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Ecofriendly management of root rot tropical sugarbeet (*Scleoritum rolfsii* (Sacc)) by organic amendments

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Abstract

Organic amendments were attributed to inhibit the soil-borne diseases by increasing the saprophytic soil microbial population. Twelve organic amendments in two different concentrations (5.0 and 10.0%) were tested against the growth of *Sclerotium rolfsii*. The neem cake extract at 10 per cent concentration highly inhibited the pathogen growth (88.76 %) and also registered complete inhibition of sclerotial production and germination. In pot culture experiment, neem cake (10%) accounted for 86.09 per cent disease reduction on 150 Days After Sowing (DAS) and increased crowns and tropical sugar beet tuber weight.

Keywords: sugarbeet, organic amendments, *Sclerotium rolfsii*, root rot

INTRODUCTION

The decomposition of any organic amendment provides the food source on which the antagonistic fungi thrive and multiply rapidly because of continuous supply of nutrients from the substrate. For e.g., the mahua oil cake extract (10%) was found to be effective in reducing the mycelial growth, sclerotial production and sclerotial germination of *Sclerotium rolfsii* (Alice *et al.*, 1998). Smolinska (2000) found that the cruciferous plant residues added to the soil significantly reduced the survival of sclerotia of *Sclerotium cepivorum* in onion and chlamydospores of *Fusarium oxysporum*. f. sp *lycopersici* in tomato. The least incidence of groundnut stem rot was recorded in soil amended with wheat husk, mustard cake and castor cake (Prakhia and Akbari, 2004). Sonali and Gupta (2004) reported that mustard cake (5 %) and neem cake (1 %) were found to be effective in reducing the sclerotial germination of *S. rolfsii.* Jatav and Mathur (2005) found the neem based formulation for seed treatment to record maximum reduction of root rot complex disease in cluster been crop. This paper evaluates the efficacy of twelve organic amendments in two different concentrations (5.0 and 10.0 %) against the growth of *S. rolfsii*.

MATERIALS AND METHODS

Preparation of aqueous extracts of oil cake

Required quantities of oil cakes *viz*., castor *(Ricinus communis* (Euphorbiaceae)) cake, gingelly *(Sesamum indicum* (Pedaliaceae)) cake, groundnut (*Arachis hypogaea* (Fabaceae)) cake, mahua *(Cassia longifolia* (Ceasalpiniaceae)) cake, neem *(Azadirachta indica* (Meliaceae)) cake and pungam *(Pongamia pinnata* (Fabaceae)) cake were taken and made into powder. They were soaked in sterile distilled water @ 1 g in 1.25 ml of water and kept over night. The materials were ground with distilled water using a pestle and mortar and filtered through a muslin cloth and the filtrate was centrifuged at 10,000 rpm for 15 minutes. The supernatant served as the standard oil cake extract solution (100%) (Dubey and Patel, 2000).

In vitro testing of antifungal activity of oil cake extracts against *S. rolfsii.*

The efficacy of oil cake extracts was tested against *S. rolfsii* using poisoned food technique (Schmitz, 1930). The freshly prepared PDA medium was distributed to several conical flasks and used for the study. Aqueous extracts of oil cake @ 2.5 and 5 ml were mixed with 47.5 and 45.00ml of PDA medium respectively to obtain 5 and 10 per cent concentrations and sterilized @1.05 kg / cm^2 for 15 minutes. The sterilized PDA medium was poured on sterilized Petri plates @ 15 ml per Petri plate and then allowed to solidify. Mycelial disc (9 mm) of *S.rolfsii* was taken from actively growing culture and placed at the centre of each Petri plate and incubated at room temperature. The PDA medium without extract of oil cake served as control. The radial growth (cm) of *S.rolfsii* was recorded after three days of incubation. Sclerotial production was observed at 15 days after incubation.

A quantity of twenty ml of the extract (with two different concentrations *viz*., 5 and 10%) of each organic amendments amended medium was poured separately into each sterile Petri dish and allowed to solidify. Fifteen numbers of well matured sclerotia were placed in each Petri dish onto the medium at equidistance and incubated at room temperature. Three replications were maintained for each treatment. The sclerotial germination was recorded 48 h after incubation.

