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Evaluation of fungicide against sheath blight (*Rhizoctonia solani*) of Rice

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Abstract
Rice (*Oryza sativa* L.) is an important target to provide stable food and food security to millions population of the world and is one of the main foodstuffs in Asia. Rice affected by quite a lot of diseases among them Sheath blight, caused by *Rhizoctonia solani* Kunh., is a soil borne disease of rice occurs in all rice production regions of the world. In the present study aimed to test the efficacy of Carbendazim 50 % WP for the control of rice sheath blight disease. Two field trials were conducted in the rice variety BPT-5204 at Ettimadai village, Namakkal district during the year 2017-2018.The results of the present study revealed that the fungicide formulations were applied as foliar application @ 250, 500 and 650 g / ha could reduce the progress of sheath blight disease by 6.08, 6.19 and 6.35 per cent respectively when compared to untreated control (26.82 PDI). The test molecule Carbendazim 50% WP @ 650 g/ha which was on par with Carbendazim 50% WP @ 500 and 250 g/ha. Among the different treatments, Carbendazim 50%WP @.650g/ha recorded significantly highest grain yield of 9.00 t/ha which was on par with Carbendazim 50%WP @ 500 g/ha (8.85 t/ha) and 250 g/ha (8.76 t/ha). The market sample Carbendazim 50 % WP @ 500 g/ha recorded grain yield of 8.79 t/ha which was on par result with market sample of Carbendazim 50%WP@ 250 g/ha (8.70 t/ha). However, control recorded the lowest grain yield (4.56 t/ha). Similar trend in efficacy was observed with regard to per cent disease index and grain yield on second season Further, Carbendazim 50%WP @500 and 1000 g/ha tested for its phytotoxicity studies did not shows any phytotoxic symptoms like leaf injury, wilting, vein clearing, necrosis, epinasty and hyponasty from 1, 3, 5, 7 and 9 days after spraying with fungicide on rice plants.

Keywords: Sheath blight, disease incidence, grain yield, fungicide

1. Introduction
Rice (*Oryza sativa* L.) is an important food crop of the world including India. Ever growing population in the world particularly in India is further demanding more rice production and continuous reduction in the availability of cultivable land demanding higher productivity. Rice is grown in an area of 431.94 lakhs ha with an annual production of 110.15 million ton (Anonymous, 2016-2017) [1]. Gangopadyay and Chakrabarti (1987) [6] reported that among the various diseases limiting rice productivity, blast (causal organism: *Pyricularia oryzae* cavara.) and sheath blight (causal organism: *Rhizoctonia solani* Kühn,) continues to be an enigmatic problem in several rice growing ecosystems of the world especially in intensive production systems (Otorno, 1989, Savary *et al*. 1994) [11, 14]. Prasanna Kumar and Veerabhadraswamy (2014) [13] reported that total yield loss due to diseases in rice, 35% is by blast, 25% by sheath blight 20% by BLB, 10% by tungro and remaining 10% by other diseases.
The fungus *Rhizoctonia solani* produced usually long cells of septate mycelium which are hyaline within young, yellowish brown. It produced large number of globose sclerotia which initially turn white, late turn brown to purplish brown. Sclerotia as a major source of primary inoculum. The pathogen has a wide host range and can infect more than 32 plant families and 188 genera (Srinivasachary *et al*. 2011) [16], often infecting legume crops grown in rotation with rice (Zou *et al*., 2000) [21]. 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 (Kannaiyan 1987, Shimamoto 1995) [8, 15]. 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) [10]. Breeding for resistance through effective method has not succeeded due to lack of suitable clones. So far complete resistance source has not been found against this fungus, mainly because resistance is governed by quantitative trait loci (QTL), i.e. controlled by polygenes. Hence, fungicide based management of sheath blight diseases is successful at filed level in majority of the cases (Pramesh *et al*., 2017) [12]. Sheath blight disease 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.* In the present study was undertaken to test the field efficacy of Carbendazim 50%WP as foliar application on sheath blight disease and grain yield of rice under field conditions.

2. Materials and Methods

The experiment was laid out in Randomized Block Design (RBD) at the farmer's fields of Ettimadai village, Namakkal districts during 2017-2018. A popular rice variety BPT5204 which is susceptible to sheath blight disease was used for the study. Seeds were sown in the month of July and planted in August. Before sowing, healthy seeds were water soaked overnight and incubated in the gunny bags for better sprouting in the nursery. The land was prepared by puddling method by applying one ploughing followed by two ploughing after one week. The experiment was laid out in RBD with a plot size of 5 × 5 m each for all treatments. Seedlings of 30 days old were planted in trail plots at 20 ×20 cm spacing. The crop was supplied fertilizers as per recommendations mentioned in Package of Practices for field crops. The RBD experiment comprises of six treatments and four replications. The treatment details are listed below.

