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Comparison and validation of the most appropriate integrated disease management module for Sheath blight and Bacterial blight disease of Rice

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Among the important fungal and bacterial diseases of rice, sheath blight and bacterial blight have attained utmost importance during the recent years. Both are responsible for significant yield losses. Considering the importance of both the diseases and availability of scarce information on integrated disease management, a study was undertaken at AICRIP, RRTTS, Chiplima, Sambalpur, Odisha for developing an integrated disease management strategy against both the diseases. Based on several components, five IDM modules consisting of interventions in both nursery and main plots were made. The experiment was laid out in RBD with 5 modules and 4 replications. Although all the IDM practices were found to be effective in minimizing disease severity however, among different IDM modules, module 4 was found to be the best recording lowest PDI of 17.77 for sheath blight and 21.39 for bacterial blight disease respectively. The module also produced highest yield of 49 q/ha with highest BC ratio of 1.56. The module 4 involved- incorporation of FYM and application of DAP and MOP in the nursery bed,seed treatment and spraying with carbendazim in nursery plot, application of FYM + *Trichoderma* in the main field before transplanting, application of 75% RDF and micro nutrient solution (agromin), cultural practices like cleaning of bunds, hand weeding etc., blanket application of granular insecticide carta phydrochloride at 15 DAT and spraying of propiconazole and streptocycline at booting stage for sheath blight and bacterial blight respectively followed by one additional application of streptocycline and propiconazole at 10 days and 15 days after the first spray respectively.

Keywords: Bacterial blight, IDM, module, rice, Sheath blight

INTRODUCTION

Rice (*Oryza sativa* L) is the main food crop of majority of the Indian population. Rice plants suffer from many diseases caused by fungi, bacteria, viruses, phytoplasma, nematodes and other non-parasitic disorders. Sheath blight disease of rice, earlier considered to be a minor disease, has attained the status of a major disease since last decade (Singh *et al.* 2013). Sheath blight is caused by a soil living basidiomycotan fungal pathogen, *Rhizoctonia solani* Kuhn.

Besides quality deterioration, it has been reported to cause yield losses ranging from 4 to 50% (Bhunkal *et al.* 2015, Singh et *al.* 2016). Among the bacterial diseases, Bacterial blight, or Bacterial Leaf Blight (BLB) is considered as a major threat to rice production because of its widespread distribution and its destructiveness under favourable conditions. The disease is caused by *Xanthomonas oryzae* pv. *oryzae* and is one of the most destructive diseases in irrigated and rain fed environments in Asia. It causes considerable loss, especially, in areas where high yielding varieties are grown.

Integrated rice disease management is the combination of different methods to control diseases in a cost-effective way, based on sound environmental management. Pathogen populations are kept at low levels, not causing economic damage, using a combination of appropriate technologies. None of these methods or techniques can by itself ensure efficient and sustainable protection. Chemicals are the important components of integrated disease

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management (IDM) for mitigating the plant diseases. Hence, commercially available fungicides and antibiotics are used against the diseases. The biological control agents are also equally important components of an IDM. Application of bio agents not only acts as an antagonist to pathogens but also promotes the growth of plant and induces multiple systemic disease resistance. Therefore, effort has been made in this regard to see the efficacy of biological control agent against the target diseases under field condition. Finally, chemicals, antagonists, and nutrient application were utilized to manage both the diseases.

As most of the prevalent disease control methods are focused against the pathogen directly and have been moderately successful, reliable, and effective disease management strategies are needed for managing both the diseases. Lack of durable resistant rice varieties and environmental concerns about chemical usage have led to developing sustainable control methods using microorganisms. Considering the importance of both the diseases and availability of scarce information on integrated disease management, this study was undertaken for developing an integrated disease management strategy.