In vitro efficacy of organic amendments extracts on mycelial dry weight of *S. rolfsii.*

Potato dextrose broth was prepared and distributed uniformly in 250 ml conical flasks @ 100 ml per flask and sterilized at 1.04 kg / cm^2 pressure for 20 minutes. A quantity of twenty ml of the extract (with two different

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concentrations *viz*., 25% and 50% so as to get 5 and 10 % after mixing with 80 ml of PDB) of each organic amendment was added to 80 ml of potato dextrose broth separately and sterilized in autoclave at 1.04 kg/ cm^2 pressure for 20 minutes. A nine mm disc of actively growing *S. rolfsii* was inoculated into each flask under aseptic conditions and incubated at room temperature (28±2°C) for one week. Then the mycelial mats of the pathogen were removed on pre weighed filter paper, air dried and weighed separately. Potato dextrose broths without any organic extract served as control. Three replications were maintained for each treatment. The results were expressed as mycelial dry weight of pathogen in grams.

Effect of organic amendments on root rot disease of tropical sugar beet under pot culture conditions

To study the effect of organic amendments on root rot of tropical sugarbeet, a pot culture experiment was conducted. The details of the treatments are furnished below. Susceptible tropical sugarbeet variety *Indus* was used in this study. Organic amendments were mixed as per the standard dosage with the soil in the pots of 15 cm diameter one week prior to the inoculation of the pathogen. The pathogen inoculums multiplied in sand maize medium and were mixed with pot soil at five per cent (w/w). Ten plants were maintained for each treatment at the rate of one plant per pot. These pots were maintained in the green house with regular, uniform and judicious watering. The disease incidences were assessed 150 days after sowing.

Treatment details

T1 Castor cake @ 150 kg ha^{-1}

T2 Gingelly cake @ 150 kg ha^{-1}

T3 Ground nut cake @ 150 kg ha^{-1}

T4 Mahua cake @ 150 kg ha^{-1}

T5 Neem cake @ 150 kg ha^{-1}

T6 Pungam cake @ 150 kg ha^{-1}

T7 Composted coir pith @ 6.25 t ha^{-1}

T8 FYM (Farm Yard Manure) @ 12.5 t ha^{-1}

T9 Poultry manure @ 6.25 t ha^{-1}

T10 Soil drenching with Carbendazim (0.1 %)

T11 Control I (Pathogen uninoculated)

T12 Control II (pathogen inoculated)

RESULTS AND DISCUSSION

In vitro* efficacy of organic amendments extracts against *S. rolfsii

Twelve organic amendments at different concentrations (5.0 and 10.0%) were tested against the growth of *S. rolfsii*, and the results were presented in Table 1. The results showed that neem cake extract at 10% concentration resulted in the highest inhibition of the pathogen growth (88.76 %), followed by mahua cake (86.51%). Neem and mahua cake extracts at 5% concentrations recorded 75.28 and 62.92 per cent growth reduction of mycelial growth, respectively. The extracts of other organic amendments *viz*., FYM, gingelly cake, castor cake, groundnut cake, pungam cake, goat and sheep manure, poultry manure and composted coir pith were less effective against the pathogen (Table 1).

The sclerotial production of *S. rolfsii* was totally inhibited by neem cake extract at 10% concentration which recorded 100 per cent reduction, followed by mahua extracts with 98.29% reduction. Neem and mahua cake extracts at 5% concentration recorded 98.29 and 74.46 per cent reduction in sclerotial production reduction, respectively. But other organic amendments did not reduce the sclerotial production significantly (Table 1).

In respect of sclerotial germination, 5% and 10% neem cake extracts inhibited the sclerotial germination at 91.09 and 100.00 per cent, respectively followed by 10% mahua cake (with 86.14 per cent reduction). Untreated control showed cent per cent sclerotial germination (Table 1).

