

## Integrated disease management of *Phomopsis* leaf blight and fruit rot of brinjal (*Solanum melongena* L.)

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An integrated disease management strategy was applied from nursery till the completion of the experiment. Under integrated disease management strategy in the nursery, six treatments were given in individual plots viz. soil solarization, soil fumigation, soil solarization + FYM, soil solarization + spent compost, FYM treated with *T. viride* (JMU-24) after soil-solarization and non solarized plots. Seeds were treated with *T. viride* (JMU-24) @  $1 \times 10^9$  spores ml<sup>-1</sup> and fungicide (carbendazim @ 0.2%) and these two sets of seeds were sown in separate rows in nursery plots along with untreated seeds as control. The seedlings raised from the seeds treated with *T. viride* (JMU-24) and carbendazim were raised as individual treatments along with seedlings from control plot. Foliar application of fungicides was started at 90 (carbendazim @ 0.1%), 105 (mancozeb @ 0.25%), 120 (carbendazim 12% + mancozeb 63% @ 0.2%) and 135 (carbendazim @ 0.1%) days after transplantation. The treatment comprising of FYM treated with *T. viride* (JMU-24) after soil solarization followed by seed treatment of carbendazim @ 0.2% and four foliar sprays of carbendazim @ 0.1%, mancozeb @ 0.25%, carbendazim 12% + mancozeb 63% @ 0.2% and carbendazim @ 0.1% gave maximum control of leaf blight and fruit rot (incidence and intensity) coupled with maximum yield 275.00 and 268.00 q/ha in 2007 and 2008, respectively.

**Key words:** Brinjal, biocontrol agent, fungicides, management, *Phomopsis vexans*

### INTRODUCTION

Brinjal leaf blight and fruit rot caused by *Phomopsis vexans* (Sacc. & Syd.) Harter, (perfect stage: *Diaporthe vexans* Gratz) is a major constraint in producing the profitable crop and is one of the major limitations for limited productivity of brinjal throughout the world. In India, *Phomopsis* blight of brinjal was first reported from Gujrat in 1914 and thereafter from many other parts of the country (Harter, 1914). In India yield loss due to fruit rot, ranges from 10 to 20 per cent (Panwar *et al.*, 1970). It is more destructive in subtropical and tropical regions where 50 per cent losses have been recorded (Sherf and Macnab, 1986). There have been numerous studies on the management of leaf blight and fruit rot of eggplant with the fungicides alone by various scientists. An experiment has, therefore, been conducted under field conditions for two years by developing an integrated disease management strategy for the control of brinjal leaf blight and fruit rot.

### MATERIALS AND METHODS

The experiment was conducted at the University Research Farm, Chatha in the years 2007 and 2008. Under integrated disease management strategy in the nursery, six treatments were given in individual plots viz. soil solarization, soil fumigation, soil solarization + FYM @ 1000 g/m<sup>2</sup>, soil solarization + spent compost @ 1000 g/m<sup>2</sup>, FYM treated with *Trichoderma viride* (JMU-24) after soil solarization and control.

Soil fumigation was done with 5 liters of formalin solution per plot and the treated plots were covered with polyethylene sheet for 15 days before sowing and seeds were sown only when soil became free from formalin vapours. The beds which were to be subjected to soil solarization treatment were irrigated to the level of field capacity to ensure the presence of adequate moisture during the period of solarization. These beds were covered with transparent polyethylene sheet of 25 µm thickness, placing the ends of the sheets in furrows buried



with compact soil to ensure that all the edges were thoroughly sealed. Soil solarization was done for 40 days.

Before sowing brinjal seeds of the variety Pusa Purple Long were treated with biocontrol agent *Trichoderma viride* (JMU-24) @  $1 \times 10^9$  spores  $\text{ml}^{-1}$  and carbendazim @ 0.2% separately and these two sets of seeds were sown in separate rows in nursery plots (1x1 m) along with untreated seeds in control. Sowing of the brinjal seeds were done in 1st week of June in the years, 2007 and 2008. The seedlings raised from the seeds treated with bio-control agent and carbendazim were raised as individual treatments along with seedlings from control plot after transplanting. One month old seedlings were transplanted in the third week of July in plots of 2x3 m size. All the recommended agronomic practices were followed as per the SKUAST-J package of practices throughout the growing season. The treatment combinations after transplanting were as follows: P<sub>1</sub>= soil solarization + *T. viride* (JMU-24) (seed Treatment), P<sub>2</sub>= soil solarization + farmyard manure + *T. viride* (JMU-24) (seed Treatment), P<sub>3</sub>= FYM treated with *T. viride* (JMU-24) after soil solarization + *T. viride* (JMU-24) (seed Treatment), P<sub>4</sub>= soil solarization + Spent compost + *T. viride* (JMU-24) (seed Treatment), P<sub>5</sub>= soil fumigation + *T. viride* (JMU-24) (seed treatment), P<sub>6</sub>= soil solarization + carbendazim (seed treatment), P<sub>7</sub>= soil solarization + farmyard manure + carbendazim (seed treatment), P<sub>8</sub>= FYM treated with *T. viride* (JMU-24) after soil solarization + carbendazim (seed treatment), P<sub>9</sub>= Soil solarization + spent compost + carbendazim (seed treatment), P<sub>10</sub>= soil fumigation + carbendazim (seed treatment), P<sub>11</sub>= control. Each treatment was followed by four sprays, first spray with carbendazim @ 0.1% was done at 90 days after transplanting, which was followed by mancozeb @ 0.25% at 105 days, combination of carbendazim 12% + mancozeb 63% @ 0.2% at 120 days and carbendazim @ 0.1% at 135 days after transplanting.

