Integration of garlic bulb extract and carbendazim can manage *Sclerotinia* rot on Indian mustard

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Abstract

Rot of Indian mustard (*Brassica juncea*) caused by *Sclerotinia sclerotiorum* (Lib.) de Bary has become important in recent times in India and elsewhere with high disease incidence and severe yield losses leading to discouragement of growers of the crop. The pathogen is reported to infect about 400 plant species with no proven source of resistance against the disease reported till date in any of the hosts. This laboratory has earlier reported success in managing *Sclerotinia* rot using garlic (*Allium sativum*) bulb extract, *Trichoderma harzianum* as seed treatments supplemented by their foliar applications during 50 and 70 days after sowing. Garlic bulb extract (1% w/v) and *T. harzianum* were found to be 34% compatible with each other *in vitro*. To validate the same in field conditions, a trial was laid out in randomised block design with 31 treatments (including control) in two replications on *Sclerotinia* infested plots at experimental farm, Sewar [77°27'E, 27°12'N, 160 m above mean sea level, deep loamy alluvium derived soil with pH 8.0] and farmers' field at village Richoli, Bharatpur [77°22'E, 27°01'N, 182 m above mean sea level, deep loamy alluvium derived soil with pH 7.5] in 2004-05 and 2005-06 post-monsoon seasons. The crop was sown at Richoli (16 Oct 2004, 05 Oct 2005) and Sewar (19 Oct 2004 and 07 Oct 2005), with garlic bulb extract (1% w/v), *T. harzianum* and Carbendazim (0.1% a.i) applied as seed treatment or foliar spray (at 50 and 70 days after sowing) singly or in different combinations. Seed treatment with garlic bulb extract provided significantly better ($P < 0.05$) and the best initial plant stand at both the locations with a mean 20.2% increase in germination over control in 2004-05. Seed treatment with garlic bulb extract followed by carbendazim supplemented by foliar spray with the same mixture was significantly better ($P < 0.05$) among the treatments in reducing the *Sclerotinia* rot incidence and in increasing yield over control consistently over the two years.

Key words: *Brassica juncea, Sclerotinia sclerotiorum*, disease control, seed treatment, bioagent

Introduction

Indian mustard [*Brassica juncea* (L.) Czern and Coss.] is an important oilseed crop of India. During 2003-04, rapeseed-mustard represented 21.6 and 23.2 per cent of the total oilseed hectarage and production, respectively. *Sclerotinia* rot of mustard has become important recently in India and elsewhere with high disease incidence and severe yield losses leading to discouragement of growers of the crop (Chattopadhyay *et al*., 2003). The pathogen is known to infect about 408 plant species (Boland and Hall, 1994) with no proven source of resistance. Unlike several temperate countries, in India the soilborne inoculum happens to be the most important source of infection. Because of the wide host range and lack of tissue specificity, breeding resistant varieties appears to be less successful. In order to check the secondary spread of the disease the possibility of control of the disease through foliar sprays of chemicals has been investigated. In recent years, an increasing consciousness about environmental pollution due to pest and development of fungicide resistant strains in plant pathogens (Annette Penaud *et al*., 2003) has challenged plant pathologists to search for eco-friendly tools for disease management. Earlier workers reported management of *Sclerotinia* rot of mustard by fungicides (Rajinder Singh *et. al*., 1994). This laboratory has earlier reported success in managing *Sclerotinia* rot using garlic (*Allium sativum*) bulb extract, *Trichoderma harzianum* as seed treatments supplemented by their foliar applications during 50 and 70 days after sowing (Chattopadhyay *et al*., 2002, 2004). Seed treatment is important keeping in view the soilborne nature of the pathogen in India. Here we report the results of investigation of integration of different agents in managing *Sclerotinia* rot of mustard.

Materials and Methods

Laboratory studies were carried out by poisoned food technique (Nene and Thapliyal, 1993) on Petri plates with four replications to understand the compatibility between garlic (*A. sativum*) bulb extract, *T. harzianum.* Potato dextrose agar (PDA) medium poisoned with garlic (*A. sativum*) bulb extract @ 1, 2 and 5% (w/v) sterilised by passing through autoclaved no. 5 sintered glass filter. The medium in plates was inoculated with sporulating agar blocks from seven-day growth of GR, P, SI-1, SI-2 isolates of *T. harzianum,* maintaining suitable check and incubated for seven days at 25°C.