The efficacy of organic amendments against mycelial dry weight of *S. rolfsii* are presented in Table.2 and it revealed that neem cake extracts at 10% concentration completely inhibited (100%) the mycelial growth of *S. rolfsii* followed by 10% mahua cake (96.42%). At 5 % concentration the neem cake and mahua cake extracts recorded 76.58 and 68.68 per cent reduction of mycelial biomass, respectively. Other organic amendments were found to be ineffective in reducing the mycelial dry weight of *S. rolfsii*. The present study revealed that neem cake extract at 10 percent concentration completely inhibited the mycelial growth, biomass and sclerotial production of *S. rolfsii* under *in vitro* condition (Tables 1 and 2) followed by 5% neem cake extract. These findings agree with the findings of earlier workers in the case of *Fusarium udum* (Sing and Sing, 1982; Singh and Singh, 1985). Alice *et al*. (1998) found that mahua cake extract (10 %) was effective in reducing mycelial growth, sclerotial production and sclerotial germination of *S. rolfsii*.

The results of pot culture experiment revealed that neem cake (150kg/ha) recorded the minimum root rot disease incidence of (13.91%) per cent which accounted for 86.09 per cent disease reduction on 150 DAS (Days After Sowing) followed by mahua cake (150 kg/ha) with 17.88 per cent disease incidence. Comparatively carbendazim at 1 g/kg soil resulted in 37.75 per cent root rot incidence on 150 DAS as against 100.00 per cent in the control with pathogen inoculated (Table 3).

The number of crowns and tuber weight increased significantly in all the treatments except in control. Basal application of neem cake @ 150 kg ha^{-1} recorded the highest number of crowns and root weight 21.90/ plant and 1.29 kg/tuber followed by that of mahua cake

Table1. Efficacy of organic amendments against *S. rolfsii in vitro* (values are means of three replicates); Figures in parentheses are arc sine transformed values)

S. No	Treatment	Concentration (%)	Mycelial growth		Number of sclerotia		Sclerotial germination (%)	
			Mycelial growth in diameter (cm)	Growth inhibition (%)	No. of sclerotia/ plate	Per cent reduction	Sclerotial germination (%)	Per cent reduction
1	Castor cake	5	8.50	4.49	186.12	20.00	97.02 (85.30)	2.98
		10	7.20	19.10	120.78	48.11	64.35 (53.39)	35.65
2	Gingelly cake	5	6.80	23.59	138.60	40.42	99.00 (87.96)	1.00
		10	4.60	48.31	113.85	51.06	79.20 (63.14)	20.80
3	Groundnut cake	5	8.00	10.11	168.30	27.65	99.00 (87.96)	1.00
		10	6.70	24.71	118.80	48.93	83.16 (66.23)	16.84
4	Mahua cake	5	3.30	62.92	59.40	74.46	59.40 (50.44)	40.60
		10	1.20	86.51	3.96	98.29	13.86 (21.84)	86.14
5	Neem cake	5	2.20	75.28	39.96	98.29	8.91 (17.35)	91.09
		10	1.00	88.76	0.99	100.00	0.00 (0.29)	100.00
6	Pungam cake	5	8.70	2.24	188.10	19.14	99.00 (87.96)	1.00
		10	7.80	12.35	128.70	44.68	87.12 (69.83)	12.88
7	Composted coir pith	5	8.00	10.11	148.50	36.17	84.15 (67.07)	15.85
		10	5.60	37.07	89.10	61.70	72.27 (58.35)	27.47
8	FYM (Farm Yard Manure)	5	6.00	32.58	67.32	71.06	58.41 (49.86)	41.59
		10	4.00	55.05	44.55	80.85	30.69 (33.62)	69.31
9	Poultry manure	5	8.50	4.49	191.07	17.87	96.03 (84.17)	3.97
		10	6.50	26.96	88.11	62.12	75.24 (60.33)	24.76
10	Goat manure	5	8.90	0.00	198.00	14.89	99.00 (87.96)	1.00
		10	8.30	6.74	158.40	31.91	85.14 (67.94)	14.86
11	Sheap manure	5	7.90	11.23	183.15	21.20	98.01 (86.54)	1.99
		10	5.80	34.83	69.30	70.21	78.21 (62.42)	21.79
12	Rabbit manure	5	8.80	1.21	178.20	23.40	90.09 (73.47)	9.91
		10	8.30	6.74	143.55	38.29	84.64 (67.49)	15.36
13	Control		8.90	-	232.65	-	100.00 (90.42)	-
CD (P < 0.05)		Treatments		0.28	0.73		0.39	
		Concentrations		0.11	0.28		0.19	
		T x C		0.39	1.03		0.50	

