken to find out the eco-friendly components against *Fusarium* wilt management of eggplant.

MATERIAL AND METHODS

The experiment was conducted for two consecutive years during *kharif* 2018-19 and *kharif* 2019-20. Brinjal cultivar Arka Shirish was transplanted in randomized plots. Transplantation was done in July 2018 and July 2019 for two *Kharif* seasons. The crop was grown by applying all package of practices and irrigated as and when required. Observations on wilt incidence as well as yield were recorded.

Experiment details:

Design	:	RBD
Replications	:	Three
Treatments	:	Twelve
Variety	:	Arka shirish
Spacing	:	60 x 45 cm^2
Block size/ Treatment	:	2.40 x 3.15 m^2

RESULTS AND DISCUSSION

In agreement with the preliminary management practices conducted alone *in vitro* and *in vivo*, it was further proceeded to investigate an integrated disease management at field level during *kharif* 2018-19 and 2019-20. Owing to integration of selective and best treatments from preliminary treatments, all the treatments has shown significant results in integrated management of *Fusarium* wilt of eggplant.

Integrated management of *Fusarium* wilt in brinjal under natural field conditions during *kharif* 2018-19.

Per cent wilt incidence

Results in Table II and Fig.I revealed that all the treatments significantly influenced the incidence of *Fusarium* wilt caused by caused *F.oxysporum* f.sp.*melongenae*. The per cent wilt incidence recorded with all the treatments was ranged from 3.52 to 24.62 per cent, as against 35.16 per cent in untreated control. However, the treatment found most effective with significant least incidence (3.52 %) was T11 followed by T10 (6.55) , T9 (11.17) , T7 (13.79) ,T6 (12.33) , T3(14.64) , T5 (15.52) , T4 (16.14) , T8 (20.25) , T1 (21.11) and T2 (24.62%) .All the treatments were found to reduce per cent disease incidence, over untreated control. The reductions in per cent disease incidence were ranged from 29.98 to 90.00 per cent. However, highest reductions in per cent disease incidence (90.00%) was recorded with the treatment T11 followed by T10(81.35) , T9 (68.22) , T6 (64.96) , T7 (60.78) , T3 (58.37) , T5 (55.86) , T4 (54.10), T8 (42.41) , T1 (39.96) and T2 (29.98%).

Effect on eggplant yield

The results (Table II and Fig.I) indicated that the eggplant yield (q/ha.) was significantly influenced by various imposed treatments to manage eggplant *Fusarium* wilt disease. The yield was ranged from 129.19 to 202.73 q/ha with various treatments as against control yield 93.43 q/ha. Among the integrated treatments, T11 recorded significantly highest yield (202.73 q/ha.) followed by T10 (192.83 q/ha.), T9 (186.50 q/ha.), T6 (176.60 q/ha.), T3 (176.00 q/ha.), T8 (165.87 q/ha.), T5 (157.17 q/ha.), T7 (155.17 q/ha.), T1 (146.53 q/ha.),

T4 (135.23 q/ha.) and T2 (129.19 q/ha.). All the treatments were found to influence eggplant yield, over untreated control. The per cent increase in yield over the control was ranged from 38.27 to 116.99 per cent. However, highest per cent increase yield (116.99%) was noticed with the treatment T11followed by T10 (106.39), T9 (99.61), T7 (66.08), T6 (89.02), T3 (88.38), T8 (77.53), T5 (62.22), T1 (56.83), T4 (44.74) and T2 (38.27%).

Integrated management of *Fusarium* wilt of eggplant under field condition during *kharif* 2019-20.

Per cent wilt incidence

Results in Table .III and Fig.II revealed that all the treatments significantly influenced the incidence of *Fusarium* wilt caused by caused *F.oxysporum* f.sp.*melongenae*.

