Crop Protection 90 (2016) 186–190

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

Effect of planting date, fungicide timing and cultivar susceptibility on severity of narrow brown leaf spot and yield of rice

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ARTICLE INFO

Article history:
Received 19 September 2015
Received in revised form
21 July 2016
Accepted 26 July 2016

Keywords:
Narrow brown leaf spot
Rice
Planting date
Fungicide application timing
Cultivar susceptibility
Yield loss

ABSTRACT

Narrow brown leaf spot (NBLS) of rice (*Oryza sativa* L.) is caused by *Cercospora janseana* (Racib). O. Const. (Synonyms: *Cercospora oryzae* Miyake, *Passalora janseana* Racib. U.). Experimental studies were conducted at Rice Research Station, Louisiana State University, and Agricultural Center, Crowley, to manage NBLS by fungicide application of propiconazole at different growth stages of rice cultivars having different susceptibility levels to NBLS in different planting dates. Results of these studies revealed that April (early) had less NBLS severity as compared to May (late) planting. Very susceptible cultivars, CL131 and Cheniere, had the highest and resistant cultivars, Della and Presidio, had the lowest NBLS severity at both the planting dates. Propiconazole application significantly reduced the NBLS severity in comparison to untreated. Fungicide application at panicle initiation was the most effective time to manage NBLS on the very susceptible and susceptible cultivars at both planting dates. NBLS on moderately susceptible cultivars was best managed by applying fungicide either at panicle initiation or early boot stage in early planting but panicle initiation was the best time to apply fungicide in late planting. Resistant cultivars did not need fungicide in April planting but did need in May planting. Rice yield was determined to be higher in April than May planting. Fungicide application at early boot stage protected the yield by 9.4% in April planting and 34.2% when applied at panicle initiation in May. Susceptible cultivar, Cheniere, exhibited the greatest yield and resistant cultivars had lowest yield in both the planting dates regardless of its susceptibility level to NBLS. Yield of very susceptible to susceptible cultivars was reduced in late planting but no effect was observed on yield of moderately susceptible and resistant cultivars.

1. Introduction

Narrow brown leaf spot (NBLS) is an endemic, foliar disease of rice in Louisiana caused by *Cercospora janseana* (Racib.) O. Const. [Synonyms: *Cercospora oryzae* Miyake, *Passalora janseana* (Racib.) U.] (Braun, 2000; Groth and Hollier, 2010). Narrow Brown Leaf Spot has been commonly observed on rice in Asia, Australia, and Latin America (Mew and Misra, 1994). Narrow Brown Leaf Spot was first described in 1906 by a Japanese pathologist (Hollier, 1992) and reported as a serious problem in rice growing areas in the United States in the 1940s (Ryker, 1943). Severe epidemics have been reported over the last few decades in rice growing areas throughout the world causing more than 40% yield losses (Anonymous, 2011). Due to its erratic nature, NBLS was not previously considered as a major disease of rice. Therefore, few studies have been done on its epidemiology, yield losses, and management. During 2006, a severe NBLS epidemic occurred in the southwestern rice production area of Louisiana (Groth and Hollier, 2010). Susceptible cultivars, a warm spring, and wet summer resulted in early initiation and severe NBLS development (Groth, 2013).

The DMI (demethylation inhibitor) fungicide propiconazole (Tilt EC250, Syngenta Crop Protection) has been used to manage rice diseases in the U.S. and other parts of world (Jones et al., 1987; Hossain et al., 2011; Gupta et al., 2013), but little is known about optimum rates and times of application for managing NBLS. Cultivar resistance plays a key role in NBLS, and rice cultivars with different degrees of susceptibility from resistant to very susceptible are available. Although resistant cultivars are available commercially, sole dependence on resistance is not advisable due to the frequent emergence of new races of *C. janseana* that break cultivar resistance (Groth and Hollier, 2010; Groth, 2013). In addition, the

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http://dx.doi.org/10.1016/j.cropro.2016.07.029
0261-2194/

severity of diseases caused by species of *Cercospora* can be adversely affected by later planting date (Enikuomehin et al., 2002; Swamy et al., 2012; Lemtur et al., 2013). Due to the erratic nature of NBLS and its potential threat to rice production, better understanding of factors affecting epidemic severity is needed. The effects of propiconazole application on NBLS and rice yield of cultivars with different susceptibility levels and crop planting times are unknown. Therefore, the currently reported studies were designed to develop integrated management strategies to manage NBLS on cultivars with different susceptibility at different planting dates. Because no fungicide application timing system exists, another objective was to determine the best timing of application.

