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S Dilip Kumar Reddy
Department of Plant Pathology, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

SL Godara
Department of Plant Pathology, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Ashok Kumar Meena
Department of Plant Pathology, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Vijay Shree Gahlot
Department of Plant Pathology, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Nitika Kumari
Department of Plant Pathology, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Corresponding Author:
S Dilip Kumar Reddy
Department of Plant Pathology, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Management of Sclerotinia stem rot of Brinjal

S Dilip Kumar Reddy, SL Godara, Ashok Kumar Meena, Vijay Shree Gahlot and Nitika Kumari

Abstract
Brinjal is one of the important tropical vegetable crops in India. *Sclerotinia* stem rot of brinjal was found to be a serious disease of brinjal that causes damage partial or complete wilting of the plant. In the field experiment, seedling treatment and soil drenching with fungicides (tebuconazole 50%+ trifloxystrobin 25% WG and carbendazim 12% + mancozeb 63% WP) and soil application of bioagents (*T. harzianum* and *P. fluorescens*) were alone and in combination were used. Seedling treatment in combination with soil drench of fungicide tebuconazole 50%+ trifloxystrobin 25% WG gave the minimum disease incidence and highest per cent disease control, and highest yield over other treatments followed by seedling treatment in combination with soil drenching of carbendazim 12% + mancozeb 63% WP. Least effective was found in case of soil application of *Pseudomonas fluorescens*.

Keywords: Brinjal, stem rot, bio agents, fungicides, management

Introduction
Brinjal (*Solanum melongena* L.) is one of the most widely cultivated vegetable crops all over the world, including the Indian sub-continent. Brinjal is commonly known as eggplant, belongs to family Solanaceae. India is considered to be the centre of origin of cultivated brinjal from where it spread to other parts of the world.

Brinjal is cultivated in all states but major brinjal growing states are West Bengal, Odisha, Gujarat, Bihar, Madhya Pradesh (Anonymous, 2018) [1]. Brinjal is infected by a number of diseases caused by fungi, bacteria, nematodes, virus and phytoplasma which adversely effect the yield and the quality *viz*., Damping-off (*Rhizoctonia solani*, *Pythium aphanidermatum*), Phomopsis blight (*Phomopsis vexans*), Leaf spot (*Cercospora melongenae*), Alternaria leaf spots (*Alternaria melongenae*), Fruit Rot (*Phytophthora nicotianae* var. *parasitica*), Verticilium wilt (*Verticilium dahlia*), Collar rot (*Sclerotium rolfsii*), Stem rot (*Sclerotinia sclerotiorum)*, Bacterial wilt (*Pseudomonas solanacearum*), Little leaf of brinjal (phytoplasma like organism) and mosaic.

Among all the diseases, stem rot caused by *Sclerotinia sclerotiorum* de Bary is considered as one of the devastating diseases in almost all the brinjal growing areas of country. It is more common and severe in temperate and subtropical regions of cool and wet seasons (Purdy, 1979 [11]; Willetts and Wong, 1980 and Saharan and Mehta, 2008 [14]). *S. sclerotiorum* can also be known as cottony rot, watery soft rot, stem rot, crown rot and blossom blight. The fungus can survive in the soil, on infected tissues and on living plants.

The fungus *Sclerotinia sclerotiorum* (Lib.) de Bary is a worldwide, necrotrophic, phytopathogenic, filamentous ascomycete (Duan, 2012) [4] affects the yield of several crops (Hegedus and Rimmer 2005 [7]; Bolton *et al*., 2006 [3]). It affects a wide range of wild and cultivated host plants infect over 400 species of plants (Boland and Hall, 1994) [2]. It causes severe economic losses in crops such as oilseeds, pulses, forage legumes, vegetables and ornamentals (Sharma *et al*., 2017) [17]. The pathogen causes losses in brinjal ranges from 26-47% (Iqbal *et al.*, 2003) [8]. The occurrence of sclerotinia has been reported from the several countries and hosts by many workers. In India *Sclerotinia* stem rot was reported for the first time by Shaw and Ajerakar (1915) on several hosts including rapeseed and mustard. From Rajasthan pathogen *S. sclerotiorum* was first reported on gillardia (Rai and Agnihotri, 1971) [12] from Jobner (Jaipur). Later on it was reported on fennel, sunflower, pea, brinjal, mustard, etc. from other parts of the state (Sehgal and Agrawat, 1971 [16]; Singh and Agrawat, 1989).