MATERIALS AND METHODS

Field experiment was conducted during two consecutive kharif season to validate the most appropriate and cost-effective integrated disease management module for the management of sheath blight and bacterial blight diseases in rice at All India Co-ordinated Rice Improvement Project, Regional Research and Technology Transfer Station,Chiplima, Sambalpur, Odisha. The station is located at $20^0$21'N latitude and 80^0 55'E longitude with an elevation of 178.8 m above mean sea level. A susceptible variety Swarna (MTU 7029) was selected for the study and twenty-five days old seedlings were transplanted in plot size of 15 m^2 with a spacing of 15cm x 20 cm having bunds all around the plots. The experiment was laid out in RBD with 5 modules and 4 replications. Replications were separated with a gap of 1 meter for irrigation channels. Based on different components (Table1), five IDM modules consisting of interventions in both nursery and main plots were made (Table2).

For seed treatment, seeds were soaked overnight in a bucket of water, water was decanted, and quantity of fungicides was mixed thoroughly with the soaked seeds and then treated seeds were kept in moist cloth bag, tied properly with a twine, and incubated in a humid and warm place for 2 days for germination. These treated seeds were used for raising the seedlings. For fertilizer application, entire phosphorus, potassium, and half dose of nitrogen were applied as basal dose and the remaining half nitrogen at maximum tillering stage. Micronutrient solution was made by mixing 2 g micronutrient product (agromin) per litre of water and was sprayed 15–20 days after transplanting. The experiment was conducted under natural field condition for both the diseases. Weeds were controlled by hand picking. One additional spray of streptocycline @ 1g/10 l water for bacterial blight and propiconazole 25 EC @ 1ml/l for sheath blight were given at M_2, M_3 and M_4. To evaluate the efficacy of IDM modules, the treatments were compared with control (N_3 + F_7) which included 100% RDF. No seed treatment or chemical spraying or application of biocontrol agents was adopted in control plots. The data on sheath blight and bacterial blight disease severity was recorded 15 days after the last spray. From each treatment, 10 hills were selected randomly, and the plants were assessed for the diseases individually using SES scale (0–9 scale) (Anonymous 2016). The disease severity was noted as Percent Disease Severity (PDS) and was averaged. The Percent Disease Index was calculated by using the following formulaeby McKinny, H.H. (1923):

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of all numerical ratings}}{\text{No. of observations x maximum rating}} x100$$

The grain yield was recorded on plot basis and converted to q/ha.

Percent yield increase in protected plots over the unprotected (control) was worked out by using the following formula given by Kumar, B. (2020).

$$\text{Increase in grain yield (\%)} = \left[\frac{Yt - Yc}{Yc}\right] x100$$

where, Yt = yield in treated (protected) plots,Yc = yield in control (untreated) plots.

The benefit: cost (B:C) ratio was also worked out for each module based on prevailing market rate (chemicals, labour, grain etc). The data obtained were subjected to statistical analysis and were tested at five per cent level of significance to interpret the treatment differences following Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Although all the IDM practices were found to be effective in minimizing the sheath blight disease however, of the different IPM practices, module M_4 (N_1 + N_2 + N_3 +F_5 +F_6 + F_8 +F_9 + F_{10}) was found to be the best, recording lowest PDI of 17.77 for sheath blight disease (Table3). The module also provided highest % control in severity of the disease (52.6%). However, the module M_3 was found to be at par with M_4.

In case of Bacterial blight also, module M_4 (N_1 + N_2 + N_3 +F_5 +F_6 + F_8 +F_9 + F_{10}) was found to be the best and recorded the lowest PDI of 21.39 and highest % control in severity of the disease (54.2 %). However, the modules M_2 and M_3 were found to be at par with M_4.

The data pertinent to grain yield of rice is presented inTable 4**.**The grain yield ranged between 42.7 and 49q/ha being maximum in M_4 and lowest in control (M_5). M_4produced significantly higher yield than rest of the modules with highest percent yield increase of 14.8 % over control and gave the highest BC ratio of 1.56 and proved to be the best of all other modules.

