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Study of bioefficacy and phytotoxicity of azoxystrobin 120 + tebuconazole 240 SC against sheath blight (*Rhizoctonia solani*) diseases in Rice

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Abstract
Sheath blight of rice incited by *Rhizoctonia solani* is one of the major important disease. In the present investigation study of bioefficacy and phytotoxicity of Azoxystrobin 120 + Tebuconazole 240 SC against Sheath blight (*R solani*) diseases in Rice. The field experiment was conducted at Killimangalam village, Cuddalore dt., Tamil nadu. The treatments with new combination fungicide, Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha recorded the minimum sheath blight incidence with 11.34, 11.04 and 10.95 per cent after first, second and third spray respectively. This was followed by the dosage level with Azoxystrobin 120 + Tebuconazole 240 SC @ 676 ml/h which recorded 11.23, 11.13and 11.09 per cent after first, second and third spray respectively. While the untreated control recorded the maximum PDI (29.80, 37.75, 50.71) was recorded. Similarly Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha recorded the maximum grain yield with 48.35 q/ha and maximum straw yield with 39.98 q/ha which was followed by the treatment Azoxystrobin 120 + Tebuconazole 240 SC @ 676 ml/ha with grain yield with 46.56 q/ha and maximum straw yield with 38.24 q/ha. Further the treatments with new combination fungicide no phototoxic consequence and was also found safe to the crop as it did not influence the natural enemy population.

Keywords: Azoxystrobin + tebuconazole, paddysheathbligt (*Rhizoctonia solani*) bioefficacy

Introduction
Rice (*Oryza sativa* L.) is one of the most important cereals of the world and is consumed by 50% of the world population Luo Y *et al*. 1998 [6]. In India, it is cultivated on an area of 53.2 million hectares with a total production of 99.8 million tons. In Karnataka it is cultivated on an area of 1.53 million hectares with a total production of 3.80 million tons anonymous, 2011. India has the largest acreage under rice (46.3 million ha) with the production of about 89.09 million tonnes and productivity of 2.13 tonnes/hectare (Economic Survey, 2010-2011) [8]. Being the staple food for more than 65 per cent of the people, our national food security hinges on the growth and stability of its production. Among cereal crops, rice is the host of a large number of pests and diseases. Ou (1985) [18] has described 60 rice diseases of which 37 are of fungal origin. Among the different diseases, sheath blight of rice incited by *Rhizoctonia solani* Kuhn was earlier considered as a minor disease of a mere scientific curiosity. However it has now assumed a greater significance and importance in various rice growing countries. In the tropical and temperate regions, it now ranks second to blast in terms of economic losses and has become a major important disease of great concern (Rush, 1971; Gangopadhyay and Chakraborti, 1982; Manibhusanrao, 1995) [24, 9, 15].
Rice sheath blight was reported from Japan (Miyake, 1910) [16] and since then it became established in many oriental countries, and is often referred to as oriental leaf and sheath blight (Kozaka, 1975) [12]. In India, it was first reported from Gurdaspur in Punjab (Paracer and Chahal, 1963) [19], and later from Uttar Pradesh (Kohli, 1966). Singh and Pavgi (1969) [26], who reported its widespread occurrence in Varanasi, described the perfect stage of the fungus [*Thanatephorus cucumeris* (Frank) donk] on the plants for the first time in India. Further, the disease was reported from Tamil Nadu, Kerala, Andhra Pradesh and Kashmir (Reddy and Reddy, 1986) [23]. Under field condition, fungicide based management is most successful in majority of the cases Kandhari and Gupta 2003 [10], Bhuvaneswari and, Raju 2012 [10], and Kumar *et al*, 2013 [14]. Most of the fungicides such as benomyl, carbendazim, chloroneb, captafol, mancozeb, zineb, edifenphos, iprobenphos, thiophanate, carboxin, *etc*. have been found effective under field conditions Singh and, Sihna 2004 [26].

Recently many combination fungicides such as kresoxim methyl 40% + hexaconazole 8%, azoxystrobin 18.2% + difenoconazole 11.4% SC, Trifloxystrobin 25% + tebuconazole 50% 75 WG, and kasugamycin 5% + copper oxychloride 45% WP, have been shown to control the sheath blight disease under field dition Kumar and Veerabhraswamy 2014 and Pramesh *et al*,. 2016 [13, 20]. Continuous use of same group fungicides having same mode of action will lead to the development of resistant strain of same fungi and hence, it is necessary to search for a new molecule with different mode of action Kumar and Veerabhraswamy 2014 [13]. Thus, present study was under taken to determine the field efficacy of a new combination fungicide Azoxystrobin 120 + Tebuconazole 240 SC against sheath blight disease of rice under field conditions.