The per cent wilt incidence recorded with all the treatments was ranged from 4.31 to 23.18 per cent, as against 32.83 per cent in untreated control. However, the treatment T11 found most effective with significant least incidence 4.31 per cent followed by T10 (7.39), T9 (9.37),T6 (10.31), T7(11.61) ,T5(14.64), T3 (17.40), T4(18.00), T1(19.33), T8(21.65) and T2 (23.18%).All the treatments were found to reduce per cent disease incidence, over untreated control (Table III and Fig.II). The reductions in per cent disease incidence were ranged from 29.40 to 86.87 per cent. However, highest reductions in per cent disease incidence (86.87 %) was recorded with the treatment T11 followed by T10 (77.49) , T9 (71.45) , T6 (68.60) , T7 (64.65) , T5 (55.40) , ,T3 (46.99) , T4 (45.15), T1 (41.12) ,T8 (34.06) and T2 (29.40%).

Effect on eggplant yield

The results (Table III and Fig.II) indicated that the eggplant yield (q/ha) was significantly influenced by various treatments imposed to manage eggplant *Fusarium* wilt disease. The yield was ranged from 132.57 to 204.57 q/ha with various treatments as against control yield 95.67 q/ha. Among the treatments, significantly highest yield of 204.57 q/ha was recorded with the treatment T11 followed by T10 (194.33 q/ha), T9 (188.44 q/ha), T6 (180.14 q/ha %), T3 (179.08 q/ha), T8 (170.47 q/ha), T5 (159.48 q/ha), T7(158.97 q/ha) , T1 (150.97 q/ha),T4 (138.17 q/ha) and T2 (132.57 q/ha). All the treatments were found to influence eggplant yield, over untreated control. The per cent increase in yield over the control was ranged from 27.83 to 53.23 per cent. However, highest increase per cent yield 53.23 per cent was noticed with the treatment T11 followed by T10 (50.77), T9 (49.23), T6 (46.89), T3 (46.58), T8 (43.88), T5 (40.01), T7 (39.82), T1 (36.24), T4 (30.76) and T2 (27.83%).

Integrated management of *Fusarium* wilt of eggplant under field condition (Pooled)

The cumulative results in Table IV and fig.III revealed that all the treatments significantly influenced the incidence of *Fusarium* wilt and yield of eggplant during *kharif* 2018-19 and 2019-20.

Per cent wilt incidence

The wilt incidence of pooled mean recorded with all the treatments were ranged from 3.91 to 23.90 per cent, as against 34.00 per cent in untreated control. However, the treatment found most effective with significant least incidence was T11(3.91 %) followed by T10(6.92 %), T9(10.27 %), T6(11.31 %), T7(12.70%), T5(15.08 %), T3(16.02 %), T4(17.07 %), T1 (20.22 %), T8(20.95 %) and T2(23.90%). All the pooled mean treatments were found to reduce per cent disease incidence, over untreated control (Table IV and Fig.III). The reduction in per cent disease incidence was ranged from 29.70 to 88.49 per cent. However, highest reductions in per cent disease incidence was recorded with the treatment T11(88.49 %) followed by T10(79.49 %), T9(69.78 %), T6(66.71 %), T7(62.65%) , T5(55.64 %), T3(52.88 %), T4(49.79 %), T1(40.52 %), T8(38.38 %) and T2 (29.70%).

Effect on eggplant yield

The results (Table IV and Fig. III) indicated that the eggplant pooled mean yield (q/ha) was significantly influenced by various imposed treatments to manage eggplant *Fusarium* wilt disease. The yield was ranged from 130.87 to 203.65 q/ha with various treatments as against control yield 94.55 q/ha. Among the treatments, significantly highest yield of 203.65 q/ha was recorded with the treatment T11 followed by T10(193.58 q/ha), T9(187.47 q/ha.), T6(178.37 q/ha.) , T3(177.54 q/ha.), T8 (168.16 q/ha.), T5(158.32 q/ha.), T7(157.06 q/ha.) , T1(148.75 q/ha.),T4 (136.70 q/ha.) and T2 (130.87 q/ha.).All the pooled mean treatments were found to influence eggplant yield, over untreated control. The per cent increase in yield over the control was ranged from 38.41 to 115.39 per cent. However, highest increase per cent yield 115.39 per cent was noticed with the treatment T11 followed

by T10 (104.74%), T9 (98.27%), T6 (88.65%), T3 (87.77 %), T8 (77.85%), T5 (67.44%), T7 (66.11%), T1 (57.32%), T4 (44.58%), T2 (38.41%).

