DOI: 10.15740/HAS/AU/12.TECHSEAR(1)2017/238-246
Agriculture Update
Volume **12** | TECHSEAR-1 | 2017 | 238-246
Visit us : *www.researchjournal.co.in*
e ISSN-0976-6847

RESEARCH ARTICLE :

Integrated management of stem rot and pod rot (*Sclerotium rolfsii*) of groundnut (*Arachis hypogaea* L.)

D.P. KULDHAR AND A.P. SURYAWANSHI

ARTICLE CHRONICLE :
Received :
11.07.2017;
Accepted :
26.07.2017

SUMMARY : The studies were carried out on stem rot and pod rot caused by *Sclerotium rolfsii* Sacc. on Groundnut (*Arachis hypogaea* L.), at Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The *in-vitro* evaluation (@ 1000, 1500 and 2000 ppm) revealed highest average mycelial growth inhibition with fungicides, Thiram + Carbendazim (96.31 %), Carbendazim (95.26 %) and Thiram (94.80 %). Of the bioagents evaluated, significantly highest mycelial growth inhibition was recorded with *T. harzianum* (78.37%), *T. viride* (74.70 %) and *T. hamatum* (73.96 %). Aqueous extracts of all botanicals tested (@ 10, 15 and 20%) exhibited antifungal potential and significantly highest average mycelial growth inhibition was recorded with *Azadirachta indica* (70.02 %), *Z. officinale* (66.58 %) and *P. hysterophorus* (65.52 %). Significantly highest seed germination (98.33%) was recorded with the treatment Thiram + Carbendazim + *T. harzianum* + *P. fluorescens* + NSC + *A. indica* extract. Significantly highest reduction in pre-emergence (97.61 %), post-emergence (95.77 %) and average (96.69 %) mortality were recorded with treatment of Thiram + Carbendazim + *T. harzianum* + *P. fluorescens* + NSC + *A. indica* extract. Thus, it is concluded that groundnut stem rot and pod rot can be managed effectively by seed treatment with fungicides (Thiram, Carbendazim), bioagent (*T. harzianum* + *P. fluorescens*) and soil amendment with Neem seed cake + *A. indica* extract.

How to cite this article : Kuldhar, D.P. and Suryawanshi, A.P. (2017). Integrated management of stem rot and pod rot (*Sclerotium rolfsii*) of groundnut (*Arachis hypogaea* L.). *Agric. Update,* **12**(TECHSEAR-1) **: 238-246; DOI: 10.15740/HAS/AU/12.TECHSEAR(1)2017/238-246.**

KEY WORDS :
Arachis hypogaea, Bioagents, Botanicals, Fungicides, Organic and inorganic amendments, *Sclerotium rolfsii*

Author for correspondence :
D.P. KULDHAR
Department of Agricultural Entomology, Vasantrao Naik Marathwada KrishiVidyapeeth, PARBHANI (M.S.) INDIA
Email:dinkumar007@gmail.com

See end of the article for authors' affiliations

BACKGROUND AND OBJECTIVES

Groundnut (*Arachis hypogaea* L.), is one of the most popular oil seed crops grown throughout the world. It is considered as "King of oilseed crops", because it contains 40 to 49 per cent oil. The area, production and productivity of groundnut has been reported to be 20.84 and 5.00 million hectares, 37.20 and 5.00 million metric tons and 1.79 and 1.00 metric tons per hectare, respectively in the World and India (Anonymous, 2013). The total area in Maharashtra under groundnut was 0.357 million hectares, production of 0.458 million metric tons and productivity of 1.28 metric tons per hectare (Anonymous, 2012). Groundnut is affected by several plant pathogens including fungi, bacteria, viruses and nematodes (Kannaiyan, 1989). *Sclerotium*

rolfsii Sacc., an omnivorous and devasting soil borne fungal plant pathogen. The pathogen has a wide host range of over 500 plant species in 100 families, throughout the world (Ferreira and Boley, 1992), mostly infecting legumes, crucifers and cucurbit. The diseases caused by the fungus are more serious in tropical and sub-tropical regions. The large number of sclerotia produced by *S. rolfsii* and their ability to persist in the soil for several years, as well as the profuse growth rate of the fungus make it well suited facultative parasite and a pathogen of major importance throughout world (Punja, 1985). In India, stem rot is of common occurrence in all groundnut growing states. The yield losses in the range of 10-50 per cent due to stem and pod rot caused by *Sclerotium rolfsii* (*Corticium rolfsii*) in groundnut were reported (Chohan, 1974; Mayee and Datar, 1988; Mehan and McDonald, 1990; Dandnaik *et al.*, 2006 and Rakholia *et al.*, 2012). Keeping these facts in view along with economic importance of groundnut and yield losses aused by *Sclerotium rolfsii* in groundnut, Therefore, present studies were undertaken at the Department of Plant Pathology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra.

