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Raju MRB
Agricultural Research Station, Ragolu (Acharya N G Ranga Agricultural University), Srikakulam, Andhra Pradesh, India

Visalakshmi V
Agricultural Research Station, Ragolu (Acharya N G Ranga Agricultural University), Srikakulam, Andhra Pradesh, India

Corresponding Author:
Raju MRB
Agricultural Research Station, Ragolu (Acharya N G Ranga Agricultural University), Srikakulam, Andhra Pradesh, India

Effective scheduling of fungicide and insecticide combination for the management of Rice Sheath rot caused by *Sarocladium oryzae* (Sawada) W. Gams & D. Hawksw

Raju MRB and Visalakshmi V

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Abstract
Sheath rot caused by *Sarocladium oryzae* was recorded in more than 65% locations surveyed in the North coastal zone of Andhra Pradesh. A field trail was conducted at Agricultural Research Station, Ragolu during 2010-13 to study efficacy of fungicide (carbendazim and propiconazole) and insecticide (Profenofos, Cartap hydrochloride) combinations for the management of sheath rot and stem borer in paddy. Scheduled prophylactic spray with propiconazole @ 1 ml/l + cartap hydrochloride (2 g/l) for two times *i.e.*, first spray at 50% of panicle initiation and II spray at 50% flowering resulted in significant reduction of sheath rot (10.6% incidence) in comparison to 29.7% disease recorded in untreated control. Profenofos + propiconazole/ carbendazim treatment combinations were also found effective, but keeping in view the environmental risks posed by Profenofos, scheduled prophylactic foliar spray with propiconazole + cartap hydrochloride could be an effective means in managing stem borer and sheath rot in paddy.

Keywords: Rice, sheath rot, fungicide, stem borer, propiconazole, cartap hydrochloride, carbendazim

Introduction
Rice (*Oryza sativa* L.) is the major crop grown predominantly during kharif in the North coastal zone of Andhra Pradesh (75% of cropped area). Resource poor farmers in this part of Andhra Pradesh depend on monsoon rains and tanks for cultivation of crops. Climatic vagaries coupled with this biotic constrains often result in heavy losses to the resource poor farmers,. Among the biotic constraints, neck blast, sheath blight, sheath rot, false smut, stem borer, BPH, panicle and leaf folder were of importance in causing significant yield loss. Recently, the emergence of sheath rot of rice caused by *Sarocladium oryzae* (Sawada) Gama and Hawksworth is leading to significant yield loss in this region (Anonymous, 2012) [1]. The disease was found to be severe under temperatures (27 - 30^{0}C) and 92-100% RH during October - December (Sinha and Sinha 1996) [8], which generally prevail in this region of Andhra Pradesh. Limited success has been achieved in the management of sheath rot even with the use of fungicides and botanicals (Pramod and Bimla 2011; Jagannathan and Sivaprakasam 1996; Devi and Singh 1996; Bag *et al.*, 2010) [6, 4, 3, 2]. Sheath rot of rice caused by *Sarocladium oryzae* was cited as a weak pathogen infecting rice crop at panicle emergence stage, the pathogen was found to gain entry into the host passively by the wounds made by insect pests (stem borer, panicle mite etc.) and cause rotting of sheath portion of panicle leading to incomplete or partial emergence of the panicle resulting in chaffy grains and yield loss (Karmakar and Mohapatra 2004) [5]. Often damage by insect pests resulted in more damage to crop (Raja and Theradimani 2010) [7]. The pathogen was also found to cause grain discoloration in partially emerged panicles leading to loss in quality and marketability of the produce. Although a number of fungicides have been found effective against the pathogen (Venkateswarlu and Venkateswarlu 2009) [11], lack of sufficient knowledge regarding timely interventions was found to be the reasons for increasing yield losses. Keeping in view, the complexity of the disease and involvement of insects in aggravating the disease, there is a need to evaluate different insecticide/ miticide and fungicide combinations for effective management of the sheath rot complex.

Materials and Methods

A field trial was conducted in field no. 13B of Agricultural Research Station, Ragolu (Andhra Pradesh) during kharif season for three consecutive years *viz*., 2010-11, 2011-12 and 2012-13 to study the efficacy of selected insecticide + fungicide combinations for effective management of sheath rot in paddy.

