An Estimate of Aboveground Dry Matter (ADM) Yield Loss due to Rust on Switchgrass

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INTRODUCTION

Rust, caused by *Puccinia emaculata*, has been reported in switchgrass feedstock plantings in Arkansas (5), Iowa (2), South Dakota (3), and Tennessee (1). None of these reports provides details concerning the impact of rust on switchgrass feedstock yield or quality. Rust first appears in switchgrass in late May and will intensify into early September (1). While Alamo and Kanlow switchgrass show moderate rust resistance (2), severe disease has been noted in the former population in southwest Alabama (4). Switchgrass rust is recognized as a significant threat to switchgrass feedstock production (6); however, impact of this disease on switchgrass ADM yield is unknown. The study objective was to define the relationship between rust canopy blighting and ADM yield.

METHODS

Single plant microplots of the cloned switchgrass cv 'Cloud Nine' were established in 2011 at the Brewton Agricultural Research Unit (USDA Hardiness Zone 8a). Soil fertility was adjusted according to the results of a soil assay. Plants were watered as needed. A factorial arranged in a split plot with five single-plant replications was used. Eagle 20EW @ 8 fl oz/100 gal, Daconil Ultrex at 1.4 lb/100 gal, and Heritage 50WDG @ 4 oz/100 gal applied at 1, 2, 3 or 4-wk intervals. Non-treated controls were included. Rust was rated using a modified 1 to 10 rating scale where 1 = no disease, 2 = very few pustules, 3 = few pustules, 4 = pustules present and ≤ 10% leaf blight, 5 = pustules noticeable and ≤ 25% leaf blight, 6 = pustules numerous and ≤ 50% leaf blight, 7 = pustules very numerous and ≤ 75% leaf blight, 8 = numerous pustules and ≤ 90% leaf blight, 9 = few remaining leaves covered with pustules and ≤ 95% leaf blight, and 10 = leaves dead. Biomass harvest involved cutting shoots 2 in. above the soil surface and weighing the bundled shoots. Fresh shoot samples were weighed, then dried, and weighed dry to determine aboveground dry matter (ADM) yield. Significance of treatments and interactions were evaluated using PROC GLIMMIX in SAS. PROC REG in SAS was used for linear regression analysis. For non-normal data, analyses were done on rank transformations, which were back transformed for presentation. Means were separated using Fisher's least significant difference (LSD) test ($P \leq 0.05$).

Table 1. Source of variation for rust severity and ADM yield on 'Cloud Nine' switchgrass.

Source of Variation (*F* value)	Rust severity	ADM yield
Year	4.30*[z]	81.64***
Fungicide	90.48***	40.30***
Year x Fungicide	3.87**	3.03*
Interval	53.32***	17.87***
Year x Interval	3.81**	1.03
Fungicide x Interval	6.13***	1.87
Year x Fungicide x Interval	0.86	0.49

[z]Significance of *F* values at the 0.05, 0.01, and 0.001 levels are indicated by *, **, or ***, respectively.

Table 2. Rust[z] and ADM yield[y] as impacted by year and fungicide, and year x application interval.

	% Canopy blighted by rust[z]			ADM yield (lb)[y]		
Fungicide	2012	2013	2014	2012	2013	2014
Control	73.7 a[x]	75.0 a	75.3 a	4.9 e	8.3 d	10.5 bc
Daconil Ultrex	48.5 b	44.2 b	29.1 bc	5.5 e	9.6 c	11.5 b
Eagle 20EW	16.5 d	17.9 cd	14.0 d	8.1 d	12.7 a	12.8 a
Heritage 50WDG	20.6 cd	11.7 d	11.3 d	7.3 d	12.8 a	13.9 a
Interval						
1 wk	4.4 d	7.3 d	5.2 d	8.1 d	13.7 a	13.8 a
2 wk	28.6 bc	24.1 c	15.6 cd	7.4 de	11.6 bc	12.3 abc
3 wk	39.4 b	24.7 c	23.7 bc	6.4 ef	10.8 bc	12.5 ab
4 wk	40.4 b	41.0 b	27.9 c	6.0 ef	10.7 c	12.2 abc
Control	73.7 a	75 a	69.1 a	4.9 f	8.3 d	11.0 bc

[z]Rust intensity was rated on a 1 to 10 leaf spot ratings scale and converted to % canopy blighted.
[y]ADM yield is expressed as pounds (lb) of dry matter per plot.
[x]Means followed by the same letter are not significantly different according to Fisher's LSD test ($P<0.05$).