The components of Module 4 include (i) incorporation of FYM @ 1kg/sqm in the nursery bed, (ii) seed treatment with carbendazim @ 2g/kg seed and spraying of carbendazim @ 1g/l seven days before uprooting, (iii) application of DAP @ 10g/sqm (to supply 20 kg nitrogen and 50 kg phosphorus per hectare) and muriate of potash (MOP) @ 8.5 g/sqm (to supply 50 kg/ha potassium) in nursery bed, (iv) application of FYM @ 1kg/sqm + T*richoderma* @ 2g/kg FYM in the main field just before transplanting,(v) cultural practices like hand weeding, cleaning of bunds etc. to keep the field weed free, (vi) application of 75% of RDF i.e., 60:30:30 kg NPK/ha + micronutrient solution (agromin) @ 0.5 l/10 m^2 (vii) one blanket application of cartap 4G @ 10 kg/acre at 15 DAT, (viii) one blanket application of propiconazole 25 EC @ 1ml/l for sheath blight and streptocycline @ 1g/1 ml water for bacterial blight at booting stage and ix. one additional application of streptocycline @ 1g/10 l water for bacterial blight and propiconazole 25 EC @ 1ml/l for sheath blight at 10 days and 15 days after the first spray respectively**.**

The present finding of sheath blight management is in line with the findings of several researchers (Prajapati *et al*. 2014;Yellareddygari *et al*. 2014; Kumar *et al*. 2019) who suggested a systemic management approach combining all available sheath blight management options for better disease management. Application of balanced dose of manures and fertilizers followed by minimum application of plant protection chemicals have always been recommended by researchers for better management of diseases and obtaining maximum crop yield. In majority of the rice growing areas, rice is cultivated invariably on the same land year after year, even in some areas rice is taken twice or thrice in a year on the same field which makes the soil sick and highly susceptible to soil-borne pathogens. Growing the same crop year after year in the same field without following any crop diversification programme make the soil borne pathogens of that crop more active and can easily perennate and increase their population over time and may cause epiphytotic disease at times. Over dependence on chemical pesticides and indiscriminate use of inorganic fertilizers and single method of disease control is not sufficient to manage sheath blight disease of rice as it is caused by a soil borne pathogen *Rhizoctonia solani*. Previously also, many scientists worked on the integrated management aspects of sheath blight disease. Rodrigues *et al.* (2003) found that adoption of green manuring, avoidance of field-to-field irrigation, planting of rice seedlings a little distance away from the bunds and keeping the bunds and field free from alternate and collateral weed hosts can significantly reduce sheath blight disease severity. Application of Farmyard Manure both in the nursery and main field, application of bio control agent *Trichoderma* in the mainfield, seed treatment with suitable fungicide, application of balanced dose of fertilizers, adoption of minimum crop protection chemicals altogether has certainly helped in reducing sheath blight disease severity and improving the grain yield.

Table 1: Components of Integrated Disease Management

Components Nursery	Details of Components
N_1	Incorporation of FYM @ 1 kg/m ^{2}
N_2	Seed treatment with carbendazim (2g/kg) along with one foliar application of carbendazim @1 g/l seven days before transplanting
N_3	Application of DAP @ 108 g/10 m ^{2} area (to supply 20 kg nitrogen and 50 kg phosphorus per hectare) and application of MOP @85 g/10 m ^{2} nursery area (to supply 50 kg/ha potassium)
Main Field	
F_4	Application of FYM @ 1 kg/ m ^{2} before transplanting
F_5	Application of FYM @ 1 kg/ m ^{2}+ *Trichoderma*@ 2 g/kg of FYM before transplanting
F_6	Cultural practices (cleaning of bunds, hand weeding etc.)
F_7	Application of 100% Recommended Dose of Fertilizers (RDF) @ 80:40:40 kg NPK/ha
F_8	Application of 75% RDF @ 60:30:30 kg NPK/ha + micronutrient solution (agromin) @ 0.5 l/10 m^2
F_9	One blanket application of granular insecticide carta phydrochloride 4% G @ 18.75 kg/ha at 15 DAT
F_{10}	One blanket application of propiconazole 25 EC @ 1ml/l for sheath blight and streptocycline @ 1g/10l water for bacterial blight at booting stage; one additional application of streptocycline @ 1g/10 l water for bacterial blight and propiconazole 25 EC @ 1ml/l for sheath blight at 10 days and 15 days after the first spray respectively.

