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# Effect of cultivar susceptibility and planting date on narrow brown leaf spot progression in rice

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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 in Louisiana to study NBLS progression in resistant to very susceptible cultivars at different planting dates. The very susceptible cultivars CL131 and Cheniere, susceptible CL111, moderately susceptible CL151, and resistant cultivars, Della and Presidio were planted in mid-April and mid-May plantings. Weekly disease assessments began at 45 days after sowing (DAS) and the final disease assessments were done at 109 DAS. Results revealed that AUDPC and final NBLS severity were greater in very susceptible and susceptible cultivars as compared to resistant cultivars. The AUDPC for mid-May plantings were greater for all cultivars. AUDPC increased with increasing susceptibility rating in the mid-April planting. Early onset of NBLS was observed in very susceptible and susceptible cultivars regardless of planting date. Significant interactions were detected between cultivar and planting date for AUDPC and final disease but were non-significant for apparent infection rate. Apparent NBLS infection rate was greatest in the highly susceptible Cheniere and CL131 in the mid-May planting. Apparent infection rates were less in the susceptible and moderately susceptible cultivars and least for the resistant cultivars in both plantings.



## 1. Introduction

Narrow brown leaf spot of rice (NBLS) is caused by the fungal pathogen *Cercospora janseana* Racib. O. Const. also known as *Cercospora oryzae* Miyake or *Passalora janseana* (Racib.) U. Braun (2000). NBLS is an endemic, although erratic in severity, foliar disease in the rice growing states of the United States, including Arkansas, Mississippi, Louisiana and Texas, as well as other rice growing regions throughout the world (Hollier, 1992; Mew and Misra, 1994). Several outbreaks of NBLS have been reported in rice growing areas where it caused more than 40% yield loss (Anonymous, 2011). NBLS is normally not an economically important disease of rice in the southern U.S., but an epidemic in 2006 in parts of southern Louisiana caused significant economic yield losses (Groth, 2013; Kaur et al., 2014a; Smith, 2007). A large percentage of susceptible cultivars, a warm winter allowing rice to overwinter, and favorable environmental conditions during the summer resulted in an early start for the epidemic leading to a severe outbreak (Groth, 2013). Since then, severe epidemics have not occurred, but most of the rice cultivars reported to produce high yield grown in Louisiana are either rated as susceptible or very susceptible to NBLS. Although resistant cultivars are available, dependence on resistance is not advisable due to the frequent emergence of new races of *C. janseana* (Groth and Hollier, 2010a; Groth, 2013). Due to the erratic nature of NBLS and its potential threat to rice production, a better understanding of factors affecting epidemic severity is needed.

Cultivar susceptibility and late planting have previously been reported to affect disease development caused by species of *Cercospora* in several notable crops (Dube et al., 2003; Elmer et al., 1996; Enikuomehin et al., 2002; Kaur et al., 2014b; Mani et al., 2016). Resistant cultivars with low infection rates delayed the appearance and reduced the development of *C. beticola* on sugar beet, *C. apii* on celery, and *C. arachidicola* on peanut cultivars and low apparent infection rate (Berger, 1976; Gaurilcikiene et al., 2006; Waliyar et al., 1993). In other foliar disease systems, such as disease severity of rice blast (*Pyricularia grisea*) and gray leaf spot

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(*Cercospora zea-maydis*) on maize were also reduced by changing the planting date of susceptible cultivars (Andi and Nur, 2013; Atta et al., 2013; Bhatia and Munkvold, 2002).

The research in the current paper was conducted to evaluate the effects of cultivar susceptibility and time of planting on NLBS epidemic development. The objectives of this study were to determine and compare the temporal increase of NBLS epidemics by using apparent infection rate and area under the disease progress curve in mid-April and mid-May plantings and evaluate those parameters and final disease severity to establish a suitable method of NBLS assessment that can be used for selection of resistant cultivars. Information generated from this study will help to develop effective disease management strategies for NBLS.

## 2. Materials and methods

### *2.1. Cultivars and planting dates*

Field experiments were conducted at the Louisiana State University Agricultural Center H. Rouse Caffey Rice Research Station in Crowley, LA during 2011 and 2012. Cultivars selected were based on NBLS susceptibility, and included the very susceptible cultivars ‘Cheniere and CL131’, the susceptible cultivar ‘CL111’, the moderately susceptible cultivar ‘CL151’, and the resistant cultivar ‘Della’ in 2011 and ‘Presidio’ in 2012 (Saichuk et al., 2012). Della was selected as the resistant cultivar in 2011, but due to lodging, in 2012, another resistant cultivar, Presidio, was used for the study. Experiments were drill-seeded on 6 April and 17 May in 2011, and 15 April and 21 May in 2012, at a seeding rate of 136 kg $ha^{-1}$. Experimental units were 1.2 × 4.9 m and consisted of seven rows with 18 cm row width spacing. The soil class was a Crowley silt loam (pH 6.0, clay 12%, silt 71%, sand, and CEC 9.4/kg). Fertilizer (N-P-K) was incorporated 1 day before planting at a rate of 24-67-67 kg $ha^{-1}$. Agronomic, weed, and insect management practices followed current standard Louisiana recommendations (Saichuk, 2012). Nitrogen was applied prior to flooding at 133 kg N $ha^{-1}$ as urea at the 3 to 4 leaf stage, and after flooding at the rate of 51 kg N $ha^{-1}$ as urea at the beginning of stem internode elongation.