The present results of integrated disease management were in agreement with many previous research findings [2, 5, 8, 9, 16, 21-26].Treatment T11 showed superior effect compare to remaining treatment it may be justified that Carbendazim and bioagents combination treatment which interferes with energy production and cell wall synthesis of fungi and induce nuclear instability by disturbing the mitosis and meiosis [11]. The mechanism for explaining increased growth responses and yield in plants has been attributed to the chemical factors like release of nutrients and other growth factors, nullification of the toxins and biological factors, elimination of minor and unknown pathogens and stimulation of beneficial microorganisms present in the rhizosphere soil [6]. Thus, the best treatment combines with antagonistic agent and fungicide that were possibly takes care of the soil-borne and seed-borne inoculum and conferring added advantage to the system by improving the plant health directly and indirectly.

The treatment T10 followed as second best treatment which contains Carbendazim, bioagents and *brassica* tissue incorporation. These *brassica* tissue release volatile compounds like phenyl isothiocyanate, allyl isothiocyanate, dimethyl sulphide, acetic acid, ethanol etc. reported the inhibitory effect on soil borne fungi [19, 22, 25, 12]. Results of pooled mean showed that treatments contains organic amendments like oil cakes, composts, residues of the crop plants and other plant products as soil amendments have been reported to enhance the activity of the soil microflora which are potentially competitive or antagonistic to several soil borne pathogens by different modes of actions including production of various biochemical substances during decomposition [7, 14, 18].

However, owing to the limitations in the use of chemical fungicides, integrated disease management strategy adopted in the present investigation with application of biocontrol coupled with biofumigation and biofortification for controlling the *Fusarium* wilt disease may certainly be useful alternatives over the conventional methods.

Economics of integrated management practices on *Fusarium* wilt of eggplant

The economic evaluation of the above experiments was done to evaluate the best treatment in terms of monitory units. The economics of benefit: cost ratio was worked out and presented in Table V revealed that, treatment T11(Carbendazim 50 % +*Trichoderma* fortified neem seed cake soil application +Mustard tissue soil incorporation) obtained maximum yield (202.96q/ha),highest gross income (Rs. 5,07,402/ha), net profit (Rs.4,02,171/ha) and B:C ratio (3.82:1). The second best treatment T10 (Carbendazim 50% WP + *Trichoderma* soil application + along with soil application of Mustard soil incorporation) was showed superior yield (192.97 q/ha) and B:C ratio (3.64:1). Rest of the treatments found economical with better B:C ratio were T6(3.48:1), T9 (3.43:1), T8 (3.11:1), T5 (3.01:1), T7 (3.02:1), T3 (3.33:1), T1(2.78:1), T4 (2.61:1) and lastly T2 (2.55:1).