Sclerotia plays very crucial role in propagating the pathogen (Willett and Wong, 1971 [19]; Rollins and Dickman 1998) [13]. The infection occurs on the stem, branches, leaves and fruits.

The symptoms are water soaked lesion on the stem which gradually increase in length and reaches the branches. White cottony mycelial growth covers the major portion of the infected area and sclerotia develops on the mycelial growth and finally, plant wilted and died. On opening dry portion of the stem, pith was full of fungal sclerotia. Fruits are infected directly from the soil surface or through the peduncle rot quickly. In advanced stages, white, cottony mycelium blankets covered the affected tissue, and sclerotia form on the surface of the fruit (Hansda *et al*., 2014) [6].

Management of *S. sclerotiorum* is a major challenge, and various measures like cultural practices, chemical, biological and resistance varieties were practiced. The experiment was conducted in order to study the effect of biocontrol agents as soil application alone and fungicides as seedling treatment and soil drenching and combination of bio-agents and fungicides on stem rot incidence.

Materials and Methods

The experiment was conducted at Experimental farm, College of Agriculture, SKRAU, Bikaner. The brinjal seedlings were transplanted keeping plot size 2.4 x 3 m^2 with 60 x 30 cm row to row and plant to plant spacing following Randomized Block Design with three replications.

Talc based formulations of two bio-agents *viz*., *T. harzianum* and *P. fluorescens* were used as a soil application to control *Sclerotinia sclerotiorum*. Two fungicides *viz*., tebuconazole 50%+ trifloxystrobin 25% WG (Nativo) @ 1.5 g l^{-1} water and carbendazim 12% + mancozeb 63% WP (Companion) @ 2 g l^{-1} water were used for seedling treatment and soil drenching. The observations disease incidence (%), disease control (%) and fruit yield (t ha^{-1}) were recorded.

$$\text{Per cent Disease Control} = \frac{\text{Stem rot incidence in control (\%)} - \text{Stem rot incidence in treatments (\%)}}{\text{Stem rot incidence in control (\%)}} X100$$

$$\text{Disease Incidence (\%)} = \frac{\text{Number of plants infected}}{\text{Total number of plants}} X100$$

Statistical analysis

The experiment was conducted in Randomized Block Design (RBD) and statistically analysed by using analysis of variances.

Table 1: Details of treatments

Treatments	Dose
T_1- tebuconazole 50%+ trifloxystrobin 25% WG	ST @ 1.5 g l^{-1} water
T_2-carbendazim 12% +mancozeb 63% WP	ST @ 2g l^{-1} water
T_3-tebuconazole 50%+ trifloxystrobin 25% WG	SD @1.5g l^{-1} water
T_4-carbendazim 12%+ mancozeb 63% WP	SD @ 2g l^{-1} water
T5-*Trichoderma harzianum*	SA @ 10 kg ha^{-1} with 100 Kg FYM
T_6-*Pseudomonas fluorescens*	SA @ 10 kg ha^{-1} with 100 Kg FYM
T_7-T1 + SA with *T. harzianum*	ST @ 1.5 g l^{-1} water +SA @10 kg ha^{-1} with 100 Kg FYM
T_8-T2 + SA with *T. harzianum*	ST @ 2 g l^{-1} water + SA @10 kg ha^{-1} with 100 Kg FYM
T_9-T1 + SA with *P. fluorescens*	ST @ 1.5 g l -1 water +SA @10 kg ha^{-1} with 100 Kg FYM
T_{10}-T2 + SA with *P. fluorescens*	ST @ 2 g l^{-1} water +SA @10 kg ha^{-1} with 100 Kg FYM
T_{11}-tebuconazole 50%+ trifloxystrobin 25% WG	ST @ 1.5 g l^{-1} + SD @1.5g l^{-1} water
T_{12}-carbendazim 12% + mancozeb 63% WP	ST @ 2 g l^{-1} + SD @ 2g l^{-1} water
T13- Control	