Field studies were carried out in randomised block design with 31 treatments (including control) in two replications on *Sclerotinia* infested plots at experimental farm, Sewar [77°27'E, 27°12'N, 160 m above mean sea level, deep loamy alluvium derived soil with pH 8.0] and farmers' field at village Richoli, Bharatpur [77°22'E, 27°01'N, 182 m above mean sea level, deep loamy alluvium derived soil with pH 7.5] in 2004-05 and 2005-06 post-monsoon seasons. The crop (*B. juncea* cv. Rohini) was sown at Richoli (16 Oct 2004, 05 Oct 2005) and Sewar (19 Oct 2004 and 07 Oct 2005) in plots of 3 m×2.2 m with 30 cm×10 cm spacing, with garlic bulb extract (1% w/v), *T. harzianum* and Carbendazim (0.1% a.i.) applied as seed treatment or foliar spray (at 50 and 70 days after sowing) singly or in different combinations. Seed treatment and foliar sprays with *T.*

harzianum, *A. sativum*) bulb extract @ 1% and Carbendazim (0.1% a.i.) was done by methodology indicated by Chattopadhyay *et al*., (2002). Percentage disease incidence (PDI) was recorded before harvest while seed yield was recorded at harvest. Data was statistically analysed as per design using ANOVA. Percentage increase or reduction due to any treatment was calculated as: [(Data in treatment – Data in control) / Data in control]×100.

Table 1: Effect of chemical and biological treatments on Sclerotinia rot incidence