2. Materials and methods

2.1. Experimental details

Field experiments were conducted at the Rice Research Station, Louisiana State University, and Agricultural Center in Crowley, LA during 2011 and 2012. The cultivars for this study were selected based on NBLS natural infection severity ratings (Saichuk et al., 2010). Narrow brown leaf spot very susceptible 'Cheniere' and 'CL131', susceptible 'CL111', moderately susceptible 'CL151', and resistant cultivars 'Della' (2011) and 'Presidio' (2012) were drill-seeded on 6 April (early planting date) and 17 May (late planting date) in 2011, and 15 April and 21 May in 2012, at 136 kg ha^{-1}. Experimental units were 1.2 × 4.9 m and consisted of seven rows with an 18-cm spacing. The soil type was silt loam (pH 6.0; clay 12%; silt 71%; and 17% sand; CEC 9.4/kg). Fertilizer (N-P-K) was incorporated 1 day before planting at the rate of 24-67-67 kg ha^{-1}. Agronomic, weed, and insect management practices followed current standard recommendations (Saichuk, 2012). Nitrogen was applied prior to flooding at 133 kg N ha^{-1} as urea at the three to four leaf stage, and after flooding at the rate of 51 kg N ha^{-1} as urea at the beginning of stem internode elongation. April plantings were harvested on 30 July and 2 August during 2011and 2012, respectively. May plantings were harvested on 15 and 18 September in 2011 and 2012, respectively.

2.2. Fungicide applications

Propiconazole (Tilt 250 EC, Syngenta Corp.) was applied at the rate of 0.17 kg active ingredient ha^{-1}, at either panicle initiation (PI), early boot (EB, 5- to 10-cm panicle in the boot), or late boot (LB, just before heads emerge from the boot) rice growth stages (Saichuk, 2012). Treatments were applied at a delivery rate of 140 L ha^{-1} with a CO_2-pressurized backpack sprayer with pressure 20 psi, using 8002 flat fan tips (Table 1).

2.3. Disease assessment and yield determination

To follow the NBLS epidemics, five plants in the central two rows of the experimental unit were arbitrarily selected and their lower, middle and flag leaves were tagged as they appeared. Lower and middle leaves (one each per level) were tagged 45 days after sowing (DAS), and flag leaves were tagged 64 DAS. Narrow brown leaf spot severity was rated for each leaf using a 0–9 scale where 0 = no disease, 1 = 1–3%, 2 = 3–5%, 3 = 5–12%, 4 = 12–25%, 5 = 25–40%, 6 = 40–65%, 7 = 65–75%, 8 = 75% and 9 = more than 75%, leaf area. Narrow brown leaf spot percentages on lower, middle and flag leaves were averaged across leaves and used as the percentage of diseased leaf area for the entire plant. The mid-point percentage was used to calculate percent leaf area for analysis (Groth et al., 1993). At 109 DAS, final disease severity at harvest was collected (Groth et al., 1993). Resistant cultivar, Della, is susceptible to lodging and was completely lodged prior to harvest. Therefore, it was replaced with another resistant cultivar, Presidio, in 2012. The center four rows of each experimental unit were harvested with a small-plot combine (Mitsubishi, VM13). Grain yield and moisture were determined, and rice yield was adjusted to 12 g kg^{-1} moisture content.

2.4. Data analysis

Treatments were replicated four times in a randomized complete block design. Factors included six cultivars and four fungicide timings including untreated under the two planting dates. Box plots and Kolmogorov-Smirnov (KS) tests were used to check data normality. Final NBLS disease severity values were used to analyze the effect of treatments. Final NBLS percentage was logit transformed as ln x/(1-x) where x is proportion of disease (Campbell and Madden, 1990; Arneson, 2001). Transformed data were analyzed using the SAS mixed procedure as a design was factorial design (SAS 9.3 Institute, Cary, NC). Replications were taken as a random factor, and year, planting date, cultivar, and fungicide application timing including a non-sprayed control were taken as fixed factors. Tukey's Kramer method of means comparison was used to compare least square means. Significant differences among the treatments were determined using SAS Macro function. After analysis, logits were back transformed to percentage using the formula {Exp. (logit)/1 + Exp. logit}*100 (Arneson, 2001) for presentation in tables and figures.

3. Results

3.1. Effects of planting date, cultivar and fungicide application time on NBLS severity

Analysis of variance indicated no year by treatment interactions for any of the parameters (data not presented). Therefore data across years were combined. Narrow Brown Leaf Spot was significantly affected by cultivar, planting date, fungicide application timing, and their interactions (Table 2). Yield was affected by cultivar, planting date, and fungicide timing and interactions planting date x cultivar and planting date * fungicide timing.

Narrow brown leaf spot severity was greater in the May planting in all the treatments, cultivars and fungicide timings, as compared to April. The very susceptible cultivars (CL131 and Cheniere) had the greatest and the resistant cultivars (Della and Presidio) had the lowest disease severity in both the planting dates (Table 3). In the April planting NBLS ratings decreased with increasing resistance levels. In the May planting with higher disease levels, susceptible (CL111) and moderately susceptible (CL151) cultivars had similar disease severity.

Propiconazole application reduced disease severity in the very susceptible, susceptible, and moderately susceptible cultivars in both planting dates (Table 3). Fungicide treatment had variable, fewer effects on the resistant cultivars. Untreated plots of resistant

Table 1
Fungicide application time schedule for 2011 and 2012, April and May plantings, Louisiana State University Agricultural Center, Rice Research Station, Crowley.

Year	Planting date	Growth stage and dates for fungicide application[a]		
		Panicle initiation	Early boot	Late boot
2011	April	15 June (70)	30 June (85)	6 July (91)
	May	22 July (60)	29 July (67)	4 Aug. (72)
2012	April	21 June (67)	3 July (79)	10 July (86)
	May	18 July (58)	26 July (66)	2 Aug. (73)

[a] Numbers in the parentheses are days after sowing (DAS).