

Original Research Article

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## Comparative Efficacy of Some Non Systemic Fungicides against Rice Sheath Blight (*Thanatephorus cucumeris*)

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### ABSTRACT

Six fungicides viz., captan 50 WP, copper oxychloride 50 WP, dodine 65 WP, mancozeb 75 WP, propineb 70 WP and zineb 80 WP were evaluated against rice sheath blight (*Thanatephorus cucumeris*). The *in-vitro* evaluation of these fungicides through poisoned food technique at five different concentrations viz., 50, 100, 200, 500 and 1000 µg a.i ml<sup>-1</sup> indicated that mancozeb proved the most effective exhibiting mean mycelial growth inhibition of 95.26 per cent followed by captan and dodine with 93.80 and 93.66 per cent, respectively. Copper oxychloride proved least effective and resulted in only 44.08 per cent mean inhibition of mycelial growth. Maximum mean inhibition of sclerotial germination was exhibited by mancozeb (51.33%) followed by captan (45.06%) while dodine and propineb caused only 41.20 and 33.86 per cent mean inhibition of sclerotial germination, respectively. Copper oxychloride proved least effective causing 2.44 per cent mean inhibition of sclerotial germination only. In field evaluation, three foliar sprays of each fungicide at their recommended concentrations, separately applied at tillering, booting and post flowering stages of rice cultivar K-448 (Jhelum), revealed that mancozeb 75 WP was most efficacious and reduced the mean disease incidence and disease intensity from 40.00 and 19.15 per cent in unsprayed check to 18.50 and 6.98 per cent, respectively, and increased the grain yield from 5.10 t ha<sup>-1</sup> in unsprayed check to 6.25 t ha<sup>-1</sup>, providing an increase of 22.54 per cent over control. Captan 50 WP was next in efficiency and resulted in mean disease incidence of 21.50 and mean disease intensity of 8.24 per cent and a mean grain yield of 6.05 t ha<sup>-1</sup>, providing an increase in grain yield of 18.62 per cent. The other fungicides in order of their decreasing efficacies were dodine 65 WP, propanib 70 WP and zineb 80 WP which resulted in mean disease incidence of 24.25, 25.25 and 27.00 per cent, disease intensity of 8.55, 9.26 and 9.72 per cent and a mean grain yield of 5.95, 5.80 and 5.65 t ha<sup>-1</sup> with an increase in grain of 16.66, 13.72 and 10.78 per cent, respectively. Copper oxychloride 50 WP proved least efficacious, exhibiting disease mean incidence of 32.00 per cent and mean disease intensity of 11.99 per cent and a grain yield of 5.45 t ha<sup>-1</sup>, with lowest increase in grain yield of 6.86 per cent only.

#### Keywords

Evaluation, Sheath blight, Fungicides, rice, *Thanatephorus cucumeris*

#### Article Info

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### Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop of India. It is staple food crop of Jammu and Kashmir where it occupies 261.35 thousand hectare area with an annual

production of 5001 thousand tonnes in 2011 (Kaloo *et al.*, 2014). The crop is attacked by a number of fungal, bacterial and viral diseases, which inflict heavy yield losses every year.

Among the fungal diseases, the rice blast (*Pyricularia grisea*), rice sheath blight (*Thanatephorus cucumeris*) and brown leaf spot (*Helminthosporium oryzae*) are most important and potentially damaging in Jammu and Kashmir. Sheath blight of rice has attained the status of a major disease in the recent past from what was described as a minor disease by Ramakrishna (1971). The disease has wide geographic distribution and now occurs throughout the temperate and tropical rice production areas, being most prominent where rice is grown under intense, high fertility production system (Eizenga *et al.*, 2002). Sheath blight of rice was first reported in India by Paracer and Chahal (1963), while from Kashmir it was reported by Mir (1986).

