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Bioefficacy of Strobilurin Based Fungicides against Rice Sheath Blight Disease

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Abstract

As the usage of fungicides catapulted with the onward march of the dial hour, fungicidal resistance by the pathogens emerged as a new constraint. This amalgamated with the growing demand by the farmers for crop protection agents with low use rates, a benign environmental profile and a low toxicity to human and wild life, further gave an impetus to the search of new molecule of fungicides with novel modes of action. Sheath blight of rice caused by *Rhizoctonia solani Kühn* is one of the devastating diseases in eastern part of India. Various attempts were taken to develop sheath blight resistant variety but till date no such varieties were released. Various cultural practices combined with use of fungicides are the most common option of managing the disease. Repeated use of same fungicides in the same field sometimes become less or not effective, may be due to development of resistance recombinant of *R. solani*. Several experiment proved strobilurin based molecules like azoxystrobin, trifloxystrobin, metominostrobin manage the disease effectively and eco-friendly way than other commercially available fungicides.

Keywords: Disease; Fungicide; Sheath blight; Strobilurin

Introduction

Sheath Blight (ShB) (C.O. *Rhizoctonia solani* Kühn) is one of the most devastating diseases of rice particularly in wet season. The disease has spread in all rice growing areas in large scale and in some areas it is due to widespread cultivation of susceptible variety, as in case of West Bengal and Odisha where 'Swarna' (MTU 7029) which is widely cultivated and is highly susceptible to sheath blight pathogen '*R. solani*'. Damage is estimated upto 100% in favourable climatic condition and yield loss of rice varies from 5.2-50% depending on disease severity [1-3]. Though cultivation of resistant variety is the best option to cope up the attack of this pathogen but till date no such variety is available to the growers. Thus, in present situation cultural practices combined with foliar spray of fungicide is the most common practice to manage the disease and even in integrated pest management system need based application of fungicide has been recommended. In this context, a long term experiment was conducted to evaluate the efficacy of new generation bio-rational fungicide of 'strobilurin derivatives'. Strobilurins (also known as β-methoxyacrylates) or QoI (Quinone outside Inhibitors) fungicides, launched in 1996 are analogues of strobilurin-A [4] originally derived from natural products [5] (*Strobilurus tenacellus*, a wild mushroom growing in forests). Strobilurins, are now the second largest chemistry group of fungicides, widely used on cereals and, more recently, on soybeans (a market that reached $600 million in 2004). The strobilurin fungicides mainly act on mitochondrial synthesis in *cytochrome bc1*, are highly effective, and are suitable for a wide range of crops include Azoxystrobin, Fluoxastrobin, Kresoxim-methyl, Metominostrobin, Picoxystrobin, Pyraclostrobin and Trifloxystrobin (Table 1). The new fungicides were most effective in decreasing disease severity and increasing grain yield in comparison to control (without fungicide). These fungicides were also proved as best or at par with leading triazole compounds to manage the sheath blight disease of rice at several collaborating and volunteer centre under All India Coordinated Rice Improvement Programme (AICRIP) [6,7].

Materials and Methods

Systematic research was initiated since 2002 and followed up to 2010 at experimental farm of Rice Research Station, Chinsurah, West Bengal (22°89′N and 88°39′E) to evaluate various strobilurin and combination of strobilurin fungicide viz. azoxystrobin 25 SC, trifloxystrobin 25%+tebuconazole 50% 75 WG and Metaminostrobin 20 SC. In each experiment, new fungicide, 2-3 commercial fungicides, control (without fungicide) and one best commercial fungicide (check fungicide) were taken as treatments. All the experiments were

Name	Chemical name	Use
Azoxystrobin	Methyl(E)-2-2-[6-(2-cyanophenoxy) yrimidin-4 yloxy]phenyl-3-methoxyacrylate	Fungicide with protectant, curative, eradicant, translaminar and systemic properties. Inhibits spore germination and mycelial growth, and also shows anti-sporulant activity.
Fluoxastrobin	E)-2-[6-(2-chlorophenoxy)-5-fluoropyrimidin-4-yloxy] phenyl (5,6dihydro-1,4,2-dioxazin-3-yl) methanone O-methyloxime	Systemic (and locosystemic) fungicide with protective and curative properties. It is acropetally translocated when sprayed on leaves. Acts as an inhibitor of spore germination and mycelia growth.
Kresoxim-methyl	Methyl(E)-methoxyimino[2-(o-tolyloxymethyl) phenyl] acetate	Fungicide with protective, curative, eradicative and long residual disease control; acts by inhibiting spore germination. Redistribution via the vapour phase contributes to activity.
Metominostrobin	(E)-2-methoxyimino-N-methyl-2-(2-phenoxyphenyl) acetamide	Systemic fungicide with protective and curative action.
Picoxystrobin	Methyl(E)-3-methoxy-2-[2-(6-trifluoromethyl-2-pyridyloxymethyl)phenyl] acrylate	Preventive and curative fungicide with unique distribution properties including systemic (acropetal) and translaminar movement, diffusion in leaf waxes and molecular redistribution in air.
Pyraclostrobin	Methyl-N-2-[1-(4-chlorophenyl)-1H-pyrazol-3-yloxymethyl] phenyl (N-methoxy)-carbamate	Fungicide with protectant, curative, and translaminar properties.
Trifloxystrobin	Methyl(E)-methoxyimino-(E)-[1-(α,α,α,-trifluoro-m-tolyl) ethylideneaminooxy]-otolyl acetate	Mesostemic, broad-spectrum fungicide with preventive and specific curative activity. Displays rain-fastness property. Translocate by superficial vapor movement and also has translaminar activity.

