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Evaluation of new fungicide against sheath blight (*R. solani)* of Rice

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Abstract
Rice sheath blight, caused by the fungal pathogen *Rhizoctonia solani* Kuhn [Sexual stage: *Thanetophorus cucumeris* (Frank) Donk] is one of the major production constraints in rice-growing countries of the world. Under conditions favoring disease, up to 50% of grain yield may be lost (Marchetti and Bollich 1991). Control may be achieved with fungicides (Groth 2008), but cost and the potential for development of pathogen resistance make plant genetic resistance preferable. Plants can be induced locally and systemically to become more resistant to diseases through various biotic or abiotic stresses. The best characterized signal pathway for systemically induced resistance is SAR (systemic acquired resistance) that is activated by localized infections with necrotizing pathogens. It is characterized by protection against a broad range of pathogens, by a set of induced proteins and by its dependence on salicylic acid (SA) Various chemicals have been discovered that seem to act at various points in these defense activating networks and mimic all or parts of the biological activation of resistance. Resistance inducing chemicals that are able to induce broad disease resistance offer an additional option for the farmer to complement genetic disease resistance and the use of fungicides. If integrated properly in plant health management programs, they can prolong the useful life of both the resistance genes and the fungicides presently used Thifluzamide is a member of the carboxamide class of fungicides which is single-site inhibitors of the succinate ubiquinone reductase or succinate dehydrigenase (Sdh) complex in the respiratory chain (FRAC 2007) interfere with fungal respiration via their inhibitory effect on succinate dehydrogenase within the tricarboxylic acid cycle. (O'Reilly1995). We have observed Thifluzamide to be effective in controlling rice sheath blight and therefore the fungicide can fit into resistance management system by integrating in spray schedules in potential rice growing tracts.

Keywords: Sheath blight, disease incidence, Fungicide

1. Introduction
Sheath blight caused by *Rhizoctoniasolani*Kühn (teleomorph: *Thanatephoruscucumeris* (A.B. Frank) Donk) is a major constraint (second only to rice blast) to rice production (Teng, Torres, Nuque, & Calvero, 1990), causing 5-10% yield losses in low land tropical Asia (Willocquet *et al.*, 2004). The pathogen has a wide host range and can infect more than 32 plant families and 188 genera (Srinivasachary, Willocquet, & Savary, 2011), often infecting legume crops grown in rotation with rice (Zou *et al*., 2000). The emergence of *R. solani* as economically important rice pathogen has been attributed to the intensification of rice cropping systems with the development of new short-stature, high-tillering, high-yielding varieties, high plant densities and increased level of fertilizers and other inputs (Chahal *et al*. 2003, Siddiq 1999) and these factors promote disease spread by providing favourable micro climatic condition due to dense leaf canopy with an increase leaf-to-leaf and leaf to- sheath contact (Savary *et al.* 1995). Both seedlings and adult plants are equally affected but loss is much more when the disease appears in seedlings. The older plants are attacked in flooded conditions and swampy rice fields (Dodman and Flentje 1970, Kannaiyan 1987, Shimamoto 1995). The infection and spread of disease before the flag leaf stage revealed 20% grain loss. Further, a strong relationship between the severity of symptom and yield reduction was reported among cultivars (Marchetti and Bollchi 1991). Sheath blight can be effectively controlled with the application of systemic fungicides. However, bio-fungicides and resistant varieties are the other options of control management but, are not *at par* with chemical control. These fungicides are very popular and are at the peak of its usage which may lead to reduced residual period and efficacy due to increased virulence of *R. solani*.

2. Materials and methods
The present investigation entitled "Evaluation of new fungicide against *R. solani*in rice." was conducted at the Molecular Plant Pathology, laboratory of Biotechnology,

College of Agricultural University, IGKV, Raipur (Chhattisgarh). During the course of study, potato dextrose agar was used for maintaining the culture of Rhizoctonia solani. Prior to use the glass wares were clened with labolin, rinsed with tap water and / or distilled water. The dried glass wares were sterilized in hot air oven at 180˚c for two hours. The forceps, inoculums needle and other metallic instrument were sterilized by dipping them in alcohol and heating over the flame of strip during isolation, multiplication and other studies. Media was sterilized by autoclaving at 121˚c and 15 psi for 30 min. Wherever required, glasswares of Borosil make and chemicals of standard make (Himedia, SD fine, Qualigens, Merck etc.) were used during the course of investigation.