Observations on leaf blight and fruit rot (incidence and intensity) were recorded at weekly intervals. The per cent disease intensity on leaf was recorded using 1-12 point scale proposed by Horsfall and Barratt (1945) given as Grade = Per cent leaf area : 1 = 0, 2 = 0-3, 3 = 3-6, 4 = 6-12, 5 = 12-25, 6 = 25-

50, 7 = 50-75, 8 = 75-87, 9 = 87-94, 10 = 94-97, 11 = 97-100, 12 = 100.

The per cent disease intensity on fruit was recorded using 1-8 point scale (Kumar, 1998) given as Grade = Hull rot%: 1 = 0, 2 = 0-10, 3 = 11-25, 4 = 26-50, 5 = 51-75, 6 = 76-90, 7 = 91-100, 8 = 100.

The per cent disease incidence and per cent disease intensity on leaf blight and fruit rot were calculated as given below (Wheeler, 1969):

$$\text{Per cent disease incidence} = \frac{\text{No. of diseased plants}}{\text{Total No. of plants observed}} \times 100$$

$$\text{Per cent disease intensity} = \frac{\text{Total sum of numerical ratings}}{\text{Number of samples observed} \times \text{Maximum disease rating}} \times 100$$

The first observation was recorded on the day before first spraying and thereafter at 15 days interval of first, second, third and fourth spraying. The yield per plot was recorded for each treatment and transformed into q/ha. The experiment was laid out in a Randomized Block Design (RBD) with three replications.

## RESULTS

Brinjal seeds treated with biocontrol agent *Trichoderma viride* (JMU-24) and systemic fungicide carbendazim were sown in soil solarized nursery plots. After transplanting the disease symptoms appeared in the field, significant difference in the per cent disease incidence and intensity of leaf blight and fruit rot was recorded from different treatments at 90 days after transplanting (DAT) i.e. before conducting the first spray, reflecting the effect of soil solarization, soil fumigation, addition of soil amendments and seed treatments, but the effect was not sufficient to check the disease at later stages, therefore at 15 days interval four sprays with fungicides viz. carbendazim, mancozeb, carbendazim 12% + mancozeb 63% and carbendazim were done. The data recorded were subjected to statistical analysis and the results are presented in Tables 1-4. A perusal of the data revealed that the results were statistically significant for the years, 2007 and 2008. The analysis of the pooled data of the entire study period also exhibited similar results.

A perusal of the data presented in Tables 1-4 revealed that during 2007 and 2008 and the pooled





Fig. 1: Fruit rot symptoms caused by *Phomopsis vexans* on brinjal

data of the two years, the per cent disease incidence and intensity of leaf blight and fruit rot recorded 90 days after transplanting (before 1st spray) was significantly different from control for the years 2007 and 2008. It was observed from the data recorded at the time of second spray that there was a slight increase in per cent disease incidence and intensity of leaf blight (Fig 1) and fruit rot (Fig. 2) in all treatments. However, after subsequent sprays significant decrease in per cent

disease incidence and intensity of leaf blight and fruit rot was recorded in all the treatments, when compared to control from 90 DAT to 150 DAT. It was observed that the treatment P<sub>1</sub>, integrated effect of FYM treated with *Trichoderma viride* (JMU-24) after soil solarization + seed treatment with carbendazim followed by four foliar sprays of the fungicides was most successful in reducing the per cent disease incidence and intensity of leaf blight and fruit rot in 2007 and 2008. The treatment P<sub>1</sub> recorded leaf blight incidence of 25.00 (2007) and 26.67 (2008) per cent (Table 1), leaf blight intensity of 11.72 (2007) and 14.63 (2008) per cent (Table 2), fruit rot incidence of 16.67 (2007) and 21.67 (2008) per cent (Table 3), fruit rot intensity of 4.79 (2007) and 5.04 (2008) per cent (Table 4) at 150 days after transplanting. All the treatments were significantly different from control. A perusal of data presented in Table 5 revealed that during 2007 and 2008 maximum yield 275.00 and 268.00 q/ha, respectively, was recorded from the treatment P<sub>1</sub>.

