RESEARCH ARTICLE

Management of wilt complex in brinjal using chemical, biocontrol agent and soil amendment alone and in combinations

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ABSTRACT: Wilt in brinjal has become more damaging in the red lateritic soil of Jharkhand due to the prevalence of *Fusarium oxysporum* and *Ralstonia solanacearum* making it wilt complex disease. Out of six organic amendments tested soil application of neem cake (5q/ha) proved to be the most effective treatment to minimize wilt incidence (26.3%) and increased fruit yield (19.23 kg/plot). Among the five fungicides viz; carbendazim, mancozeb, tricyclazole, blitox, oxathiin and streptocycline, seedling dip with mancozeb (2.5g/l) was most effective and showed least wilt incidence (24.21%) with highest fruit yield (21.59 kg/ plot) which was significantly at par with blitox-50. Among four bioagents viz; *Trichoderma viride* (TvD) Delhi isolate, *Trichoderma harzianum* Ranchi isolate (ThR), *Trichoderma harzianum* (ThD) Delhi isolate and *Pseudomonas fluorescens* Delhi (PfD) isolate soil application of precolonized ThD proved to be most effective in reducing wilt severity (16.15%) and highest fruit yield (24.79 kg/plot) were recorded. In the integrated approach of chemicals with bioagents and organic amendments under field condition among all the combinations, minimum wilt incidence (20.34%) was recorded in neem cake precolonized with ThD + seedling dip in copper oxychloride (0.3%). This treatment also provided the highest fruit yield (24.97 kg).

Keywords: Antibiotics, fungicides, integrated management, organic amendments, soil application

Brinjal (*Solanum melongena*) suffers from many bacterial and fungal diseases such as damping off, rust, leaf spot, phomopsis blight, little leaf, powdery mildew, *Fusarium* wilt and bacterial wilt etc. Out of which, wilt complex of brinjal is a serious disease caused by *Ralstonia solanacearum* and *Fusarium oxysporum* causing huge yield losses in red and lateritic soils of Jharkhand (Sharma and Kumar, 2009). The pathogens are mainly soil borne and attack the crop at seedling as well as adult stage and causes complete failure of the crop. But wilting at the time of fruiting is more prominent. The wilt incidence was invariably higher when *Meloidogyne* sp was present in combination with *Fusarium* sp, *Rhizoctonia solani* and *Ralstonia solanacearum* (Razdan *et al.*, 2013). Singh *et al.* (2010) also observed that bacterial wilt is more in tomato than in brinjal and they reported biovar 3 of race 1 of *Ralstonia solanacearum* of brinjal from Jharkhand. Bacterial wilt of brinjal was first reported in India from Pune district (Maharashtra) whereas fungal wilt of brinjal was first reported during regular survey at Pune. In Bihar, it was first reported by in 1969. The disease is distributed throughout the country. Bacterial wilt has been found to be as high as 80 percent in eggplants from other regions of India. Recently, wilt complex has devastated brinjal in the adjoining areas of Ranchi also. Isolations of the pathogens collected from

the field indicated the prevalence of *Ralstonia solanacearum* and *Fusarium oxysporum*. An attempt was made in the present investigation to work out eco-friendly management of this dreaded disease in Jharkhand.

MATERIALS AND METHODS

Effect of organic amendments

Field trials were conducted for two consecutive *kharif* seasons of 2011 and 2012 in research farm of Birsa Agricultural University, Ranchi which is situated at 23°17' north latitude and 85°19' east longitude with an altitude of 625m above mean sea level in wilt complex sick plots and the effects of organic amendments were examined on the incidence of wilt disease. Neem cake, karanj cake, mustard cake, wheat straw, paddy straw and neem + karanj (1:1) cake were applied as organic manure. All treatments were incorporated in the soil before transplanting as and when needed. Individual plots measured 5x5 m in which there were 100 plants with a spacing of 50 cm row to row and 50cm plant to plant in three replications using randomized block design. 1.25 kg of cake was amended per plot while straw was amended at 0.75 kg/plot. Observation of the wilted plants was taken at 15 days intervals regularly. The disease incidence was recorded as the percentage of plants wilted in each plot.

