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Efficacy of new fungicides against sheath blight disease management of rice caused by *Rhizoctonia solani* under field condition

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Abstract

Rice (*Oryza sativa* L.) is second most important cereal and the staple food for more than half of the world's population. Sheath blight is one major biotic constraints that affects rice production in India and is considered economically important disease of rice in the world The disease is caused by *Rhizoctonia solani* Kuhn (Teleomorph: *Thanetophorus cucumeris* (Frank) Donk), a fungal pathogen of both rice and soyabeans. The yield loss due to this disease is reported to range from 5.2-50 per cent depending on the environmental conditions, crop stages at which the disease occurs, cultivation practices and cultivars used. The disease has been named as "sheath blight" because of primary infection on leaf sheath. The fungus attack the crop from tillering to heading stage and leaf blade symptoms also observed. Initial symptoms are noticed on leaf sheath near water level. As the spot enlarge, the centre become grayish with irregular brown blackish border. 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.In the study an experiment was laid out in the field condition during 2017-18 at experimental field of IGKV, Raipur to control the sheath blight disease of rice by application of different doses of chemical fungicide, the treatment of Propiconazole 13% + Difenconazole 13.9% SC (Tespa), Propiconazole 25% EC (Tilt), Tebuconazole 50% +Trifloxystrobin 25% WG (Nativo), Azoxystrobin 23% EC (Amistar), Validamycin 5% L (Vamcin), Captan 70% + Hexaconazole, WB (Takat), Hexaconazole 5% EC (Contaf), Carbendazin 50 WP (Bavestin) where tested in field under artificial condition. The Hexaconaxoke 5% EC found highly effective in reducing the Sheath blight disease severity (11.11%) and increase the grain yield (5566 kg/ha). The maximum disease severity (20.77%) and lowest grain yield (2600 kg/ha) was recorded under control condition.

Keywords: Sheath blight, fungicide, severity

Introduction

Rice (*Oryza sativa* L.) is second most important cereal and the staple food for more than half of the world's population. It provides 20% of the worlds dietary energy supply followed by Maize and Wheat. The production of rice to be achieved by 2020 is 128 Mt to feed the growing population in India. To meet the global demand, it is estimated that about 114 Mt of additional milled rice needs to be produced by 2035 with an increase of 26% in next 25 years. In the world at present the area of rice is 162.26 Mha. with production of 483.80 million metric ton and productivity of 2.98 Mt ha^{-1} In India the area of rice is 44.50 Mha^{-1} with production of 106.50 million metric ton and productivity 3.59 Mt ha^{-1}. (Anonymous, 2016) [2].