Table. I. Treatment details

Tr. No.	**Treatments**	**Method of application**
T_1	Carbendazim 50 WP	Seedling root dip Carbendazim @1 gm/lit
T_2	*Trichoderma harzianum*(T.hz)	Soil application @10 gm/lit($5x10^7$ cfu/gm carrier)
T_3	*Trichoderma* fortified Neem Seed Cake(TfNSC)	Soil application @4 kg/plot
T_4	*Brassica* tissue incorporation(Bti)	Soil incorporation @4 kg/plot
T_5	$T_1 + T_2$ (Carbendazim 50 WP+T.hz)	Seedling root dip Carbendazim @ 1 gm/lit + Seedling root dip (T.hz) @ 10 gm/lit
T_6	$T_1 + T_3$ (Carbendazim 50 WP +TfNSC)	Seedling root dip (Carbendazim @ 1 gm/lit + Soil application (TfNSC) @ 4 kg/plot
T_7	$T_1 + T_4$ (Carbendazim 50 WP +Bti)	Seedling root dip Carbendazim @ 1 gm/lit + Soil incorporation Bti @ 4 kg/plot
T_8	Carbendazim 50 WP +NSC	Seedling root dip(T.hz) @ 10 gm/lit + Soil application (NSC)@ 4 kg/plot
T_9	$T_3 + T_4$ (TfNSC+Bti)	Soil application TfNSC@4 kg/plot + Soil incorporation (Bti)@ 4 kg/plot
T_{10}	T1+T2+T4 (Carbendazim+T.hz+Bti)	Seedling root dip @1 gm/lit + Seedling root dip (T.hz) @ 10 gm/lit + Soil incorporation(Bti) @ 4 kg/plot
T_{11}	$T_1 + T_3 + T_4$ (Carbendazim+TfNSC+Bti)	Seedling root dip @ 1 gm/lit + Soil application (TfNSC) @ 4 kg/plot + Soil incorporation(Bti) @ 4 kg/plot.
T_{12}	Control	Untreated

Table II . Integration of different treatments on per cent *Fusarium* wilt incidence in brinjal under natural field conditions during *Kharif* 2018-19

Tr. No.	Treatment	Dose/Method of Application (g/l of water or q/ha of soil)	Wilt incidence (%)	Per cent reduction over control	Yield (q/ha)	Per cent increase over control
T_1	Carbendazim(seedling root dip@1 gm/lit)	SRD @1 gm/lit	21.11 (27.33)*	39.96	146.53	56.83
T_2	*Trichoderma harzianum*(Soil application @10 gm/lit($5x10^7$ cfu/gm carrier)	SI @10 gm/lit($5x10^7$ cfu/gm carrier)	24.62 (29.73)	29.98	129.19	38.27
T_3	Trichoderma fortified Neem Seed Cake(TFNSC- Soil application @4 kg/plot)	SA @4 kg/plot	14.64 (22.36)	58.37	176.00	88.38
T_4	*Brassica* tissue incorporation(Bti - Soil incorporation @4 kg/plot)	SI @4 kg/plot	16.14 (23.44)	54.10	135.23	44.74
T_5	$T_1 + T_2$ (Carbendazim+ *T.harzianum*)	SRD @ 1 gm/lit + SRD @ 10 gm/lit	15.52 (23.19)	55.86	157.17	68.22
T_6	$T_1 + T_3$ (Carbendazim+TFNSC)	SRD @ 1 gm/lit + SA @ 4 kg/plot	12.33 (20.53)	64.96	176.60	89.02
T_7	$T_1 + T_4$ (Carbendazim+Bti)	SRD @ 1 gm/lit + SI @ 4 kg/plot	13.79 (21.78)	60.78	155.17	66.08
T_8	Carbendazim+NSC	SRD @ 10 gm/lit + SA @ 4 kg/plot	20.25 (26.73)	42.41	165.87	77.53
T_9	$T_3 + T_4$ (TFNSC+Bti)	SA @4 kg/plot + SI@ 4 kg/plot	11.17 (19.51)	68.22	186.50	99.61
T_{10}	T1+T2+T4 (Carbendazim+*T.harzianum*+Bti)	SRD@1 gm/lit + SRD @ 10 gm/lit + SI @ 4 kg/plot	6.55 (14.82)	81.35	192.83	106.39
T_{11}	$T_1 + T_3 + T_4$ (Carbendazim+TFNSC+Bti)	SRD @ 1 gm/lit + SA@ 4 kg/plot + SI @ 4 kg/plot.	3.52 (10.78)	90.00	202.73	116.99
T_{12}	Control	NIL	35.16 (36.35)	0.00	93.43	0.00
SE(m)±			**0.98**		**0.96**	
C.D.(P=0.05)			**2.89**		**2.83**	