Materials and Methods

Field studies

A field experiment was conducted at Killimangalam village, Cuddalore dt., Tamil nadu during 2016-2017. The plot size is 40m^2 per treatment with spacing of 25x25cm, and the soil type is clay loamy soil. The experiment was laid out in Randomized Block Design (RBD), with three replications. The test fungicide, Azoxystrobin 120+Tebuconazole 240, was evaluated at three doses 830, 676, and 520ml, along with standards and untreated check against Sheath blight diseases. The crop was raised as per the recommended package of practices, except plant protection measures. The first treatment spray was done soon after the on set of the disease and following three sprays were taken up, at an interval of 15 days. 500 liter spray volume was used per hectare the crop was maintained with judicial irrigation and fertilizer schedule were followed as per standard procedures.

Treatment details: Eight treatments

Treatments	Product name	Dosage per ha	
		A.I. (gm)	Formulation (ml)
T_1	Azoxystrobin 120 + Tebuconazole 240 SC	156	520
T_2	Azoxystrobin 120 + Tebuconazole 240 SC	203	676
T_3	Azoxystrobin 120 + Tebuconazole 240 SC	249	830
T_4	Hexaconazole 5% EC	50	1000
T_5	Tebuconazole 25.9% EC	187.5	750
T_6	Kresoxim-Methyl 44.3% SC	250	500
T_7	Kitazin 48% EC	0.10% or 100 gm in 100 litres of water	0.20% or 200 ml in 200 litres of water
T_8	Control	-	-

Method and date of foliar spray application

As per the treatment schedule, the product was mixed with required quantity of water and sprayed with a high volume knapsack sprayer three times at 10 days interval starting from the initiation of the disease.

a) Date of first spraying : 19/12/2016
b) Date of second spraying : 29/12/2016
C) Date of Third spraying : 08/01/2017

Observations recorded

Bio-efficacy (PDI) for each diseases
Phytotoxicity viz., Leaf injury on tips/surface, Wilting, Vein clearing, Necrosis, Epinasty, Hyponasty etc. (If any) evaluation at 1, 3, 5, 7 & 10 days after spray using 0 -10 rating scale
Yield data at the time of harvest (q/ha)
Effect on Natural Enemies

Assessment of sheath blight disease

During the trial, plants affected due to sheath blight disease were found and also the total number of plants observed were counted and recorded. For disease scoring, the typical assessment system for rice developed by the International Rice Research Institute (SES, 2002) was followed.

Disease scale

0 - No infection
1 - Vertical spread of the lesions up to 20% of plant height
3 - Vertical spread of the lesions 21 - 30% of plant height
5 - Vertical spread of the lesions 31 - 45% of plant height
7 - Vertical spread of the lesions 46 - 65% of plant height
9 - Vertical spread of the lesions > 65% of plant height

$$\text{Disease severity \%} = \frac{\text{Sum of disease grades}}{\text{Total No. of Tillers assessed X Maximum disease grades}} \times 100$$

Phytotoxicity

Phytotoxicity effects (If any) at 'X', '2X' and 4X was recorded at 1, 3, 5, 7 and 10 days after application.

Product Name	Dosage	
	a.i. g/ha	Formulation ml/ha
Azoxystrobin 120 + Tebuconazole 240 SC	249	830
Azoxystrobin 120 + Tebuconazole 240 SC	498	1660
Azoxystrobin 120 + Tebuconazole 240 SC	996	3320

Phytotoxicity scale

Crop response/ Crop injury	Rating
0-00	0
1-10%	1
11-20%	2
21-30%	3
31-40%	4
41-50%	5
51-60%	6
61-70%	7
71-80%	8
81-90%	9
91-100%	10

Effect on natural enemies

The population of the natural enemies viz., Spiders, Dragon fly, Wasp and damsel fly was also assessed following standard procedures in the fungicide treated and untreated plots and recorded.

Grain yield and straw yield

The crop was harvested at maturity and sun dried. The harvested plants were thrashed, grains separated and cleaned by winnowing. The grains and straw were weighed separately. The yield per hectare was calculated and recorded.