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Effect of seedling root dip with chemicals

Seedlings were raised in nursery bed of glass house compound under natural conditions. Four week old seedlings uprooted and washed thoroughly in running tap water to remove the adhering soil and inert materials. For making the chemical solutions three systemic fungicide viz., Carbendazim (0.2%), Baan (0.1%) and Vitavax (0.2%), two non-systemic fungicides viz; Mancozeb (0.25%) and Blitox-50 (0.3%), one antibiotic Streptocycline (200 ppm) of each chemical was added in one liter water and stirred well. Then roots of the ninety five seedlings were dipped in the solution of each chemical separately for half an hour. Treated seedlings were transplanted in wilt sick plot in three replication with Randomized Block Design. Recommended agronomic practices were followed to raise the crops and data on wilt percentage were recorded.

Effect of microbial agents

The field experiment was carried out during *kharif* season of 2011-12 in wilt sick plots in R.B.D. with 4 replications to determine the effects of bioagents on the incidence of wilt disease. Different isolates of *Trichoderma* and *Pseudomonas* were precolonized in FYM at 1.0 per cent. The FYM precolonized with *T.harzianum* (Delhi) at 10q/ha, *Trichoderma harzianum* (Ranchi) at 10q/ha, *Trichoderma viride* (Delhi) at 10q/ha and *Pseudomonas fluorescens* (Delhi) at 10 q/ha was added in the plot before transplanting of seedlings. The seedlings were transplanted in wilt sick plot of 5.0x 5.0 m² and good agronomic practices were followed to raise the crops and observations on mortality of plants were recorded after 60 DAP and percent wilt incidence and percent disease control over check were calculated as per standard procedure.

Integration of organic amendments, microbial agents and chemicals

The field experiment was conducted using different combination of organic amendments, bioagents and chemicals in plot size 5 m x 5 m with plant to plant distance 50 cm and row to row distance 50 cm with 3 replication in RBD for two consecutive *kharif* season of 2012 and 2013. The following treatments combinations like a) Neem cake precolonized with *T. harzianum* + seedling dip in Blitox, b) karanj cake precolonized with *T. harzianum* + seedling dip in Streptocycline, c) Neem cake precolonized with *T. harzianum* + seedling dip in Carbendazim, d) neem cake precolonized with *Pseudomonas fluorescens* + seedling dip in Blitox, e) karanj cake precolonized with *P. fluorescens* + seedling dip in Streptocycline, and f) neem cake precolonized with *P. fluorescens* + seedling dip in Carbendazim were used. Good agronomic practices were followed to raise the crops and observations on mortality of plants were recorded after 60 DAP and percent wilt incidence (PWI) and percent disease control over check (PDC) were calculated as per standard procedure.

RESULTS AND DISCUSSION

Different oil cakes alone and in combination were applied in soil one months prior to transplanting to determine their effect of wilt and the mean of two year data revealed that neem cake amended plot showed minimum wilt severity (26.30%) and maximum yield of 19.27 kg/plot and gave 61.53 per cent disease control closely followed by neem + karanj cake (1:1) which provide 28.42 per cent disease severity and 16.15 kg/plot yield giving 58.23 percent disease control (Table 1). Wheat and paddy straw incorporation in the field at 3q/ha were least effective and provided 29.9-32.79 per cent disease control. Less

Table 1. Effect of organic amendments against wilt complex disease and yield of brinjal

Treatments	Dose (q/ha)	Wilt incidence* (%)		Percent disease control		Yield *(kg/plot)	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Neem cake	5	25.96 (30.25)**	26.65 (30.72)	61.85	61.22	18.52	20.03
Karanj cake	5	31.57 (34.12)	31.18 (33.89)	53.61	54.63	14.18	15.20
Mustard cake	5	39.99 (39.18)	39.25 (38.75)	41.24	42.89	13.03	14.33
Wheat straw	3	48.06 (43.86)	47.81 (43.71)	29.38	30.43	12.46	12.73
Paddy straw	3	45.96 (42.66)	45.97 (42.67)	32.47	33.11	10.88	13.98
Neem + Karanj cake (1:1)	2.5 + 2.5	28.41 (31.36)	28.44 (32.04)	57.85	58.62	15.55	16.74
Control	-	68.06 (55.60)	68.73 (55.98)	-	-	9.26	9.26
SEm±		1.903	2.762			1.058	1.008
CD (P=0.05)		4.471	4.719			3.295	3.139
CV (%)		16.850	15.833			13.631	11.946