*figures in the parenthesis are angular transformed values, **SRD**:seedling root dip, **SI**:soil incorporation, **SA**:soil application

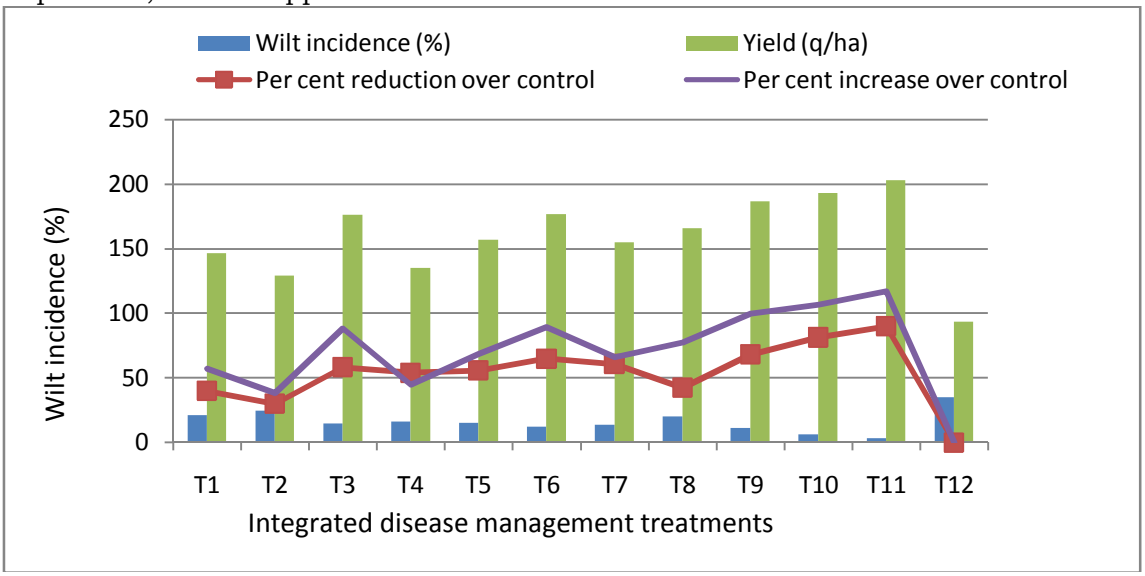

Fig.I.Integrated management of *Fusarium* wilt incidence in brinjal under field conditions during 2018-19

Table III. Integrated management of *Fusarium* wilt in brinjal under natural field conditions during *kharif* 2019-20

Treatment		Dose/Method of Application (g/l of water or q/ha of soil)	wilt incidence %	Per cent Reduction over control	Yield q/ha	Per cent increase over control
T_1	Carbendazim	SRD @1 gm/lit	19.33 (26.05)*	41.12	150.97	57.80
T_2	*Trichoderma harzianum*	SI @10 gm/lit($5x10^7$ cfu/gm carrier)	23.18 (28.76)	29.40	132.57	38.57
T_3	Trichoderma fortified Neem Seed Cake	SA @4 kg/plot	17.40 (24.64)	46.99	179.08	87.19
T_4	*Brassica* tissue incorporation	SI @4 kg/plot	18.00 (25.09)	45.18	138.17	44.42
T_5	$T_1 + T_2$ (Carbendazim+ *T.harzianum*)	SRD @ 1 gm/lit + SRD @ 10 gm/lit	14.64 (22.35)	55.40	159.48	66.70
T_6	$T_1 + T_3$ (Carbendazim+TFNSC)	SRD @ 1 gm/lit + SA @ 4 kg/plot	10.31 (18.70)	68.60	180.14	88.29
T_7	$T_1 + T_4$ (Carbendazim+Bti)	SRD @ 1 gm/lit + SI @ 4 kg/plot	11.61 (19.78)	64.65	158.97	66.16
T_8	Carbendazim+NSC	SRD @ 10 gm/lit + SA @ 4 kg/plot	21.65 (27.71)	34.06	170.47	78.19
T_9	$T_3 + T_4$ (TFNSC+Bti)	SA @4 kg/plot + SI@ 4 kg/plot	9.37 (17.80)	71.45	188.44	96.97
T_{10}	T1+T2+T4 (Carbendazim+*T.harzianum*+Bti)	SRD@1 gm/lit + SRD @ 10 gm/lit + SI @ 4 kg/plot	7.39 (15.74)	77.49	194.33	103.13
T_{11}	$T_1 + T_3 + T_4$ (Carbendazim+TFNSC+Bti)	SRD @ 1 gm/lit + SA@ 4 kg/plot + SI @ 4 kg/plot.	4.31 (11.93)	86.87	204.57	113.83
T_{12}	Control	NIL	32.83 (34.02)	0.00	95.67	0.00
	SE(m)+		**0.95**		**1.06**	
	C.D.(P=0.05)		**2.81**		**3.14**	