Sheath blight is one major biotic constraints that affects rice production in India and is considered economically important disease of rice in the world The disease is caused by *Rhizoctonia solani* Kuhn (Teleomorph: *Thanetophorus cucumeris* (Frank) Donk), a fungal pathogen of both rice and soyabeans. The yield loss due to this disease is reported to range from 5.2-50 per cent depending on the environmental conditions, crop stages at which the disease occurs, cultivation practices and cultivars used. Significant grain yield losses were reported due to sheath blight when susceptible varieties were grown. The disease has been named as "sheath blight" because of primary infection on leaf sheath. The fungus attack the crop from tillering to heading stage and leaf blade symptoms also observed. Initial symptoms are noticed on leaf sheath near water level. As the spot enlarge, the centre become grayish with irregular brown blackish border. The presence of several large lesions on leaf sheath causes death of whole leaf and in several causes all the leaf of a plant blighted. The infection spreads to inner sheath resulting death of entire plant. Older plants are highly susceptible, plants heavily infected by in the only heading and grain filling growth stage produced poorly filled grain. 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. Wide host range of the pathogen *Rhizoctonia solani* makes management of the disease a different tast. Hence the disease is being managed by changing the cultural practices by one of chemical fungicide and limited extend with a biological control and biopesticide.The systematic search of higher plants for antifungal activity has shown that plant extracts have the ability to inhibit spore germination and mycelia growth in many fungal species. During recent years, use of plant extracts particularly neem derivatives for the control of plant diseases is gaining importance due to their antifungal and antibacterial properties. Many plant extracts are reported to specifically inhibit the germination of fungal spores. Since, *Rhizoctonia solani* is a typical soil borne fungus and its management through chemicals is expensive and not feasible, because of the physiological heterogeneity of the soil, other edaphic factors *etc.* might prevent effective concentrations of the chemical reaching to the pathogen. Integrated approaches for the disease management are paying more dividences in terms of sustainability. This approach mainly emphasizes on the host plant resistance, cultural practices, eco-friendly means i.e. through the use of botanicals and bio-pesticides *etc.* with a need based application of chemical molecules for disease management. Integrated disease management (IDM) blending to the traid *viz.*, cultural, biological, Bio-pesticide and use of resistance source in the right manner could be adopted. Looking to the above figure and facts, an attempt was made through this investigation to study the different methods contributing for the effective management of sheath blight of rice. Fungicide application is the most common approach among the farmers for the management of sheath blight throughout the world. The resistant or tolerant sources to sheath blight are not available and biological controls are still not successful at field level. However it is necessary to screen the new fungicidal molecule or product to manage the disease effectively to avoid resistance developments in pathogen and minimize the fungicidal residues for ecological sustainability. If used judiciously, chemical control can go a long way for managing the plant diseases. It can also form an important component in integrated management of rice diseases. These fungicides to control diseases cause several adverse effects i.e. development of resistance in the pathogen, residual toxicity, pollution to the environment *etc*. Grasela *et al.* (1990) also reported that, despite advances in antifungal therapies, many problems remained to be solved for most antifungal drugs available. Therefore, it has become necessary to adopt eco-friendly approaches for enhancing crop yield and better crop health. Plants provide abundant resources of antimicrobial compounds and have been used for centuries to inhibit microbial growth (Jun-Dong *et al.*, 2006) [7]. Flavanoids, triterpenoids, steroids and other phenolic compounds in plants have been reported to have antimicrobial activity (Rojas *et al.*, 1992 [9] and Hostetmann *et al.*, 1995). Tiwari *et al.* (2002) [11] used 7 fungicides to control sheath blight of rice and reported that Carbendazim + Epoxiconazole (0.2%), Hexaconazole (0.2%), Epoxiconazole (0.24%) and Propicanzole (0.2%) were significantly more effective in controlling disease severity than other fungicides.

Material and Method

Experimental site

The field experiment was conducted during *kharif* 2016 at the experimental field of the Department of Plant Pathology situated in the Research farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). Besides the field experiment, all the *in vitro* studies were conducted in the laboratory of Department of Plant Pathology.

Statistical analysis

The data obtained in the present study were subjected to analysis of variance (ANOVA) and comparison of treatment means was made using Duncan‘s multiple range test (DMRT) (Little and Hills, 1978) [8].

Test varieties

In general “Swarna” the susceptible varieties were used for sheath blight disease of rice for experimental studies, unless and otherwise mentioned. The varieties were grown under field condition for further studies.

Efficacy of new fungicide against sheath blight of rice under field condition

To test the efficacy of new fungicides the twenty one day old seedlings of the cultivar “Swarna” were transplanted in a net plot size of 3 × 1.60 m^2 with a spacing of 1m between replication to replication. Row to row and plant to plant spacing was 20 × 15 cm. The experiment was laid in Randomized Block Design (RBD) with three replications. Fertilizer was applied @ N120: P50: K0/ha. Fifty percent of N and total P were given as basal dose and remaining N applied in two split doses as top dressing at tillering and panicle initiation stage. There were 9 treatments i.e. Propiconazole 13% + Difenconazole13.9%SC (Taspa), Propiconazole 25% EC (Tilt), Tebuconazole50% + Trifoxystrobin 25% WG (Nativo), Azoxystrobin 23% SC (Amistar), Validaycin 3% L (Vamcin), Captan 70% + Hexaconazole 5% WB (Takat), Carbendazim 50 WP (Bavistin), Hexaconazole 5% EC (Contaf) including untreated (control) for each replication.

