INTERNATIONAL JOURNAL OF PLANT PROTECTION / VOLUME 6 | ISSUE 1 | APRIL, 2013 | 82-85

IJPP

RESEARCH ARTICLE

Integrated management of rice sheath rot incited by *Sarocladium oryzae*

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Received : 17.07.2012
Revised : 27.01.2013
Accepted : 15.02.2013

Key Words :
Rice sheath rot,
Integrated management,
Sarocladium oryzae

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ABSTRACT

In the field trial conducted during *Kharif* season, spraying at booting stage (85DAS) and 15 days later with carbendazim (500 g/ha) + phosphamidon (1 lit./ha) was the most effective in reducing sheath rot disease incidence, besides giving the maximum yield. Among the plant products and antagonists, neem oil (3%) spray had the maximum efficacy in reducing the disease incidence followed by neem seed kernel extract (5%), *Pseudomonas fluorescens* (1 kg/ha), *Bacillus subtilis* (1 kg/ha), leaf extracts (10%) of *Acalypha indica , Convolvulus arvensis* and in the *Rabi* season experiment also, the same trend was observed. The maximum cost benefit ratio was recorded in *P. fluorescens* sprayed plots.

How to view point the article : Raja, I. Yesu and Mahalakshmi, P. (2013). Integrated management of rice sheath rot incited by *Sarocladium oryzae*. *Internat. J. Plant Protec*., **6**(1) : 82-85.

INTRODUCTION

Sheath rot caused by *Sarocladium oryzae* (Sawada) W.Gams and D.Hawksw. has become endemic and one of the major constraints in production and off-setting the efforts to attain targetted levels of rice production in Tamil Nadu and also in other rice growing states. The disease affected severe yield loss and could be a potential threat to rice production as reported by Chen (1957). The average reduction in grain yield due to this disease was estimated to be 14.50 per cent in West Bengal (Chakravarthy and Biswas, 1978) and in Tamil Nadu it was as high as 57.40 per cent (Mohan, 1976).The maximum of 85 per cent yield loss was reported in Andhra Pradesh by Muralidharan and Venkata Rao (1980).

At present, sheath rot of rice could not be effectively controlled by chemical means alone. Moreover, use of chemicals for plant disease management has to be restricted to the minimum in view of their inherent ill effects like environmental pollution, residual toxicity, human health hazards and development of resistance by plant pathogens etc. However, till such effective non-chemical methods are developed, the use of chemicals is essential to the extent warranted for plant disease management. To develop effective management strategies, wide knowledge on the disease and pathogen and also the effectiveness of fungicides, fungicide-insecticide combinations, plant products and biocontrol agents is necessary. To bridge this gap, the present study was carried out.

MATERIALS AND METHODS

Two field experiments in a Randomized Block Design with 14 treatments and three replications were conducted in 'B' block of the farm at Agricultural College and Research Institute, Madurai, respectively during the first (*Kharif*) and second crop season (*Rabi*), to evaluate the efficacy of plant products, antagonists, fungicides and fungicide-insecticide combinations against sheath rot disease.

Based on the efficacy of plant products, phylloplane antagonists, fungicides and fungicide-insecticide combinations under pot culture conditions, five promising plant products *viz.*, leaf extracts of *Acalypha indica, Ocimum tenuiflorum, Convolvulus arvensis, Catharanthus roseus* and neem oil and neem seed kernel extract, two phylloplane bacterial antagonists *viz., Pseudomonas fluorescens* and *Bacillus subtilis,* one fungicide carbendazim and four

fungicide-insecticide combinations *viz.,* carbendazim + phosphamidon, carbendazim + monocrotophos, tridemorph + phosphamidon and tridemorph + monocrotophos were selected for testing their efficacy against sheath rot disease under field conditions. The details of the treatments are given below.

Treatments :

T_1 *Acalypha indica* leaf extract (10%)
T_2 *Ocimum tenuiflorum* leaf extract (10%)
T_3 *Convolvulus arvensis* leaf extract (10%)
T_4 *Catharanthus roseus* leaf extract (10%)
T_5 Neem oil (3%)
T_6 Neem seed kernel extract (5%)
T_7 *Pseudomonas fluorescens* talc based (1 kg/ha)
T_8 *Bacillus subtilis* talc based (1 kg/ha)
T_9 Carbendazim (500 g/ha)
T_{10} Carbendazim (500 g/ha) + phosphamidon (1 lit./ha)
T_{11} Carbendazim (500 g/ha) + monocrotophos (1 lit./ha)
T_{12} Tridemorph (500 ml/ha) + phosphamidon (1 lit./ha)
T_{13} Tridemorph (500 ml/ha) + monocrotophos (1 lit./ha)
T_{14} Control