Table 2. Effect of organic amendments against *S. rolfsii* mycelial dry weight *in vitro* (Values are means of three replications)

Treatment	Concentrations (%)	Mycelial dry weight (g)	Growth inhibition (%)
Castor cake	5	1.68	33.33
	10	1.48	41.26
Gingelly cake	5	2.27	9.92
	10	1.78	29.36
Ground nut cake	5	2.07	17.85
	10	1.83	27.38
Mahua cake	5	0.79	68.65
	10	0.09	96.42
Neem cake	5	0.59	76.58
	10	0.00	100.00
Pungam cake	5	1.74	30.95
	10	1.18	53.17
Composted coir pith	5	2.07	17.85
	10	1.77	29.76
FYM (Farm Yard Manure)	5	1.38	45.23
	10	0.99	60.71
Poultry manure	5	1.58	37.30
	10	1.38	45.23
Goat manure	5	2.17	13.88
	10	1.73	31.34
Sheep manure	5	2.12	15.87
	10	2.10	16.66
Rabbit manure	5	1.98	21.42
	10	1.58	37.30
Control		2.52	-
CD (P= 0.05)	Treatments	0.02	
	Concentrations	0.001	
	T x C	0.03	

Table 3. Effect of organic amendments on the management of root rot of tropical sugarbeet (Pot culture) (Values are means of three replications; Figures in parentheses are arc sine transformed values)

Organic amendment	Disease incidence (%)	Percent reduction over control	Number of crown/plant (100 DAS)*	Root weight (kg)
Castor cake	49.67 (44.81)	50.33	14.90	0.69
Gingelly cake	52.65 (46.51)	47.35	13.90	0.67
Ground nut cake	51.65 (45.94)	48.35	15.40	0.57
Mahua cake	17.88 (25.01)	82.12	19.90	1.08
Neem cake	13.91 (21.89)	86.09	21.90	1.29
Pungamcake	47.68 (43.66)	52.32	17.90	0.77
Composted coir pith	55.63 (48.23)	44.37	15.90	0.70
FYM (Farm Yard Manure)	45.69 (42.53)	54.31	18.90	0.98
Poultry manure	67.55 (55.27)	32.45	12.90	0.46
Carbendazim	37.75 (37.90)	62.25	17.90	1.01
Control I (Pathogen uninoculated)	0.00 (0. 28)	100.00	16.90	0.91
Control II (Pathogen inoculated)	100.00 (89.71)	-	5.00	0.05
CD (P= 0.05)	0.41		0.16	0.08

*DAS – Days After Sowing

@ 150 kg ha^{-1} and farm yard manure (12.5 t ha^{-1}) which recorded 19.90 crowns/plant and 1.08 kg/tuber and 18.90 crowns/plant and 0.98kg/tuber, respectively, and these two treatments were found to have results on par with each other. The uninoculated control recorded 5 crowns /plant and 0.05 kg/tuber (Table 3).

The organic amendments might have reduced the disease incidence directly by affecting the activity of the pathogen by antibiosis or reducing the number of propagules or indirectly by increasing the saprophytic soil flora which might show antagonism or competition towards the pathogen (Zakaria and Lockwood, 1980 and Chakrabarti and Sen, 1991). Karthikeyan and Karunanithi (1996) reported that neem cake @ 250 kg/ ha was the most effective amendment in controlling *Fusarium* wilt in banana (cv. Rasthali). Baby and Rao (1993) reported that there was increased population of *Tricoderma* in the presence of Neem cake. However, Rajappan *et al*. (1995) reported that the growth of *P. fluorescens* was not affected by neem based formulation.

The present study, showed that neem based organic amendments provided food source on which the antagonistic fungi thrive and multiply rapidly because of continuous supply of nutrients from the substrate. Further more, fungal antagonistic micro organisms are capable of rapid colonization on the organic material. New approaches involving biocontrol agents are considered as an alternative to chemical fungicides due to their target specificity, economical to use, no chance for development of resistance by pathogens and increases in the plant growth and yield potential of crops. As such the organic amendments for e.g., neem cake amendments might be useful no such approaches.

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