In the field inoculation, sclerotia from 7-9 days old culture and rice stem bits (*Rhizoctonia solani* mycelium profusely grown) were used for inoculation of the rice plants at the maximum tillering stage. The primary tillers of each hill were tagged and inoculated gently by punching and pushing single sclerotium or rice stem bit into the sheath just 1 ½ to 2 ½ cm above the water surface level as per the position of the sheath. After 6 days of inoculation the first spray of each treatments was given, on 10th day after first spray second spray was repeated. Disease severity of sheath blight was recorded at 21 days of inoculation of the disease, crop in 0-9 scales by following the procedure of SES of International Rice Testing Programme (IRRI, 1980) [5]. The numerical values were further used for the calculation of PDI (Percent disease index) using the formula.

The disease development would be recorded in each variety and Percent Disease severity and Percent Disease Index will be calculated as:

$$\text{Disease severity} = \frac{\text{Total lesion lenght}}{\text{Total lenght of sheath}} \text{X } 100$$

$$\text{Percent Disease Index} = \frac{\text{Sum of all individual disease ratings}}{\text{Total no. of plant asseded X maximum rating}} \text{X } 100$$

Table 1: Chemical name of the fungicides and Dosage l^{-1} of water

Treatment	Trade name	Technical name	Doses l^{-1} of water
T1	Taspa	Propiconazole 13%+ Difenconazole 13.9% SC	1ml
T2	Tilt	Propiconazole 25% EC	1ml
T3	Nativo	Tebuconazole 50% + Trifloxystrobin 25% WG	1ml
T4	Amistar	Azoxystrobin 23% SC	1ml
T5	Vamcin	Validmaycin 3% L	0.1ml
T6	Takat	Captan 70% + Hexaconazole 5% WB	1gm
T7	Contaf	Hexaconazole 5% EC	2ml
T8	Basvistin	Carbendazim 50 WP	1gm
T9	Control	Untreated	-

Artificial Inoculation

In the field experiments, sclerotia from 7-9 days old culture and rice stem bits (*R. solani* mycelium profusely grown) were used for inoculation of the rice plants at the maximum tillering stage. The primary tillers of each hill were tagged and inoculated gently by punching and pushing single sclerotium or rice stem bit into the sheath just 1 ½ to 2 ½ cm above the water surface level as per the position of the sheath.

Disease assessment and statistical analysis

For artificial inoculation, rice plants at maximum tillering stage were taken for inoculation. The inoculation was done by placing sclerotia of *R. solani* with the help of sterilized forceps in the centre of each hill. For each variety five healthy tillers were inoculated at random. After inoculation, crop was regularly watched for appearance of disease. Rice varieties/entries were screened against sheath blight severity. Each plot was observed in number of infected tiller and each tiller were observed plant height and symptoms length of sheath blight of rice. The disease development was recorded in each variety and percent disease severity was calculated as standard evaluation system (SES), (Anomymous 1988). Observations were recorded 30 days after inoculation and graded as per 0-9 SES scale.

Results and Discussion

Efficacy of Botanical plant product and extracts against sheath blight of rice under field condition

An experiment was laid out in the field conditions during 2016-2017 at experimental field of IGKV, Raipur to control sheath blight disease of rice by application of new fungicides i.e. Propiconazole 13% + Difenconazole13.9% SC (Taspa), Propiconazole 25% EC (Tilt), Tebuconazole50% + Trifloxystrobin 25% WG (Nativo), Azoxystrobin 23% SC (Amistar), Validamycin 3% L (Vamcin), Captan 70% + Hexaconazole 5% WB (Takat), Hexaconazole 5% EC (Contaf), Carbendazim 50 WP (Bavistin), were used under the study.

Data on Table 2 and Fig.1 revaluated that at 21 days all fungicidal sprays significantly reduced sheath blight severity over control. The tested fungicide *i.e.* Hexaconazole 5 SC (Contaf) treatment found highly effective in reducing the disease severity of sheath blight 11.11% and 46.50% decrease of the disease over control this was at par with Captan70% + Hexaconazole5% WB (Takat) with 11.48% disease severity and 42.94% decrease disease over control, Azoxystrobin23% SC (Amistar) with 11.85% disease severity and 40.79% decrease the disease over control Propiconazole13% + Difenconazole 13.9% SC (Taspa) with 12.03% the disease severity and 42.07% decrease the disease over control, Tebuconazole 50% + Trifloxystrobin 25% WG (Nativo) 12.22% reducing the disease severity and 41.16% decrease the disease over control Propiconazole 25% EC (Tilt) 12.59% reducing disease severity and 30.38% decrease the disease over control, Carbendazim 50 WP with 13.05% disease severity and recorded 37.16% decrease disease over control. The minimum decrease in disease severity 33.82% with 13.33% disease severity was recorded in Validamycin 3% L W.P. Were as the maximum disease severity 20.77% was recorded under control treatment.