1. Cleaning and sterilization of materials

Whenever required, the glasswares were cleaned with detergent powder, finally washed by cleaning solution and rinsed with tap water or distilled water. The dried glasswares were sterilized in hot air oven at 180ºC for two hours. The forceps and other metallic instrument were sterilized by heating over the spirit lamp flame after dipping them in alcohol. Sterilization of the media was done in general by autoclaving at 1.41 kg/cm2 for 20 min. All materials, except fungal culture, are to be sterilized or thoroughly clean with ethanol before use.

2. Media used

For each set of treatment, three replications were maintained in all *in vitro* studies. In general, 15 to 20 ml of potato dextrose agar (PDA) medium was poured in a petriplates and supplemented with Streptomycin sulphate in order to check the bacterial contamination. Composition of PDA is as follows. Potato Dextrose Agar (Riker and Riker, 1936) with the following composition was used.

Table 3.1: Chemical Composition of Fungicide

S. No.	Ingredient	Content
1.	Pealed potato	200 gm
2.	Dextrose	20 gm
3.	Agar- Agar	20 gm
4.	Distilled Water	1000 ml

The inoculated Petriplates were incubated in the BOD incubator at 27 + 20C for maximum period of 12 days.

3. Collection of disease specimen

Rice plants showing symptoms of sheath blight, was collected from the research farm of Indira Gandhi Agricultural University and from the adjoining farmers field. The diseased specimen were preserved for isolation and purification in brown paper bags.

3.1. Isolation of the fungus

A multinucleate compatible isolate of *R. solani* isolate Rice, belonging to the AG-1 IA anastomosis group was derived from naturally infected rice plant and was maintained on potato dextrose agar in the Molecular Plant Pathology Laboratory, Department of Plant Molecular Biology and Biotechnology laboratory, IGKV Raipur. The diseased samples were washed with tap water. Small pieces of infected parts containing healthy as well as diseased tissues were cut with the help of sterilized scalpel blade. These pieces were surface sterilized with 1 per cent Sodium hypochlorite solution for 1 minute with 3 subsequent changes in sterilized water to remove traces of the chemical. The pieces were than transferred aseptically to petridishes containing PDA and were incubated at 28 ± 2 ºC. The petri-plates were examined at regular intervals for fungal growth radiating from the infected pieces and were cultured on PDA slants. In all the inoculation studies, unless or otherwise mentioned, fresh sclerotia/mycelial mat of 7-9 days old culture was used. Culture was maintained on potato dextrose agar (PDA) (Difco) at 25 ˚C.

4. Pathogenicity of *R. solani* field isolates

The infection assays were conducted in the glass house on rice variety swarna which were raised in earthen pots during August, 2014, where congenial temperature and humidity were maintained for the development of the symptom. Pots were watered regularly. Field isolate was multiplied on PDA at 27□1 º C in petri dish till the formation of sclerotia. The 21-day old seedlings were inoculated by inserting sclerotia under sheath (in case of rice). The inoculated seedlings were kept separately and were provided sufficient moisture for the inoculum for infection. Observations were recorded at 7 days and 10 days after inoculation by measuring the lesion size or percentage of leaf area infected. Plants inoculated with progenies with positive reaction were sprayed with alcohol before discarding.

5 Fungicide used during the present investigation

Nine fungicide (Taqat, Captaf, Contaf Plus, Pulsor, Propiconazole, Ill-Hexacarb, Hexaconazole, Bavistin, and Folicur) were used to evaluate the efficacy against sheath blight disease. The different fungicide at recommended concentration (detailed elsewhere in result and discussion) in water (Taqat, Captaf, Contaf Plus, pulsor, Propiconazole, Hexacarb, Hexaconazole, and bavistin, Hexaconazole, Folicur) was sprayed with the help of hand sprayer. Plant of variety swarna were inoculated first and a day after the inoculated plants were sprayed with fungicides.