Treatment	2004-05						2005-06						Pooled	
	Sewar*[a]		Richoli*[b]		Mean		Sewar*[d]		Richoli*[e]		Mean[f]		Mean[h]	
	PDI	PDR	PDI	PDR	PDI	PDR	PDI	PDR	PDI	PDR	PDI	PDR	PDI	PDR
TH ST	18.0(9.5)	53.0	17.4(9.2)	58.2	17.8(9.4)	55.6	26.6(20.2)	54.0	30.8(26.3)	47.8	28.8(23.2)	50.7	23.3(16.3)	52.2
GBE ST	18.2(9.8)	51.5	13.4(5.4)	75.4	15.8(7.6)	63.3	26.3(19.6)	55.3	31.7(27.8)	44.8	29.0(23.7)	49.7	22.6(15.6)	54.2
Ca ST	20.4(12.2)	39.6	13.9(5.8)	73.6	17.2(9.0)	56.6	29.7(24.6)	44.0	33.9(31.5)	37.5	31.9(28.0)	40.5	24.7(18.5)	45.7
TH ST + GBE ST	19.5(11.2)	44.5	13.1(5.1)	76.8	16.3(8.2)	60.6	26.5(19.9)	54.7	28.6(23.0)	54.4	27.6(21.4)	54.6	22.1(14.8)	56.6
GBE ST + Ca ST	21.8(13.8)	31.7	14.4(5.4)	75.4	17.6(9.6)	53.5	23.0(15.3)	65.1	32.6(29.2)	42.1	27.9(22.2)	52.9	23.1(15.9)	53.4
TH SP	18.2(9.8)	51.5	15.6(7.2)	67.3	16.9(8.5)	59.4	26.7(20.2)	54.0	30.7(26.5)	47.4	28.8(23.3)	50.5	22.9(15.9)	53.4
GBE SP	19.7(11.3)	44.1	13.3(5.3)	75.9	16.5(8.3)	60.0	26.2(19.5)	55.6	32.4(28.9)	42.6	29.4(24.2)	42.5	23.1(16.2)	52.5
Ca SP	21.2(13.1)	35.1	21.9(15.0)	31.8	22.0(14.0)	33.4	28.3(22.5)	48.7	34.1(31.8)	36.9	31.3(27.1)	42.5	26.7(20.6)	39.6
TH SP + GBE SP	22.3(14.4)	28.7	18.1(9.9)	55.0	20.3(12.2)	41.8	25.3(18.3)	58.3	29.9(25.2)	50.0	27.7(21.7)	53.9	24.1(16.9)	50.4
Ca SP + GBE SP	21.6(14.0)	30.7	17.8(9.7)	55.9	20.1(11.9)	43.3	28.3(22.5)	48.7	36.1(34.9)	30.7	32.3(28.7)	39.1	26.3(20.3)	40.5
TH ST + *TH* SP	19.5(11.1)	45.0	20.1(11.8)	46.4	19.8(11.5)	45.7	33.6(30.6)	30.3	33.3(30.6)	39.3	33.6(30.6)	35.0	26.7(21.0)	38.4
TH ST + GBE SP	20.6(12.5)	38.1	19.6(11.2)	49.1	20.1(11.8)	43.6	24.2(16.9)	61.5	31.4(27.2)	46.0	27.8(22.0)	53.3	24.1(16.9)	50.4
TH ST+ Ca SP	20.1(11.8)	41.6	22.1(14.1)	35.9	21.4(12.9)	38.7	27.3(21.0)	52.2	31.1(27.3)	45.8	29.4(24.1)	48.8	25.4(18.7)	45.2
TH ST + TH SP+ GBE SP	20.5(11.2)	44.5	17.9(9.5)	56.8	18.7(10.3)	50.6	24.7(17.5)	60.1	38.6(38.9)	22.8	31.7(28.2)	40.1	25.4(19.3)	43.4
TH ST + *Ca* SP + GBE SP	17.3(8.8)	56.4	17.0(8.6)	60.9	17.1(8.7)	58.6	26.1(19.4)	55.8	36.8(36.1)	28.4	31.5(27.7)	41.2	24.5(18.2)	46.6
GBE ST + *TH* SP	19.1(10.9)	46.0	16.3(8.0)	63.6	17.8(9.4)	54.8	27.1(20.8)	52.6	33.9(31.2)	38.1	30.5(26.0)	44.8	24.3(17.7)	48.1
GBE ST + GBE SP	16.2(7.8)	61.4	19.6(11.3)	48.6	17.9(9.5)	55.0	24.6(17.4)	60.4	34.3(31.9)	36.7	29.5(24.6)	47.8	23.9(17.1)	49.8
GBE ST + Ca SP	15.3(7.0)	65.3	20.2(12.1)	45.0	17.8(9.6)	55.1	26.8(20.4)	53.5	34.4(32.3)	35.9	30.7(26.3)	44.2	24.4(17.9)	47.5
GBE ST + Ca SP + GBE SP	16.9(8.4)	58.4	22.1(14.2)	35.4	19.5(11.3)	46.9	24.9(17.8)	59.4	40.0(41.3)	18.0	32.5(29.5)	37.4	26.3(20.4)	40.2
GBE ST + Ca SP + GBE SP	17.9(9.5)	53.0	18.5(10.1)	54.1	18.2(9.8)	53.5	26.7(20.2)	54.0	32.6(29.1)	42.3	29.7(24.6)	47.8	24.0(17.2)	49.6
TH ST + GBE ST + *TH* SP	16.5(8.1)	59.9	18.5(10.1)	54.1	17.5(9.1)	57.0	32.2(28.5)	35.1	36.1(34.8)	30.9	34.2(31.6)	32.9	25.9(20.4)	40.2
TH ST + GBE ST + GBE SP	15.0(6.7)	66.8	15.4(7.0)	68.2	15.2(6.8)	67.5	26.2(19.6)	55.3	35.4(33.6)	33.3	30.8(26.6)	43.5	23.1(16.7)	51.0
TH ST + GBE ST + Ca SP	16.1(7.8)	61.4	16.1(7.7)	65.0	16.2(7.7)	63.2	29.1(23.8)	45.8	30.8(26.6)	47.2	30.1(25.2)	46.5	23.1(16.5)	51.6
TH ST + GBE ST + *TH* SP + GBE SP	16.7(8.3)	58.9	14.7(6.6)	70.0	15.8(7.4)	64.4	31.4(27.1)	38.3	34.1(31.6)	37.3	32.8(29.3)	37.8	24.3(18.4)	46.0
TH ST + GBE ST + Ca SP + GBE SP	17.4(9.3)	54.0	15.6(7.2)	67.3	16.7(8.2)	60.6	25.2(18.1)	58.8	32.1(28.4)	43.6	28.7(23.2)	50.7	22.8(15.7)	53.9
GBE ST + Ca ST + *TH* SP	18.4(10.0)	50.5	15.7(7.3)	66.8	17.1(8.6)	58.6	26.8(20.4)	53.5	32.2(28.4)	43.6	29.5(24.4)	48.2	23.3(16.5)	51.6
GBE ST + Ca ST + GBE SP	15.6(7.3)	63.9	13.2(5.2)	76.4	14.4(6.2)	70.1	28.0(22.2)	49.4	34.2(31.6)	28.4	31.2(26.9)	42.9	22.9(16.6)	51.3
GBE ST + Ca ST + Ca SP	19.0(10.6)	47.5	13.5(5.6)	74.5	16.3(8.1)	61.0	25.0(17.9)	59.2	35.7(34.2)	32.1	30.4(26.0)	44.8	23.6(17.1)	49.8
GBE ST + Ca ST + Ca SP + GBE SP	16.8(8.4)	58.4	13.4(5.4)	75.4	15.1(6.9)	66.9	23.8(16.3)	62.9	35.9(34.4)	31.7	29.9(25.3)	46.3	22.7(16.1)	52.8
GBE ST + Ca ST + Ca SP + GBE SP	17.2(8.8)	56.4	14.5(6.2)	71.8	15.8(7.5)	64.1	23.6(16.0)	63.5	35.5(33.8)	32.9	29.6(24.9)	47.1	22.9(16.2)	52.5
Control	26.7(20.2)		27.9(22.0)		27.3(21.1)		41.5(43.9)		45.2(50.4)		43.4(47.1)		35.4(34.1)	
C.D. ($P < 0.05$)	3.8		5.5		4.9		4.4		NS		5.4		3.8	