In vitro evaluation of fungicides :

The efficacy of 14 fungicides was evaluated *in vitro* at different concentrations (@ each 1000, 1500 and 2000 ppm) against *S. rolfsii* (SrNd isolate), applying Poisoned Food Technique (Nene and Thapliyal, 1993). Each of the test fungicide and its test concentrations, three plates / treatment / replication were maintained and each test fungicide with various concentrations was replicated thrice. All the plates were inoculated aseptically with a 5 mm culture disc obtained from a week old actively growing pure culture of *S. rolfsii*. The culture disc was placed on PDA in inverted position in the centre of the Petri plate and plates were incubated at 28 $\pm$ 2^{0}C. Petri plates filled with plain PDA (without any fungicide) and inoculated with the culture disc of *S. rolfsii* were maintained as untreated control.

Observations on radial mycelial growth were recorded at an interval of 24 hours and continued till untreated control plates were fully covered with mycelial growth of the test fungus. Per cent inhibition of the test pathogen with the test fungicides over untreated control was calculated by applying following formula (Vincent, 1927).

$$\text{Per cent inhibition} = \frac{C - T}{C} \times 100$$

where,

C = Growth of the test fungus in untreated control plates.

T = Growth of the test fungus in treated plates.

In vitro evaluation of bioagents :

Five fungal antagonists *viz., Trichoderma viride, T. harzianum, T. hamatum, T. longibrachiatum, T. koningii* and two bacterial antagonists *viz., Pseudomonas fluorescens, Bacillus subtilis* were evaluated *in vitro* against *S. rolfsii* (SrNd isolate), applying Dual Culture Technique (Dennis and Webster, 1971). Seven days old cultures of the test bioagents and the test pathogen (*S. rolfsii*) were used for the study. Culture discs (5 mm dia) of the test pathogen and bioagents were cut out with sterilized cork borer. Then two culture discs, one each of the test fungus and bioagent were placed aseptically at equidistance and exactly opposite with each other on solidified PDA medium in Petri plates and plates were incubated at 28 $\pm$ 2^{0}C. Three plates/ treatment/ replication were maintained. PDA plates inoculated only with culture disc of the test pathogen were maintained as untreated control.

Observations on linear mycelial growth of the test pathogen and bioagent were recorded at an interval of 24 hours and continued till untreated control plates were fully covered with mycelial growth of the test pathogen. Per cent inhibition of the test pathogen by the bioagent over untreated control was calculated by applying following formula (Arora and Upadhyay, 1978).

$$\text{Per cent growth inhibition} = \frac{\text{Linear mycelial growth in control plate} - \text{Linear mycelial growth in intersecting plate}}{\text{Linear mycelial growth in control plate}} \times 100$$

In vitro evaluation of botanicals :

Aqueous extracts of 16 botanicals were evaluated *in vitro* against *S. rolfsii* (SrNd isolate), applying Poisoned food technique. Leaf / rhizome extracts of the test botanicals were prepared by grinding with mixture-cum grinder. The 100 g washed leaves / rhizomes of each of the test botanical were macerated separately in 100 ml distilled water (w/v) and the macerates obtained were filtered through double layered muslin cloth. Each of the filtrate obtained was further filtered through Whatman No. I filter paper, using funnel and volumetric flasks (100 ml cap.). The final clear extracts/filtrates obtained formed

the standard aquous extract of 100 per cent concentration. These were evaluated (@ 10%, 15% and 20% each) *in vitro* against *S. rolfsii* (SrNd isolate), applying Poisoned Food Technique (Nene and Thapliyal, 1993) and using Potato dextrose agar (PDA) as basal culture medium.

An appropriate quantity of each test aqueous extract (100%) was separately mixed thoroughly with autoclaved and cooled (40^0C) PDA medium in conical flasks (250 ml cap.) to obtain desired concentrations (each 10, 15 and 20 %). The PDA medium amended separately with test aqueous extract was then poured (20 ml / plate) into sterile glass Petri plates (90 mm dia.) and allowed to solidify at room temperature. For each test botanical extract and their respective concentrations, three plates / treatment / replication were maintained and all the treatments were replicated thrice. Upon solidification of the PDA, all the treatment plates were aseptically inoculated by placing in the centre a 5 mm mycelial disc obtained from a week old actively growing pure culture of *S. rolfsii*. Plates containing plain PDA without any botanical extract and inoculated with mycelial disc of the test pathogen served as untreated control. All these plates were then incubated at 28 $\pm$ 2^0C temperature for a week or till the untreated control plates were fully covered with mycelial growth of the test fungus. Observations recorded as per in *in vitro* evaluation of the fungicides.

In vitro evaluation of organic and inorganic amendments :

Aqueous extracts of 11 amendments (10 organic and one inorganic) were evaluated. Except Gypsum powder and Vermicompost, rest of the amendments were crushed to the fine powder with pestle and mortar and dispensed @ 100 gm in 100 ml sterile distilled water (w/ v) and kept soaking overnight. On next day, these were filtered through double layered muslin cloth and the filtrate obtained was further passed through Whatman No. 1 filter paper, using funnel and volumetric flasks (100 ml cap.). The final clear extracts/filtrates obtained formed the standard extract of 100% concentration. These aqueous extracts were evaluated (each @ 10%) *in vitro* against *S. rolfsii*, applying Poisoned food technique. (Nene and Thapliyal, 1993) and using Potato dextrose agar (PDA) as basal culture medium.