The treatment of new fungicides also enhances the yield kg ha^{-1} of rice over control treatment. There was significant difference in yield increase was observed by application of new fungicides on over control treatment. The Hexaconazole 5 SC (Contaf) gave highest grain yield (5566 kg ha^{-1}) followed by Captan 70% + Hexaconazole 5% WB (4066 kg ha^{-1}) grain yield, Propiconazole13% + Difenconazole (3266 kg ha^{-1}) grain yield, Carbendazin 50 WP (3233 kg ha-^{1}) grain yield, Tebuconazole 50% + Trifloxystrobin 25% WG (3166 kg ha^{-1}) grain yield, Azoxistrobin 23% SC (3166 kg ha^{-1}) grain yield Propiconazole 25% EC (3088 kg ha-1) grain yield, where as the lowest grain yield was recorded under untreated control (2600 kg ha-^{1}).

Present finding are in agreement with the findings of Johnson *et al.* (2013) [6] that the Hexaconnazole at different doses *viz.*, 500, 1000, 1500 and 200 ml ha^{-1} effectively reduced the sheath blight incidence in all the field trail. It also recorded maximum yield of 3000 and 2800 kg ha^{-1} in second and third trails respectively. The above finding were also support Raji *et al.* (2016) [10] that the systematic fungicides Tebuconazole + Trifloxystrobin 75WG (1.4g) Tebuconazole 250 EC (1.5ml) Fluzilazole 40 EC (0.5 ml) and contact fungicide Pencycuron 250 (1.5 ml) were evaluable effective as standard check fungicide Hexaconzole 5 EC (2 ml) in reducing sheath blight severity and improving yield. Tiwari *et al.* (2002) used 7 fungicides to control sheath blight of rice and reported that Carbendazim + Epoxiconazole (0.2%), Hexaconazole (0.2%), Epoxiconazole (0.24%) and Propicanzole (0.2%) were significantly more effective in controlling disease severity than other fungicides.

Table 2: Efficacy of medicinal plant extract against sheath blight of rice under field condition

Treatment	Medicinal plants	Doses l^{-1} of water	Percent disease index	Percent decrease over control	Grain yield ($kgha^{-1}$)
T1	Aloe vera	50ml	13.33 (3.77)*	33.35	3209
T2	Lemon grass	100ml	14.09 (3.88)*	29.55	3151

T3	Tulsi	150ml	14.07 (3.58)*	29.65	3131
T4	Garlic	100ml	12.59 (3.68)*	37.05	4425
T5	Onion	100ml	12.50 (3.58)*	37.50	4608
T6	Hexaconazole	2ml	11.11 (3.48)*	44.45	5184
T7	Control	Untreated	20.00 (4.75)*	-	2592
SE(m ±)			0.12		214.46
CD at 5%			0.39		68.84
CV (5%)			5.68		3.17

