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

Nirmal Prasad, Nohar Singh, Avinash P and Pradeep Kumar Tiwari

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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 soybeans. 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 (Tepa), 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 Hexaconazole 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 world’s 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 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 soybeans. 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

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are noticed on leaf sheath near water level. As the 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 task. 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 dividends 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 fungidical molecule or product to manage the disease effectively to avoid resistance developments in pathogen and minimize the fungidical 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]. Flavonoids, 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 Propiconazole (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 Vidyavidyalaya, 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 $3 \times 1.60$ m² 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% + Difenconazole 13.9% (Taspa), Propiconazole 25% EC (Tilt), Tebuconazole50% + Trioxystrobin 25% WG (Nativo), Azoxytrobin 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) [3]. 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:
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 of rice. The disease development was recorded in each variety and percent disease severity was calculated as standard evaluation system (SES), (Anonymous 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 of rice by application of new fungicides i.e. Propiconazole 13% + Difenoconazole13.9% SC (Taspa), Propiconazole 25% EC (Tilt), Tebuconazole50% + Trioxystrobin 25% WG (Nativo), Azoxystrobinc 23% SC (Amistar), Validamycin 3% L (Vamcin), Captan 70% + Hexaconazole 5% WB (Takat), Hexaconazole 5% EC (Contaf), Carbendazim 50 WP (Bavistin) and Trifloxystrobin 75WG (1.4g) Tebuconazole 250 EC (1.5 ml) were evaluable effective as standard check trails respectively. The above finding were also support Raji et al. (2016) that the systematic fungicides Tebuconazole + Trioxystrobin 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 Hexaconozole 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 Propiconazole (0.2%) were significantly more effective in controlling disease severity than other fungicides.

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 varieties/entries were screened against sheath blight severity.

Disease severity and statistical analysis

Disease assessment and statistical analysis

Disease severity = \[
\frac{\text{Total lesion length}}{\text{Total length of sheath}} \times 100
\]

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 | 1 ml |
| T2        | Tilt       | Propiconazole 25% EC | 1 ml |
| T3        | Nativo     | Tebuconazole 50% + Trioxystrobin 25% WG | 1 ml |
| T4        | Amistar    | Azoxystrobin 23% SC | 1 ml |
| T5        | Vamcin     | Validamycin 3% L | 0.1 ml |
| T6        | Takat      | Captan 70% + Hexaconazole 5% WB | 1 gm |
| T7        | Contaf     | Hexaconazole 5% EC | 2 ml |
| T8        | Bavistin   | Carbendazim 50 WP | 1 gm |
| T9        | Control    | Untreated | - |

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 (kg ha⁻¹) |
|-----------|------------------|--------------------|-----------------------|-------------------------------|----------------------|
| T1        | Aloe vera        | 50 ml              | 13.33 (3.77)*         | 33.35                         | 3209                 |
| T2        | Lemon grass      | 100 ml             | 14.09 (3.88)*         | 29.55                         | 3151                 |

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

Artificial Inoculation

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|   | Treatment       | Volume | Percent disease index | SE (m ±) | CD at 5% | CV (5%) |
|---|-----------------|--------|-----------------------|----------|----------|---------|
| T3 | Tulsi           | 150ml  | 14.07 (3.58)*         | 0.12     | 0.39     | 5.68    |
| T4 | Garlic          | 100ml  | 12.59 (3.68)*         | -        | -        | 2.17    |
| T5 | Onion           | 100ml  | 12.50 (3.58)*         | 0.12     | 0.39     | 5.68    |
| T6 | Hexaconazole    | 2ml    | 11.11 (3.48)*         | 0.12     | 0.39     | 5.68    |
| T7 | Control         | Untreated | 20.00 (4.75)*         | -        | -        | 2.17    |

*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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