*mean of two replications; figures in parentheses are actual PDI and others are angular transformed values; Date of sowing: [a]19 Oct 2004, [b]16 Oct 2004, [d]07 Oct 2005, [e]05 Oct 2005; Observation recorded on: [a]133 days after sowing (DAS), [b]128 DAS; [d]132 DAS, [e]131 DAS; ST: seed treatment; SP: foliar spray; PDI: percent disease incidence; PDR: percent disease reduction; [ef]mean of two locations; [h]mean of two years over locations

Ca: Carbendazim; GBE: garlic bulb extract; TH: *Trichoderma harzianum*

Results and Discussion

In vitro studies indicated that GR isolate of *T. harzianum* was 34.5% compatible with 1% garlic (*A. sativum*) bulb extract while there was no growth of *T. harzianum* in higher concentrations of the extract indicating that the isolate was not compatible with higher (≥2% w/v) concentrations of the bulb extract. No other isolate (P, SI-1, SI-2) of *T. harzianum* was compatible with the bulb extract at any concentration.

Seed treatment with garlic bulb extract provided significantly better ($P < 0.05$) and the best initial plant stand at both the locations with a mean 20.2% increase in germination over control in 2004-05. Garlic bulb extract and Carbendazim both as seed treatment in combination was significantly better ($P < 0.05$) than control and caused the best mean disease reduction (65.1%) among the treatments at Sewar (Table 1). At Richoli, the best disease reduction was caused by a combination of seed treatment by *T. harzianum* and garlic bulb extract (54.4%), which was also the best in pooled analysis of data for the two locations and again the best among treatments (percentage disease reduction: 56.6), when pooled analysis for the two years over locations was done (Table 1). However, the best mean seed yield (32.3% increase over control) was provided by the combination of seed treatments by garlic bulb extract and carbendazim supplemented by foliar sprays by garlic bulb extract and carbendazim at Sewar, which was also the best treatment for seed yield for the mean over the two locations in 2005-06 (Table 2). At Richoli, the best seed yield was provided by combination of *T. harzianum* and garlic bulb extract as seed treatment supplemented by foliar spray of *T. harzianum*, which was also the best in pooled analysis of the two years over the two locations (Table 2). Success of garlic bulb extract and *T. harzianum* (Chattopadhyay *et al*., 2002, 2004) or by interplanting with *A. sativum* (Liangjin Yang *et al*., 2003) in management of *Sclerotinia* rot of oilseed Brassica has been reported earlier, which has been further vindicated by the conclusions of this study. Further, seed treatment plays an important role in protecting the crop from the soilborne pathogen. However, study on integration of different agents was not reported earlier.