ST= Seedling Treatment SD= Soil Drenching SA= Soil application

Results and Discussion

The results showed that the stem rot of brinjal was significantly reduced in fungicidal treatments. The data reveals that the minimum disease incidence (8.48%), maximum disease control (86.21%) and highest fruit yield (29.71 t ha^{-1}) were recorded in tebuconazole 50% + trifloxystrobin 25% WG used as seedling treatment and as soil drenching followed by carbendazim 12% + mancozeb 63% WP in combination of seedling treatment with soil drench which showed 12.96%, 78.93% and 28.03 t ha^{-1}.

Maximum disease incidence (49.07%), minimum disease control (20.21%) and lowest yield (11.61t ha^{-1}) were found in the treatment soil application of *P. fluorescens* followed by the treatment of soil application of *T. harzianum* where disease incidence (43.48%), disease control (29.30%) and yield (13.10 t ha^{-1}).

Table 2: Management of stem rot of brinjal through bio-agents and fungicides

Treatments	Disease incidence (%)	Disease control (%)	Fruit yield (t ha^{-1})
T_1	21.74 (27.65)	64.65	22.40
T_2	24.17(29.33)	60.69	19.30
T_3	33.41(35.21)	45.67	18.51
T_4	38.01(38.02)	38.20	15.79
T_5	43.48 (41.22)	29.30	13.10
T_6	49.07 (44.45)	20.21	11.61
T_7	14.76 (22.46)	76.01	27.40
T_8	17.13 (24.37)	72.15	25.09
T_9	16.50 (23.80)	73.17	26.52
T_{10}	18.41 (25.23)	70.07	23.87

T_{11}	8.48 (16.85)	86.21	29.71
T_{12}	12.96 (20.93)	78.93	28.03
T_{13}	61.50 (51.68)	-	9.52

Krishnamoorthy *et al*., (2017) [9] reported the combined application of *B. amyloliquefaciens* isolate B15 and nativo was found to be highly effective with the least disease incidence of 8.67 per cent indicating 78.55 per cent reduction over control followed by nativo alone with disease incidence of 8.74 per cent and 78.37 per cent reduction over control. Ghasolia and Shivpuri (2008) [5] found that seed treatment with carbendazim + mancozeb (1:1) was effective in reducing incidence of Sclerotinia rot of mustard and improved seed yield.

Satyendra and Singh (2012) [15] reported that *Trichoderma* treated seedlings showed lowest disease incidence and higher yield with comparison to untreated pathogen inoculated control. Similarly, Mehta *et al*. (2012) [10] also reported that the isolates of *T.harzianum* - 3 and *T. harzianum* - 4 were significantly better and most potent in reducing the growth and sclerotia formation of *S. sclerotiorum*