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S. No.	Treatment	Formulation dose (g/ ha)	Method of Application	Dilution in water (lit/ha)
T_1	Carbendazim 50 % WP	100	Foliar spray	750
T_2	Carbendazim 50 % WP	250	Foliar spray	750
T_3	Carbendazim 50 % WP	500	Foliar spray	750
T_4	Carbendazim 50 % WP	650	Foliar spray	750
T_5	Market sample-Carbendazim 50 % WP	250	Foliar spray	750
T_6	Market sample Carbendazim 50 % WP	500	Foliar spray	750
T_7	Control	-	-	-
T_8	Carbendazim 50 % WP (Only for phytotoxicity)	1000	Foliar spray	750

Bio-efficacy was evaluated by spraying all the test chemicals twice at 15 days interval starting from the initiation of the disease.

2.1 Disease assessment and statistical analysis

Fourteen days after the fungicide application disease assessment was carried out. The disease was measured using the disease rating scale of 0-9 developed by International Rice Research Institute (IRRI, 1996) [7] for sheath blight disease. The details are given below.

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Grade	Symptoms
0	No incidence
1	Less than 1% sheath area affected
3	1-5% sheath area affected
5	6-25% sheath area affected
7	26-50% sheath area affected
9	51-100% sheath area affected

Further, the scored data was converted into per cent disease index (PDI) using formula given below. The data on the yield were recorded by marking 3 x 2 m section within each plot using a wire frame as described by (IRRI 1996) [7] and tillers within the frame were cut and harvested in order to determine the yield. Data from 2017 and 2018 seasons were pooled to get the average PDI and yield values. Subsequently, the data on disease severity and yield parameters were subjected to appropriate statistical analysis.

3. Results and Discussion

3.1 Efficacy of Carbendazim 50%WP on rice sheath blight (%) and grain yield on rice season-I and II

The data presented in Table 1 shows that the fungicide formulations were applied as foliar application @ 250, 500 and 650 g / ha could reduce the progress of sheath blight disease by 6.08, 6.19 and 6.35 per cent respectively when compared to untreated control (26.82 PDI). The test molecule Carbendazim 50% WP @ 650 g/ha which was on par with Carbendazim 50% WP @ 500 and 250 g/ha. The market sample Carbendazim 50% WP @ 250 g/ha recorded 6.22 PDI which was on par with Carbendazim 50 % WP market sample @500 g/ha with 6.44 PDI.

Among the different treatments, Carbendazim 50%WP @.650g/ha recorded significantly highest grain yield of 9.00 t/ha which was on par with Carbendazim 50%WP @ 500 g/ha (8.85 t/ha) and 250 g/ha (8.76 t/ha). The market sample Carbendazim 50 % WP @ 500 g/ha recorded grain yield of 8.79 t/ha which was on par result with market sample of Carbendazim 50%WP@ 250 g/ha (8.70 t/ha). However, control recorded the lowest grain yield (4.56 t/ha). Similar trend in efficacy was observed with regard to per cent disease index and grain yield on second season trials by different treatments (Table 2).

Table 1: Efficacy of Carbendazim 50%WP against rice sheath blight on rice: I Season (July-November 2017)

S. No.	Treatment	Dose (g/ha)	Sheath blight (PDI)				% Disease reduction over control	Grain yield (t/ha)
			Before spray	Before 2nd Spray	Before 3rd spray	15 days after 3rd spray		
T_1	Carbendazim 50 % WP	100	2.03(8.19)	5.69(13.80)	8.20(16.63)	10.02(18.45)	62.63	6.01(3.44)
T_2	Carbendazim 50 % WP	250	2.00(8.13)	3.28(10.43)	5.56(13.63)	6.35(14.59)	76.32	8.76(5.02)
T_3	Carbendazim 50 % WP	500	2.01(8.15)	3.16(10.23)	5.23(13.22)	6.19(14.40)	76.92	8.85(5.16)
T_4	Carbendazim 50 % WP	650	2.04(8.21)	3.10(10.14)	5.14(13.10)	6.08(14.27)	77.33	9.00(4.99)
T_5	Market sample-Carbendazim 50 % WP	250	2.02(8.17)	3.56(10.87)	5.72(13.83)	6.44(14.70)	75.98	8.70(5.04)
T_6	Market sample Carbendazim 50 % WP	500	2.05(8.23)	3.20(10.30)	5.28(13.28)	6.22(14.44)	76.90	8.79(2.61)
T_7	Control	-	2.06(8.25)	10.51(18.91)	20.64(27.02)	26.82(31.19)	-	4.56(12.32)
	SEd±	-	0.01	0.08	0.21	0.16	-	0.11
	CD@ 5%	-	0.02	0.19	0.43	0.28	-	0.25

* Mean of four replications. DAT – Days after Treatment. PDI - Per cent Disease Index.
Values in the parentheses are arc sine transformed values.