Table. 2: Integrated Disease Management Modules

Modules	Treatments
M_1	$N_3 + F_4 + F_7$
M_2	$N_1 + N_2 + N_3 + F_4 + F_7 + F_{10}$
M_3	$N_1 + N_2 + N_3 + F_5 + F_7 + F_9 + F_{10}$
M_4	$N_1 + N_2 + N_3 + F_5 + F_6 + F_8 + F_9 + F_{10}$
M_5	$N_3 + F_7$ (Control)

N_1, N_2 and N_3 are nursery treatments and F_4 to F_{10} are main field treatments.

Management of bacterial blight disease through the antibiotics is considered one of the most significant counter measures hostiles to the disease. Basically, the evaluation of chemicals towards the control of bacterial blight was initiated with the zone of inhibition technique. Result of the present study in relation to bacterial blight management is supported by findings of Biswas *et al.* (2009) who studied the effect of antibiotics and fungicides on bacterial blight of paddy. One blanket application of granular insecticide cartap hydrochloride 4% G @ 18.75 kg/ha was given at 15 DAT to manage the insect population below Economic Threshold Level (ETL) because once the crop is damaged by insects, it becomes vulnerable to diseases. So, it is equally important to manage the insect population along with diseases in a successful IDM programme.

The experimental result implies that the IDM practices have significant effect on management of both the diseases and in improving the yield as well. So, it can be concluded that module M_4 ($N_1 + N_2 + N_3 + F_5 + F_6 + F_8 + F_9 + F_{10}$), a combination of nursery and main field treatments was the best among all the modules to manage both sheath blight and bacterial blight with highest yield (49 q/ha) and BC ratio (1.56).

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Table. 3: Effect of IDM modules on sheath blight and bacterial blight disease severity of rice

Modules	Treatment Details	ShBl severity%	Percent Disease Control (%)	BLB severity%	Percent Disease Control (%)
		PDI		PDI	
M_1	$N_3 + F_4 + F_7$	36.11 (36.88) *	3.7	37.22 (37.56)	20.2
M_2	$N_1 + N_2 + N_3 + F_4 + F_7 + F_{10}$	28.89 (32.37)	23.0	26.39 (30.71)	43.5
M_3	$N_1 + N_2 + N_3 + F_5 + F_7 + F_9 + F_{10}$	22.22 (28.04)	40.8	29.45 (32.77)	36.9
M_4	$N_1 + N_2 + N_3 + F_5 + F_6 + F_8 + F_9 + F_{10}$	17.77 (24.75)	52.6	21.39 (27.43)	54.2
M_5	$N_3 + F_7$ (Control)	37.50 (37.71)	-	46.67 (43.04)	-
	CD (0.05)	6.30		6.03	

*Figures in the parenthesis are angular transformed value

Table 4: Effect of IDM modules on yield of rice

Modules	Treatment Details	Grain Yield q/ha	% Yield increase over control	BC Ratio
M_1	$N_3 + F_4 + F_7$	43.1	1.0	1.29
M_2	$N_1 + N_2 + N_3 + F_4 + F_7 + F_{10}$	44.4	4.0	1.32
M_3	$N_1 + N_2 + N_3 + F_5 + F_7 + F_9 + F_{10}$	46.5	9.0	1.41
M_4	$N_1 + N_2 + N_3 + F_5 + F_6 + F_8 + F_9 + F_{10}$	49.0	14.8	1.56
M_5	$N_3 + F_7$ (Control)	42.7	-	-
	CD (0.05)	2.15		

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DECLARATIONS

Conflict of Interest. Authors declare no conflict of interest.

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