Table 2: Effect of different chemical and biological treatments on mustard seed yield

Treatment	Seed yield (kg/ ha)*						
	2004-05			2005-06			Pooled Mean[h]
	Sewar[a]	Richoli[b]	Mean[c]	Sewar[d]	Richoli[e]	Mean[f]	
TH ST	1840.9 (25.9)	2136.4 (37.6)	1988.6 (31.7)	4109.8 (8.0)	3371.2 (14.1)	3740.5 (10.6)	2864.5 (17.2)
GBE ST	2674.2 (82.9)	2181.8 (40.5)	2428.0 (61.7)	3731.1 (-2.0)	3712.1 (25.6)	3721.6 (10.1)	3074.8 (25.8)
Carbendazim ST	2143.9 (46.6)	2037.9 (31.2)	2090.9 (38.9)	3636.4 (-4.7)	3333.3 (12.8)	3484.8 (3.1)	2787.8 (14.1)
TH ST + GBE ST	2068.2 (41.4)	2409.1 (55.1)	2238.6 (48.2)	3920.4 (3.0)	3409.1 (15.4)	3664.7 (8.4)	2951.6 (20.8)
GBE ST + Carbendazim ST	1803.0 (23.3)	2424.2 (56.1)	2113.6 (39.7)	4242.4 (11.4)	3390.1 (14.7)	3816.2 (12.9)	2964.9 (21.3)
TH SP	1916.7 (31.1)	1893.9 (21.9)	1905.3 (26.5)	3371.2 (-11.4)	3541.7 (19.9)	3456.4 (2.2)	2680.8 (9.7)
GBE SP	2106.1 (44.0)	1931.8 24.4)	2018.9 (34.2)	3806.8 (0.0)	3806.8 (28.8)	3806.8 (12.6)	2912.8 (19.2)
Carbendazim SP	1916.7 (31.1)	2272.7 (46.3)	2094.7 (38.7)	4450.8 (17.0)	3219.7 (9.0)	3835.2 (13.4)	2964.9 (21.3)
TH SP + GBE SP	2371.2 (62.2)	2143.9 (38.0)	2257.6 (50.1)	4166.7 (9.4)	3579.5 (21.1)	3873.1 (14.6)	3065.3 (25.4)
Carbendazim SP + GBE SP	2522.7 (72.5)	2060.6 32.7)	2291.7 (52.6)	4185.6 (9.9)	3049.2 (3.2)	3617.4 (7.0)	2954.5 (20.9)
TH ST + *TH* SP	2295.5 (57.0)	1992.4 (28.3)	2143.9 (42.6)	3965.9 (4.2)	3295.4 (11.5)	3630.6 (7.4)	2887.2 (18.1)
TH ST + GBE SP	2068.2 (41.4)	2143.9 (38.0)	2106.1 (39.7)	3844.7 (1.0)	2840.9 (-3.8)	3342.8 (-1.1)	2724.4 (11.5)
TH ST+ Carbendazim SP	1840.9 (25.9)	2386.4 (53.7)	2113.6 (39.8)	4564.4 (19.9)	3314.4 (12.2)	3939.4 (16.5)	3026.5 (23.8)
TH ST + TH SP+ GBE SP	2219.7 (51.8)	2197.0 (41.5)	2208.3 (46.6)	4185.6 (9.9)	2670.4 (-9.6)	3428.0 (1.4)	2818.1 (15.3)
TH ST + *Carbendazim* SP + GBE SP	1992.4 (36.3)	2060.6 (32.7)	2026.5 (34.5)	3598.5 (-5.5)	2992.4 (1.3)	3295.4 (-2.5)	2660.9 (8.9)
GBE ST + *TH* SP	2295.5 (57.0)	2007.6 (29.3)	2151.5 (43.1)	4507.6 (18.4)	3447.0 (16.7)	3977.3 (17.6)	3064.4 (25.4)
GBE ST + GBE SP	2295.5 (57.0)	2083.3 (34.1)	2189.4 (45.5)	4053.0 (6.5)	3522.7 (19.2)	3787.8 (12.4)	2988.6 (22.2)
GBE ST + Carbendazim SP	2143.9 (46.6)	1893.9 (21.9)	2018.9 (34.2)	3825.8 (0.5)	2954.5 (0.0)	3390.1 (0.3)	2704.5 (10.6)
GBE ST + Carbendazim SP + GBE SP	2143.9 (46.6)	1780.3 (14.6)	1962.1 (30.6)	3579.5 (-6.0)	3409.1 (15.4)	3494.3 (3.4)	2728.2 (11.6)
GBE ST + Carbendazim SP + GBE SP	2750.0 (88.0)	1969.7 (26.8)	2359.9 (57.4)	4015.1 (5.5)	3049.2 (3.2)	3532.1 (4.5)	2946.0 (20.5)
TH ST + GBE ST + *TH* SP	3053.0 (108.8)	2212.1 (42.4)	2632.6 (75.6)	4185.6 (9.9)	4393.9 (48.7)	4289.7 (26.9)	3461.1 (41.6)
TH ST + GBE ST + GBE SP	1992.4 (36.3)	2106.1 (35.6)	2049.2 (35.9)	4223.5 (10.9)	3522.7 (19.2)	3873.1 (14.6)	2961.1 (21.1)