Table 1: Different strobilurin analogues and their use.

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Treatment	Dose per litre of water	Percent Disease severity	Percent disease decreased over control	Yield (t/ha)	Percent yield increased over control
Azoxystrobin 25SC	1.0 ml	16.4	63.9	5.2	24.5
Hexaconazole 5SC (Check fungicide)	2.0 ml	28.7	36.9	4.9	16.5
Control (Untreated)	-	45.5	-	4.2	-
LSD (0.05)		2.42		0.2	
Trifloxystrobin 25%+Tebuconazole 50% 75 WG	0.4 g	52.6	37.6	6.0	50.0
Hexaconazole 5SC (Check fungicide)	2.0 ml	62.1	26.4	5.3	32.5
Control (Untreated)	-	84.3	-	4.0	-
LSD (0.05)		4.9		0.07	
Metaminostrobin 20SC	2.0 ml	30.1	64.7	6.35	40.5
Hexaconazole 5SC (Check fungicide)	2.0 ml	42.1	50.6	5.60	23.9
Control (Untreated)	-	85.3	-	4.52	-
LSD (0.05)		1.36		0.8	

Table 2: Bioefficacy of new fungicide against sheath blight disease.

conducted with rice variety 'Swarna' (MTU 7029) following standard agronomic practices except using higher nitrogenous (120 $kgha^{-1}$) and lower pottasic (30 $kgha^{-1}$) fertilizer dose than the normal dose (N_2:P_2O_5:K_2O::100:50:40). For confirming appearance of disease, artificial inoculation with virulent strain of ShB pathogen *R. solani* were performed following 'Straw-bit' method [8] during active tillering stage. Fungicides were sprayed thrice at an interval of 10 days starting from the initial appearance of the disease. The final disease incidence was recorded 15 days after last spray from 20 randomly affected hills in each treatment and the plants were assessed individually using SES scale (0-9 scale) [9].

Results and Discussion

It is evident from all the experiment that new strobilurin fungicides are effective in checking sheath blight disease and further spread of the pathogen when used as a sole chemical or in combination with other triazole compound (Table 2).

It was observed that azoxystrobin 25 SC @ 1 ml l^{-1} effectively controlled the disease (having the lowest disease severity 16.4%) and improved grain yield (max. 5225 $kgha^{-1}$) [10]. 'trifloxystrobin 25%+tebuconazole 50% 75 WG' @ 0.4g l^{-1} -a combination of two systemic fungicides like strobilurin compound 'trifloxystrobin' and triazole compound 'tebuconazole' along with two effective commercial fungicides viz., Hexaconazole 5 EC and Validamycin 3L were taken as commercial check fungicides for the experiment. Disease severity was 37.61% lower and yield 50% higher over untreated (control) [11]. Another experiment revealed that Metaminostrobin 20 SC @ 2 ml l^{-1} was superior to any other popular check fungicides. This product reduced the disease severity by 64.7% lower and yield 40.5% higher over untreated (control) [12]. Various experimental reports confirmed that strobilurin compounds found to be effective in controlling other rice diseases like blast [13], grain discoloration [14], sheath rot and brown spot etc. [15]. In a recent report it was evident that not only fungal diseases, viral disease like TMV infection is also restricted in Tobacco plant pre-treated with pyraclostrobin [16]. Though several fungicides like carbendazim, validamycin and several triazoles like propiconazole, hexaconazole have been recommended for sheath blight disease management but in areas which regularly suffer with severe sheath blight disease, application of any strobilurin fungicides viz. azoxystrobin 25 SC @ 1 ml l^{-1}, trifloxystrobin 25%+tebuconazole 50% 75 WG' @ 0.4g l^{-1} or Metaminostrobin 20 SC @ 2 ml l^{-1} may be advocated for recommendation for management and may include in IPM for improving of the grain yield which has ultimately enhance the productivity of rice in West Bengal [17]. Strobilurin compound based fungicides are formulated using very less active ingredient and are eco-freindly, possessing desired fungi-toxicity, good light stability, systemic properties without phytotoxicity and safe to use in plant disease control.

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