Importance of the disease

A production oriented survey was conducted during kharif, 2012-13 in the north coastal districts *viz.*, Srikakulam, Vizianagaram and Visakhapatnam of Andhra Pradesh covering seventy-two locations to study the prevalence of biotic constraints. Data collected was presented as percent incidence and % prevalence using the formula.

$$\% \text{ Incidence} = \frac{\text{Total no. of hills} - \text{Diseased hills}}{\text{Total hills}} \text{ X } 100$$

$$\% \text{ Prevalence} = \frac{\text{Total no. of locations surveyed} - \text{No. of locations showing disease}}{\text{Total no. of locations}} \text{ X } 100$$

Design

A field trial was laid out in Randomized block design with 10 treatments each replicated thrice. Uniform plot size of 4.8x2.4m was adopted with a spacing of 20x15cm. Standard recommended package of practices (ANGRAU) were adopted during the trails. Sheath rot susceptible variety PLA 1100 was selected for conducting the study.

Treatment Imposition

Keeping in view, the etiology of disease and factors which lead to disease development *i.e.*, injury made by insects, following chemicals and their combination treatments were selectively formulated for evaluation of against sheath rot complex *viz*., carbendazim, propiconazole, streptocycline, carbendazim + Profenofos, carbendazim + cartap hydrochloride, propiconazole + Profenofos, propiconazole + cartap hydrochloride, streptocycline + cartap hydrochloride, streptocycline + Profenofos and untreated control. The chemicals were used at their recommended dose and treatment imposition was done for two times, first at 50% panicle initiation and subsequent spray at 50% flowering during evening hours. Spraying of water alone served as control.

Data collection

Data on stem borer incidence, panicle mite and sheath rot damage were recorded before the first treatment imposition and final data was recorded at 20 days after the second spray. Data on biotic constraints was expressed as % incidence. Grain yield was recorded and expressed as kg per hectare. Data in each of replication was collection in fixed one sq. m area from a 11.52 m^2 plot and the results were expressed as per cent disease incidence/ pest incidence. Arc sine data was analyzed following standard statistical procedures.

Results and Discussion

During the production oriented survey conducted for studying biotic and abiotic constraints in paddy production, neck blast, sheath blight, stemborer and sheath rot were found be major biotic constraints in paddy cultivation. Sheath rot was recorded in more than 65% of the locations surveyed in all the three districts with 100 % prevalence in Vizianagaram district, sheath rot incidence ranged from 0.5% to 29.2% (Table 1). Whereas panicle mite infestation as recorded on leaves, ranged from 0.6-46.3% with maximum mean panicle mite incidence of 11.2% observed in Vizianagaram district in comparison to 3.4% stem borer incidence recorded in the same district. Sheath rot was observed in all the locations surveyed in Vizianagaram district. Stem borer infestation was comparatively more in Visakhapatnam district compared to the other two districts of the zone.

Table 1: Incidence and Prevalence of Sheath rot and associated pests in North coastal zone of Andhra Pradesh (Kharif 2012-13)

Pest/ Disease Recorded	Srikakulam		Vizianagaram		Visakhapatnam	
	% Incidence and (Range)	% Prevalence	% Incidence and (Range)	% Prevalence	% Incidence and (Range)	% Prevalence
Panicle mite	5.2 (0.6-33.4)*	24.2	11.1 (1.1-33.2)	85.0	7.8 (1.9-46.3)	52.9
Stem borer	2.2 (0.5-10.7)	87.9	3.4 (0.5-11.7)	90.0	3.8 (1.1-13.6)	70.6
Sheath Rot	3.7 (0.7-29.2)	81.8	8.0 (0.5-25.0)	100.0	4.4 (0.9-16.9)	64.7

* - Range of pest/disease incidence across locations surveyed

Results of the field trial indicate that during the three years of study, natural infestation of stem borer incidence (20.03%) was more during 2012-13 and panicle mite infestation was high during 2011-12 (10.2 per cent incidence). Treatments combinations involving cartap hydrochloride and Profenofos were found superior in reducing the stem borer (white ears) incidence in paddy and panicle mite infestation in paddy. However, Profenofos sprays were found statistically superior to cartap hydrochloride in reducing the infestation of panicle mite over the three years of study (Table 2).