Table 2: Efficacy of Carbendazim 50%WP against rice sheath blight on rice: II Season (July-November 2018)

S. No.	Treatment	Dose (g/ha)	Sheath blight (PDI)				% Disease reduction Over control	Grain yield (t/ha)
			Before spray	Before 2nd Spray	Before 3rd spray	15 days after 3rd spray		
T_1	Carbendazim 50 % WP	100	1.26(6.44)	5.13(13.09)	7.35(15.73)	8.52(16.97)	62.36	6.93(3.97)
T_2	Carbendazim 50 % WP	250	1.27(6.47)	2.52(9.13)	4.62(12.41)	5.92(14.08)	73.85	9.00(5.16)
T_3	Carbendazim 50 % WP	500	1.24(6.39)	2.46(9.02)	4.57(12.34)	5.78(13.91)	74.46	9.10(5.22)
T_4	Carbendazim 50 % WP	650	1.22(6.34)	2.42(8.94)	4.52(12.27)	5.68(13.78	74.91	9.14(5.24)
T_5	Market sample-Carbendazim 50 % WP	250	1.25(6.41)	2.64(9.35)	4.95(12.85)	6.12(14.32)	72.96	8.87(5.08)
T_6	Market sample Carbendazim 50 % WP	500	1.26(6.44)	2.55(9.18)	4.59(12.37)	5.85(13.99)	74.16	9.05(5.19)
T_7	Control	-	1.23(6.36)	8.7617.21)	17.64(24.83)	22.64(28.41)	-	4.80(2.75)
	SEd±	-	0.01	0.04	0.05	0.11	-	0.07
	CD@ 5%	-	0.02	0.11	0.12	0.26	-	0.16

* Mean of four replications. DAT – Days After Treatment. PDI - Per cent Disease Index.
Values in the parentheses are arc sine transformed values.

Pramesh *et al*. (2016) [12] recorded that the combination fungicide Trifloxystrobin 25% + Tebuconazole 50% (Nativo 75 WG) @ 0.4 g/l was found effective against blast and sheath blight diseases recording least Percent Disease Index (PDI) of 17.02 and 24.7 respectively. Recently, Ashok kumar *et al*. (2018) [2] reported that 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.

3.2 Phytotoxic effect of Carbendazim 50%WP on rice

Carbendazim 50%WP @500 and 1000 g/ha tested for its phytotoxicity studies did not shows any phytotoxic symptoms like leaf injury, wilting, vein clearing, necrosis, epinasty and hyponasty from 1, 3, 5 , 7 and 9 days after spraying with fungicide (data not shown).Among the fungicides evaluated, tricyclazole 45% + hexaconazole 10% WG @1g/l was significantly effective in controlling the disease severity of sheath blight and neck blast with PDI of 10.36 and 9.78 and an yield of 5954 kg/ha as against a PDI of 65.18 and 61.06 and yield of 3061 kg/ha in untreated control. Tricyclazole 45% + hexaconazole 10% WG at higher concentration did not show any symptoms of phyto-toxicity till 15 days after application (Chethana, 2018) [4].

In a rice ecosystem, in each season, more than one disease is observed and hence new fungicidal groups like Carbendazim are gaining importance as they are broad spectrum fungicides providing effective control against rice sheath blight and blast (Stammler *et al*., 2007) [17]. However, the broad spectrum fungicides may not give sufficient protection when the disease severity is very high. At present the ruling chemicals such as Hexaconazole, Propiconazole, Validamycin, Carbendazim which are effectively used for the management of sheath blight disease (Viswanathan and Mariappan, 1980, Das and Mishra, 1990, Van Eechout *et al*. 1991) [20, 5, 19]. Further, laboratory studies on two isolates of *R. solani* from rice and potato showed significant variation in response to different concentrations of fungicides tested (carbendazim, carboxin, pencycuron, Propiconazole and Validamycin) (Thind and Aggarwal, 2005) [18]. Lore *et al*. (2005) [9], Biswas (2002) [3] evaluated and reported effectiveness of new fungicide Pencycuron (Moncern 250 EC) against rice sheath blight in Punjab and West Bengal. The above results lend support to the present findings.

4. Conclusion

Rice plants sprayed with Carbendazim 50%WP @250-500g/ha can be effectively reduced the incidence of sheath blight disease caused by *Rhizoctonia solani* along with significant increase in grain yield. These fungicides were also effective in reducing the lesion length and therefore identified as most effective fungicide in reducing the sheath blight infections. Further, these fungicides were tested at higher concentration did not show any phytotoxicity symptoms on rice plants. Hence, Carbendazim 50%WP @@250-500g/ha may be recommended for the management of rice sheath blight disease.

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