figures in the parenthesis are angular transformed values, **SRD**:seedling root dip, **SI**:soil incorporation, **SA**:soil application

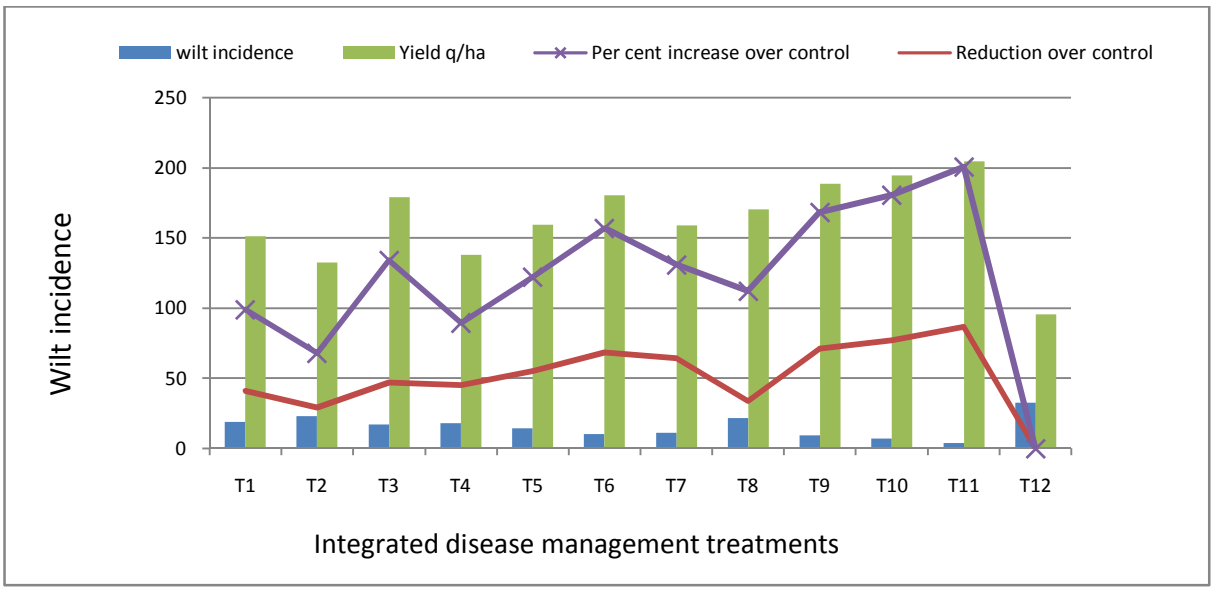

Fig.II.Integrated management of *Fusarium* wilt in brinjal under natural field conditions during *kharif* 2019-20

Table IV. Integration of different treatments on *Fusarium* wilt incidence in brinjal under field conditions (Pooled Mean)

