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Development of integrated disease management module for early blight of tomato in Jammu

Sunita Rani, Ranbir Singh and Sachin Gupta

Abstract
Evaluation of chemical fungicides and plant extracts against *Alternaria solani* causing early blight of tomato revealed that Tebuconazole (25 EC) was the most effective fungicide followed by Difenconazole (25 EC). Amongst plant extracts, maximum mycelial inhibition was exhibited by *Datura stramonium* (20%) followed by *Lantana camara* (20%) and *Azadirachta indica* (20%). Amongst the bio agents tested using dual culture technique, *Trichoderma harzianum* showed maximum growth inhibition of the pathogen and appeared to be the most effective. To develop Integrated Disease Management module for early blight of tomato fungicides, plant extracts and bio agents were integrated in different treatments and applied in field with varying spray schedules consecutively for two seasons. It was observed that treatment comprising of Mancozeb (0.25%), Datura (50%) and *T. harzianum* s.t ($1x10^7$ spores/ml) reduced disease intensity up to 84.00% followed by treatment comprising of Mancozeb (0.25%) and *T. harzianum* s.t ($1x10^7$spores/ml) which reduced disease intensity to 82.33%.

Keywords: *Alternaria solani*, bio-control, early blight, fungicides, plant extract, *T. harzianum*

1. Introduction
Tomato (*Solanum lycopersicum* L.) belongs to the family Solanaceae and is one of the most widely grown vegetables in the world. India ranks second in the area used for the cultivation of tomato as well as in its production (FAO STAT, 2012) [16]. It is an important commercial crop grown in India over an area of 1.2 million hectare with a production of 19.4 million tonnes (Anonymous, 2014) [3]. Tomato crop is infected by a large number of diseases among which early blight caused by *Alternaria solani* (Ellis and Martin) Jones and Grout is one of the important foliage disease causing about 80-86% yield losses (Pandey and Pandey, 2003) [27]. Although the disease is called early blight, but it can occur on the plant at all the stages of development and is particularly destructive in temperate humid climate. During the last few years, early blight has assumed serious endemic proportions in Jammu region owing to air-borne spread of the fungus, local overwintering/oversummering of inoculum, cultivation of susceptible varieties and favourable environmental conditions (Rani, 2015) [31]. Timely application of fungicides is considered to be the most suitable method to manage early blight as reported by several workers (Mathur *et al*., 1971; Singh, 1971; Dahmen and Staub, 1992) [23, 35, 8]. However, the fungicides cannot be considered as a long-term solution, due to concerns of expense, exposure risks and the hazards of its residues. Moreover, the development of resistance of pathogenic fungi towards synthetic pesticides is a great problem that can significantly affect the efficacy of chemical fungicides (Kirk *et al*., 2005) [18]. A successful disease control program could involve just a single practice, but the long term reduction of disease losses generally requires the application of several control measures. The best way to ensure success of a disease management program is to use integrated disease management measures (Ganie *et al*., 2013) [13].
The present paper discusses the *in vitro* efficacy and effectiveness of resident bio agents and systemic, non-systemic and combinations fungicides at different concentrations against *Alternaria solani* causing early blight of tomato. An attempt has also been made to test the efficacy of extracts of medicinal plants available in Jammu region against *A. solani*. The treatments which showed promising results under *in vitro* conditions were integrated and further evaluated under field conditions so as to develop an integrated module for disease management.

2. Material and Methods
Isolation, purification and mass multiplication of *A. solani*
During field surveys conducted for two years (2011 and 2012), plants showing disease symptoms of dark brown or black lesions with concentric rings on leaves were used for the

isolation of causal pathogen associated with the diseased plants. Small bits from diseased plant material were cut from the junction of diseased and healthy portion. The bits were then dipped in mercuric chloride (0.1%) solution for 30 seconds for surface sterilization and washed in three changes of distilled water. The bits were then dried on sterilized blotting paper and placed on to PDA petri plates under aseptic conditions. The plates were incubated at 25 ± 1 ^{0}C and fungal cultures were purified by hyphal tip method from a vigorously growing culture. The pure culture was maintained on PDA medium through routine sub culturing at fortnightly interval. Visual characters *viz*. grey brown to black colonies and grey to black mycelium with tints of olive or brown and microscopic characters *viz*. septate, dark coloured mycelium ranging from grey to black, dark coloured, muriform condia with 9 to 11 transverse septa and 2 to 3 longitudinal septa were recorded and the identity of the pathogen was established after comparison with the standard literature (Ellis, 1971) [12].