Results and Discussion

Sheath blight

With regard to the incidence of Sheath blight of paddy, the treatments with Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha recorded the minimum sheath blight incidence with 11.34, 11.04 and 10.95 per cent after first, second and third spray respectively. This was followed by the dosage level with Azoxystrobin 120 + Tebuconazole 240 SC @ 676 ml/ha which recorded 11.23, 11.13and 11.09 per cent after first, second and third spray respectively. The market sample of Tebuconazole 25.9 % EC @ 750 recorded PDI 12.89, 12.75 and 12.56 after I,II and III spray followed by Kitazin 48% EC @ 500 ml/ha, Hexaconazole 5% EC and Kresoxim-Methyl 44.3% SC. While the untreated control recorded the maximum PDI (29.80, 37.75, 50.71) was recorded (Table 2). These findings are in reliable with the results of earlier investigations, where trifloxystrobin 25%+ tebuconazole 50 % w/w SC at 0.4 g/lperformed better in reducing the sheath blight disease severity. Bag 2009 [3]. Results reported by Bhuvaneshwari and Raju 2012 [4] where better efficacy of combination fungicide azoxystrobin18.2% + difenconazole 11.4% SC (Strobilurin +triazole) against sheath blight disease is much better than other solo fungicides. Various reviews confirmed that strobilurin compounds found to be effective in controlling many diseases like leaf blast, [Pramesh *et al*, 2016, Dutta *et al*, 2012] [20, 7], sheath blight Seebold *et al*, 2004, Bag *et al*., 2016 Pramesh, *et al*., 2016] [25, 2, 21], grain discolouration Bag, 2009 [3] and sheath rot and brown leaf spot [Biswas and Bag 2010] [5]. Pramesh *et al*. (2017) [22] revealed that the treatment azoxystrobin 11% + tebuconazole18.3% w/w SC at 1000 ml/ha recorded lowest PDI of sheath blight These earlier reports lend support the present investigation. In this experiment, our report also confirms the superior efficacy of strobilurin derived fungicide against sheath blight disease of rice.

Yield (Grain and Straw)

The results showed that all the treatments with chemical fungicides recorded higher grain and straw yields when compared to control. However, among the treatments, Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha recorded the maximum grain yield with 48.35 q/ha and maximum straw yield with 39.98 q/ha which was followed by the treatment Azoxystrobin 120 + Tebuconazole 240 SC @ 676 ml/ha with grain yield with 46.56 q/ha and maximum straw yield with 38.24 q/ha. These were followed by the treatments with Tebuconazole 25.9% EC, Kresoxim-Methyl 44.3% SC, Hexaconazole 5% EC, Azoxystrobin 120 + Tebuconazole 240 SC@520ml/ha and Kitazin 48% EC in the decreasing order of merit. The untreated control recorded the lowest yield parameters with 32.19 q/ha of grain yield and 28.73 q/ha of straw yield (Table 1). Application of fungicides has been reported to enhance the crop yield due to reduction in disease load (Pramesh *et al*., 2016; Seebold *et al*., 2004; Naik *et al*. 2012 [20, 25].

Effect on the population of natural enemies

The occurrence of natural enemy's viz., spiders, Dragon fly, Damsel fly and wasps population were not affected in the plots treated with Azoxystrobin 120 + Tebuconazole 240 SC. (Table 3).

Phytotoxicity

The use of Azoxystrobin 120 + Tebuconazole 240 SC fungicide is found to be safe to rice crop and none of the symptoms like chlorosis, necrosis, scorching, epinasty and hyponasty symptoms were recorded even at the highest dosage of treatment viz., 3320 ml/ha and up to 10 days of after I, II & III spraying (Table 4a, 4b, 4c).

Conclusion

The results indicated that foliar spray with Azoxystrobin 120 + Tebuconazole 240 SC fungicide (Sponsored by M/s. Nagarjuna Agrichem Ltd) @ 830 ml/ha as foliar spray once at disease initiation stage and repeated twice at 10 days interval effectively controlled the incidence of blast and Sheath blight diseases with enhanced yield of rice with no phytotoxic effect and was also found safe to the crop as it did not affect the natural enemy population.

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Table 1: Efficacy of azoxystrobin 120 + tebuconazole 240 SC on the management of Sheath blight disease incidence of rice (CR 1009)