Among the 10 treatments evaluated, propiconazole + Profenofos combination (5.1% stem borer incidence) followed by carbendazim + cartap hydrochloride (5.8%) and propiconazole + cartap hydrochloride (5.9%) combination were found most effective in reducing stem borer incidence in comparison to untreated control (18.3%). Lower panicle mite infestation was recorded in all treatments involving Profenofos (1.8– 2.1%) in comparison to mean 6.9 per cent infestation recorded in untreated control during the study. Among the individual fungicidal and bactericidal treatments, none of the treatments were found effective in reducing pest infestation in paddy.

Table 2: Effect of different fungicide and fungicide + insecticide combinations on the incidence of stem borer (white ears) and panicle mite infestation in paddy (2010-13)

S. No.	Fungicide/ Fungicide + Insecticide combination	Mean stem borer incidence (%)				Mean panicle mite incidence (%)			
		2010-11	2011-12	2012-13	Pooled Mean+	2010-11	2011-12	2012-13	Pooled Mean
1	Propiconazole	19.7 (26.3)	19.9 (26.5)	15.9 (23.5)	18.5 (25.5)	9.5 (17.9)	6.8 (15.1)	2.3 (8.7)	6.2 (13.9)
2	Carbendazim	13.7 (21.7)	17.8 (25.0)	13.6 (21.6)	15.03 (22.8)	7.6 (16.0)	6.6 (14.9)	4.8 (12.7)	6.3 (14.5)
3	Streptocycline	17.9 (25.0)	18.9 (25.8)	14.4 (22.3)	17.1 (24.4)	10.0 (18.4)	6.7 (15.0)	2.6 (9.3)	6.4 (14.3)
4	Propiconazole + cartap hydrochloride	4.5 (12.3)	7.7 (16.1)	5.5 (13.6)	5.9 (14.0)	7.8 (16.3)	5.1 (13.0)	1.8 (7.6)	4.9 (12.3)
5	Carbendazim + cartap hydrochloride	3.4 (10.6)	8.3 (16.8)	5.8 (13.9)	5.8 (13.8)	6.5 (14.8)	6.5 (14.8)	3.7 (11.0)	5.6 (13.5)
6	Streptocycline + cartap hydrochloride	5.0 (13.0)	7.4 (15.8)	5.8 (13.9)	6.1 (14.2)	10.6 (19.0)	5.9 (14.1)	3.2 (10.3)	6.6 (14.4)
7	Propiconazole +Profenofos	4.7 (12.5)	7.0 (15.4)	3.7 (11.0)	5.1 (13.0)	4.6 (12.4)	1.1 (6.0)	0.7 (4.7)	2.1 (7.7)
8	Carbendazim + Profenofos	5.8 (13.9)	7.0 (15.3)	5.7 (13.8)	6.2 (14.4)	3.3 (10.5)	1.2 (6.3)	0.8 (5.1)	1.8 (7.4)
9	Streptocycline + Profenofos	12.9 (21.0)	7.2 (15.6)	5.9 (14.1)	8.7 (16.9)	3.4 (10.6)	1.3 (6.5)	0.9 (5.3)	1.8 (7.5)
10	Untreated control	18.7 (25.6)	20.0 (26.6)	16.1 (23.6)	18.3 (25.3)	10.2 (18.6)	7.1 (15.5)	3.2 (10.4)	6.9 (14.8)
	CV (%)	14.3	6.7	9.9	9.4	16.8	11.8	12.4	12.0
	CD (0.05)	2.7	2.3	2.9	3.0	2.8	4.1	4.4	2.5

* Figures in parentheses are arc sine transformed values
\+ Pooled data for three years (2010-13)

Data on the efficacy of treatments on sheath rot incidence revealed that propiconazole + Profenofos combination as most effective recording mean 6.1% sheath rot incidence followed by Profenofos + cartap hydrochloride (10.6%) and carbendazim + cartap hydrochloride treatment (14.2%) in comparison to 29.7% sheath rot incidence in untreated control. Mean highest yield (5611 kg/ha.) was recorded in propiconazole + Profenofos treatment, the treatment was found to be statistically at par to propiconazole + cartap hydrochloride and carbendazim + cartap hydrochloride and carbendazim + Profenofos treatments. Earlier studies indicate the *in vitro* and *in vivo* efficacy of certain fungicides against *Sarocladium oryzae* (Venkateswarlu and Chauhan 2005; Thapak *et al*., 2003) [10, 9]. However, our study indicates prophylactic chemical management of stem borer and panicle mite for reducing sheath rot incidence.