***In vitro* evaluation of different fungicides**

For the present study four systemic fungicides *viz*. tebuconazole 25 EC (Folicur), hexaconazole 5 EC (Contaf), difenconazole 25 EC (Score) and carbendazim 50 WP (Derosal) and three non-systemic fungicides mancozeb 75 WP (Dithane M-45), copper oxychloride 50 WP (Blitox), captaf 50 WP (Captan)] and two combination fungicides metalaxyl 8% + mancozeb 64% 72 WP (Ridomil MZ) and carbendazim 12% + mancozeb 63% (SAFF) were selected after scanning the available literature and *in vitro* evaluation against *Alternaria solani* was performed using poisoned food technique (Nene and Thapliyal, 1993). Systemic fungicides were tested at 10, 25, 50 and 100 ppm concentration while non systemic and combination fungicides were tested at 250, 500, 750 and 1000 ppm concentration. Stock solutions (1000 ppm) of these fungicides were prepared and adjusted to desired concentration. Three replications for each treatment were maintained while PDA medium without fungicide served as control. The poisoned plates were inoculated with a 5 mm mycelial disc of the pathogen (*A. solani*) taken from seven day old culture raised on PDA medium. The inoculated plates were incubated in B.O.D at 25 ± 1 ^{0}C till the fungal mycelial growth covered the whole plate of control treatment. The radial growth of mycelium was recorded after 7 days of incubation in each treatment and per cent inhibition over control was calculated as per formulae given by Vincent (1927) [38].

***In vitro* evaluation of plant extracts**

Fresh leaves of *Datura stramonium*, *Lantana camara*, *Cannabis sativa*, *Ocimum sanctum* and fresh leaves as well as seeds of *Azadirachta indica* were collected from different locations of Jammu division. Ten grams of the fresh leaves/seeds were washed with water and crushed in a mortar and pestle by adding sterile distilled water at the rate of 10 ml/g of plant tissue and homogenized in an electric blender. The homogenate was filtered out through double layer of muslin cloth and passed through Whatman filter paper No. 1 to avoid microbial contamination. The resultant extracts were considered as 100 per cent concentration. These extracts were evaluated at three concentrations (10, 15 and 20%) using poison food technique. PDA was used as nutrient medium and required quantity of each plant extract was added separately so as to get a requisite concentration of the plant extract. 15 ml poisoned medium was poured to each of the 90 mm petri dishes and allowed for solidification. The actively growing hyphal bit (5 mm) from periphery of the seven day old culture of *A. solani* was carefully cut using a cork borer and transferred aseptically to the centre of each petri dish containing the poisoned medium. Suitable control was maintained by growing the cultures on PDA without the plant extract. The plates were incubated at 25 ± 1 ^{0}C for seven days and the colony diameter was recorded.

***In vitro* evaluation of bio-agents**

Isolation of bio control agents and pathogens

Bio control agents were isolated from the rhizosphere of healthy tomato plants grown at Research Farm, Facualty of Agriculture-Chatha, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. King's B medium (KB) was used for isolation of *Pseudomonas fluorescens* and *Bacillus subtilis* whereas, *Trichoderma* selective medium (TSM) was used for the isolation of *Trichoderma* spp. (Askew and Laing, 1993) [4]. Identity of the isolates of *Trichoderma harzianum* was established by taking standard references of Rifai (1969) [32] and Persoon (1794) [29]. Isolates of *T. harzianum* showed white to light green mycelium. Conidiophores with phialides in whorls of 3-4 were observed. Colonies were yellowish, bright, dull to dark green, phialids typically crowded arising from broad cells. *Pseudomonas fluorescence* and *Bacillius subtilis* were identified as per Migula (1895) [25] and Cohn (1872) [6]. Isolates of *Pseudomonas fluorescence* showed Gram negative, fluorescent yellow-green and non-spore forming colonies whereas isolates of *Bacillius subtilis* showed gram-positive, rod shape characteristics. The isolates showing fastest and vigorous growth were selected for checking their antagonistic activity against the test pathogen using dual culture technique in which 20 ml of PDA was poured into 90 mm diameter petri dishes and allowed to solidify. The 5 mm mycelial disc of *A. solani* taken from 7 days old culture was placed at one end of petri dish and respective the antagonistic at the opposite side. A control was maintained by inoculating only *A. solani* at one end in case of fungal antagonist. In case of bacterial antagonist, *A. solani* was placed at both ends of petriplate and bacterial culture was inoculated at the centre of Petri plates. Control was maintained by inoculating *A. solani* at both the ends of Petri plate. Each treatment was replicated thrice and incubated for 7 days at 25 ± 1 ^{0}C. The activity of antagonistic organisms was recorded by measuring the colony diameter of *A. solani* in each treatment and compared with control using the formula as suggested by Vincent (1927) [38].