Thirty day old rice seedlings of CO 43 were transplanted adopting the recommended spacing (20 x10 cm) and the fertilizer dosage (150 : 50 : 50 kg NPK/ha). The first spraying of the treatments along with 0.10 per cent teepol was given at the boot leaf stage and the second 15 days later. Sheath rot incidence and the intensity were assessed at grain maturity stage in 25 hills (200 tillers) selected at random in each plot (Narayanasamy and Viswanathan, 1990). The grain yield per plot was also recorded. The cost benefit ratio was calculated for each treatment by computing with the prevailing local market price for the various inputs used in the experiment.

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

***Kharif* season :**

All the treatments tested, significantly reduced the disease incidence. Among these, carbendazim (500 g/ha) + phosphamidon (1 lit./ha) combination was superior in reducing the disease incidence by 81.56 per cent with the disease index of 76.00 which was at par (79.26% disease reduction) with carbendazim (500 g/ha) + monocrotophos (1 lit./ha). In the case of botanicals and antagonists, spraying neem oil (3%) ranked first by reducing the disease incidence to 55.30 per cent followed by neem seed kernel extract (5%), *Pseudomonas fluorescens* (1 kg/ha), *Bacillus subtilis* (1 kg/ha), leaf extracts (10%) of *A. indica, C. arvensis, C. roseus* and O. *tenuiflorum.* These recorded 51.68, 50.75, 47.31, 40.98, 37.93, 37.82 and 36.67 per cent disease reduction, respectively (Table 1).

A significant increase (53.82%) in the grain yield was recorded due to carbendazim (500 g/ha) + phosphamidon (1 lit./ha) treatment (7441.667kg/ha) which was on par (51.40%) with carbendazim (500 g/ha) + monocrotophos (1 lit./ha). Among the botanicals and antagonists, neem oil (3%) spray

Table 1: Efficacy of plant products, antagonists, fungicide and fungicide-insecticide combinations against incidence of sheath rot in the field (*Kharif* season)

Sr. No.	Treatments	Disease index*	Disease reduction (%)*	Yield/plot 5x4m^2 (kg)*	Yield/ha (kg)	Yield increase (%)*	Cost benefit ratio
1.	*Acalypha indica* leaf extract (10%)	243.33	40.98 (39.80)^{h}	11.753	5876.667	21.47 (27.57)^{g}	1 : 6.96
2.	*Ocimum tenuiflorum* leaf extract (10%)	261.00	36.67 (37.27)^{I}	11.275	5637.500	16.53 (23.95)^{h}	1 : 5.36
3.	*Convolvulus arvensis* leaf extract (10%)	255.83	37.93 (38.00)^{hi}	11.377	5688.333	17.57 (24.76)^{h}	1 : 5.70
4.	*Catharanthus roseus* leaf extract (10%)	256.33	37.82 (37.93)^{hi}	11.420	5710.000	18.02 (25.10)^{h}	1 : 5.85
5.	Neem oil (3%)	184.17	55.30 (48.05)^{e}	12.950	6475.000	33.83 (35.56)^{e}	1 : 3.52
6.	Neem seed kernel extract (5%)	199.17	51.68 (45.96)^{f}	12.780	6390.000	32.07 (34.49)^{e}	1 : 8.75
7.	*Pseudomonas fluorescens* talc based (1 kg/ha)	203.00	50.75 (45.43)^{f}	12.660	6330.000	30.84 (33.73)^{e}	1: 14.92
8.	*Bacillus subtilis* talc based (1 kg/ha)	217.17	47.31 (43.46)^{g}	12.225	6112.500	26.35 (30.86)^{f}	1: 12.74
9.	Carbendazim (500 g/ha)	95.83	77.31 (61.56)^{bc}	14.480	7240.000	49.65 (44.80)^{bc}	1: 12.46
10.	Carbendazim (500 g/ha) +phosphamidon (1 lit./ha)	76.00	81.56 (64.58)^{a}	14.883	7441.667	53.82 (47.19)^{a}	1 : 7.31
11.	Carbendazim (500 g/ha) +monocrotophos(1lit./ha)	85.50	79.26 (62.91)^{ab}	14.650	7325.000	51.40 (45.80)^{ab}	1 : 8.34
12.	Tridemorph (500 ml/ha) +phosphamidon (1 lit./ha)	102.67	75.09 (60.06)^{cd}	14.257	7128.333	47.33 (43.47)^{cd}	1 : 5.73
13.	Tridemorph (500 ml/ha) +monocrotophos (1 lit./ha)	111.00	73.07 (58.74)^{d}	14.050	7025.000	45.21 (42.25)^{d}	1 : 6.40
14.	Control	412.17	0.00 (2.03)^{j}	9.677	4838.333	0.00 (2.03)^{I}	