The sheath blight of rice caused by *Thanatephorus cucumeris* [Anamorph: *Rhizoctonia solani* Kuhn] is one of the important biological constraints in achieving the stable rice production. The disease can result in yield losses ranging from 20-50 per cent (Rajan, 1987). However, under conditions of heavy severity, yield loss of more than 70 per cent has been reported from Chennai, India (Baby, 1992), and even complete crop failure has also been reported in Vietnam (Ou, 1992).

One of the major causes for the increased incidence of this disease has been ascribed to the introduction and wide spread cultivation of high yielding fertilizers responsive varieties producing maximum number of productive tillers per unit area of field, thus creating conditions of increased relative humidity and prolonged leaf wetness and therefore, making the crop more vulnerable to the attack by the pathogen. The presently cultivated rice varieties do not possess desirable levels of resistance and require support of frequent applications of fungicides. Therefore, an attempt was made to evaluate

some non-systemic fungicides against the disease and the results are presented herein.

## Materials and Methods

The fungicide was evaluated against rice sheath blight (*T. cucumeris*) *in-vitro* and in the field.

### *In-vitro* evaluation

The test fungicides were evaluated at 50, 100, 250, 500 and 1000 µg a.i ml<sup>-1</sup> through poisoned food technique (Carpenter, 1942) using potato dextrose agar medium for their effects on inhibition of mycelial growth and sclerotial germination of *Thanatephorus cucumeris*. The required concentrations of fungicides were prepared by adding appropriate amount of fungicides to sterilized molten PDA medium in conical flasks. Thirty ml of such amended PDA was aseptically poured in sterilized Petri plates. A 5 mm diameter mycelial disc of *T. cucumeris* was aseptically placed in the centre of each Petri plate. Petri plates containing PDA media amended with equal amount of sterilized distilled water and inoculated with mycelial disc of *T. cucumeris* (5 mm diameter) served as check. Each treatment was replicated thrice and incubated at 28±2° for 48 hrs. The comparative efficacy of fungicides was calculated as per cent inhibition of mycelial growth of the test fungus in each treatment as compared to check by the following formula:

$$\text{Per cent mycelial Growth inhibition} = \frac{C - T}{C} \times 100$$

Where

C = Radial mycelial growth (mm) in check  
T = Radial mycelial growth in the treatment (mm)

Fungicides were also evaluated against inhibition of sclerotial germination of *Thanatephorus cucumeris*. The sclerotia of *T. cucumeris* from 7 days old culture were used. Twenty five sclerotia were used in each treatment and each treatment was replicated thrice. The inhibition of sclerotial germination was recorded after 48 hours and percentage of inhibition of sclerotial germination was recorded as per formula given below:

Inhibition of sclerotial Germination (%) =

$$\frac{\text{No. of un-germinated sclerotial}}{\text{Total no. of sclerotia}} \times 100$$

### Field evaluation

Thirty-day old seedlings of rice variety 'Jhelum' (K-448) were transplanted in 5 x 2 m plots in randomized block design replicating the treatments thrice. Three sprays of each fungicide at their recommended concentrations were applied separately at maximum tillering, booting and post flowering stages of crop growth. Treatments where only water was sprayed served as check for all the experiments. Observations on disease incidence and disease intensity were recorded ten days after the last spray (Vihol *et al.*, 2009), whereas the observation on grain yield were recorded at harvest and expressed in tonnes per hectare.

### Results and Discussions

Six fungicides were evaluated *in vitro* for inhibition of mycelium growth and inhibition of sclerotial germination of the pathogen (*T. cucumeris*).

#### Effect on mycelial growth inhibition

The data (Table 1) revealed that all the test

fungicides significantly inhibited the mycelial growth at all the test concentrations. On an overall mean basis, mancozeb 75 WP proved most effective exhibiting mean mycelial growth inhibition of 95.26 per cent followed by captan 50 WP and dodine 65 WP with 93.80 and 93.66 per cent mean inhibition of mycelial growth while propineb and zineb caused 83.99 and 78.33 per cent mean inhibition of mycelial growth, respectively. Copper oxychloride proved least effective resulting in only 44.08 per cent mean inhibition of mycelial growth. In general, the efficacy of fungicides varied significantly with change in fungicide concentration. At 50 µg a.i ml<sup>-1</sup> concentration, the mean mycelial growth inhibition was 66.83 per cent which increased to 72.06, 79.16, 92.98 and 96.56 per cent at 100, 250, 500 and 1000 µg a.i ml<sup>-1</sup> concentrations, respectively.