$$I = \frac{C - T}{C} \times 100$$

where, I = Per cent inhibition of mycelial growth
C = Growth of fungal plant pathogens in control (mm)
T = Growth of fungal plant pathogens in dual culture plate (mm)

Field evaluation of bio control agents, botanical extracts, fungicides and their integrated effect

The field experiment was conducted at Research Farm, FOA-Chatha, SKUAST-Jammu. Seeds of Pusa Ruby cultivar were raised in nursery and the apparently healthy seedlings were transplanted to 2 × 2m experimental plots, maintaining a row to row and plant to plant spacing of 60 x 45 cm. All the recommended practices for the cultivation of tomato were followed in order to raise healthy crop (Anonymous, 2010) [2]. The experiment was laid out in Randomized Block Design (RBD) with three replications of each treatment consecutively for two years i.e. 2011 and 2012. Intensity of Alternaria blight

was recorded using 0-5 scale (Datar and Mayee, 1986) and expressed as Percent Disease Intensity.

$$Percent\,disease\,intensity = \frac{Sum\,of\,all\,disease\,ratings}{Total\,number\,of\,Ratings \times Maximum\,disease\,rating} \times 100$$

Different treatment combination integrating the fungicides, botanical extracts and bio agents showing the promising results under *in vitro* conditions were made and tested under field conditions against early blight of tomato. For mass multiplication of *T. harzianum,* sorghum grains were soaked in water for two hours and the extra water was decanted. 50 gm sorghum grains were transferred into each polyethylene bag. The bags were sealed and then sterilized in an autoclave at 15 psi for 20 minutes and allowed to cool down at room temperature. Spore suspension of *T. harzianum* was prepared by adding 20 ml sterile water to one week old culture of the fungus on potato dextrose agar (PDA) medium in a 9 cm diameter Petri plate and rubbing the surface with a sterile spatula. The population was determined with the help of haemocytometer and adjusted to containing 1×10^8 conidia ml^{-1}. Two ml of the suspension were inoculated with the help of a sterile syringe into each bag containing 50 gram sorghum grain. The inoculated bags were stored at 28 ± 2 ^{0}C. After 15 days of growth, the colonized sorghum gains were dried at 30^0C and ground to powder using a laboratory blender (Prasad *et al*., 1999) [30]. For application of *T. harzianum*, thick slurry of powder formulation was made @ 10g/kg of seed and seeds were dipped for 30 minutes in the slurry. The soaked seeds were air dried under shade before sowing while all other treatments were given as sprays and applied at 45, 60 and 75 days after transplanting. First spray was scheduled after the appearance of disease and subsequent two sprays were given at fortnightly interval. The observations on disease intensity were recorded after 45, 60 and 75 days and the pooled yield was taken for the whole season. The data were subjected to statistical analysis using Statistical package SPSS-16.0 version.

3. Results and Discussion

In vitro efficacy of fungicides

In vitro efficacy of different test fungicides assessed using poisoned food has been presented in Table 1. The data revealed that all the test fungicides at various concentrations significantly inhibited the mycelial growth of *A. solani*. Tebuconazole proved to be the most effective fungicide exhibiting maximum mean mycelial growth inhibition (94.44%) followed by Difenconazole (90.37%). However, Carbendazim showed minimum mycelial growth inhibition of (55.19%). It was observed that with the increase in the concentration of fungicide, there was a significant decrease in the respective mycelial growth and accordingly more inhibition was observed at high concentrations than at lower concentrations. Data further revealed a significant interaction between fungicides and concentration. Various fungicides including captafol, mancozeb, benomyl, carbendazim, copper oxychloride and Mancozeb were investigated by Mate *et al* (2005) and maximum radial mycelial growth inhibition was observed in mancozeb. Akbari and Parakhia (2007) [1] reported that systemic fungicides completely inhibited the mycelial growth of *A. alternata* even at 50 ppm, while non-systemic fungicides gave cent percent inhibition of *A. alternata* at a minimum concentration of 500 ppm. Similar observations have also been reported by Patel *et al* (2005).