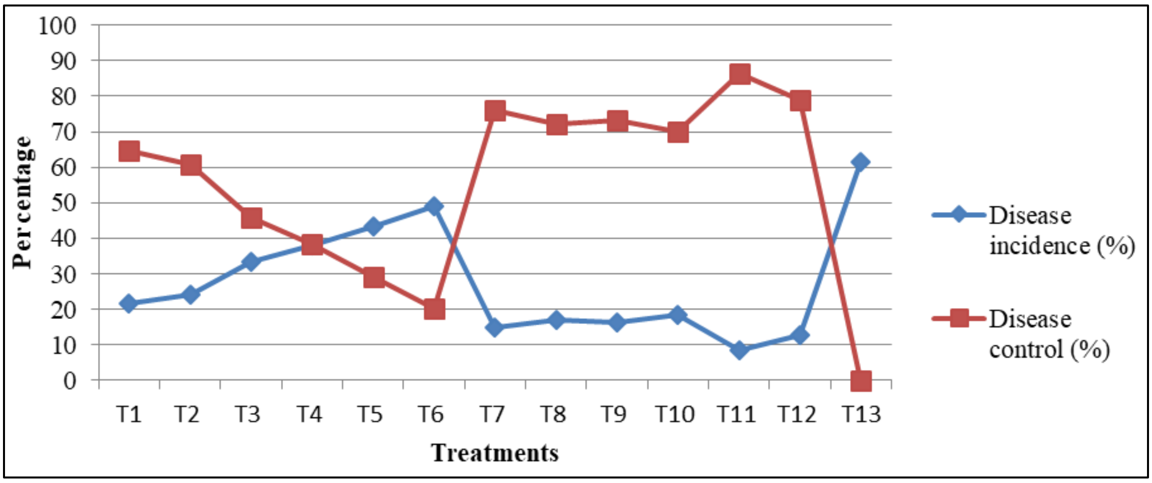

Fig 1: Disease incidence and disease control of stem rot of brinjal under various treatments

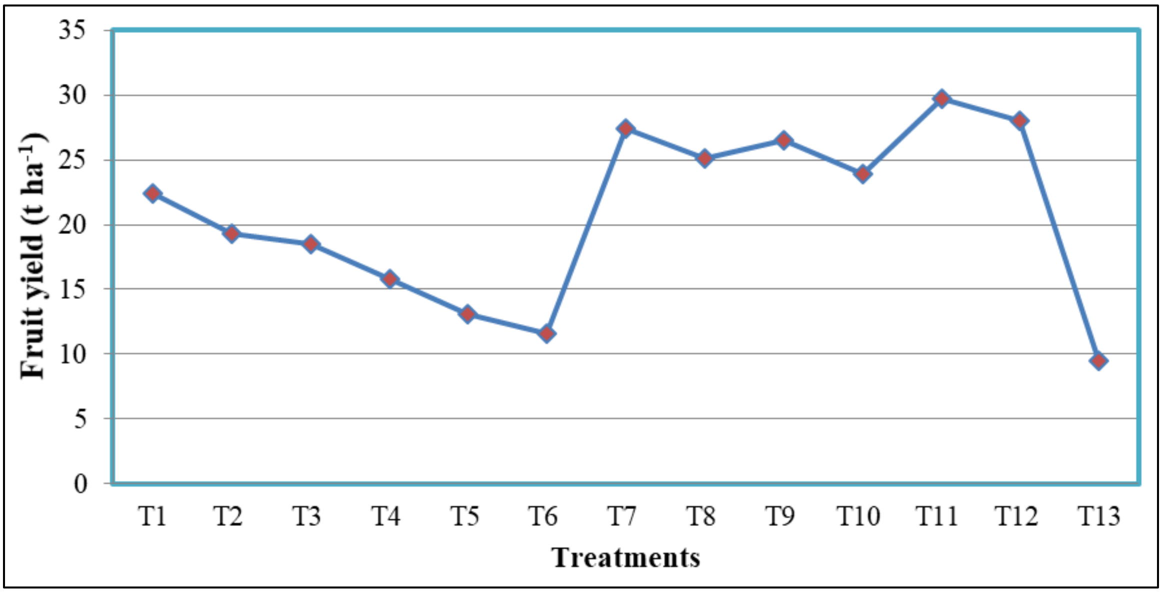

Fig 2: Fruit yield (t ha-1) of brinjal under various treatments

Conclusion

The maximum per cent disease control and highest fruit yield was found in treatment seedling treatment in combination with soil drench of tebuconazole 50% + trifloxystrobin 25% WG followed by seedling treatment in combination with soil drench of carbendazim 12% + mancozeb 63% WP.

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