An appropriate quantity of the test extract (100%) was separately mixed thoroughly with autoclaved and cooled (40^0C) PDA medium in conical flasks to obtain desired concentrations of 10 per cent each. The PDA medium amended separately with each test extract was then poured (20ml / plate) into sterile glass Petri plates (90 mm dia.) and allowed to solidify at room temperature. For each amendment extract, three plates / replication were maintained and each treatment was replicated thrice. Upon solidification of PDA, all these plates were aseptically inoculated by placing in the centre a 5 mm mycelial disc obtained from a week old actively growing pure culture of *S. rolfsii*. Plates containing plain PDA without any amendment extract and inoculated with mycelial disc of the test pathogen were maintained as untreated control. All these plates were then incubated at 28$\pm$ 2^0C temperature for a week or till the untreated control plates were fully covered with mycelial growth of the test fungus. Observations recorded as per in *in vitro* evaluation of the fungicides.

Integrated evaluation of effective fungicides, botanicals, bioagents and organic amendments :

Those fungicides, botanicals, bioagents and organic amendments found most effective against *S. rolfsii* during present *in vitro* and pot culture studies were selected and evaluated for integrated management of stem rot (*S. rolfsii*) of groundnut (pot culture). The earthen pots (30 cm dia.) after disinfection with 5 per cent solution of Copper sulphate were filled with autoclaved potting mixture of soil : sand : fym (2:1:1). The mass multiplied (sand : maize) inoculum of *S. rolfsii* was inoculated (@ 50 g / kg potting mixture) to the potting mixture in pots, mixed thoroughly, watered adequately and incubated for 8-10 days in screen house to proliferate the pathogen. This pot culture experiments comprised of 15 treatments as described under treatment details. The test fungicides and talc based formulation of the bioagents (alone and combination) were applied as pre-sowing treatment to the seeds (protective) of susceptible groundnut cv. JL-24 and sown (10 seeds/ pot) in the earthen pots containing *S. rolfsii* sick soil / potting mixture. The powdered oil cakes of Neem, Castor and Karanj were amended (each @ 50g/kg soil or potting mixture) in the earthen pots containing *S. rolfsii* sick soil mixed thoroughly watered adequately and maintained in screen house. After 72 hrs., these pots were seeded (10 seeds/ pot) with the surface sterilized (0.01 % $HgCl_2$) healthy seeds of groundnut cv. JL-24. To the earthen

pots containing *S. rolfsii* sick soil and pre-sown with surface sterilized healthy seeds of groundnut cv. JL-24, after 72 hrs., of sowing crude extracts (@) 50 % conc.) of the test botanicals were drenched (each @ 50 ml/kg soil) as curative treatment.

Surface sterilized (0.1% $HgCl_2$) healthy seeds of groundnut cv. JL-24 were sown (10 seeds/pot) in the earthen pots containing *S. rolfsii* sick soil / potting mixture were maintained as untreated control. All these pots (treated and untreated) were watered regularly and maintained in the screen house for further observations. Observations on seed germination and pre-emergence seed rot (PESR) were recorded at seven days after sowing and that of post-emergence seedling mortality (PESM) at 30 days after sowing. The percentage seed germination, pre-emergence seed rot, post-emergence seedling mortality, increase (%) in seed germination, reduction (%) in PESR and PESM was calculated by the formulae.

$$\text{Germination (\%)} = \frac{\text{No. of seeds germinated}}{\text{Total no. of seeds sown}} \times 100$$

$$\text{PESR (\%)} = \frac{\text{No. of seeds ungerminated}}{\text{Total no. of seeds sown}} \times 100$$

$$\text{PESR (\%)} = \frac{\text{No. of seedlings died}}{\text{Total no. of seedlings}} \times 100$$

$$\text{Increase (\%) in seed germination} = \frac{T - C}{C} \times 100$$

where,

T = Per cent seed germination in treatment pots

C = Per cent seed germination in control (untreated) pots

$$\text{Reduction (\%) in PESR and PESM} = \frac{C - T}{T} \times 100$$

where,

C = Per cent seed rot / seedling mortality in treatment pots

T = Per cent seed rot / seedling mortality in control (untreated) pots

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Effect of fungicides :

The results indicated that all the 14 fungicides tested exhibited a wide range of radial mycelial growth of *S. rolfsii* and was found to be decreased drastically with increase in the concentrations (each @ 1000, 1500 and 2000 ppm) of the fungicides tested (Table 1).

At 1000 ppm, it was significantly highest with fungicide Thiram + Carbendazim (88.94 %), followed by the fungicides *viz.*, Carbendazim (85.78 %), Thiram (84.39 %), Carboxin (82.33%), Hexaconazole (81.17%), Carbendazim + Mancozeb (80.11%). However, Chlorothalonil and Metalaxyl were found comparatively less effective with 58.17 and 53.56 per cent mycelial inhibition, respectively of the test pathogen.

At 1500 ppm, significantly highest mycelial inhibition with Thiram + Carbendazim, Carbendazim and Thiram (each 100 %), followed by the fungicides, *viz.*, Carboxin (87.50%), Hexaconazole (86.83%), both were at par. However, Chlorothalonil and Metalaxyl were found comparatively less effective with 66.94 and 62.11 per cent inhibition, respectively of the test pathogen.