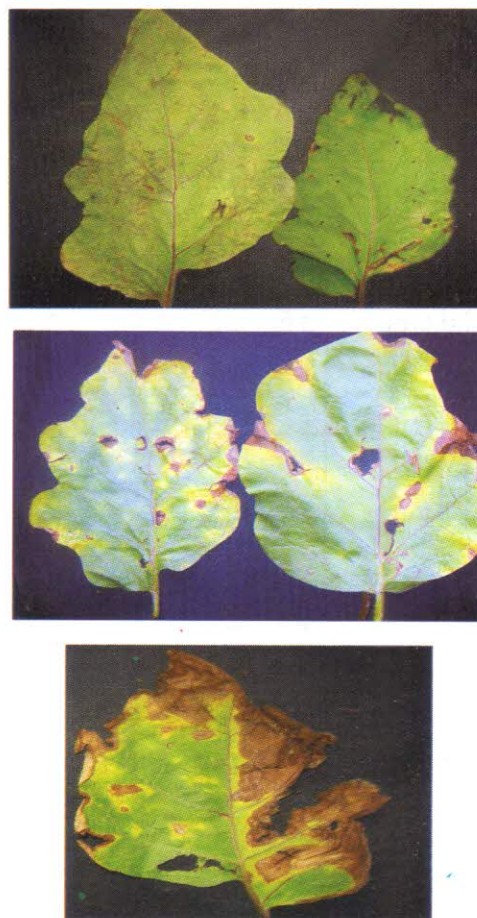


Fig. 2: Leaf blight symptoms caused by *Phomopsis vexans* on brinjal



Table. 1: Effect of different treatments in the integrated disease management of leaf blight incidence of brinjal

Treatment	Per cent disease incidence (leaf blight)														
	2007				2008				Pooled						
	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After IVth spray (150)	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After IVth spray (150)	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After IVth spray (150)
P1 = S.S + ST (BCA)	61.67 (51.73)	66.67 (54.73)	63.33 (52.72)	51.67 (45.94)	43.33 (41.15)	68.33 (55.75)	71.67 (57.84)	63.33 (52.72)	55.00 (47.86)	45.00 (42.10)	65.00 (53.72)	69.17 (56.25)	63.33 (52.72)	53.33 (46.90)	44.17 (41.63)
P2 = S.S + FYM + ST (BCA)	61.67 (51.73)	66.67 (54.73)	61.67 (51.73)	46.67 (43.07)	38.33 (38.23)	71.67 (57.84)	70.00 (56.77)	63.33 (52.72)	51.67 (45.94)	43.33 (41.15)	66.67 (54.73)	68.33 (55.74)	62.50 (52.22)	49.17 (44.50)	40.83 (39.70)
P3 = FYM treated with BCA after S.S + ST (BCA)	51.67 (45.94)	56.67 (48.82)	50.00 (44.98)	40.00 (39.22)	30.00 (33.20)	61.67 (51.73)	61.67 (51.73)	53.33 (46.90)	41.67 (40.18)	33.33 (35.24)	56.67 (48.82)	59.17 (50.26)	51.67 (45.94)	40.83 (39.70)	31.67 (34.23)
P4 = S.S + S.C + ST (BCA)	63.33 (52.72)	70.00 (56.77)	65.00 (53.74)	53.33 (46.89)	45.00 (42.11)	73.33 (58.91)	73.33 (58.91)	63.33 (52.72)	55.00 (47.85)	46.67 (43.07)	68.33 (55.75)	71.67 (57.82)	64.17 (53.22)	54.17 (47.37)	45.83 (42.59)
P5 = S.F + ST (BCA)	58.33 (49.78)	65.00 (53.71)	58.33 (49.78)	48.33 (44.03)	36.67 (37.24)	65.00 (53.74)	65.00 (53.71)	58.33 (49.78)	50.00 (44.98)	41.67 (40.18)	61.67 (51.76)	65.00 (53.71)	58.33 (49.78)	49.17 (44.50)	39.17 (38.73)