Table 3: Evaluation of fungicides, and fungicide + insecticide combinations against sheath rot incidence of paddy (2010-13)

S. No.	Fungicide/ Fungicide + Insecticide combination	Dose (per liter)	Mean Sheath rot incidence (%)*				+Pooled Mean Yield (Kg/ha)
			2010-11	2011-12	2012-13	Pooled Mean+	
1	Propiconazole	1 ml	2.0 (8.2)*	29.8 (33.1)	8.8 (17.3)	13.6 (19.5)	5127
2	Carbendazim	1 g	1.6 (7.3)	29.8 (33.1)	9.2 (17.6)	13.5 (19.3)	4926
3	Streptomycin sulphate	0.12 g	2.6 (9.4)	36.4 (37.1)	17.2 (24.5)	18.7 (23.6)	4926
4	Propiconazole + cartap hydrochloride	1 ml+2 g	2.4 (8.9)	22.6 (28.4)	6.8 (15.2)	10.6 (17.5)	5541
5	Carbendazim + cartap hydrochloride	1 g+2 g	1.3 (6.5)	32.8 (34.9)	8.5 (16.9)	14.2 (19.4)	5547
6	Streptomycin sulphate + cartap hydrochloride	0.12g+2 g	3.0 (9.9)	43.4 (41.2)	13.2 (21.3)	19.8 (24.1)	5210
7	Propiconazole + Profenofos	1 ml+2 ml	2.5 (9.1)	11.2 (19.5)	4.5 (12.2)	6.1 (13.6)	5611
8	Carbendazim + Profenofos	1 g+2 ml	2.5 (9.1)	32.6 (34.8)	8.5 (17.0)	14.5 (20.3)	5437
9	Streptomycin sulphate + Profenofos	0.12g +2 ml	5.3 (13.3)	33.1 (35.1)	19.3 (26.0)	19.2 (24.8)	4633
10	Untreated control	-	9.9 (18.4)	54.7 (47.7)	24.5 (29.7)	29.7 (31.9)	4107
		CV (%)	14.9	9.7	10.1	15.4	9.5
		CD (0.05)	1.33	5.9	3.4	5.6	488

* Figures in parentheses are arc sine transformed values
\+ - Pooled data for three years under study (2010-13)

Use of insecticides for the management of insects which aggravate the sheath rot disease in combination with fungicides would be an effective strategy for management of sheath rot. From the data (Table 3) it is clear that combination treatments (insecticide + fungicide) at critical phases of pathogen entry and infection, can significantly lower pest and

disease incidence thereby enhancing the yields in paddy. Reduction in sheath rot incidence in combination treatments supports the role of insect pests in aggravating the disease. Similar findings on the involvement of insect pests in dispersal or aiding in passive entry has been documented earlier (Raja and Theradimani 2010) [7]. Prophylactic spray schedule (one spray at 50% panicle initiation and II spray at 50% flowering) with Profenofos + propiconazole (or) propiconazole + cartap hydrochloride (or) carbendazim + cartap hydrochloride at recommended doses can help minimize the recurrent losses due to biotic constraints (insects pests *viz.*, stem borer, panicle mite, gall midge and disease) at reproductive phase in paddy.

Conclusion

In a survey conducted to study the incidence/ prevalence of pests and diseases in north coastal zone of Andhra Pradesh, sheath rot incidence ranged from 0.5% to 29.2%, whereas, panicle mite infestation as recorded on leaves, ranged from 0.6-46.3% with maximum mean panicle mite incidence (11.2%) recorded in Vizianagaram district in comparison to 3.4% stem borer incidence in the same district. In the field study conducted during three years (2010-13) for studying comparative efficacy of combination treatments involving insecticides and fungicides, prophylactic spray schedule involving a combination of Profenofos (2 ml/l) + propiconazole (1 ml/l) or propiconazole + cartap hydrochloride/ carbendazim + cartap hydrochloride for two times *viz.*, first spray 50% of panicle initiation and II spray at 50% flowering helped in enhancing yields with significant reduction in stem borer, panicle mite and sheath rot incidence. The study, also emphasizes the importance of insect vectors in aggravating sheath rot incidence in paddy. Keeping in view recent environmental concerns, prophylactic treatments with propiconazole + cartap hydrochloride/ carbendazim + cartap hydrochloride can be effective for sheath rot management in paddy. Use of insecticides for the management of insects which aggravate the sheath rot disease in combination with fungicides would be an effective strategy for management of sheath rot

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