At 2000 ppm, all the 14 fungicides tested exhibited similar trend but with increased mycelial growth inhibition as compared to that of at 1000 and 1500 ppm. However, significantly highest mycelial inhibition was recorded with the fungicides *viz.*, Thiram + Carbendazim, Carbendazim and Thiram (each 100 %), followed by Carboxin (92.61 %), Hexaconazole (91.22 %), Carbendazim + Mancozeb (89.05%), Captaf (87.67 %), Metalaxyl + Mancozeb (84.67 %) and Copperoxy chloride (82.27 %). Similar fungistatic effects of test fungicides against *S. rolfsii*, infecting groundnut along with many other crops have been reported (Bhuiyan *et al*., 2012; Chavan and Hedge, 2012; Hedge *et al*., 2012 and Ambekar *et al*., 2013)

Effect of bioagents :

All the treatments exhibited fungistatic / antifungal activity against *S. rolfsii* and significantly inhibited mycelial growth of test pathogen over the control (Table 2). Of the treatments, least mycelial growth (19.80 mm) and its highest inhibition (78.37%) were recorded with *T. harzianum,* followed by *T. viride* (: 22.77 mm and 74.70 %) *T. hamatum* (24.03 mm, 73.96 %) mycelial growth and per cent inhibition, respectively.

The bioagents, *viz., T. viride. T. harzianum, T.hamatum, T. longibrachiatum, T. koningii, P. fluorescens* and *B. subtilis* were reported fungistatic against *S. rolfsii,* (Bhuiyan *et al.,* 2012; Khirood and Jite, 2012 and Sharma *et al.,* 2012).

Table 1 : *In vitro* efficacy of fungicides at various concentrations on mycelial growth and inhibition of *S. rolfsii*

Treatments	Col. Dia. (mm)* at Conc.			Av. (mm)	% Inhibition*			Av. (%) Inhibition
	1000 ppm	1500 ppm	2000 ppm		1000 ppm	1500 ppm	2000 ppm	
Carboxin 75 WP	15.90	11.25	06.65	11.27	82.33 (65.26)	87.50 (69.29)	92.61 (74.22)	87.48 (69.59)
Carbendazim 12 % + Mancozeb 63 % 75 WP	17.90	13.70	09.85	13.82	80.11 (63.50)	84.78 (67.03)	89.05 (70.67)	84.65 (67.07)
Hexaconazole 5 EC	16.95	11.85	07.90	12.23	81.17 (64.27)	86.83 (68.72)	91.22 (72.76)	86.41 (68.58)
Captaf 50 WP	19.17	16.00	11.10	15.42	78.05 (62.06)	82.22 (65.06)	87.67 (69.41)	82.65 (65.51)
Metalaxyl 8 % + Mancozeb 64 % 72 WP	27.15	17.80	13.80	19.58	69.83 (56.72)	80.22 (63.58)	84.67 (66.44)	78.24 (62.25)
Metalaxyl 35 SD	41.80	34.10	25.15	33.68	53.56 (46.17)	62.11 (52.00)	72.05 (58.08)	62.57 (52.08)
Mancozeb 75 WP	31.55	23.05	19.35	24.65	64.94 (53.81)	74.39 (59.59)	78.50 (62.37)	72.61 (58.59)
Thiophanate methyl 70 WP	31.85	26.50	20.20	26.18	64.61 (53.49)	70.55 (57.13)	77.56 (61.71)	70.91 (57.44)
Chlorothalonil 75 WP	37.65	29.75	22.85	30.08	58.17 (49.69)	66.94 (54.90)	74.61 (59.74)	66.57 (54.78)
Propineb 70 WP	33.75	26.56	21.05	27.12	62.50 (52.23)	70.49 (57.13)	76.61 (61.07)	69.87 (56.81)
Copperoxy chloride 50 WP	29.55	22.05	15.95	22.52	67.17 (55.03)	75.50 (60.29)	82.27 (65.09)	74.98 (60.14)
Thiram 75 WP	14.05	00.00	00.00	4.68	84.39 (66.72)	100 (89.98)	100 (89.98)	94.80 (82.22)
Carbendazim 50 WP	12.80	00.00	00.00	4.67	85.78 (67.83)	100 (89.98)	100 (89.98)	95.26 (82.23)
Thiram + Carbendazim (1 :1)	09.95	00.00	00.00	3.32	88.94 (70.57)	100 (89.98)	100 (89.98)	96.31 (83.51)
Control (untreated)	90.00	90.00	90.00	90.00	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)
S.E. ±	0.37	0.28	0.36	0.33	0.32	0.24	0.28	0.28
C.D. (P=0.05)	1.12	0.84	1.08	1.01	0.99	0.74	0.85	0.86

*-Mean of three replications
Figure in parenthesis are angular transformed values
Av.-Average Col.- Colony Dia.-Diameter Conc.-Concentration.