The highest mycelial growth inhibition at 50 µg a.i ml<sup>-1</sup> concentration was exhibited by mancozeb 75 WP exhibiting 88.33 per cent mean mycelial inhibition followed by captan 50 WP and dodine 65 WP, each causing 85.00 per cent mean mycelial inhibition while copper oxychloride 50 WP was least efficacious and resulted in only 9.33 per cent mean mycelial inhibition. Similar pattern in efficacy was recorded by all the fungicides at higher concentrations. Mancozeb 75 WP, captan 50 WP, dodine 65 WP and propineb 70 WP completely inhibited the mycelial growth at 500 µg a.i ml<sup>-1</sup> concentration followed by zineb 80 WP with 91.66 per cent mycelial inhibition, while copper oxychloride 50 WP caused least mycelial growth inhibition (66.25%) at the same concentration.

At 1000 µg a.i ml<sup>-1</sup> concentration, 100.00 per cent mycelial growth inhibition was again caused by mancozeb 75 WP, captan 50 WP, dodine 65 WP and propineb 70 WP followed by zineb 80 WP (95.00%) while copper oxychloride 50 WP was least effective and

resulted in only 84.41 per cent inhibition at the same concentration.

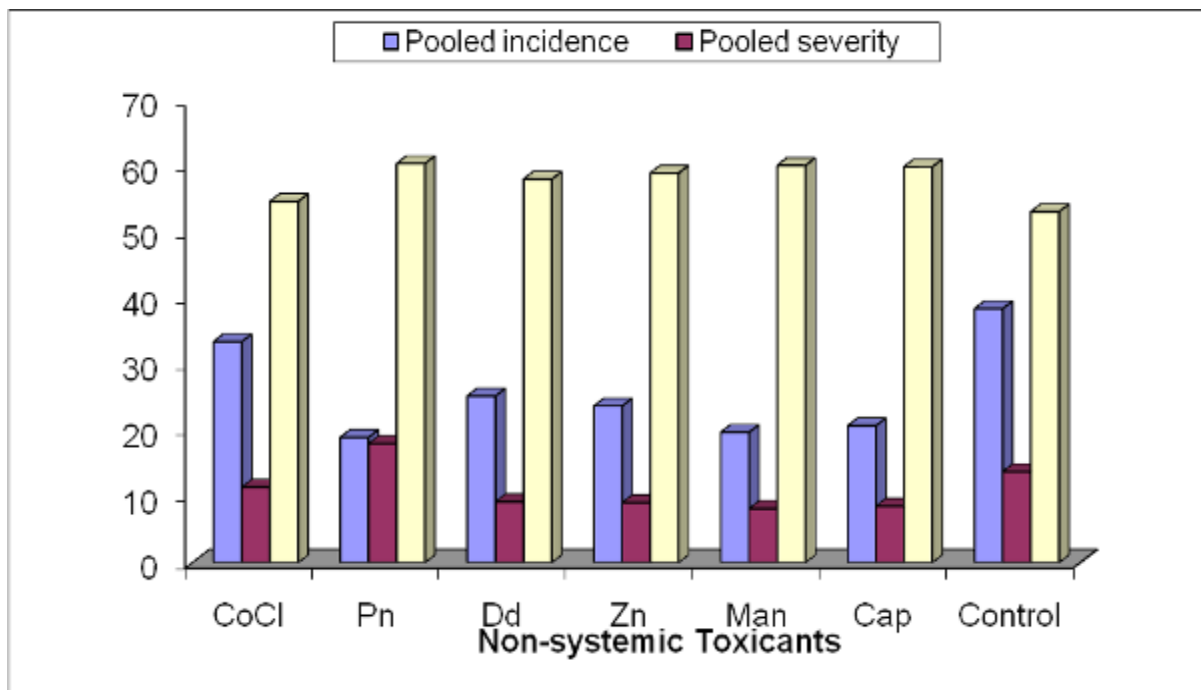
**Effect on inhibition sclerotial germination**