Table 3.2: Chemical composition of Fungicide

Sr.	Fungicide	Chemical composition
1	Taqat	Captan 70% +Hexaconazole 5% WP
2	Captaf	Captan 50% WP
3	Contaf Plus	Hexaconazole 5% SC
4	Pulsor	Thifluzamide 24% SC
5	Propiconazole	Propiconazole 25%EC
6	Iil-Hexacarb	Hexacarb
7	Hexaconazole	Hexaconazole 25% EC
8	Bavistin	Carbendazim 50%WP
9	Folicur	Tebuconazole25.9%EC

6. Inoculum Production

Multinucleate compatible isolate of *R. solani* isolate Rice, belonging to the AG-1 IA anastomosis was grown on potato dextrose agar at 28 ± 1 °C for 6 days for mass multiplication. Rice bran was easily obtained from rice mills. Rice bran supplemented with dextrose (@ 17g / kg), was moistened, thoroughly mixed and filled to 3/4th the volume of glass bottles. These were then sterilized at 121.60C for 45 minutes. Small bits of PDA blocks containing actively growing mycelium of *R solani* was inoculated in bottles containing pre-sterilized cooled rice bran and incubated at 250 ±1C. Growth of *R solani* appeared over night and the fungus completely colonized the rice bran within one week at 250 ±1C. No sclerotial were produced in the colonized rice bran. *R solani* colonized rice bran was harvested and pooled in a tray. Clumps in rice bran were formed due to colonization of

R solani and were further pulverized by passing them through a wire mesh. This resulted in the breaking of the mycelium into small fragments. Every particle of the pulverized rice bran was of uniform size and contained colonized mycelial bits of *R solani* and therefore served as inoculum.

7. Plant materials

7.1. Plant materials for fungicide evaluation

The experiment was laid in randomized block design with three replications. Twenty one days old seedlings of the test variety (Swarna) were transplanted in 5 x 2 Sq meter plots with a spacing of 60 c.m. between plot to plot and replication to replication. The fertilizer was applied at the rate of N120 P50 K0 kg/ha.

8. Inoculation Procedure

The method of inoculum deposition in our present investigation mimics high contact frequency between tissues essentially required for sheath blight epidemics. Considering the ease of maintaining uniformity of inoculum, the inoculation procedure was adopted for evaluation of new fungicide molecule on swarna and for QTL identification using RIL mapping population. Inoculation procedure is detailed as follows:

Thirty five days old plants were sprayed with water and the pulverized rice bran containing colonized mycelial bits of *R solani* were deposited uniformly by sieving over the wet leaf surface. The inoculum also got deposited near the base of the leaf adjacent to the leaf sheath or near the base of the plant. Wet plant surface not only helped the inoculum to stick but also immediately soaked it. The incubation period (IP) was estimated as the period from inoculation to appearance of approximately 50% water soaked lesions (Yeh and Bonman 1986). The size of lesions was assessed 96 h after inoculation.

At random 35 plant were assessed for disease incidence (by visual observation) and severity (measuring the lesion length and total sheath length). Disease severity was calculated as:

$$\text{Disease severity \%} = \frac{\text{Total lesion length}}{\text{Total sheath length}} \times 100$$

Result and discussion

Rice sheath blight, caused by the fungal pathogen *Rhizoctonia solani* Kuhn [Sexual stage: *Thanetophorus cucumeris* (Frank) Donk] is one of the major production constraints in rice-growing countries of the world. Under conditions favoring disease, up to 50% of grain yield may be lost (Marchetti and Bollich 1991). Control may be achieved with fungicides (Groth 2008) [6], but cost and the potential for development of pathogen resistance make plant genetic resistance preferable. If integrated properly in plant health management programs, they can prolong the useful life of both the resistance genes and the fungicides presently used. Nevertheless the issue prompted us to investigate Efficacy of fungicide application on sheath blight development in rice,

1. Inoculation method

Rice bran is commercially cheap and nutritionally rich carrier molecule, and can be very easily colonized by *R solani* and therefore can be used for mass multiplication. Colonized rice bran can deposited between the tillers of rice hills with at most ease by passing the inoculum through sieve. Rice bran displayed a unique characteristic that when moist becomes spongy and retains moisture for longer duration and induces mycelia growth and when dry the colonized mycelium in rice bran remains dormant and therefore mimics the natural process of sclerotial germination. Three rows of each rice germplasm was transplanted, which was 1 meter wide (5 rice hills / 1M row) with 20cm x 20 cm plant to plant and row to row distance. Plants at maximum tillering stage were inoculated with the inoculum (*R solani* colonized rice bran) by passing through a sieve (grids size of sieve: 3mm x 3mm). A rectangular sieve (internal dimension (L x W x H) 15"x 10"x 1") was filled with handful of inoculum and was held over each rice hill. By slightly rubbing action the inoculum in the sieve passed through the grids of the sieve. Approximately 2-3 gram of inoculum per hill was sieved. Because the sieve was held over the rice hill the inoculum got deposited / trapped between the tillers / at the base. Pulverized rice bran containing colonized mycelial bits of *R solani* bypassing through sieve resulted in uniform particulate distribution of colonized inoculum in the rice hill. Covering the inoculated plants with plastic shed net (90% density) is conditional and was done only if the sun light was intense. The inoculum got uniformly deposited on the soil, near the base of the tillers / in between tillers and also got trapped near the collar region (circular collar joins the leaf blade and the leaf sheath / region joining leaf blade and leaf sheath and from where ligule and auricles originates). Wet plant surface aids in attachment of the inoculum (*R solani* colonized rice bran) on the plant surface and also induce mycelial growth. Mycelial growth of *R. solani* from the inoculated rice bran was visible within 24 hours of incubation. The mycelial growth from the colonized rice bran mimic's the growth from primary source of inoculum under natural conditions (sclerotia etc).