P6 = S.S + ST (carbendazim)	58.33 (49.81)	65.00 (53.71)	60.00 (50.75)	45.00 (42.10)	35.00 (36.26)	66.67 (54.73)	66.67 (54.73)	56.67 (48.82)	46.67 (43.07)	38.33 (38.23)	62.50 (52.22)	65.83 (54.21)	58.33 (49.78)	45.83 (42.59)	36.67 (37.25)
P7 = S.S + FYM + ST (carbendazim)	55.00 (47.85)	60.00 (50.75)	53.33 (46.89)	41.67 (40.18)	33.33 (35.24)	63.33 (52.72)	61.67 (51.73)	51.67 (45.94)	43.33 (41.15)	35.00 (36.26)	59.17 (50.27)	60.83 (51.24)	52.50 (46.41)	42.50 (40.67)	34.17 (35.75)
P8 = FYM treated with BCA after S.S + ST (carbendazim)	46.67 (43.07)	51.67 (45.94)	45.00 (42.11)	35.00 (36.26)	25.00 (29.99)	55.00 (47.85)	55.00 (47.85)	46.67 (43.07)	36.67 (37.24)	26.67 (31.06)	50.83 (45.46)	53.33 (46.89)	45.83 (42.59)	35.83 (36.75)	25.83 (30.53)
P9 = S.S + S.C + ST (carbendazim)	56.67 (48.82)	65.00 (53.74)	58.33 (49.78)	46.67 (43.07)	38.33 (38.21)	73.33 (58.91)	68.33 (55.75)	58.33 (49.78)	50.00 (44.98)	41.67 (40.18)	65.00 (53.72)	66.67 (54.72)	58.33 (49.78)	48.33 (44.03)	40.00 (39.21)
P10 = S.F + ST (carbendazim)	55.00 (47.86)	61.67 (51.73)	56.67 (48.83)	40.00 (39.20)	31.67 (34.22)	61.67 (51.73)	60.00 (50.75)	50.00 (44.98)	41.67 (40.18)	35.00 (36.26)	58.33 (49.79)	60.83 (51.24)	53.33 (46.89)	40.83 (39.69)	33.33 (35.25)
P0 = Control	68.33 (55.75)	80.00 (63.41)	85.00 (67.19)	83.33 (65.93)	80.00 (63.41)	80.00 (63.52)	88.33 (70.09)	90.00 (71.54)	86.67 (68.64)	83.33 (65.93)	74.17 (59.43)	84.17 (66.54)	87.50 (69.27)	85.00 (67.23)	81.67 (64.63)
CD (P=0.05)	3.72	2.54	3.09	2.97	2.73	3.40	2.60	3.00	2.98	2.99	2.87	1.52	2.28	2.50	1.87
SE (m)	1.25	0.85	1.04	1.00	0.92	1.14	0.87	1.01	1.00	1.00	0.96	0.51	0.77	0.84	0.63