*figures in the parenthesis are square root transformed values

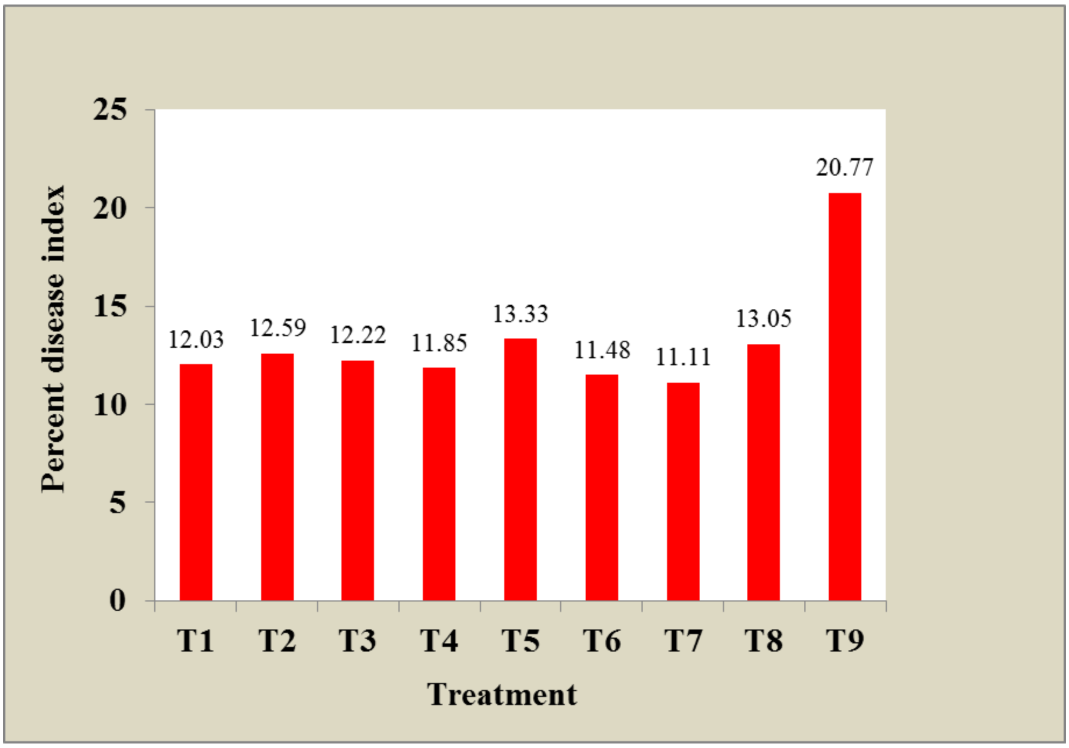

Fig 1: Efficacy of the new fungicides for the control of sheath blight of rice

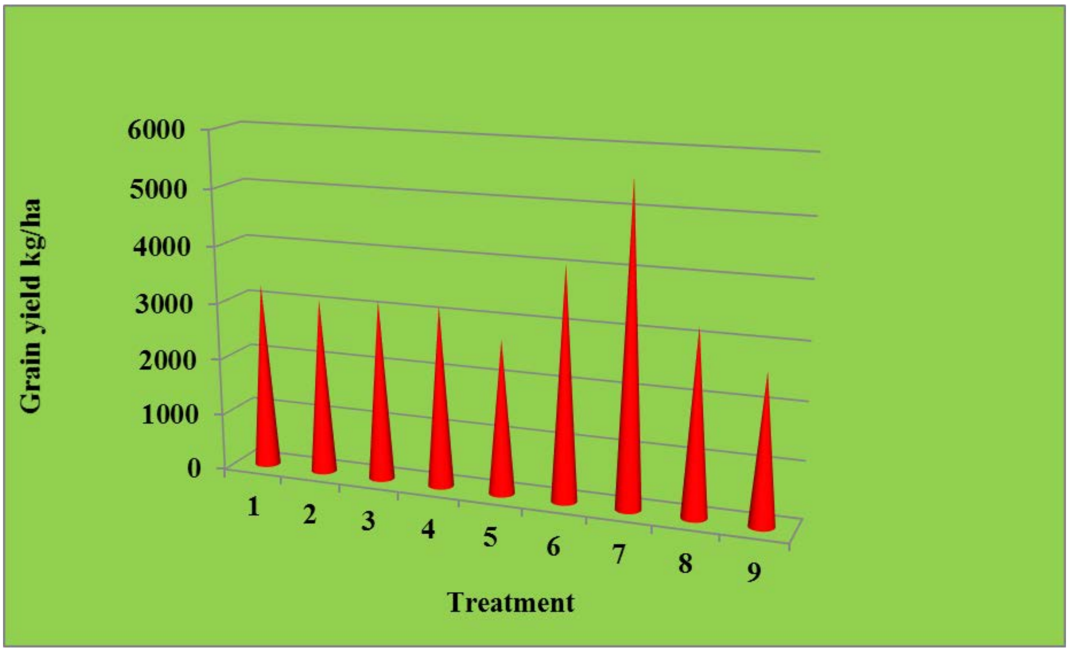

Fig 2: Efficacy of the new fungicides on grain yield

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