C.D. (P = 0.05) , 1.92, 2.01 , * Mean of three replications, (Data in parentheses are arc sine transformed values) In a column, means followed by common letter(s) are not significantly different at 5 % level by DMRT

ranked first but next only to the above chemicals in giving the highest yield of 33.83 per cent which was on par with five per cent neem seed kernel extract (32.07%) and *P. fluorescens* spray (1 kg/ha) (30.84%). These were followed by *B. subtilis* (1 kg/ha) and the leaf extracts (10%) of *A. indica, C. roseus, C. arvensis* and *O. tenuiflorum* which recorded 26.35, 21.47, 18.02, 17.57 and 16.53 per cent yield increase respectively.The cost benefit ratio in respect of *P. fluorescens* was the highest (1:14.92) followed by *B. subtilis* (1:12.74) and carbendazim spray (1:12.46). It was less in neem oil spray (1:3.52) (Table 1).

***Rabi* season :**

Among all the treatments, carbendazim (500 g/ha) + phosphamidon (1 lit./ha) was the most effective in the management of the disease by recording the lowest (113.17) disease index and per cent disease reduction (76.73). This treatment was on par with carbendazim (500 g/ha) + monocrotophos (1 lit./ha) which showed 75.03 per cent disease reduction with the disease index of 121.50.

Among the botanicals and antagonists tested, neem oil (3%) had the maximum efficacy in reducing the disease incidence to 51.11 per cent which was significantly different from other treatments. This was followed by *P. fluorescens* (1 kg/ha), neem seed kernel extract (5%), *B. subtilis* (1 kg/ha), leaf extracts (10%) of *A. indica, O. tenuiflorum, C. arvensis* and *C. roseus* which recorded 46.35, 45.14, 41.16, 33.87, 31.64, 30.74 and 29.65 per cent disease reduction, respectively. The disease load was very much high (487.00 disease index) during this season as compared to *Kharif,* 2000 season (412.17 disease index).

A significant increase of 51.62 per cent in the grain yield (6044.44kg/ha) was recorded due to carbendazim (500 g/ha) + phosphamidon (1 lit./ha) spraying which was on par with carbendazim (500 g/ha) + monocrotophos (1 lit./ha) spray (48.70%). This was followed by carbendazim (500 g/ha), tridemorph (500 ml/ha) + phosphamidon (1 lit./ha) and tridemorph (500 ml/ha) + monocrotophos (1 lit./ha) which respectively recorded 46.41, 44.54 and 42.14 per cent yield increase. Among the botanicals and antagonists, neem oil (3%) was the best by recording 30.25 per cent increase yield and it was on par with *P. fluorescens* (27.95%) and neem seed kernel extract (27.67%). This was followed by *B. subtilis, A. indica, O. tenuiflorum, C. arvensis* and *C. roseus* which recorded 23.22, 18.19, 15.37, 14.85 and 14.43 per cent yield increase respectively. *P. fluorescens* (1 kg/ha) spray recorded the highest cost benefit ratio of 1:11.14 followed by carbendazim (500 g/ha) spray (1:9.60) and *B. subtilis* (1:9.25). Neem oil (3%) spray showed the lowest cost benefit ratio of 1:2.59 (Table 2).

Srinivasan and Pari (1978) reported that ediphenphos was the best, closely followed by carbendazim and mancozeb for the control of sheath rot under field conditions. Kanagarajan (1988) observed that spraying of propiconazole reduced the incidence of sheath rot on CO 43 rice and increased the yield. Pandiaraja Kumar (1992) reported that propiconazole (0.1%) + monocrotophos (0.2%) spray was superior in reducing both the disease incidence and disease intensity followed by tridemorph (0.1%) + monocrotophos (0.2%).