Table 2 : *In vitro* efficacy of biocontrol against mycelial growth and inhibition of *S. rolfsii*

Treatments	Col. Dia. (mm) of Pathogen	% Inhibition
Trichoderma viride	22.77	74.70 (59.79)
T. harzianum	19.80	78.37 (62.28)
T. hamatum	24.03	73.96 (59.31)
T. longibrachiatum	25.00	72.22 (58.18)
T. koningii	25.77	71.37 (57.64)
Pseudomonas fluorescens	34.17	61.93 (51.89)
Bacillus subtilis	34.77	61.22 (51.47)
Control (untreated)	90.00	00.00 (00.00)
S.E. ±	0.27	0.44
C.D. (P=0.05)	0.82	1.34

*-Mean of three replications
Figures in parenthesis are angular transformed values

Effect of botanicals extract :

Aqueous extracts of all test botanicals at 10, 15 and 20 per cent concentrations significantly inhibited mycelial growth of *S. rolfsii* over the control and it was found to be increased with increase in concentrations of the botanicals tested (Table 3). At 10, 15 and 20 per cent, significantly highest mycelial growth inhibition was recorded with *A. indica* (64.28 %, 70.17 % and 75.61 %), *Z. officinale* (63.17 %, 64.39 % and 72.17 %) and *P. hysterophorus* (62.05 %, 63.33 % and 71.17 %) whereas, *P. granatum* was found less effective with least mycelial inhibition of 23.33 %, 35.55 % and 43.28 %,

Table 3 : *In vitro* efficacy of botanicals against mycelial growth and inhibition of *S. rolfsii*

Treatments	Col. Dia. (mm) * at Conc.			Av.	% Inhibition at Conc.			Av.
	10 %	15 %	20 %	(mm)	10 %	15 %	20 %	(%)
V. rosea	47.05	43.15	35.90	42.03	47.72 (43.68)	52.05 (46.16)	60.11 (50.82)	53.29 (46.88)
L. camera	46.25	41.10	32.50	39.95	48.61 (44.19)	54.33 (47.47)	58.89 (50.13)	53.94 (47.26)
L. innermis	57.05	51.85	40.95	49.95	36.61 (37.22)	42.39 (40.61)	54.50 (47.57)	44.50 (41.80)
P. longifolia	62.00	56.15	45.85	54.67	31.11 (33.89)	37.61 (37.82)	49.05 (44.45)	39.26 (38.72)
B. spectabilis	60.05	53.95	48.20	54.07	33.28 (35.22)	40.05 (39.25)	46.44 (42.95)	39.92 (39.14)
P. pinnata	37.25	33.15	26.15	32.18	58.61 (49.95)	63.17 (52.62)	70.94 (57.37)	64.24 (53.31)
A. vera	46.00	41.05	32.20	39.02	48.89 (44.35)	54.39 (47.51)	64.22 (53.25)	55.83 (48.83)
Z. *officinale*	33.15	32.05	25.05	30.08	63.17 (52.62)	64.39 (53.35)	72.17 (58.14)	66.58 (54.70)
D. metal	44.05	38.85	28.90	38.00	51.05 (45.59)	56.83 (48.91)	67.89 (55.47)	58.59 (49.52)
O. sanctum	49.85	47.05	41.05	45.98	44.61 (41.90)	47.72 (43.68)	54.38 (47.51)	48.90 (44.36)
A. indica	32.15	26.85	21.95	26.98	64.28 (53.28)	70.17 (56.88)	75.61 (60.39)	70.02 (56.85)
P. carnea	59.00	52.10	41.85	50.98	34.44 (35.92)	42.11 (40.45)	53.50 (47.00)	43.35 (41.12)
A. squimosa	62.95	56.95	48.15	56.05	30.05 (33.23)	36.72 (37.29)	46.39 (42.92)	37.72 (37.81)
P. hysterophorus	34.15	33.00	25.95	31.03	62.05 (51.96)	63.33 (52.72)	71.17 (57.37)	65.52 (54.01)
E. globulus	47.95	44.00	39.15	43.70	46.72 (43.11)	51.11 (45.63)	56.50 (48.72)	51.44 (45.82)
P. granatum	69.00	58.00	51.05	59.35	23.33 (28.87)	35.55 (36.59)	43.28 (41.12)	34.05 (35.53)
Control (Untreated)	90.00	90.00	90.00	90.00	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)
S.E. ±	0.34	0.32	0.37	0.34	0.23	0.21	0.70	0.38
C.D. (P=0.05)	1.03	0.94	0.94	0.97	0.70	0.63	2.21	1.18

*-Mean of three replications, Av. Average
Figures in parenthesis are angular transformed values

Table 4 : *In vitro* efficacy of organic and inorganic amendments extracts on mycelial growth and inhibition of *S. rolfsii*

Treatments	Colony diameter (mm)*	% Inhibition
Neem seed cake	19.13	78.74 (62.53)
Castor cake	20.07	77.70 (61.81)
Groundnut cake	29.77	66.92 (54.88)
Cotton seed cake	27.50	69.37 (56.38)
Sunflower cake	32.03	64.40 (53.36)
Safflower cake	31.27	65.25 (53.87)
Karanj cake	23.93	73.40 (58.94)
Compost	44.43	50.62 (45.35)
Poultry manure	36.67	59.25 (50.32)
Vermicompost	35.80	60.22 (50.88)
Gypsum	40.10	55.44 (48.11)
Control (untreated)	90.00	00.00 (00.00)
S.E.±	0.13	0.15
C.D. (P = 0.05)	0.39	0.44

*- Mean of three replications.
Figures in parenthesis are angular transformed values

respectively at 10,15 and 20 per cent botanical concentrations. The bioagents, *viz., T. viride. T. harzianum, T.hamatum, T. longibrachiatum T. koningii P. fluorescens* and *B. subtilis* were reported fungistatic against *S. rolfsii,* botanicals (Gour and Sharma, 2010 ; Begum *et al*., 2012 and Subhashini ,2012).