Tr. No.	Treatment	Dose/Method of Application (g/l of water or q/ha of soil)	wilt incidence (%)				Yield (q/ha)			
			2018-19	2019-20	Mean	Per cent reduction over control	2018-19	2019-20	Mean	Per cent increase over control
T_1	Carbendazim	SRD @1 gm/lit	21.11 (27.33)	19.33 (26.05)	20.22	40.52	146.53	150.97	148.75	57.32
T_2	*Trichoderma harzianum*	SI @10 gm/lit($5x10^7$ cfu/gm carrier)	24.62 (29.73)	23.18 (28.76)	23.90	29.70	129.19	132.57	130.87	38.41
T_3	Trichoderma fortified Neem Seed Cake	SA @4 kg/plot	14.64 (22.36)	17.40 (24.64)	16.02	52.88	176.00	179.08	177.54	87.77
T_4	*Brassica* tissue incorporation	SI @4 kg/plot	16.14 (23.44)	18.00 (25.09)	17.07	49.79	135.23	138.17	136.70	44.58
T_5	$T_1 + T_2$ (Carbendazim+ *T.harzianum*)	SRD @ 1 gm/lit + SRD @ 10 gm/lit	15.52 (23.19)	14.64 (22.35)	15.08	55.64	157.17	159.48	158.32	67.44
T_6	$T_1 + T_3$ (Carbendazim+TFNSC)	SRD @ 1 gm/lit + SA @ 4 kg/plot	12.33 (20.53)	10.31 (18.70)	11.31	66.71	176.60	180.14	178.37	88.65
T_7	$T_1 + T_4$ (Carbendazim+Bti)	SRD @ 1 gm/lit + SI @ 4 kg/plot	13.79 (21.78)	11.61 (19.78)	12.7	62.65	155.17	158.97	157.06	66.11
T_8	Carbendazim+NSC	SRD @ 10 gm/lit + SA @ 4 kg/plot	20.25 (26.73)	21.65 (27.71)	20.95	38.38	165.87	170.47	168.16	77.85
T_9	$T_3 + T_4$ (TFNSC+Bti)	SA @4 kg/plot + SI@ 4 kg/plot	11.17 (19.51)	9.37 (17.80)	10.27	69.78	186.50	188.44	187.47	98.27
T_{10}	T1+T2+T4 (Carbendazim+*T.harzianum*+Bti)	SRD@1 gm/lit + SRD @ 10 gm/lit + SI @ 4 kg/plot	6.55 (14.82)	7.39 (15.74)	6.97	79.49	192.83	194.33	193.58	104.74
T_{11}	$T_1 + T_3 + T_4$ (Carbendazim+TFNSC+Bti)	SRD @ 1 gm/lit + SA@ 4 kg/plot + SI @ 4 kg/plot.	3.52 (10.78)	4.31 (11.93)	3.91	88.49	202.73	204.57	203.65	115.39
T_{12}	Control	NIL	35.16 (36.35)	32.83 (34.02)	34.00	0.00	93.43	95.67	94.55	0.00
	SE(m) ±		**0.98**	**0.95**			**0.96**	**1.06**		
	C.D.(P=0.05)		**2.89**	**2.81**			**2.83**	**3.14**		

*figures in the parenthesis are angular transformed values, **SRD**:seedling root dip, **SI**:soil incorporation, **SA**:soil application