The data (Table 1) revealed that mancozeb 75 WP resulted in highest overall mean inhibition (51.33%) of sclerotial germination followed by captan 50 WP (45.06%) while dodine 65 WP and propineb 70 WP caused 41.20 and 33.86 per cent mean inhibition of sclerotial germination, respectively. Copper oxychloride 50 WP provided least mean inhibition of sclerotial germination (2.44%).

In general, the efficacy of fungicides varied significantly with change in fungicide concentration. At 50 µg a.i ml<sup>-1</sup> concentration, there was no inhibition of sclerotial germination. However, at 100 µg a.i ml<sup>-1</sup>, mean inhibition of sclerotial germination was 9.22 per cent which increased to 28.44, 52.22 and 79.61 per cent at 250, 500 and 1000 µg a.i ml<sup>-1</sup> concentrations, respectively. The highest mean inhibition of sclerotial germination at 100 µg a.i ml<sup>-1</sup> concentration was exhibited by mancozeb 75 WP exhibiting 29.33 per cent

mean mycelial inhibition followed by propineb (26.00%) while no other fungicide was capable of causing any inhibition in sclerotial germination at this concentration. At 250 µg a.i ml<sup>-1</sup>, mancozeb and captan, each caused highest inhibition of sclerotial germination of 46.67 per cent, followed by dodine (35.33%) and propined (34.67%).

Similar pattern in efficacy was recorded by all the fungicides at higher concentrations. Mancozeb caused 80.67 per cent inhibition in sclerotial germination at 500 µg a.i ml<sup>-1</sup> followed by captan 50 WP (78.67%), dodine 65 WP (70.67%) and propineb 70 WP (47.33%). Completely inhibition of sclerotial germination was caused by mancozeb, captan and dodine at 1000 µg a.i ml<sup>-1</sup> concentration while propineb and zineb caused 61.33 and 50.67 per cent inhibition of sclerotial germination. Copper oxychloride caused lowest inhibition of sclerotial germination of 12.33 per cent at 1000 µg a.i ml<sup>-1</sup> concentration while no inhibition of sclerotial germination was recorded below this concentration.