Effect of organic and inorganic amendments :

All the amendments extracts evaluated (each @ 10 %) exhibited fungistatic / antifungal activity against *S. rolfsii* and significantly inhibited its growth over untreated control (Table 4). Of the 11 amendments tested, Neem seed cake extract was found most effective with significantly least mycelial growth (19.13 mm) and highest mycelial inhibition (78.74 %) of the test pathogen, followed by Castor cake (20.07mm and 77.70 %) and Karanj cake (23.93 mm, and 73.40 %), respectively, whereas, Gypsum and Compost were found less effective with least mycelia inhibition of inhibition: 55.44 % and 50.62 %, respectively.

The aqueous extracts of the organic amendments *viz*., *Neem* seed cake, Castor cake, Karanj cake, Cotton

Table 5 : Efficacy of fungicides, bioagents, botanicals and organic amendments against seed germination and mortalities caused by *S. rolfsii* in groundnut cv. JL-24

Tr. No.	Treatments	Rate (g or ml / kg seed or soil)	Av. germination* (%)	Increase (%) over control	Rot / Mortality* (%)		Av. Mortality (%)	Reduction (%) over control		Av. reduction (%)	Final plant stand (%)
					PESR	PESM		PESR	PESM		
T_1	Thiram 75 WP + Carbendazim 50 WP (ST)	1.5 g + 0.5 g	95.00 (77.08)	68.42	5.00 (12.92)	7.12 (15.48)	6.06 (14.25)	92.88 (74.52)	90.96 (72.50)	91.92 (73.49)	92.88
T_2	Thiram 75 WP (ST)	3.0 g	90.00 (71.57)	66.67	10.00 (18.43)	12.96 (21.10)	11.48 (19.81)	85.71 (67.79)	83.53 (66.06)	84.62 (66.91)	87.04
T_3	Carbendazim 50 WP (ST)	1.0 g	93.33 (75.03)	67.85	6.67 (14.97)	8.97 (17.43)	7.82 (16.24)	90.47 (72.02)	88.60 (70.27)	89.54 (71.13)	91.03
T_4	*T. viride* + *P. fluorescens* (ST)	4 + 4 g	80.00 (63.43)	62.50	20.00 (26.57)	18.75 (25.66)	19.38 (26.12)	71.43 (57.69)	76.17 (60.78)	73.80 (59.21)	81.25
T_5	*T. harzianum*+*P. fluorescens* (ST)	4 + 4g	86.67 (68.59)	65.38	13.33 (21.41)	13.51 (21.57)	13.42 (21.49)	80.96 (64.13)	82.83 (65.52)	81.90 (64.82)	86.49
T_6	*T. harzianum* + *B. subtilis* (ST)	4 + 4g	83.33 (65.90)	63.99	16.67 (24.10)	18.02 (25.12)	17.35 (24.62)	76.19 (60.79)	77.03 (61.36)	76.61 (61.08)	81.98
T_7	Neem seed cake (SA)	50 g	76.67 (61.12)	60.87	23.33 (28.88)	19.58 (26.26)	21.46 (27.60)	66.67 (54.74)	75.11 (60.07)	70.89 (57.35)	80.42
T_8	Castor cake (SA)	50 g	75.00 (60.00)	60.00	25.00 (30.00)	22.22 (28.12)	23.61 (29.07)	64.29 (53.30)	71.76 (57.90)	68.03 (55.57)	77.78
T_9	Karanj cake (SA)	50 g	75.00 (60.00)	60.00	25.00 (30.00)	22.22 (28.12)	23.61 (29.07)	64.29 (53.30)	71.76 (57.90)	68.03 (55.57)	77.78
T_{10}	Z. *officinale* @ 50 % (SD)	50 ml	70.00 (56.79)	57.14	30.00 (33.21)	28.57 (32.31)	29.29 (32.77)	57.14 (49.10)	67.50 (55.24)	62.32 (52.13)	71.43
T_{11}	*A. indica* @ 50 % (SD)	50 ml	71.67 (57.84)	58.14	28.33 (32.16)	25.56 (30.37)	26.95 (31.27)	59.53 (50.49)	67.50 (55.24)	63.52 (52.84)	74.44
T_{12}	*P. hysterophorus* @ 50 % (SD)	50 ml	70.00 (56.79)	57.14	30.00 (33.21)	33.33 (35.26)	31.67 (34.77)	57.14 (49.10)	57.64 (49.39)	57.39 (49.25)	66.67
T_{13}	Thiram 75 WP + Carbendazim 50 WP (ST) + *T. harzianum* + *P. fluorescens* (ST) + Neem seed cake (SA) + *A. indica* extract @ 50 % (SD)	1.5 g + 0.5 g + 4 g + 4 g + 50 gl + 50 ml	98.33 (82.57)	69.49	1.67 (7.43)	3.33 (10.51)	2.50 (9.10)	97.61 (81.11)	95.77 (78.13)	96.69 (79.52)	96.67
T_{14}	Carbendazim 50 WP (ST) + *T. harzianum* +*B. subtilis* (ST) + Castor cake (SA) + Z. *officinale* extract @ 50 % (SD)	0.5 g + 4g + 4g + 50g + 50ml	96.67 (79.49)	68.97	3.33 (10.51)	5.00 (12.92)	4.17 (11.78)	95.24 (77.40)	93.65 (75.40)	94.45 (76.37)	95.00
T_{15}	Control	Untreated	30.00 (33.21)	--	70.00 (56.79)	78.68 (62.50)	74.34 (59.57)	00.00 (00.00)	00.00 (00.00)	00.00 (00.00)	21.32
	S.E.±	--	1.55	--	1.55	1.94	1.75	2.17	2.29	2.23	-
	C.D. (P = 0.05)	--	4.68	--	4.68	5.83	5.26	6.55	6.90	6.73	-