### *2.2. Disease assessment and parameters*

To assess NBLS, five plants in the central two rows (rows 3 and 4) of each plot were selected and their lower, middle and flag leaves were tagged with surveyors tape as they appeared. Lower and middle leaves were tagged 45 days after sowing (DAS) and flag leaves tagged after 64 DAS. At each sampling date, the selected leaves were visually evaluated for NBLS to determine progression over time. Onset of the disease was noted as a pinhead sized lesion observed on the leaf lamina. Disease severity was rated weekly using a 0–9 scale, where 0 = no disease, 1 = 1%, 2 = 3%, 3 = 5%, 4 = 12%, 5 = 25%, 6 = 40%, 7 = 65%, 8 = 75% and 9 = more than 75% leaf area diseased (Groth et al., 1993). Weekly disease assessment began at 45 DAS and the last or final disease assessment was done at 109 DAS. NBLS severity ratings for lower, middle, and flag leaves of selected plants were converted to the rating percentage interval midpoint, averaged, and used as one datum for the observation. NBLS percentage data were transformed using the logit transformation method for polycyclic diseases, ln x/(1-x), where x is proportion of disease (Arneson, 2001; Campbell and Madden, 1990). In addition, the apparent infection rate was calculated for each epidemic by regressing logits over time. A second method for measuring disease increase was area under the disease progress curve (AUDPC) (Shaner and Finney, 1977). Disease assessment ratings (n = 9) from 52 to 109 DAS were used to calculate AUDPC. No disease was observed at 45 DAS for both planting date and year.

### *2.3. Data analysis*

Treatments were replicated four times in a randomized complete block design for each planting date. Logits were analyzed using the SAS mixed procedure with a factorial design (SAS 9.3, Cary, NC). Years, planting dates, and cultivars were fixed factors, and replications were a random factor in the mixed procedure. Tukey's Kramer method of means comparison was used to compare least square means for final disease severity, AUDPC, and apparent infection rate. The SAS REG procedure was used for regression.

## 3. Results

### *3.1. Cultivars and planting date*

Interactions of fixed factor, cultivars and planting dates, with year and replications were found to be non-significant (data not presented); therefore data across years were combined. Cultivar susceptibility affected all three disease parameters, AUDPC, apparent infection rate, and final disease severity (Table 1). Planting date significantly affected AUDPC and final disease severity, but not the apparent infection rate. Significant interactions were detected between cultivar and planting date for AUDPC and final disease severity, but not for apparent infection rate.

### *3.2. Disease assessment and parameters*

NLBS incidence increased with time in all cultivars regardless of planting date (Fig. 1). Onset of disease varied by cultivar susceptibility rating and planting date. Earlier onset of NBLS was observed for the mid-May planting date as compared to mid-April planting in all susceptible cultivars. In mid-April planting, the average epidemic onset was 64 DAS in the very susceptible Cheniere and CL131 and susceptible CL111, and 72 DAS in moderately susceptible CL151 and resistant Della and Presidio cultivars. In comparison, for the mid-May planting, disease onset in thevery susceptible and susceptible cultivars averaged 58 DAS, but onset was not until 64 DAS in moderately susceptible and resistant cultivars. Differences in disease progress with time were detected among cultivars and planting dates (Fig. 1). Resistant cultivars Della and Presidio had the lowest disease increase over the season regardless of observation time or planting date. Even with similarly delayed onset of disease in resistant and moderately susceptible cultivars, the resistance of Della and Presidio resulted in slower disease development.

AUDPC was greatest in the very susceptible cultivars, Cheniere and CL131 and lowest in resistant cultivars for both mid-April and mid-May plantings (Table 2). The AUDPC for mid-May plantings was greater for all cultivars than those calculated for the mid-April plantings. The AUDPC between the very susceptible and the resistant cultivars was 66.9% and 62.9% greater in the susceptible than the resistant for mid-April and mid-May plantings, respectively. The differences in AUDPC when planting very susceptible versus susceptible rice cultivars was determined to be 32.4% and 16.9%, respectively, for mid-April versus mid-May planting dates. The moderately susceptible cultivars also reduced disease when compared with the moderately susceptible cultivars for both mid-April, 51.6%, and mid-May, 25.7%, planting dates, respectively. In addition, the apparent infection rate was determined to be greater in the very susceptible cultivars when compared to the resistant cultivars in both mid-April, 14%, and mid-May, 11%, planting dates.

Final NBLS severity was the last measurement between cultivars. Planting date greatly influenced the severity even when planting a similar cultivar at a later timing. The very susceptible cultivars had an increase in final NBLS severity of 26.9% between