T. No.	Treatments	Dose ml or gm/ha (Formulation)	Sheath blight PDI % after first spray		Sheath blight PDI % after Second spray		Sheath blight PDI % after Third spray	
			PDI %	% red over control	PDI %	% red over control	PDI %	% red over control
T_1	Azoxystrobin 120 + Tebuconazole 240 SC	520	12.56 (0.90)	57.85	12.36 (0.87)	67.25	12.35 (0.87)	75.64
T_2	Azoxystrobin 120 + Tebuconazole 240 SC	676	11.23 (0.72)	62.31	11.13 (0.70)	70.15	11.09 (0.70)	75.53
T_3	Azoxystrobin 120 + Tebuconazole 240 SC	830	11.34 (0.73)	61.94	11.04 (0.69)	69.80	10.95 (0.68)	78.40
T_4	Hexaconazole 5% EC	1000	14.34 (1.17)	51.87	14.23 (1.16)	62.30	14.17 (1.15)	72.02
T_5	Tebuconazole 25.9% EC	750	12.89 (0.95)	56.74	12.75 (0.93)	66.225	12.56 (0.90)	75.23
T_6	Kresoxim-Methyl 44.3% SC	500	20.45 (2.39)	31.37	20.25 (2.35)	46.3	20.12 (2.32)	60.32
T_7	Kitazin 48% EC	0.20% or 200 ml in 200 litres of water	14.56 (1.21)	51.14	14.23 (1.16)	62.30	14.05 (1.13)	71.40
T_8	Control		29.80 (5.09)	-----	37.75 (8.19)	----	50.71 (14.90)	-----
	SE.d CD (p=0.05)		0.13 0.56		0.78 1.66		0.41 0.97	

Table 2: Effect of Azoxystrobin 120 + Tebuconazole 240 SC on the population of natural enemies

T. No	Treatments	Dose ml or gm/ha	'Spiders (Nos.)			'Dragon fly (Nos.)			'Damsel fly (Nos.)			'Wasp (Nos.)		
			I spray	II spray	III spray	I spray	II spray	III spray	I spray	II spray	II spray	I spray	II spray	III spray
T1.	Azoxystrobin 120 + Tebuconazole 240SC	520	10.89	11.16	11.70	1.71	1.73	1.86	5.11	5.30	5.66	3.46	3.87	4.00
T2.	Azoxystrobin 120 + Tebuconazole 240SC	676	11.53	11.56	11.65	1.86	1.69	1.90	4.80	5.56	5.45	3.90	4.42	4.65
T3.	Azoxystrobin 120 + Tebuconazole 240SC	830	11.35	11.45	11.77	1.81	1.75	1.82	4.60	5.64	5.25	3.76	3.66	2.96
T4.	Hexaconazole 5% EC	1000	9.91	10.56	10.81	1.50	1.75	1.79	4.70	4.75	5.56	3.70	3.67	3.98
T5.	Tebuconazole 25.9% EC	750	11.92	12.95	12.60	1.87	1.86	2.00	4.55	5.56	5.51	3.54	4.45	4.76
T6.	Kresoxim-Methyl 44.3% SC	500	8.69	8.70	5.76	1.52	1.10	0.75	4.70	3.49	3.57	1.50	1.45	1.41
T7	Kitazin 48% EC	0.20% or 200 ml in 200 litres of water	11.84	11.40	11.70	1.75	1.70	1.80	4.76	5.44	5.44	3.75	3.54	2.88
T8	Control		11.15	11.45	11.75	1.80	1.78	1.81	4.76	5.63	5.63	3.74	3.32	2.79
	SE.d CD (p=0.05)		0.02 0.06	0.01 0.03	0.03 0.07	0.01 0.02	0.31 0.63	0.01 0.04	0.03 0.08	0.01 0.02	0.02 0.05	0.01 0.02	0.04 0.09	0.03 0.07

Table 3a: Evaluation of phytotoxic effect of Azoxystrobin 120 + Tebuconazole 240 SC rice (CR 1009)

Treatments	Phytotoxicity Symptoms- Days after I application of test chemical (DAA)																																							
	Leaf Injury						Wilting						Vein Clearing						Necrosis						Epinasty						Hyponasty						Stunting					
	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10
Azoxystrobin 120 + Tebuconazole 240 SC 830 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 1660ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 3320ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3b: Evaluation of phytotoxic effect of Azoxystrobin 120 + Tebuconazole 240 SC rice (CR 1009)

Treatments	Phytotoxicity Symptoms- Days after I application of test chemical (DAA)																																							
	Leaf Injury						Wilting						Vein Clearing						Necrosis						Epinasty						Hyponasty						Stunting					
	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10
Azoxystrobin 120 + Tebuconazole 240 SC 830 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 1660ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 3320ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3c: Evaluation of phytotoxic effect of Azoxystrobin 120 + Tebuconazole 240 SC rice (CR 1009)

Treatments	Phytotoxicity Symptoms- Days after I application of test chemical (DAA)																																							
	Leaf Injury						Wilting						Vein Clearing						Necrosis						Epinasty						Hyponasty						Stunting					
	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10
Azoxystrobin 120 + Tebuconazole 240 SC 830 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 1660ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 3320ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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