*-Mean of three replications , Figures in parenthesis are angular transformed values
Av. : Average, ST : Seed Treatment, SA : Soil Application
PESR : Pre-emergence seed rot PESM : Post -emergence seedling mortality

seed cake and Groundnut cake were reported antifungal / fungistatic against *S. rolfsii* earlier by many workers Haseeb and Kumar, 2007. The antifungal / fungistatic activity of the organic amendments may be due to presence of antibiotics and phenolic compounds of unknown nature (Bhagwat, 1997; Haseeb and Kumar, 2007 and Jha *et al.*, 2007).

Integrated management :

Seed germination :

All the treatments (Table 5) enhanced percentage seed germination significantly over the control and it was significantly highest (98.33 %) with Thiram + Carbendazim + *T. harzianum* + *P. luorescens* + NSC + *A. indica* extract, followed by Carbendazim + *T. harzianum* + *B. subtilis* + astor cake + Z. *officinale* extract (96.67 %) and Thiram + Carbendazim (95.00 %); all of which were at par. The Z. *officinale* and *P. hysterophorus* leaf extract was found comparatively least effective with minimum seed germination (70.00%).

Pre- and post-emergence mortality :

All the treatments influenced both pre- and post-emergence mortality significantly in groundnut. The treatments, *viz.*, (PESR) Thiram + Carbendazim + *T. harzianum* + *P. fluorescens* + NSC + *A. indica* extract (1.67 %), Carbendazim + *T. harzianum* + *B. subtilis* + Castor cake + Z. *officinale* extract (3.33 %), Thiram + Carbendazim (5.00 %) Carbendazim (6.67 %) and Thiram (10.00 %) were found most effective with significantly least PESR; all of which were at par. The post-emergence seedling mortality in all treatments ranged from 3.33 to 33.33 per cent, as against 78.68 per cent in untreated control. However, Thiram + Carbendazim + *T. harzianum* + *P. fluorescens* + NSC + *A. indica* extract, Carbendazim+ *T. harzianum* + *B. subtilis* + Castor cake + Z. *officinale* extract, Thiram + Carbendazim and Carbendazim were found most effective with significantly least pre- emergence seed rot (PESR), respectively of 3.33, 5.00, 7.12 and 8.97 per cent; all of which were at par.

Thus, results on bioefficacy of the fungicides, bioagents, botanicals and organic amendments for integrated management of stem / pod rot (*S. rolfsii*) in groundnut are in conformity with the earlier findings in respect of integrated management of the diseases *viz.*, stem rot / pod rot, collar rot, root rot in groundnut and many other crops (Khan *et al.*, 2004; Lahre *et al.*, 2012 and Sultana *et al.*, 2012).

Authors' affiliations :

A.P. SURYAWANSHI, Department of Plant Pathology, College of Agriculture, LATUR (M.S.) INDIA

REFERENCES

Ambekar, G.A., Ingole, O.V. and Bhongle, S.A. (2013). Effiicacy of fungicides and bioagents against pathogens causing stem rot / root rot of groundnut. *Pl. Dis. Sci.*, **8** (1):129-130.

Anonymous (2012). Economic survey of Maharashtra 2011-12. https:// www. Maharashtra. gov. in.

Anonymous (2013). World Agricultural Production, USDA, Foreign Agricultural Service, Circular Series WAP 3-13 March, 2013.

Arora, D.K. and Upadhyay, R.K. (1978). Effect of fungal staling growth substances on colony interaction. *Pl. Soil.*, **49**: 685-690.

Begum, A., Dadke, M.S., Wagh, S.S. and Sonawane, A.G. (2012). *In vitro* evaluation of plant extracts against stem rots of chilli caused by *Sclerotium rolfsii*. Paper presented in Nat. Symp. on Blending Conventional and Modern Plant Pathology for Sustainable Agriculture, Dec. 4-6 at IIHR, Hesaraghatta, (Bangalore) : 199.

Bhagwat, R.V. (1997). Studies on foot rot of sunflower (*Helianthus annuus* L.) caused by *Sclerotium rolfsii* Sacc. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Dharwad, KARNATAKA (INDIA).