* Average of 3 replications

** Figures in the parentheses are arc sin transformed value

Table 2. Effect of Seedling root dip of fungicides and antibiotics against wilt complex and yield of brinjal

Treatments	Dose (g/lit)	Wilt incidence* (%)		Per cent disease control		Yield *(kg/plot)	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Carbendazim	2.0	53.32 (46.91)**	51.71 (45.97)	22.84	23.61	15.81	17.11
Mancozeb	2.5	22.10 (27.81)	26.32 (29.07)	68.02	61.12	20.96	22.23
Baan	1.0	49.82 (44.87)	50.74 (45.41)	27.91	25.05	18.36	18.28
Blitox	3.0	26.31 (30.77)	28.30 (31.76)	61.93	58.19	20.86	21.13
Streptocycline	0.2	33.32 (35.21)	31.37 (34.00)	51.78	53.66	20.03	21.10
Vitavax	2.0	38.94 (38.51)	36.3 (38.05)	43.65	46.29	19.16	19.67
Control	-	69.11 (56.22)	67.70 (55.39)			11.40	9.76
SEm±		3.932	4.887			1.566	1.510
CD (P = 0.05)		2.249	2.225			3.449	3.820
CV (%)		16.273	17.325			10.678	13.091

*Average of 3 replications

**Figures in the Parentheses are arc sin transformed value

disease severity in neem and karanj cake might be due to the reduction of primary inocula. Sharma and Kumar (2009) also observed an effective reduction in bacterial growth rate by karanj cake along with bleaching powder.

Seedling root deep with fungicides and antibiotics were evaluated against wilt complex of brinjal (Table 2). Mean of 2 year data revealed that root dipped in Mancozeb at 0.25% gave minimum wilt severity (24.21%) and highest yield (21.59kg/plot) and provided 64.57 percent disease control followed by copper oxychloride at 0.3% which give 27.30 percent disease severity and 20.99kg/ plot mean yield of brinjal and provided 60.06 per cent protection against wilt. Streptocycline at 0.02% provided 52.72 per cent protection against disease. Disease control in other treatments ranged from 23.22 to 44.97 per cent. Champawat and Sharma (2011) reported that seed treatment and soil drenching with carbendazim three times at 15 days interval was found to be most effective for the management of wilt in muskmelon.

Local isolates of *Trichoderma* as well as those procured from NCIPM, Delhi were precolonized in FYM and applied to the field before transplanting in line at 10q/ha to determine their efficacy against wilt complex of brinjal and mean of 2 years data revealed that *Trichoderma harzianum* Delhi (THD) isolates was highly effective in reducing wilt incidence (16.15%) and giving highest yield of brinjal (24.79kg/plot) and provided 73.17 percent disease control followed by Ranchi isolates which provided 66.84 per cent disease control with a yield of 20.44 kg/plot (Table 3). *Pseudomonas* colonized FYM provided least disease control (13.77%). This might be due to the prevalence of acidic soil and the bacterial isolate is known to thrive well in alkaline range. Singh and Biswas (2008) while working with *Ralstonia* in tomato also observed that a considerable number of plants in susceptible variety sel-1 were wilted in treatment

containing bleaching powder and *Pseudomonas fluorescens*.