In vitro evaluation of plant extract

Results in Table 2 indicated that all tested plant extracts *viz*. *Datura stramonium*, *Lantana camara*, *Azadirachta indica*, *Cannabis sativa, Ocimum sanctum* and seed extract of *Azadirachta indica* caused a significant reduction in the mycelial growth of *Alternaria solani* at different concentrations. Maximum inhibition was recorded by *Lantana camara* (65.07%) which was significantly higher than *Datura stramonium* (63.33%) and *Azadirachta indica* kernel (61.33%). However, *Cannabis sativa* recorded minimum mycelial growth inhibition (32.59%) at 20% concentration. It was observed that with the increase in the concentration of the extract, there was a corresponding increase in the inhibition of the pathogen. These observations are in confirmation with Nashwa (2011) [26] who reported that under *in vitro* condition leaf extracts of *D. stramonium*, *A. indica*, and *A. sativum* at 5% concentration caused highest reduction of mycelia growth of *Alternaria solani*. Maya and Thippanna (2013) [24] reported that leaf and seed extracts of *A. indica* recorded 78.83% mycelial inhibition followed by *L. camara* with 59.9% inhibition in mycelial growth of *A. solani*. These results also lined up with previous work on the role of plant extracts in the fungal disease control done by several workers including (Curtis *et al.,* 2004, Krebs *et al*., 2006 and Latha *et al.,* 2009) [7, 19, 20] who reported that plant extract from Zimmu (*Allium cepa* L. x *Allium sativum* L.) inhibited the mycelia growth of *Alternaria solani* by 87.0%.Certain plants containing products such as alkaloids, tannins, quinines, coumarins, phenolic compounds, phytoalexins, ipomeamarone in the extracts and exudates are known for antifungal activities (Dattar, 1999) [10].

In vitro effectiveness of bio agent against *A. solani*

Results presented in Table 3 revealed that the bio agents tested under dual culture technique significantly inhibited the mycelial growth of *A. solani*. Among them, *Trichoderma harzianum* (*Th* 1) showed maximum growth inhibition (65.93%) of the pathogen and appeared to be the most effective. However, *Bacillus subtilis* (*Bs* 6) showed 58.22 per cent inhibition followed by *T. viride* (*Tv* 6) (41.67%) and *Pseudomonas fluorescens* (*Pf* 9) (38.89%) (Table 3). Elad *et al.,* 1982 [11] reported that lysis and disintegration of mycelium of test fungus may be due to action of enzymes produced by *Trichoderma* spp. Antibiosis is the generally recognized principal mechanism of interference competition by which fungi may exclude other organism from resources potentially available to each other (Gomathy and Ambikapathy, 2011) [14]. The antagonism of *T. harzianum* and *T. viride* observed in the present studies is in accordance with the findings of Roopa *et al.,* 2014 [33]. Ganie *et al.,* 2013 [13] recorded caused maximum mycelial growth inhibition of 71.85 per cent in *A. solani* by *T. harzianum* followed by *T. viride* by showing strong mycoparasitic activity and completely overgrew the host mycelium once in contact with it. The effectiveness of *Trichoderma harzianum* against *A. alternata* was reported by Shikha and Harsha (2014) [34].

Integrated disease management of early blight of tomato

Attempts were therefore made to evaluate plant extracts, bio control agents and fungicides (showing promising results under *in vitro* conditions) both alone as well as in combination with each other under field conditions to develop a module for integrated disease management of early blight of tomato. All the treatments significantly reduced the disease as compared to control. However, the magnitude of reduction varied from treatment to treatment. The range of disease

intensity in treatments varied from 75 days after transplanting (8.98 to 29.04%) as compared to control (56.09%). Minimum disease intensity of 8.98 per cent was observed in plants treated with Mancozeb (0.25%), Datura (50%) (foliar spray) and *Trichoderma harzianum* (1×10^7) (seed treatment). However, Mancozeb (0.25%), Datura (50%) (foliar spray) and *T. harzianum* (1×10^7) (seed treatment) and mancozeb (0.25%) (foliar spray), *T. harzianum* ($1x10^7$) (seed treatment) were statistically at par with each other recording disease intensity of 8.98 and 9.55 per cent. Treatments mancozeb + carbendazim (0.25%) (foliar spray), *T. harzianum* ($1x10^7$) (seed treatment) and Mancozeb + Carbendazim (0.25%) (foliar spray), Datura (foliar spray) (50%) and *T. harzianum* ($1x10^6$) (seed treatment) were statistically at par with disease intensity of 13.40 and 13.67 per cent respectively. Datura extract (50%) was least effective followed by *T. harzianum* at 1×10^7spore/ml (seed treatment) with disease intensity of 29.04 and 26.67 per cent respectively over check (56.09%). Field experimentation results revealed that all the treatments tested were superior over control and showed significantly less disease intensity (9.55-29.4%) over control (56.9%) after 75 DAT. There was a significant increase in fruit yield in fungicide treated plots over control.