TH ST + GBE ST + Carbendazim SP	2447.0 (67.4)	2098.5 (35.1)	2272.7 (51.2)	3958.3 (4.0)	3428.0 (16.0)	3693.1 (9.2)	2982.9 (22.0)
TH ST + GBE ST + *TH* SP + GBE SP	2181.8 (49.2)	1969.7 (26.8)	2075.8 (38.0)	4431.8 (16.4)	3200.8 (8.3)	3816.3 (12.9)	2946.0 (20.5)
TH ST + GBE ST + Carbendazim SP + GBE SP	2068.2 (41.4)	2348.5 (51.2)	2208.3 (46.3)	4678.0 (22.9)	3522.7 (19.2)	4100.3 (21.3)	3154.3 (29.1)
GBE ST + Carbendazim ST + *TH* SP	2750.0 (88.0)	2128.8 (37.1)	2439.4 (62.5)	4337.1 (13.9)	2916.7 (-1.3)	3626.9 (7.4)	3033.1 (24.1)
GBE ST + Carbendazim ST + GBE SP	2447.0 (67.4)	2159.1 (39.0)	2303.0 (53.2)	4545.4 (19.4)	3030.3 (2.6)	3787.8 (12.0)	3045.4 (24.6)
GBE ST + Carbendazim ST + Carbendazim SP	2181.8 (49.2)	2060.6 (32.7)	2121.2 (40.9)	4166.7 (9.4)	3390.1 (14.7)	3778.4 (11.8)	2949.8 (20.7)
GBE ST + Carbendazim ST + Carbendazim SP + GBE SP	2598.5 (77.7)	2075.8 (33.7)	2337.1 (55.7)	5037.9 (32.3)	3806.8 (28.8)	4422.3 (30.8)	3379.7 (28.3)
GBE ST + Carbendazim ST + Carbendazim SP + GBE SP	2447.0 (67.4)	2272.7 (46.3)	2359.9 (56.8)	4109.8 (8.0)	3295.4 (11.5)	3702.6 (9.5)	3031.2 (24.0)
Control	1462.1	1553.0	1507.6	3806.8	2954.5	3380.6	2444.1
C.D. ($P < 0.05$)	548.0	354.6	451.3	673.9	NS	NS	365.4

*mean of two replications; figures in parentheses are percent increase in yield over control; Date of sowing: [a]19 Oct 2004, [b]16 Oct 2004, [d]07 Oct 2005, [e]05 Oct 2005; Harvested on: [a]136 days after sowing (DAS), [b]135 DAS, [d]133 DAS, [e]132 DAS; ST: seed treatment; SP: foliar spray; [cf]mean of two locations; [h]mean of two years over locations; NS: not significant

From the above facts, it seems that seed treatment with garlic bulb extract should be a mandatory for checking the disease, improving plant stand and seed yield. However, if supplemented with Carbendazim or *T. harzianum* as seed treatment, it would be better in checking the disease. For still better results to check foliar infection and improve seed yield, supplementation of the combined seed treatment with foliar spray by *T. harzianum* at 50 and 70 days after sowing could be considered. The field trial for two years over two locations conclusively proved that garlic bulb extract (1% w/v) and *T. harzianum* found to be compatible with each other *in vitro* was also found compatible when combined as seed treatments. The trials also indicated that seed treatment with garlic bulb extract followed by carbendazim supplemented by foliar spray with the same mixture was significantly better ($P < 0.05$) among the treatments in reducing the *Sclerotinia* rot incidence and in increasing yield over control consistently over the two years.

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