1st spray-carbendazim @ 0.1%, 2nd spray-mancozeb @ 0.25%, 3rd spray-carbendazim 12% + mancozeb 63% @ 0.2%, 4th spray-carbendazim @ 0.1%

\*Days after transplanting (DAT)

S.S = Soil solarization, ST = Seed treatment, BCA = *Trichoderma viride* (JMU-24), S.F = Soil fumigation, S.C = Spent compost

Table 2: Effect of different treatments in the integrated disease management of leaf blight intensity of brinjal

Treatment	Per cent disease intensity (leaf blight)														
	2007				2008				Pooled						
	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After IVth spray (150)	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After IVth spray (150)	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After IVth spray (150)
P1 = S.S + ST (BCA)	29.74 (33.03)	30.99 (33.81)	27.57 (31.66)	22.94 (28.60)	17.77 (24.92)	37.26 (37.60)	38.76 (38.49)	33.24 (35.19)	27.93 (31.89)	22.18 (28.09)	33.50 (35.35)	34.87 (36.18)	30.40 (33.45)	25.43 (30.27)	19.98 (26.54)
P2 = S.S + FYM + ST (BCA)	30.40 (33.45)	32.04 (34.46)	26.65 (31.07)	22.13 (28.05)	17.16 (24.46)	37.48 (37.74)	38.98 (38.62)	34.01 (35.66)	28.01 (31.94)	22.18 (28.09)	33.94 (35.62)	35.51 (36.56)	30.33 (33.41)	25.07 (30.04)	19.67 (26.32)
P3 = FYM treated with BCA after S.S + ST (BCA)	27.52 (31.63)	28.10 (32.00)	23.57 (29.04)	19.99 (26.54)	14.75 (22.57)	35.43 (36.51)	36.90 (37.39)	30.68 (33.62)	24.96 (29.96)	18.52 (25.48)	31.47 (34.11)	32.50 (34.74)	27.13 (31.38)	22.47 (28.29)	16.64 (24.07)
P4 = S.S + S.C + ST (BCA)	31.49 (34.12)	32.60 (34.80)	28.74 (32.40)	25.24 (30.15)	20.22 (26.71)	39.04 (38.65)	41.20 (39.92)	34.96 (36.23)	29.29 (32.75)	24.13 (29.41)	35.26 (36.42)	36.90 (37.39)	31.85 (34.35)	27.27 (31.46)	22.17 (28.08)
P5 = S.F + ST (BCA)	28.79 (32.44)	30.46 (33.48)	25.33 (30.20)	21.63 (27.70)	16.16 (23.69)	37.82 (37.93)	39.59 (38.98)	34.10 (35.71)	28.32 (32.13)	21.63 (27.70)	33.31 (35.23)	35.03 (36.27)	29.71 (33.02)	24.98 (29.97)	18.89 (25.76)
P6 = S.S + ST (carbendazim)	29.15 (32.67)	30.54 (33.53)	26.35 (30.87)	21.74 (27.78)	15.52 (23.19)	38.37 (38.26)	39.18 (38.73)	33.71 (35.48)	27.65 (31.71)	21.40 (27.55)	33.76 (35.51)	34.86 (36.17)	30.03 (33.22)	24.70 (29.79)	18.46 (25.44)
P7 = S.S + FYM + ST (carbendazim)	29.79 (33.06)	31.35 (34.03)	25.91 (30.58)	21.29 (27.47)	15.19 (22.93)	35.51 (36.56)	36.68 (37.26)	30.85 (33.73)	24.96 (29.96)	19.55 (26.23)	32.65 (34.83)	34.01 (35.66)	28.38 (32.18)	23.13 (28.73)	17.37 (24.62)
P8 = FYM treated with BCA after S.S + ST (carbendazim)	25.68 (30.44)	26.43 (30.92)	21.85 (27.86)	17.63 (24.82)	11.72 (20.01)	31.96 (34.41)	31.79 (34.31)	26.02 (30.65)	20.49 (26.90)	14.63 (22.48)	28.82 (32.46)	29.11 (32.64)	23.93 (29.28)	19.06 (25.88)	13.18 (21.28)
*P9 = S.S + S.C + ST (carbendazim)	29.65 (32.98)	31.04 (33.84)	25.49* (30.31)	21.71 (27.76)	16.66 (24.08)	38.37 (38.26)	40.54 (39.53)	34.87 (36.18)	28.40 (32.19)	21.85 (27.86)	34.01 (35.66)	35.79 (36.73)	30.18 (33.31)	25.06 (30.03)	19.26 (26.02)
P10 = S.F + ST (carbendazim)	28.68 (32.37)	28.82 (32.46)	24.60 (29.72)	20.57 (26.96)	14.91 (22.71)	34.74 (36.10)	35.59 (36.61)	29.85 (33.10)	24.43 (29.61)	19.05 (25.87)	31.71 (34.26)	32.21 (34.56)	27.23 (31.44)	22.50 (28.31)	16.98 (24.33)
P0 = Control	33.51 (35.36)	38.26 (38.20)	39.85 (39.13)	39.35 (38.83)	38.95 (38.60)	41.32 (39.98)	47.09 (43.31)	49.43 (44.65)	49.09 (44.46)	48.42 (44.08)	37.42 (37.70)	42.68 (40.77)	44.64 (41.91)	44.22 (41.67)	43.69 (41.36)
CD (P=0.05)	0.88	0.47	0.44	0.85	0.53	0.90	1.12	1.00	1.25	0.42	0.56	0.57	0.53	0.58	0.31
SE (m)	0.29	0.16	0.15	0.29	0.18	0.30	0.38	0.34	0.42	0.14	0.19	0.19	0.18	0.19	0.10

1st spray-carbendazim @ 0.1%, 2nd spray-mancozeb @ 0.25%, 3rd spray-carbendazim 12% + mancozeb 63% @ 0.2%, 4th spray-carbendazim @ 0.1%

\*Days after transplanting (DAT)

S.S = Soil solarization, ST = Seed treatment, BCA = *Trichoderma viride* (JMU-24), S.F = Soil fumigation, S.C = Spent compost



Table 3: Effect of different treatments in the integrated disease management of fruit rot incidence of brinjal