The young mycelial growth originating from the colonized rice bran further spread to the adjacent tiller and was observed as runner hyphae. All the adjacent tillers of rice hill were entangled by runner hyphae. Growth of runner hyphae originating from inoculum induced lesions at the surface of rice tissue, established penetration structures to produce primary lesion. Growth of runner hyphae originating from this lesion at the surface of rice tissues, establishes penetration structures to produce a new (daughter) lesion (Ou 1985), (T W Mew 1991) and typical symptoms of sheath blight which were observed 96 hrs after inoculation. This refers to the progress of infection along a tiller, from its base to its upper leaves ('vertical spread' termed by Kozaka 1961) by means of expanding lesions or by means of short-range progress of, and infection by, mycelial structures of the fungus. Soon after 48 hours of inoculation the plots (4 x 4 meter) containing inoculated plants were sprayed with different fungicides (Table 4.1) and the control plots were sprayed with water. Observation on infection development (Total lesion length number of tillers infected per hill, sheath length) was recorded seven days after inoculation.

1.1 Efficacy of fungicides (in different concentration) on sheath blight disease development

Efficacy of fungicide on sheath blight incidence (no. of infected plants /35 observed)

It was observed that inoculated plants in the control plots showed higher frequency of infected tillers per hill as compared to inoculated and fungicide sprayed plants. Thirty five plants / hills were observed for sheath blight infection (Table 4.1). Unsprayed plants showed 100% sheath blight incidence. Fungicide sprayed plots in the order of their increasing frequency of number of plants infected out of 35 plants observed are as follows: Thifluzamide (Pulsor S)

(42µl/l)), Thifluzamide (Pulsor S) (52µl/l), Thifluzamide (Pulsor S) (62µl/l), Propiconazole (42µl, Taqat (6g/l), Thifluzamide (Pulsor S) (21µl/l), Thifluzamide (Pulsor S) (31µl/l), Hexacarb (1200µl/l), Hexacarb (2400µl/l). Hexaconazole containing fungicides (Taqat) as observed effective at a very high concentration 6g/l. The frequency of plants showing incidence of sheath blight ranged from 3 to 9 out of 35 observed. It was observed that Hexaconazole (1300 µl/l), Hexaconazole (Contaf) (1.5ml, 1ml, 2ml /l) and Hexaconazole containing fungicides (Taqat) (1g, 1.5g and 3g /l) had poor control over sheath blight incidence. Percent incidence of sheath blight in these fungicide sprayed plots ranged from 48.57 to 97.14 (Table 4.1). Similarly captan (2.10 and 1.34 g/l) and Hexacarb 800µl sprayed plots also showed higher incidence of sheath blight.

Table 4.1: Efficacy of different fungicide affecting the rice sheath blight incidence (no. of plants /35 observed)