The effect of chemicals, oil-cakes and biocontrol agents are integrated in different combination to determine their efficacy against wilt complex of brinjal (Table 4). Mean of two year data revealed that treatment combination *T. harzianum* Delhi precolonized in neem cake + seedling dip in blitox-50 at 5q/ha +3.0g/lit recorded least disease incidence (20.34%) and highest yield (24.97 kg/plot) providing 66.45 per cent disease control which was statistically at par with combination ThD precolonized in karanj cake + seedling deep carbendazim at 5q/ha +2g/lit. This treatment recorded 21.63 per cent wilt severity and 22.96 kg/plot yield of brinjal with disease control of 66.28 per cent. The disease control in other treatment combination ranged from 45.68 to 56.5 per cent. Chakravarty and Kalita (2011) while working on bacterial wilt of brinjal reported that seed treatment +soil application + seedling root dip of *Pseudomonas fluorescens* provided 83.3 per cent control of bacterial wilt in brinjal. In the present investigation also 45.68 to 66.45 per cent disease control in wilt of brinjal was recorded. Raj *et al.* (2016) while working on integrated management of carnation wilt reported that combination of soil solarization with soil amendment with neem oil cakes/granules or *T. viride* formulation was more effective than soil drenching with chemical fungicides in improving the plant growth and quality of the flowers. Among all the treatments, integration of soil solarization with soil application of *Trichoderma viride* followed by amendment of neem cake was found most effective in improving the shoot length by 79.8 to 84.6 per cent with 48 to 55 times increase in number of A grade flowers in comparison to unsolarized and unamended control.

This is evident from the above findings that soil application of *T. harzianum* precolonized neem cake or

Table 3. Effect of soil application of microbial biopesticides against wilt complex disease and yield of brinjal

Treatments	Dose (q/ha)	Wilt incidence* (%)		Per cent disease control		Yield *(kg/plot)	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Soil application of Precolonized TvD	10	32.28 (34.55)**	33.38 (35.64)	44.65	48.01	10.95	13.00
Soil application of Precolonized ThR	10	20.13 (26.59)	20.65 (26.97)	65.48	66.84	20.99	19.90
Soil application of Precolonized ThD	10	16.31 (23.58)	15.99 (23.46)	72.03	74.32	24.24	25.35
Soil application of Precolonized PfD	10	52.77 (46.58)	51.07 (45.60)	9.53	18.01	11.01	12.68
Control	-	58.33 (49.79)	62.29 (52.09)	-	-	10.26	9.26
SEm±		2.964	2.360			1.390	1.560
CD (P=0.05)		2.816	2.817			4.614	4.817
CV (%)		14.273	13.376			15.776	14.375

*Average of four replications; ** Figures in the parentheses are arc sin transformed value

Table 4. Integrated management of wilt complex and yield of brinjal

Treatments	Dose (q/ha)	Wilt incidence* (%)		Per cent disease control		Yield *(kg/plot)	
		2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Neem cake precolonized with ThD + seedling dip in Blitox	5 q/ha + 3 g/lit	18.78 (25.60)**	21.91 (27.65)	70.57	62.34	24.10	25.85
Karanj cake precolonized with ThD + seedling dip in carberdazim	5 q/ha + 2 g/lit	20.20 (26.22)	23.06 (28.70)	68.34	64.22	23.13	22.80
Neem cake Precolonized with ThR + seedling dip in carbendazim	5 q/ha + 2 g/lit	30.13 (33.13)	29.31 (32.22)	52.78	52.13	19.34	20.57
Neem cake Precolonized with PfD + seedling dip in streptocycline	5 q/ha + 0.2 g/lit	28.00 (31.74)	26.40 (29.87)	56.12	56.89	20.45	23.07
Karanj cake precolonized with PfD + seedling dip in streptocycline	5 q/ha + 0.2 g/lit	25.17 (30.08)	23.56 (23.00)	60.12	61.52	22.20	23.17
Neem cake precolonized with PfD + seedling dip in carbendazim	5 q/ha + 2 g/lit	36.16 (36.80)	31.83 (34.27)	43.34	48.02	20.09	21.02
Control	-	63.82 (53.05)	61.24 (51.54)	-	-	10.03	8.76
SEm±		2.802	2.901			1.581	1.260
CD (P = 0.05)		8.731	9.037			4.926	4.156
CV (%)		15.284	16.194			13.832	16.949

* Average of 3 replications; ** Figures in the parentheses are arc sin transformed value

karanj cake at 5 q/ha + seedling deep either with carbendazim at 0.2% or copper oxychloride at 0.3% solution reduced the wilt severity and increased the yield of brinjal and can be adopted by the cultivators for their benefit.

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