Treatment	Per cent disease incidence (fruit rot)														
	2007						2008						Pooled		
	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After 4th spray (150)	ist spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After 4th spray (150)	ist spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After 4th spray (150)
P <sub>1</sub> = S.S + ST (BCA)	51.67 (45.94)	61.67 (51.73)	53.33 (46.89)	46.67 (43.07)	38.33 (38.23)	58.33 (49.78)	63.33 (52.75)	53.33 (46.89)	43.33 (41.15)	35.00 (36.26)	55.00 (47.85)	62.50 (52.22)	53.33 (46.89)	45.00 (42.11)	36.67 (37.24)
P <sub>2</sub> = S.S + FYM + ST (BCA)	45.00 (42.09)	56.67 (48.82)	51.67 (45.94)	41.67 (36.26)	35.00 (36.26)	55.00 (47.86)	60.00 (50.75)	51.67 (45.94)	41.67 (40.18)	35.00 (36.22)	50.00 (44.99)	58.33 (49.78)	51.67 (45.94)	41.67 (40.18)	35.00 (36.25)
P <sub>3</sub> = FYM treated with BCA after S.S + ST (BCA)	41.67 (40.18)	51.67 (45.94)	41.67 (40.18)	33.33 (35.24)	26.67 (31.06)	46.67 (43.07)	51.67 (45.94)	43.33 (41.15)	33.33 (35.24)	25.00 (29.99)	44.17 (41.63)	51.67 (45.94)	42.50 (40.67)	33.33 (35.24)	25.83 (30.53)
P <sub>4</sub> = S.S + S.C + ST (BCA)	55.00 (47.85)	65.00 (53.71)	56.67 (48.82)	48.33 (40.18)	40.00 (39.22)	61.67 (51.73)	65.00 (53.74)	58.33 (49.78)	48.33 (44.03)	38.33 (38.23)	58.33 (49.78)	65.00 (53.72)	57.50 (49.30)	48.33 (44.03)	39.17 (38.73)
P <sub>5</sub> = S.F + ST (BCA)	46.67 (43.06)	56.67 (48.82)	51.67 (45.94)	43.33 (42.11)	33.33 (35.24)	58.33 (49.78)	63.33 (52.72)	53.33 (46.89)	43.33 (41.15)	33.33 (35.24)	52.50 (46.41)	60.00 (50.75)	52.50 (46.42)	43.33 (41.15)	33.33 (35.25)
P <sub>6</sub> = S.S + ST (carbendazim)	46.67 (43.07)	58.33 (49.78)	50.00 (44.98)	41.67 (40.18)	31.67 (34.22)	53.33 (46.90)	58.33 (49.78)	50.00 (44.98)	41.67 (40.18)	31.67 (34.22)	50.00 (44.98)	58.33 (49.78)	50.00 (44.98)	41.67 (40.19)	31.67 (34.22)
P <sub>7</sub> = S.S + FYM + ST (carbendazim)	43.33 (41.15)	51.67 (45.94)	43.33 (41.15)	35.00 (35.24)	28.33 (32.13)	51.67 (45.94)	56.67 (48.82)	46.67 (43.07)	35.00 (36.24)	28.33 (32.13)	47.50 (43.55)	54.17 (47.37)	45.00 (42.11)	35.00 (36.26)	28.33 (32.13)
P <sub>8</sub> = FYM treated with BCA after S.S + ST (carbendazim)	31.67 (34.22)	38.33 (38.23)	30.00 (33.20)	21.67 (24.04)	16.67 (24.04)	41.67 (40.18)	46.67 (43.07)	36.67 (37.24)	28.33 (32.13)	21.67 (27.70)	36.67 (37.25)	42.50 (40.67)	33.33 (35.25)	25.00 (29.97)	19.17 (25.92)
P <sub>9</sub> = S.S + S.C + ST (carbendazim)	45.00 (42.10)	55.00 (47.85)	48.33 (44.03)	41.67 (40.18)	35.00 (36.22)	56.67 (48.82)	61.67 (51.73)	51.67 (45.94)	40.00 (39.22)	33.33 (35.24)	50.83 (45.46)	58.33 (49.78)	50.00 (44.98)	40.83 (39.70)	34.17 (35.74)
P <sub>10</sub> = S.F + ST (carbendazim)	38.33 (38.23)	48.33 (44.03)	41.67 (40.18)	33.33 (27.70)	26.67 (31.06)	50.00 (44.98)	51.67 (45.94)	41.67 (40.18)	33.33 (35.24)	26.67 (31.06)	44.17 (41.63)	50.00 (44.98)	41.67 (40.18)	33.33 (35.25)	26.67 (31.06)
P <sub>0</sub> = Control	56.67 (48.82)	78.33 (62.38)	85.00 (67.19)	81.67 (64.67)	78.33 (62.27)	63.33 (52.72)	80.00 (63.41)	83.33 (65.93)	80.00 (63.41)	76.67 (61.12)	60.00 (50.75)	79.17 (62.85)	84.17 (66.54)	80.83 (64.02)	77.50 (61.68)
CD (P=0.05)	4.01	3.40	2.49	2.96	3.26	3.44	3.42	2.91	2.52	3.10	2.96	2.45	2.20	2.26	2.77
SE (m)	1.35	1.14	0.84	0.99	1.10	1.16	1.15	0.98	0.85	1.04	0.99	0.82	0.74	0.76	0.93

1st spray-carbendazim @ 0.1%, 2nd spray-mancozeb @ 0.25%, 3rd spray-carbendazim 12% + mancozeb 63% @ 0.2%, 4th spray-carbendazim @ 0.1%

\*Days after transplanting (DAT)

S.S = Soil solarization, ST = Seed treatment, BCA = *Trichoderma viride* (JMU-24), S.F = Soil fumigation, S.C = Spent compost