S #	Fungicide	No of Plants		
		Observed	Infected	Incidence (%)
1	Thifluzamide (Pulsor S) 42µl	35	3	8.571429
2	Thifluzamide (Pulsor S) 52µl	35	3	8.571429
3	Thifluzamide (Pulsor S) 62µl	35	4	11.42857
4	Propiconazole 42µl	35	4	11.42857
5	Taqat 6g	35	4	11.42857
6	Thifluzamide (Pulsor S) 21µl	35	5	14.28571
7	Thifluzamide (Pulsor S) 31µl	35	5	14.28571
8	Hexacarb 1200µl	35	8	22.85714
9	Hexacarb 2400µl	35	9	25.71429
1	Hexacarb 1000µl	35	13	37.14286
2	Carbendazim (bavistin) 1000µl	35	14	40
1	Hexaconazole 1300µl	35	17	48.57143
2	Hexaconazole (Contaf) 1.5ml	35	34	97.14286
3	Hexaconazole (Contaf) 1ml	35	31	88.57143
4	Hexaconazole (Contaf) 2ml	35	33	94.28571
5	Tebuconazole 1000µl	35	30	85.71429
6	Taqat 1g/l	35	34	97.14286
7	Taqat 1.5g	35	32	91.42857
8	Taqat 3g/l	35	31	88.57143
1	Captan 2.10g	35	32	91.42857
2	Captan 1.34g	35	33	94.28571
3	Hexacarb 800µl	35	22	62.85714
1	Control-1	35	35	100
2	Control-1	35	35	100
3	Control-1	35	35	100

1.2. Efficacy of fungicide on sheath blight incidence (no. of infected tillers)

Hills exhibiting sheath blight infection were further evaluated for the number of tillers infected per hill. (Table 4.2). Quantitative data was generated by counting the number of tillers showing sheath blight symptoms per hill. (Table 4.2 and Fig 4.1). Fungicide sprayed plots in the order of their increasing frequency of number of tillers infected out of total number of tillers / plants observed are as follows: Thifluzamide (Pulser S) (62µl/l), Propiconazole (42µl/l), Thifluzamide (Pulser S) (31µl/l), Hexacarb (1200µl/l), Thifluzamide (Pulser S) (42µl/l), Hexacarb (1000µl/l), Thifluzamide (Pulser S) (21µl/l), Thifluzamide (Pulser S) (52µl/l), Taqat (6g/l), Hexacarb (2400µl/l). Frequency sheath blight infection was moderate (11.70 % to 22.06%) in fungicide sprayed plot in the order of increasing frequency for % of sheath blight incidence is s follows: Taqat (3g//l), Captan (2.10g/l), Carbendazim (bavistin) (1000µl/l), Taqat (1.5g/l), Hexacarb (800µl/l), Hexaconazole (Contaf) (1ml/l), Captan (1.34g/l), Hexaconazole (Contaf) (1.5ml/l), Taqat (1g/l, Hexaconazole (1300µl/l). Sheath blight incidence was very high in Tebuconazole (1000µl/l), Hexaconazole (Contaf) (2ml/l) sprayed plot with 40.94 and 41.67% infected tillers.

Table 4.2: Efficacy of different fungicide affecting the rice sheath blight incidence (no. of infected tillers /hill)

S #	Fungicide Treatment	No of plants infected /35	No of tillers	No of infected tillers infected	%
	Low sheath blight incidence				
1	Thifluzamide (Pulser S) 62µl	3	99	4	4.04
2	Propiconazole 42µl	4	79	4	5.06
3	Thifluzamide (Pulser S) 31µl	5	87	5	5.75
4	Hexacarb 1200µl	8	163	11	6.75
5	Thifluzamide (Pulser S) 42µl	3	59	4	6.78
6	Hexacarb 1000µl	15	281	20	7.12
7	Thifluzamide (Pulser S) 21µl	5	84	6	7.14
8	Thifluzamide (Pulser S) 52µl	3	54	4	7.41
9	Taqat 6g	28	573	49	8.55
10	Hexacarb 2400µl	9	152	13.8	9.08
	Moderate sheath blight incidence				
1	Taqat 3g/l	31	701	82	11.70
2	Captan 2.10g	33	730	86	11.78

3	Carbendazim (bavistin) 1000µl	14	246	36	14.63
4	Taqat 1.5g	32	688	104	15.12
5	Hexacarb 800µl	22	513	82	15.98
6	Hexaconazole (Contaf) 1ml	31	722	122	16.90
7	Captan 1.34g	33	685	135	19.71
8	Hexaconazole (Contaf) 1.5ml	35	711	143	20.11
9	Taqat 1g/l	35	706	142	20.11
10	Hexaconazole 1300µl	17	349	77	22.06
	High sheath blight incidence				
11	Tebuconazole (Folicur) 1000µl	30	596	244	40.94
12	Hexaconazole (Contaf) 2ml	33	672	280	41.67
13	Control	35	781	446	57.11
14	Control	35	709	433	61.07
15	Control	35	722	586	81.16