Table 2 : Efficacy of plant products, antagonists, fungicide and fungicide -insecticide combinations against incidence of sheath rot in the field (*Rabi* season)

Sr.No.	Treatments	Disease index*	Disease reduction (%)*	Yield/plot 5x4m^2 (kg)*	Yield/ha (kg)	Yield increase (%)*	Cost benefit ratio
1.	*Acalypha indica* leaf extract (10%)	321.83	33.87(35.59) ^{h}	5.653	4711.111	18.19 (25.24) ^{f}	1 : 4.86
2.	*Ocimum tenuiflorum* leaf extract (10%)	333.67	31.64 (34.23) ^{hi}	5.518	4598.611	15.37 (23.05) ^{fg}	1 : 4.11
3.	*Convolvulus arvensis* leaf extract (10%)	336.83	30.74 (33.66) ^{hi}	5.493	4577.777	14.85 (22.63) ^{g}	1 : 3.97
4.	*Catharanthus roseus* leaf extract (10%)	342.17	29.65 (32.98) ^{i}	5.473	4561.111	14.43 (22.32) ^{g}	1 : 3.86
5.	Neem oil (3%)	238.00	51.11 (45.64) ^{e}	6.230	5191.667	30.25 (33.35) ^{d}	1 : 2.59
6.	Neem seed kernel extract (5%)	266.33	45.14 (42.20) ^{f}	6.107	5088.889	27.67 (31.71) ^{d}	1 : 6.22
7.	*Pseudomonas fluorescens* talc based (1 kg/ha)	261.00	46.35 (42.91) ^{f}	6.120	5100.000	27.95 (31.90) ^{d}	1 : 11.14
8.	*Bacillus subtilis*talc based (1 kg/ha)	286.83	41.16 (39.91) ^{g}	5.893	4911.111	23.22 (28.75) ^{e}	1 : 9.25
9.	Carbendazim (500 g/ha)	132.83	72.75 (58.54) ^{bc}	7.003	5836.111	46.41 (42.94) ^{b}	1 : 9.60
10.	Carbendazim (500 g/ha) +phosphamidon(1 lit./ha)	113.17	76.73 (61.17) ^{a}	7.253	6044.444	51.62 (45.93) ^{a}	1 : 5.78
11.	Carbendazim (500 g/ha) +monocrotophos(1lit./ha)	121.50	75.03 (60.03) ^{ab}	7.113	5927.778	48.70 (44.25) ^{ab}	1 : 6.51
12.	Tridemorph (500 ml/ha) +phosphamidon (1lit./ha)	142.17	70.69 (57.25) ^{cd}	6.913	5761.111	44.54 (41.86) ^{bc}	1 : 4.44
13.	Tridemorph (500 ml/ha) +monocrotophos (1 lit./ha)	156.50	67.88 (55.48) ^{d}	6.798	5665.277	42.14 (40.46) ^{c}	1 : 4.91
14.	Control	487.00	0.00 (2.03) ^{j}	4.783	3986.111	0.00 (2.03) ^{h}	

C.D. (P = 0.05) , 2.03 , 2.31 , * Mean of three replications, (Data in parentheses are arc sine transformed values) , In a column, means followed by common letter(s) are not significantly different at 5% level by DMRT

Lakshmanan (1993) found that tridemorph + phosphamidon and propiconazole + phosphamidon sprays were very effective against sheath rot on rice cvs. IR 20 and ADT 36. Spraying of mancozeb + tricyclazole (two sprays) and mancozeb alone (four sprays) were superior in controlling sheath rot disease under field conditions (Viswanathan and Narayanasamy, 1993). Spraying of carbendazim (0.1%) twice, was the most effective as reported by Radhika (1994). Das and Nayak (1997) reported that two sprays of thiophanate-methyl or carbendazim at (0.1%) was highly effective in controlling sheath rot.

Mariappan *et al*. (1988) observed that spraying of neem oil (1%) 17 days after sowing in the nursery followed by six sprayings at weekly intervals in the main field reduced rice sheath rot incidence. Spraying of neem oil (3%) showed the maximum sheath rot disease reduction under field conditions as reported by Narasimhan *et al.* (1994) and Radhika (1994). Narasimhan *et al*.(1998) reported that neem oil and pungam oil based emulsifiable concentrate (EC) formulations *viz.,* neem oil 60 EC (acetic acid), neem oil 60 EC (citric acid), and neem oil + pungam oil 60 EC (citric acid) developed at TNAU, effectively controlled rice sheath rot and resulted in increased yield in five field trials. Spraying with the culture suspension of *P. fluorescens* reduced the severity of sheath rot by 20 to 42 per cent in five rice cultivars under field condition (Sakthivel and Gnanamanickam,1987). Manonmani (1999) observed that gypsum-based formulations of *P. fluorescens* (Pf 1) and *B. subtilis* were effective in reducing sheath rot disease incidence in both the field trials conducted.

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