Table 4 : Effect of different treatments in the integrated disease management of fruit rot intensity of brinjal

Treatment	Per cent disease intensity (fruit rot)														
	2007				2008				Pooled						
	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After 4th spray (150)	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After 4th spray (150)	1st spray (90*)	2nd spray (105)	3rd Spray (120)	4th spray (135)	After 4th spray (150)
P1= S.S + ST (BCA)	21.87 (27.87)	23.29 (28.84)	20.62 (27.00)	16.21 (23.73)	11.75 (20.03)	29.12 (32.65)	33.16 (35.15)	26.46 (30.94)	19.25 (26.01)	13.87 (21.86)	25.50 (30.32)	28.23 (32.08)	23.54 (29.01)	17.73 (24.89)	12.81 (20.97)
P2= S.S + FYM + ST (BCA)	20.96 (27.23)	22.33 (28.19)	19.41 (26.13)	15.12 (22.86)	10.66 (19.04)	28.92 (32.52)	31.75 (34.28)	25.08 (30.04)	19.87 (26.46)	13.71 (21.72)	24.94 (29.95)	27.04 (31.32)	22.25 (28.13)	17.50 (24.72)	12.19 (20.42)
P3= FYM treated with BCA after S.S + ST (BCA)	17.16 (24.46)	18.41 (25.40)	14.96 (22.74)	11.29 (19.62)	7.50 (15.88)	24.79 (29.84)	29.04 (32.59)	22.04 (27.97)	14.66 (22.48)	7.96 (16.38)	20.98 (27.25)	23.73 (29.14)	18.50 (25.46)	12.98 (21.10)	7.73 (16.13)
P4= S.S + S.C + ST (BCA)	21.87 (27.87)	23.42 (28.93)	20.21 (26.70)	16.16 (23.69)	12.54 (20.72)	29.33 (32.78)	33.41 (35.30)	27.37 (31.53)	20.46 (26.87)	14.96 (22.74)	25.60 (30.38)	28.42 (32.20)	23.79 (29.18)	18.31 (25.33)	13.75 (21.76)
P5= S.F + ST (BCA)	20.41 (26.85)	22.75 (28.48)	19.37 (26.10)	14.79 (22.61)	10.33 (18.74)	26.21 (30.78)	31.04 (33.84)	25.04 (30.01)	18.58 (25.51)	12.79 (20.95)	23.31 (28.86)	26.90 (31.23)	22.21 (28.10)	16.69 (24.10)	11.56 (19.87)
P6= S.S + ST (carbendazim)	19.25 (26.01)	21.62 (27.70)	18.33 (25.34)	13.79 (21.78)	9.66 (18.09)	27.96 (31.90)	31.04 (33.84)	25.42 (30.26)	19.00 (25.83)	12.58 (20.77)	23.60 (29.05)	26.33 (30.86)	21.88 (27.88)	16.39 (23.87)	11.12 (19.48)
P7= S.S + FYM + ST (carbendazim)	19.96 (26.52)	21.91 (27.90)	17.83 (24.97)	13.08 (21.20)	9.16 (17.61)	27.21 (31.42)	29.29 (32.75)	22.95 (28.61)	16.87 (24.23)	11.08 (19.44)	23.58 (29.04)	25.60 (30.38)	20.39 (26.83)	14.98 (22.76)	10.12 (18.54)
P8= FYM treated with BCA after S.S + ST (carbendazim)	14.83 (22.64)	16.42 (23.89)	12.67 (20.84)	8.79 (17.24)	4.79 (12.63)	20.25 (26.73)	24.46 (29.63)	17.37 (24.62)	10.62 (19.01)	5.04 (12.97)	17.54 (24.75)	20.44 (26.87)	15.02 (22.80)	9.71 (18.15)	4.92 (12.81)
P9= S.S + S.C + ST (carbendazim)	20.54 (26.93)	22.41 (28.24)	19.00 (25.83)	14.95 (22.73)	10.62 (19.00)	29.54 (32.91)	33.62 (35.43)	26.25 (30.80)	19.79 (26.39)	13.41 (21.47)	25.04 (30.01)	28.02 (31.95)	22.62 (28.39)	17.37 (24.62)	12.02 (20.28)
P10= S.F + ST (carbendazim)	19.12 (25.92)	20.67 (27.03)	17.71 (24.87)	13.00 (21.11)	8.75 (17.17)	25.12 (30.05)	28.17 (32.03)	21.25 (27.44)	15.54 (23.21)	9.92 (18.35)	22.12 (28.04)	24.42 (29.60)	19.48 (26.18)	14.27 (22.18)	9.33 (17.78)
P0 = Control	24.41 (29.60)	28.67 (32.36)	29.87 (33.12)	29.33 (32.78)	28.75 (32.41)	32.96 (35.02)	38.62 (38.41)	40.25 (39.36)	40.41 (39.46)	39.42 (38.87)	28.69 (32.37)	33.65 (35.44)	35.06 (36.30)	34.87 (36.18)	34.08 (35.71)
CD (P=0.05)	0.78	0.54	0.71	1.12	1.17	1.37	1.18	1.17	1.48	0.47	0.73	0.60	0.62	0.89	0.60
SE (m)	0.26	0.18	0.24	0.38	0.39	0.46	0.40	0.39	0.50	0.16	0.25	0.20	0.21	0.30	0.20