Bhuiyan, M.A.H.B., Rahman, M.T. and Bhujan, K.A. (2012). *In vitro* screening of fungicides and antagonists against *Sclerotium rolfsii*. *African J. Biotech.*, **11**(82) : 14822-14827.

Chavan, S.S. and Hedge Y.R. (2012). Management of wilt of stevia caused by *Sclerotium rolfsii*. Paper presented in Nat. Symp. on Blending Conventional and Modern Pl. Path. for Sustainable Agriculture. Dec. 4-6 at IIHR, Hesaraghatta, (Bangalore) : 105.

Chohan, J.S. (1974). Recent advances in diseases of groundnut in India. In: Current Trend in Plant Pathology, Lucknow Univ. Press, Lucknow, Utter Pradesh :171-184

Dandnaik, B.P., Dhoke, P.K. and Pensalwar, S.N. (2006). Integrated management of stem rot (*Sclerotium rolfsii*) in groundnut. *J. Pl. Dis. Sci.*, **1** (2): 234-235.

Dennis, C. and Webster, J. (1971). Antagonistic properties of species groups of *Trichoderma*: production of volatile and non- volatile antibiotics. *Tr. Br. Mycol. Soc.*, **57**: 41-48.

Ferreira, S.A. and Boley, A.R. (1992). *Sclerotium rolfsii*. Extension Plant Pathologist. Dept. Pl. Pathol., CTAHR. Univ. of Hawaii at Manoa.

Gour, H.N. and Sharma, P. (2010). Evaluation of fungicides *in vitro* and *in vivo* against *Sclerotium rolfsii* Sacc. causing root rot of groundnut. *Indian Phytopath.*, **63** (3) : 352-353.

Haseeb, A. and Kumar, V. (2007). Efficacy of bioagents and organic amendments against *Fusarium oxyxporum*, causing brinjal wilt. *Indian Phytopath.*, **60** (1) : 108-111.

Hedge, Y.R., Chavhan, T.N. and Keshgond, R.S. (2012). *Sclerotium* wilt of *Jatropha curcas* and is management. Papper resented in Nat. Symp. on Blending Conventional and Modern Pl. Path. Sustainable Agriculture, Dec. 4-6 at IIHR, Hesaraghatta, (Bangalore) : 108.

Jha, A.K., Upadhyay, J.P. and Lal, H.C. (2007). Evaluation of organic amendments against white mold of *Phaseolus vulgaris. J. Mycol. Pl. Pathol.*, **37** (1) : 141-142.

Kannaiyan, J. (1989). Check list of groundnut diseases recorded in Zambia. International *Arachis* Newsletter. :14

Khan, A.A., Khan, R.U. and Naimuddin (2004). Effect of fungicides and bioagents on seed germination, seedling vigour and incidence of *Macrophomina* blight in mungbean. *Indian J. Pulses Res.*, **17** (1) : 64-66.

Khirood Doley and Jite, P.K. (2012). *In vitro* efficacy of *Trichoderma viride* against *Sclerotium rolfsii* and *Macrophomina phaseolina*. *Notule Scintia Biologcae*, **4** (4) 39-44.

Lahre, S.K., Khare, N., Lakpale and Chaliganjewar, S.B. (2012). Effect of bioagents and organic amendments against *Sclerotium rolfsii* in chickpea. *J. Pl. Dis. Sci.*, **7** (1) : 32-34.

Mayee, C.D. and Datar, V.V. (1988). Diseases of groundnut in the tropics. *Rev. Trop. Pl. Path.*, **5** : 85-118.

Mehan, V.K. and Mc Donald, D. (1990). Some important diseases of groundnut, sources of resistance and their utilization in crop improvement. Paper presented in Training Course on Legumes Production, 9-17 July, 1980, Sri Lanka.

Nene, Y. L. and Thapliyal, R. N. (1993). *Evaluation of Fungicides.* In: *Fungicides for Plant Disease Control* (3rd ed.). Oxford, IBH Pub. Co. New Dehli. : 331.

Punja, Z.K. (1985). The biology, ecology and control of *Sclerotium rolfsii*. *Ann. Rev. Phytopath.*, **23** : 97-127.

Rakholia, K.B., Jadeja, K.B. and Sabalpara, A.N. (2012). Assessment of yield losses due to stem and pod rot of groundnut. Paper presented in Nat. Symp. on Blending Conventional and Modern Plant Pathology for Sustainable Agriculture, Dec. 4-6 at IIHR, Hesaraghatta, (Bangalore) : 63.

Sharma, K.K., Zaidi, N.W. and Singh, U.S. (2012). Biocontrol of phytopathogens using *Trichoderma* isolates from rhizospheric soils of Uttarakhand. *Ann. Pl. Prot. Sci.*, **20** (2) : 392-396.

Subhashini, D.V. (2012). Bioefficacy of plant extracts against major pathogens affecting tobacco nurseries. *Ann. Pl. Prot. Sci.*, **20**(1): 416.

Sultana, J.N., Pervez, Z., Rahman, H. and Islam, M.S. (2012). Integrated approach of mitigating root rot of chilli caused by *Sclerotium rolfsii*. *Bangladesh Res. Pub. J.*, **6** (3): 270-280.

Vincent, J.M. (1927). Distortion of fungal hyphae in the presence of certain inhibitors, *Nature*, 159-180.