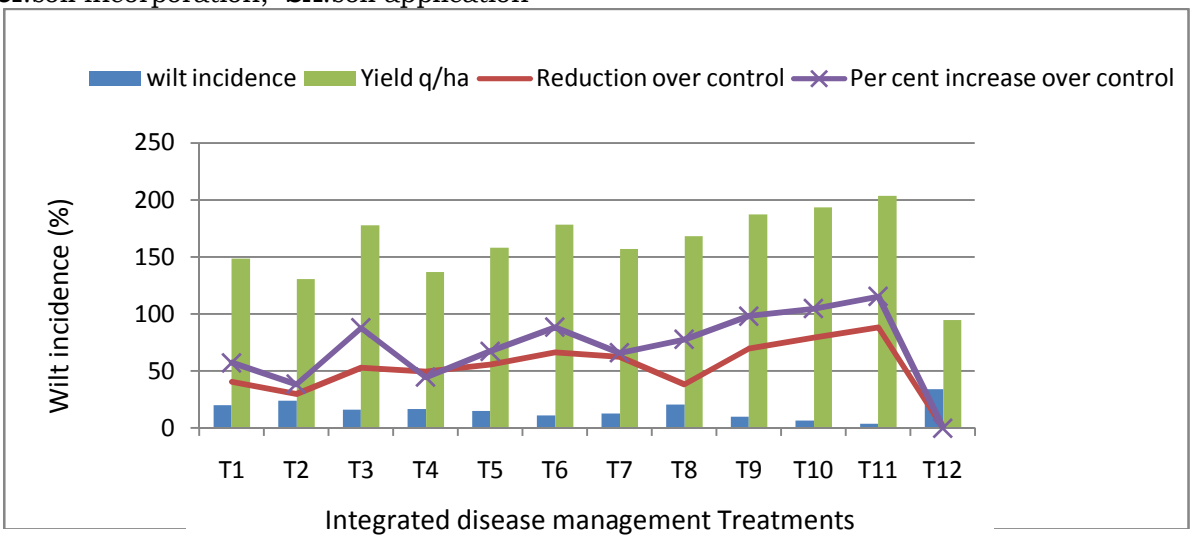

Fig.III. Integrated management of *Fusarium* wilt in brinjal under natural field conditions during *kharif*2018-19 and 2019-20 (Pooled Mean)

Table V.Economics of integrated management of *Fusarium* wilt in eggplant under natural field conditions
(Pooled Mean)

Tr. No.	Treatment	Yield (q /ha)	Total cost of treatment (Rs/ha)	Cost of Production (Rs/ha)	Gross income (Rs/ha)	Net Profit (Rs/ha)	B:C
T_1	Carbendazim	142.18	920	93939	355447	261508	2.78:1
T_2	*Trichoderma harzianum*	136.77	2200	96318	341932	245614	2.55:1
T_3	Trichoderma fortified Neem Seed Cake(TFNSC)	177.01	5300	102174	442535	340361	3.33:1
T_4	Biofumigation(Bti)	135.98	1000	94226	339945	245719	2.61:1
T_5	$T_1 + T_2$ (Carbendazim+T.hz)	157.83	3120	98285	394577	296292	3.01:1
T_6	$T_1 + T_3$ (Carbendazim+TFNSC)	177.66	6220	99176	444142	344966	3.48:1
T_7	$T_1 + T_4$ (Carbendazim+Bti)	156.57	1920	97256	391422	294166	3.02:1
T_8	Carbendazim+NSC	167.92	5300	102153	419797	317644	3.11:1
T_9	$T_3 + T_4$ ((TFNSC+Bti)	186.99	6300	105517	467475	361958	3.43:1
T_{10}	T1+T2+T4 (Carbendazim+T.hz+Bti)	192.97	4120	103870	482430	378560	3.64:1
T_{11}	$T_1 + T_3 + T_4$ (Carbendazim+TFNSC+Bti)	202.96	2200	105231	507402	402171	3.82:1
T_{12}	Control	93.66	0	92150	234152	142002	1.54:1
Average market price (Rs/q):2500/-							

CONCLUSIONS

Integrated disease management treatment T11 (Seedling root dip of Carbendazim + soil application of *Trichoderma* fortified Neem Seed Cake + *Brassica* tissue soil incorporation) recorded least wilt incidence (3.91 %) and maximum Yield (203.65 q/ha) followed by T10 (Seedling root dip of Carbendazim + Seedling root dip with *T.harzianum* + *Brassica* tissue soil incorporation) 6.97 per cent wilt incidence and 193.58 q/ha yield with benefit: cost ratio 3.82:1 and 3.64:1respectively in field experiment. Owing to the limitations in the use of chemical fungicides to reduce the chances of environmental pollution, application of bio control method and integrated disease management strategy for controlling the disease, as adopted in the present investigation may certainly be useful alternative over the conventional chemical control methods.

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