1st spray-carbendazim @ 0.1%, 2nd spray-mancozeb @ 0.25%, 3rd spray-carbendazim 12% + mancozeb 63% @ 0.2%, 4th spray-carbendazim @ 0.1%

\*Days after transplanting (DAT)

S.S = Soil solarization, ST = Seed treatment, BCA = *Trichoderma viride* (MU-24), S.F = Soil fumigation, S.C = Spent compost



## DISCUSSION

During the years 2007 and 2008, per cent leaf blight and fruit rot (incidence and intensity) exhibited the decrease in disease levels in control plot (unsprayed) as a function of time indicated that prevailing weather factors also contributed to effects of fungicidal spraying manifested in the treatment plots. Our results are in conformity to that of Chaube and Sharma (2002) who have revealed that integration of soil solarization with biocontrol agents increased soil suppressiveness and plant growth. They further observed that the introduction of biocontrol agents before solarization was less effective but their introduction after mulching, was highly effective, and it again confirms our results which exhibited that addition of FYM treated with *Trichoderma viride* (JMU-24) after soil solarization was more effective in reducing disease even before conducting the first spraying, compared to other treatments. Our results were also in conformity with the studies of Sinha, (1989); Kaushal and Sugha, (1995) and Thippeswamy *et al.* (2006), wherein, they revealed that seed treatment of carbendazim was more effective than other treatments in reducing leaf blight and fruit rot caused by *P. vexans* in brinjal before foliar sprays. Foliar sprays with carbendazim for the effective control of leaf blight and fruit rot of brinjal were reported by Islam and Pan (1993) and their results also confirmed our studies that the disease severities in different treatment plots as well as in control fell below the first spray levels when the last observations were taken, and also that marginal decrease or increase in disease levels in control plot as a function of time indicated that the prevailing weather factors also contributed to effects of fungicidal spraying manifested in the treatment plots. Nagia *et al.*, (1993) and Thippeswamy *et al.* (2006) also revealed that foliar sprays with carbendazim and mancozeb were effective for the control of leaf blight and fruit rot of brinjal.

Our studies revealed that the treatment of FYM treated with *Trichoderma viride* (JMU-24) @  $1 \times 10^9$  spores  $\text{ml}^{-1}$  after soil solarization followed by seed treatment with carbendazim @ 0.2% and four foliar sprays of carbendazim @ 0.1%, mancozeb @ 0.25%, carbendazim 12% + mancozeb 63% @ 0.2% and carbendazim @ 0.1% at 90, 105, 120 and 135 days after transplanting gave maximum control of

Table. 5: Average yield recorded during 2007 and 2008

Treatment *	Average yield (q/ha)		
	2007	2008	Pooled
P1= S.S + ST (BCA)	212.50	204.17	208.34
P2= S.S + FYM + ST (BCA)	220.55	212.50	216.53
P3= FYM treated with BCA after S.S +ST (BCA)	261.11	259.72	260.42
P4= S.S + S.C + ST (BCA)	205.56	200.00	202.78
P5= S.F + ST (BCA)	233.33	225.00	229.17
P6= S.S + ST (carbendazim)	241.67	230.83	236.25
P7= S.S+ FYM + ST (carbendazim)	245.83	237.50	241.67
P8=FYM treated with BCA after S.S + ST (carbendazim )	275.00	268.06	271.53
P9= S.S+ S.C + ST (carbendazim)	227.78	216.67	222.23
P10= S.F+ ST (carbendazim )	251.39	245.83	248.61
P0= Control	154.17	125.00	139.59
CD (P=0.05)	4.58	3.02	2.44
SE (m)	1.54	1.02	0.82

S.S = Soil solarization, ST = Seed treatment, BCA = *Trichoderma viride* (JMU-24), S.F = Soil fumigation

\*Each treatment was followed by four sprays of carbendazim, mancozeb, combination of carbendazim 12% + mancozeb 63% and carbendazim at 90, 105, 120 and 135 days after transplanting

leaf blight incidence and intensity 25.83 and 13.18 per cent, respectively, and fruit rot incidence and intensity 19.17 and 04.92 per cent, respectively, coupled with maximum average yield of 271.53 q/ha obtained during 2007 and 2008.

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