Results shown in Table 4 revealed that among the treatments, combination of Mancozeb, Datura and *T. harzianum* recorded the maximum yield (26.67 t/ha) followed by Mancozeb + *T. harzianum* (25.54 t/ha) which is at par with Mancozeb + Datura (24.74 t/ha). Patil *et al.,* 2005 concluded that the need based plant protection measures applied in IDM programme was more cost effective and achieved economic yield with less environmental pollution than sole chemical methods. Mancozeb as effective fungicide for the management of early blight and maximum fruit yield has been reported by several workers (Sobolewski and Robak, 2004; Ilhe *et al*., 2008; Chourasiya *et al*., 2013) [36, 17, 5]. Our results obtained for yield are in accordance with those of Maheshwari and Gupta (1991). Verma *et al.,* 2008 also reported that disease severity of *A. solani*, the causal agent of early blight of tomato could be significantly reduced with foliar spray of *Clerodendron aculeatum* leaf extract (15%) immediately after appearance of symptoms or foliar spray of lowed by two sprays of ma. *et al.,* 2013 reported that under *in vivo* conditions seed treatment with mancozeb + foliar spray with hexaconazole + foliar spray with datura + foliar spray with *Trichoderma harzianum* were highly effective in controlling the disease early blight of potato. Results of the present study showed that all fungicide treatments significantly controlled the early blight infection on tomato as compared to untreated control. Furthermore, there was a significant difference 998) level of control and crop yield from IDM programme are often better than conventional method. Presently, the search for natural products with novel uses, particularly related to pest management is very important.

The present investigation demonstrates that the integrated approach using the plant extracts, bio control agent and fungicides have the potential to inhibit the growth *A. solani*. These plant extract and a bio control agent could be considered as an economical and environmental friendly materials. The use of plant extract and bio control agent in alternation with the fungicides could be suggested and recommended to be applied especially in order to manage fungicide residues.

Table 1: *In vitro* evaluation of fungicides on the growth of *Alternaria solani*

Fungicide	Conc. (ppm)	Mycelial Inhibition (%)
Tebuconazole 25 EC	10	50.37 (45.19)
	25	65.19(53.87)
	50	74.81(59.87)
	100	94.44(76.33)
Defaconazole 25 EC	10	48.89(44.35)
	25	63.33(52.71)
	50	73.33(58.89)
	100	90.37(71.90)
Hexaconazole 5 EC	10	30.00(33.19)
	25	37.78(37.91)
	50	54.07(47.32)
	100	82.22(65.04)
Mancozeb 75 WP	250	72.04(58.06)
	500	74.07(59.37)
	750	78.15(62.11)
	1000	82.96(65.61)
Metalyxl + Mancozeb 72 WP	250	66.67(54.71)
	500	70.74(57.23)
	750	74.07(59.37)
	1000	78.15(62.11)
Copper oxychloride 50 WP	250	53.70(47.10)
	500	59.63(50.53)
	750	62.59(52.27)
	1000	67.04(54.94)
Mancozeb + Carbendazim 75 WP	250	68.15(55.62)
	500	73.70(59.12)
	750	77.04(61.35)
	1000	80.74(63.95)
Carbendazim 50 WP	10	44.81(42.00)
	25	49.26(44.56)
	50	51.85(46.04)
	100	55.19(47.96)
Captaf 50 WP	250	55.19(47.96)
	500	62.96(52.49)
	750	68.52(55.85)
	1000	72.59(58.40)
Factor	SEm±	CD at 1%
Fungicides	0.25	0.70
Concentration	0.17	0.47
Interaction	0.49	1.40

Table 2: Effect of plant extracts on mycelial growth (mm) of *Alternaria solani* on PDA