1.3. Efficacy of fungicide on sheath blight severity (lesion length)

Growth of runner hyphae originating from inoculum induced lesions at the surface of rice tissue, established penetration structures to produce primary lesion. Growth of runner hyphae originating from this lesion at the surface of rice tissues, establishes penetration structures to produce a new (daughter) lesion (Ou 1985), (T W Mew 1991) and typical symptoms of sheath blight which were observed 96 hrs after inoculation. This refers to the progress of infection along a tiller, from its base to its upper leaves ('vertical spread' termed by Kozaka 1961) by means of expanding lesions or by means of short-range progress of, and infection by, mycelial structures of the fungus. Quantitative data was generated for the expanding lesion by measuring the total lesion length and width and individual lesion length and width. Sheath blight severity was calculated in reference to lesion length and sheath length (Table 4.3 and Fig 4.1). No differences were observed for the lesion width (data not presented). It was observed that plots sprayed with Thifluzamide (Pulsor S) (31µl/l), Thifluzamide (Pulsor S) (52µl/l), Thifluzamide (Pulsor S) (42µl/l), Thifluzamide (Pulsor S) 62µl/l, and Hexacarb 2400µl/l affected the sheath blight development by reducing the total lesion length (minimum and maximum % sheath area infected ranged from min 2.73 to 6.00 and 13.64 to 12.50 respectively) affecting the vertical spread of the disease (Table 4.3). Rest of the other fungicides in different concentrations sprayed on the crop was not effective in reducing the vertical spread of the disease by reducing the lesion length (Table 4.3).

Table 4.3: Efficacy of different fungicide affecting the lesion length of sheath blight of rice.

S. #	Treatment	% sheath area infected		
		Min	Max	Avg
1	Thifluzamide (Pulsor S) 31µl	2.73	13.64	8.57
2	Thifluzamide (Pulsor S) 52µl	7.27	11.11	9.16
3	Thifluzamide (Pulsor S) 42µl	6.00	12.50	9.20
4	Thifluzamide (Pulsor S) 62µl	5.33	22.73	13.27
5	Hexacarb 2400µl	4.44	22.00	14.15
1	Hexacarb 800µl	4.00	50.00	19.03
2	Taqat 1.5g	5.56	62.50	22.84
3	Carbendazim (bavistin) 1000µl	6.15	33.33	17.53
4	Hexaconazole (Contaf) 1ml	6.67	77.78	36.02
5	Tebuconazole 1000µl	8.57	44.44	21.72
6	Taqat 3g/l	8.89	45.00	20.87
7	Captan 1.34g	8.89	41.67	21.12
8	Taqat 6g	8.89	55.56	22.51
9	Hexaconazole 1300µl	9.09	36.36	19.60
10	Propiconazole 42µl	9.09	41.67	22.12
11	Captan 2.10g	9.09	59.09	27.53
12	Hexacarb 1000µl	9.38	30.00	19.48
13	Control	10.00	55.56	23.62
14	Hexaconazole (Contaf) 2ml	10.00	78.57	37.85
15	Control	11.61	66.67	30.41
16	Hexaconazole (Contaf) 1.5ml	11.67	50.00	25.89
17	Control	12.50	63.64	28.21
18	Taqat 1g/l	12.50	61.11	34.41
19	Hexacarb 1200µl	13.00	30.71	21.20
20	Thifluzamide (Pulsor S) 21µl	14.29	20.00	16.99

Thifluzamide is a member of the carboxamide class of fungicides which is single-site inhibitors of the succinate ubiquinone reductase or succinate dehydrigenase (Sdh) complex in the respiratory chain (FRAC 2007) [4] interfere with fungal respiration via their inhibitory effect on succinate dehydrogenase within the tricarboxylic acid cycle. (O'Reilly 1995). This compound was reported effective against Basidiomycete fungi in particular along with efficacy on some Ascomycetes and *Rhizoctoniasolani*. This molecule is registered for use in rice, turf, potatoes, coffee and strawberries in Brazil, Mexico, Colombia, Venezuela, Japan, Korea, China and Vietnam. Since, no fungicide has been registered with this unique modes of action for the control of sheath blight of paddy, Thifluzamide can fit into resistance

management system by integrating in spray schedules in potential rice growing tracts.