RESULTS

Rust control varied by year and fungicide (Table 1). While all fungicides reduced rust severity compared with the control, Daconil Ultrex 82.5WDG gave less rust control than the equally effective Eagle 20EW and Heritage 50WDG (Table 2). Rust intensified as application interval lengthened with lowest rust ratings noted at the 1-wk than longer intervals (Table 3). In 2 of 3 years, similarly better rust control was obtained at the 2- and 3-wk interval as compared with the 4-wk interval, which has lower blighting ratings than the control in two of three years.

ADM yields differed by year and fungicide (Table 1) with similarly higher ADM yields reported for 2013 and 2014 (Table 2). Higher ADM yields were obtained with Eagle 20EW and Heritage 50WDG than with Daconil Ultrex 82.5WDG or the control, with the latter having lower ADM yields in two of three years. ADM yields were higher with 1-wk intervals than the control in all study years, as compared with the 2-, 3-, and 4-wk interval treatments where yield gains were seen in two, one, and one study year, respectively.

Fungicide efficacy against rust differed by application interval (Table 1). With all fungicides, rust intensified as application intervals lengthened from 1 to 4 wk (Table 3). Eagle 20EW and Heritage gave better rust control than Daconil Ultrex 82.5WDG at all intervals. Similar rust control was noted with the two former fungicides at each application interval interval.

Linear regression equations describing the relationship between % canopy blighting attributed to switchgrass rust and ADM yield for each study year are displayed in Figure 1. As noted above, ADM yields declined in each study year as canopy blighting intensified. ADM yield declines attributed to switchgrass rust ranged up to approximately 29% in 2014 to 50% in 2012 and 2013.

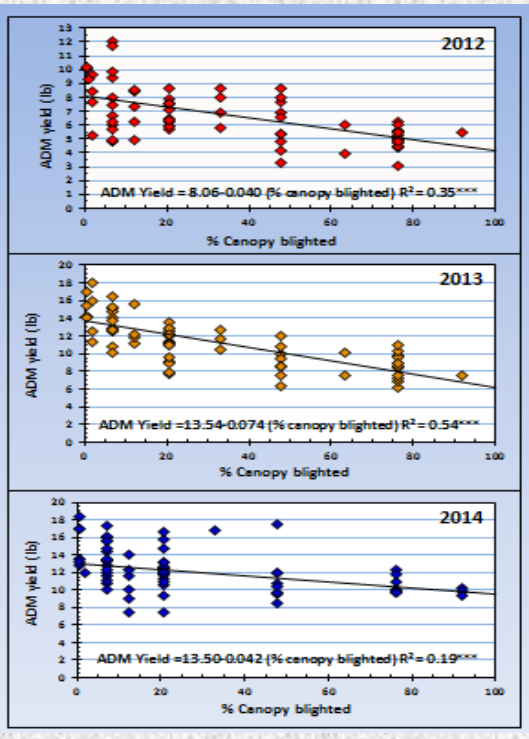
Figure 1. Rust on switchgrass: A) Close-up of rust pustules, B) numerous rust pustules on switchgrass leaves, which results in C) severe rusting and heavy leaf mortality on 'Dallas Blues' switchgrass.

Table 3. Rust severity[z] as impacted by fungicide selection and application interval.

	% Canopy blighted by switchgrass rust[z]		
Interval	Daconil Ultrex 82.5 WDG	Eagle 20EW	Heritage 50WDG
1 wk	10.9 f[y]	3.0 g	3.2 g
2 wk	41.8 c	16.3 de	12.7 ef
3 wk	48.1 bc	21.4 d	21.9 d
4 wk	61.0 ab	23.7 d	20.4 d
Control		74.7 a	

[z]Rust intensity was rated on a 1 to 10 peanut leaf spot ratings scale and converted to % canopy blighted.
[y]Means followed by the same letter are not significantly different according to Fisher's LSD test ($P<0.05$).

Figure 1. Linear models describing the relationship between canopy blighting and ADM yield.



SUMMARY

Switchgrass ADM yield declined as rust intensified. The yield decline attributed to rust differed by year with similarly high losses seen in 2012 and 2013. While Eagle 20EW (myclobutanil) and Heritage 50 WDG (azoxystrobin) gave excellent rust control when applied at 1- to 3-wk intervals, fungicide treatments are not an economically viable rust control option in a cellulosic feedstock production system, when compared to a rust-resistant population or variety.

Literature Cited:

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