Plant Extract	Percentage inhibition over control Concentration			
	10%	15%	20%	Mean
Datura stramonium (leaf)	46.67 (43.07)	56.22 (48.56)	63.33 (52.72)	55.41 (48.12)
Lantana camara (leaf)	39.67 (38.43)	54.00 (47.28)	65.07 (53.77)	52.91 (46.92)
Azadirachta indica (leaf)	27.81 (31.65)	42.51 (40.68)	56.00 (49.77)	42.11 (40.25)
Azadirachta indica (seed)	35.56 (36.58)	48.44 (44.09)	61.33 (51.54)	48.44 (44.07)
Cannabis sativa (leaf)	22.96 (28.60)	28.74 (32.40)	32.59 (34.80)	28.10 (31.94)
Ocimum sanctum (leaf)	25.85 (30.55)	35.00 (36.25)	49.93 (44.94)	36.92 (37.24)
Factor	SEm±	C.D.		
Plant Extract	0.65	1.87		
Concentration	0.46	1.33		
Interaction	1.13	3.25		

Figures in the parenthesis indicate arc sine values

Table 3: Effect of bio control agents on the growth of *Alternaria solani*

S. No.	Biocontrol agent	% inhibition of mycelial growth
1	*Trichoderma harzianum* (Th1)	65.93(54.29)
2	*Trichoderma viride* (Tv 6)	41.67(42.85)
3	*Pseudomonas fluorescens* (Pf 9)	38.89(37.13)
4	*Bacillus subtilis* (Bs 6)	58.22(51.62)
	S.Em± (standard error of mean)	0.17
	C.D. at 1%(critical difference)	0.49
	CV (%) (coefficient of variance)	5.21

Figures in the parenthesis indicate arc sine values

Table 4: Integrated management of early blight of tomato and its effect on yield of tomato under field conditions during 2011and 2012

Treatment	PDI 45DAT	Per cent inhibition over control	PDI 60DAT	Per cent inhibition over control	PDI 75DAT	Per cent inhibition over control	Yield (t/ha)	Per cent increase in yield over control
Tebuconazole[3] (0.1%)	10.48(18.86)	59.91	12.57(20.76)	67.47	15.72(23.34)	78.98	20.19	61.00
Mancozeb[3] (0.25%)	9.62(18.06)	63.17	11.55(19.86)	70.12	14.44(22.32)	74.26	23.01	83.49
Mancozeb + Carbendazim[3] (0.25%)	12.32(20.54)	52.84	14.79(22.61)	61.74	18.49(25.46)	67.04	18.59	48.25
Datura[3] (50%)	19.36(26.09)	25.91	23.23(28.80)	39.89	29.04(32.60)	48.23	15.59	24.22
Trichoderma harzianum[s.t] ($1x10^7$ spores/ml)	17.78(24.92)	31.97	21.33(27.49)	44.81	26.67(31.07)	52.46	17.76	41.63, 97.29
Mancozeb[2] (0.25%) + Datura[1] (50%)	7.81(16.23)	70.10	9.38(17.82)	75.74	11.72(20.01)	79.11	24.74	56.86
Mancozeb+Carbendazim[2] (0.25) + Datura[1] (50%)	8.93(17.37)	65.84	10.71(19.09)	72.28	13.40(21.44)	76.13	19.67	103.67
Mancozeb[2] (0.25%) + *T. harzianum*[s.t] ($1x10^7$ spores/ml)	6.36(14.60)	75.65	7.64(16.03)	80.24	9.55(17.98)	82.98	26.76	66.59
Mancozeb+Carbendazim[2](0.25%)+*T. harzianum*[s.t] ($1x10^7$ spores/ml)	9.11(17.56)	65.12	10.94(19.30)	71.71	13.67(21.69)	75.63	20.89	113.40
Mancozeb[2](0.25%)+Datura[1](50%)+*T. harzianum*[s.t] ($1x10^7$ spores/ml)	5.98(14.15)	77.10	7.18(15.54)	81.42	8.98(17.43)	84.00	25.54	77.59
Mancozeb+Carbendazim[2](0.25%)+Datura[1](50%)+*T. harzianum*[s.t]($1x10^7$ spores/ml)	7.36(15.73)	71.85	8.83(17.28)	77.16	11.04(19.40)	80.33	22.27	
Control (water spray)	26.13(30.72)	-	38.65(38.42)	-	56.09(48.48)	-	12.54	
SE(m)±	0.29		0.27		0.33		0.29	
C D at 5%	0.85		0.79		0.98		0.84	
CV (%)	4.17		3.15		3.04		2.42	

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