**Table.1** Evaluation of systemic fungicides against inhibition of mycelial growth and sclerotial germination

Fungitoxicant	Per cent Inhibition of mycelial growth at					Mean	Per cent Inhibition of sclerotial germination at					Mean
	conc. ( $\mu\text{g a.i. ml}^{-1}$ )						conc. ( $\mu\text{g a.i. ml}^{-1}$ )					
	50	100	250	500	1000		50	100	250	500	1000	
Captan	85.00 (67.21)	87.33 (69.17)	96.67 (79.52)	100.00 (90.00)	100.00 (90.00)	<b>93.80</b> <b>(79.58)</b>	0.00 (0.33)	0.00 (0.33)	46.67 (43.08)	78.67 (62.49)	100.00 (0.00)	<b>45.06 (39.11)</b>
Copper oxychloride	9.33 (17.78)	23.75 (29.16)	30.67 (36.44)	66.25 (54.48)	84.41 (67.83)	<b>44.08</b> <b>(41.14)</b>	0.00 (0.33)	0.00 (0.33)	0.00 (0.33)	0.00 (0.33)	12.33 (20.55)	<b>2.44 (19.03)</b>
Dodine	85.00 (67.21)	90.00 (71.56)	93.33 (75.05)	100.00 (90.00)	100.00 (90.00)	<b>93.66</b> <b>(78.76)</b>	0.00 (0.33)	0.00 (0.33)	35.33 (36.47)	70.67 (57.21)	100.00 (90.00)	<b>41.20 (36.73)</b>
Mancozeb	83.33 (70.02)	91.66 (72.88)	96.66 (79.52)	100.00 (90.00)	100.00 (90.00)	<b>95.26</b> <b>(80.48)</b>	0.00 (0.33)	29.33 (32.79)	46.67 (43.08)	80.67 (63.93)	100.00 (90.00)	<b>51.33 (45.76)</b>
Propineb	70.00 (56.78)	73.33 (58.90)	76.67 (61.11)	100.00 (90.00)	100.00 (90.00)	<b>83.99</b> <b>(71.36)</b>	0.00 (0.00)	26.00 (30.65)	34.67 (36.06)	47.33 (43.46)	61.33 (51.55)	<b>33.86 (32.25)</b>
Zineb	63.33 (52.73)	66.67 (54.73)	75.00 (59.99)	91.66 (73.22)	95.00 (77.08)	<b>78.33</b> <b>(63.55)</b>	0.00 (0.33)	0.00 (0.33)	7.33 (15.65)	36.00 (36.87)	50.67 (45.38)	<b>18.80 (19.58)</b>
<b>Mean</b>	<b>66.83</b> <b>(55.29)</b>	<b>72.06</b> <b>(58.09)</b>	<b>79.16</b> <b>(62.84)</b>	<b>92.98</b> <b>(81.28)</b>	<b>96.56</b> <b>(84.15)</b>	-	<b>0.00</b> <b>(0.33)</b>	<b>9.22</b> <b>(10.57)</b>	<b>28.44</b> <b>(29.06)</b>	<b>52.22</b> <b>(43.99)</b>	<b>79.61</b> <b>(63.15)</b>	
<b>CD (P=0.05)</b>						<b>CD (P=0.05)</b>						
<b>Fungitoxicant</b>	=	<b>(1.4)</b>				<b>Fungitoxicant</b>	=	<b>(0.51)</b>				
<b>Concentration</b>	=	<b>(1.05)</b>				<b>Concentration</b>	=	<b>(0.47)</b>				
<b>Fungitoxicant x concentration</b>	=	<b>(3.54)</b>				<b>Fungitoxicant x concentration</b>	=	<b>(0.15)</b>				

\*Mean of three replications; in case of inhibition sclerotoial germination 50 sclerotia/replication were observed; Figures within parentheses are angular transformed values

**Table.2** Field evaluation of some non-systemic against rice sheath blight

Fungitoxicant	Conc. (%)	Sheath blight incidence (%)		Mean	Sheath blight intensity (%)		Mean	Yield (t ha <sup>-1</sup> )		Mean	Increase in yield over control (%)
		1 <sup>st</sup> year	2 <sup>nd</sup> year		1 <sup>st</sup> year	2 <sup>nd</sup> year		1 <sup>st</sup> year	2 <sup>nd</sup> year		
Captan 50 WP2	0.30	20.00 (26.54)*	22.00 (27.96)	<b>21.50</b>	8.15 (2.85)**	8.34 (2.88)	<b>8.24</b>	6.10	6.00	6.05	18.62
Copper oxychloride 50 WP	0.30	32.00 (34.44)	34.5 (36.16)	<b>33.25</b>	11.88 (3.44)	12.11 (3.47)	<b>11.99</b>	5.50	5.40	5.45	6.86
Dodine 65 WP3	0.06	23.5 (28.99)	25.00 (29.98)	<b>24.25</b>	8.03 (2.83)	9.08 (3.01)	<b>8.55</b>	6.00	5.90	5.95	16.66
Mancozeb 75 WP1	0.30	18.50 (25.45)	19.50 (26.17)	<b>19.00</b>	6.98 (2.64)	7.22 (2.68)	<b>7.10</b>	6.30	6.20	6.25	22.54
Propineb70 WP4	0.30	24.50 (29.65)	26.00 (30.64)	<b>25.25</b>	9.08 (3.01)	9.44 (3.07)	<b>9.26</b>	5.90	5.70	5.80	13.72
Zineb 80 WP	0.20	25.50 (30.32)	28.50 (32.25)	<b>27.00</b>	9.33 (3.05)	10.12 (3.18)	<b>9.72</b>	5.70	5.60	5.65	10.78
Control		39.50 (38.93)	40.50 (39.52)	<b>40.00</b>	18.32 (25.05)	19.98 (26.55)	<b>19.15</b>	5.15	5.05	5.10	
Mean		<b>30.41</b> <b>(33.32)</b>	<b>31.00</b> <b>(33.56)</b>		<b>10.25</b> <b>(3.20)</b>	<b>10.89</b> <b>(3.30)</b>					
		<b>SE<sub>m</sub>±</b>	<b>CD(P=0.05)</b>		<b>SE<sub>m</sub>±</b>	<b>CD(P=0.05)</b>		<b>SE<sub>m</sub>±</b>	<b>CD(P=0.05)</b>		
<b>Botanical</b>	=	<b>1.07</b>	<b>2.14</b>		<b>0.62</b>	<b>1.21</b>		<b>0.12</b>	<b>0.25</b>		
<b>Year</b>	=										
<b>Botanical × Year</b>	=										