In a rice ecosystem, in each season, more than one disease is observed and hence new fungicidal groups like oryzastrobinQol are gaining importance as they are broadspectrum fungicides providing effective control against rice sheath blight and blast (Stammler *et al*. 2007). However, the broad spectrum fungicides may not give sufficient protection when the disease severity is very high. At present the ruling chemicals viz Hexaconazole, Propiconazole, Validamycin, Carbendazim which are extensively used for the management of sheath blight disease (Chien and Chu 1973, Wakae and Matsura 1975, Viswanathan and Mariappan 1980a, b, Das and Mishra 1990 [3], Van Eechout *et al*. 1991). Further, laboratory studies on two isolates of R. solani from rice and potato showed significant variation in response to different concentrations of fungicides (carbendazim, carboxin, pencycuron, Propiconazole and Validamycin) (Thind and Aggarwal 2005) [12]. Lore *et al*. (2005), Biswas (2002) evaluated and reported effectiveness of new fungicide Pencycuron (Moncern 250 EC) against rice sheath blight in Punjab and West Bengal.

Conclusion

Efficacy of fungicide application on sheath blight development in rice

1. Inoculated plants in the plots were sprayed with the fungicide Thifluzamide (Pulsor S) (31µl/l), Thifluzamide (Pulsor S) (52µl/l), Thifluzamide (Pulsor S) (42µl/l), Thifluzamide (Pulsor S) 62µl/l, and Hexacarb 2400µl/l affected the sheath blight development by reducing the number of plants, tillers showing sheath blight incidence. These fungicides were also effective in reducing the lesion length and therefore identified as most effective fungicide in reducing the sheath blight infections.
2. Application of Captan, Carbendazim, Hexaconazole, Tebuconazole did not reduced sheath blight incidence and therefore not suitable for the management of sheath blight of rice.

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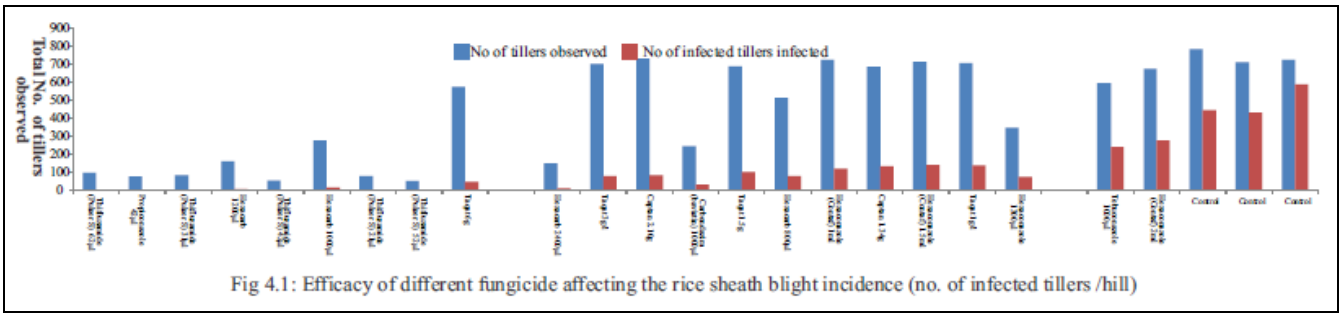

Fig 4.1: Efficacy of different fungicide affecting the rice sheath blight incidence (no. of infected tillers /hill)

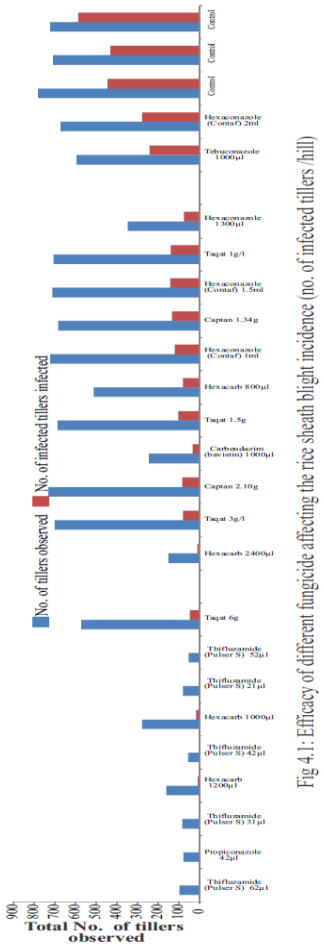

Fig 4.1: Efficacy of different fungicide affecting the rice sheath blight incidence (no. of infected tillers /hill)

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