\*Figure in the parenthesis are arc sin transformed; \*\* figures in parenthesis are sqrt transformed

### Field evaluation of fungicides

Persual of data (Table 2) revealed that on an overall basis, mancozeb 75 WP was most effective fungicide reducing the disease incidence and disease intensity to 19.00 and 7.10 per cent from 40.00 and 19.15 per cent, respectively, in unsprayed check, and increasing the yield from 5.25 t ha<sup>-1</sup> in unsprayed check to 6.25 t ha<sup>-1</sup>. Captan 50 WP was the next in efficacy, reducing disease incidence and disease intensity to 21.50 and 8.24 per cent, respectively and resulting in a grain yield of 6.10 t ha<sup>-1</sup>. The other fungicides in order of their decreasing efficacies on the basis of their overall performance during two years of experimentation were dodine 65 WP, propineb 70 WP and zineb 80 WP with mean disease incidence of 24.25, 25.25 and 27.00 per cent and mean disease intensity of 8.55, 9.26 and 9.72 per cent, and grain yield of 5.95, 5.80 and 5.65 t ha<sup>-1</sup>, respectively. Copper oxychloride 50 WP proved least efficacious, exhibiting mean disease incidence 33.25, mean disease intensity of 11.99 per cent and a grain yield of 5.45 t ha<sup>-1</sup>.

Mancozeb 75 WP resulted in highest (19.04) increase in grain yield over check followed by captan 50 WP (15.45), while dodine 65 WP and propineb 70 WP and zineb 80 WP resulted in 13.33, 10.47 and 7.61 per cent increase in grain yield, respectively. Copper oxychloride, though least efficacious among the tested fungicide, was superior to check and increased the grain yield by 3.80 per cent.

The efficacy of mancozeb 75 WP against rice sheath blight of rice has been reported Roy and Sakia (1976). Suryadai and Kadier (1989) found chlorothalonil, mancozeb and mancozeb + zineb most effective in checking the sheath blight of rice. While Jana *et al.*, 1989, reported the application of Dithane M-45 (mancozeb 75 WP) as most effective in reducing the sheath blight of rice. Biswas

(2005) reported the efficacy of propineb 70 WP for management of rice sheath blight.

Though sole dependence on chemical fungicides should not be encouraged because of long residual properties, non-target action, biological magnification and pollutant dangers but they cannot be ignored all at once unless some potential alternatives are found. Since rice grains are milled before use/cooking, the non-systemic fungicides which form the protective layers does have least chance of penetration in rice grains and thereby in the food chain of humans and therefore, their use is comparative safer than the fungicides which entre into the system of rice plant and rice grains which may result in health hazards. The present situation demands their incorporation in the integrated disease management schedule for better disease management and optimum returns from crop husbandry.

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