Weather Conditions Associated with the Development of Southwestern Rust on Cotton

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ABSTRACT

Weather conditions leading to the development of southwestern rust on cotton were evaluated at 3 locations in southeastern Arizona. Rust appeared following an extended period of wet, humid weather. In excess of 16 hours of wet canopy/high humidity conditions were observed on two consecutive days between 5 and 7 days prior to the appearance of rust. Temperatures during the wet canopy/high humidity periods were moderate, ranging from 65 F to 76 F. Afternoon rain showers initiated these extended periods of wet canopy/high humidity conditions.

INTRODUCTION

Southwestern rust (Puccinia cacabata) has been an erratic disease problem for Arizona cotton producers since its appearance in 1922. The disease typically appears in southeastern Arizona during the months of July and August. The impact of southwestern rust on cotton yield varies from year to year, with severe outbreaks causing yield reductions of 50-75%.

The infection process for southwestern rust begins when summer rains blow teliospores from the alternate host, grama grass (Bouteloua spp.) onto the leaves and bolls of the cotton plant. Provided environmental conditions are optimal, infection then proceeds quickly. Previous studies (1, 2) conducted under controlled conditions indicate infection occurs within 13 hours provided: 1) the cotton canopy remains wet, or 2) relative humidity levels remain above 90% under moderate temperature conditions (<83F). Once rust has infected the cotton plant, there are no known means of controlling the growth of the fungus. Growers use applications of mancozeb (Dithane M45) as a protective measure, but mancozeb will not stop southwestern rust once the plant is infected.

Predictive disease systems have been developed for other fungal diseases including apple scab and early blight on potato. Such systems minimize guesswork associated with managing fungal diseases and allow growers to apply fungicides only when disease probability is high. The goal of this research is to determine the feasibility of developing a predictive model for southwestern rust. Such a model requires an understanding of the interaction of weather with the outbreak of the disease. This report presents the results of a first-year study designed to isolate specific weather conditions associated with the outbreak of southwestern rust.

METHODS

Weather conditions associated with the development of cotton rust were studied during the summer of 1987 at 3 locations in southeastern Arizona. Specific information on farm cooperators, farm locations, cotton varieties, planting dates and lint yields are provided in Table 1.

A small, automated weather station was installed at each location on 23 June in a cotton field with a previous history of rust infestation. Each weather station monitored air temperature (AT) and relative humidity (RH) at 1.5m above the soil surface and precipitation (PPT) at gauge height (0.4m). The weather station was programmed to compute hourly averages (AT and RH) and totals (PPT) as well as daily extremes of AT and RH.

Each location was checked biweekly between 23 June and 1 September for the presence of cotton rust. When rust was noted, the severity of infestation was documented by counting pustule numbers and measuring pustule diameter on 10 leaves selected at random from the 2nd node below the plant apex.

Table 1. Cooperators and site-specific cultural and production information for the 3 study locations.

Cooperator	Location	Cotton Variety	Planting Date	Lint Yield (lb/A)
Owens	Bonita	Coker 304	04/05/87	725
Curry	Cochise	Acala 15/17/75	04/15/87	850
Mahaney	Elfrida	Germain GC5-10	04/10/87	750

RESULTS

Rust was first noted at all locations on 4 August. The severity of rust infestation, as measured by the number of pustules/leaf, varied with location (Table 2). Cotton at Bonita and Elfrida had significantly more pustules/leaf than did cotton at Cochise. No significant difference in pustule number/leaf was observed between the Bonita and Elfrida sites. Pustule diameter was not affected by location, remaining a constant 1mm. The presence of different varieties at each location made it impossible to determine whether the differences in pustule number/leaf were the result of environmental conditions or differences in genetic susceptibility to rust. However, the fact that rust appeared at all locations on the same day suggests that environmental conditions prior to 4 August were conducive to cotton rust infection.

Table 2. Disease severity, as measured by the average number of pustules per leaf, for each location.

LOCATION	PUSTULES/ LEAF
Bonita	63.2a[+]
Cochise	4.8b
Elfrida	57.8a

[+] Means followed by the same letter are not significantly different at p = 0.05.

We chose to examine weather conditions during the period of 27 July through 1 August, based on past research findings that indicated visible rust symptoms appear 5-6 days after initial infection. Special attention was focused on periods of rainfall and high humidity. Due to limitations of the humidity sensors used in this study, a high humidity condition was declared anytime RH exceeded 80%.

Similar weather conditions prevailed across all locations during the 6-day period (Table 3). A pronounced wet and humid period began on the afternoon of 27 July and continued throughout the remainder of the 6-day assessment period. The 3-day period encompassing 28-30 July is of particular interest in relation to rust infection (Figure 1). Beginning on 28 July, afternoon rains occurred at all locations wetting the cotton canopies and raising RH levels above 80% two to three hours prior to sunset. RH levels remained above 80% for the remainder of the night and well into the next morning. Rainfall returned to all locations by mid-afternoon on 29 July and continued

until near midnight. Again the rains wet the cotton canopies and lifted RH levels above 80% well before sunset. As with the previous day, the high RH levels continued well into the next morning (30 July). During this 3-day period, cotton at each location was exposed to two extended periods of wet canopy/high humidity conditions (16 hours or greater). Temperatures during the wet canopy/high humidity periods ranged from 65F to 76F and were consistent across locations. Such conditions have been identified by past research as optimal for rust infection.

Table 3. Weather data for the 6-day period between 27 July and 1 August.

DATE	LOCATION	AIR TEMPERATURE Max. (F)	Min. (F)	Avg. (F)	RELATIVE HUMIDITY Max. (%)	Min. (%)	Avg. (%)	PRECIP. Total (IN)
7/27	Bonita	90	63	76	93	28	47	0.21
"	Cochise	92	60	75	87	30	52	0.00
"	Elfrida	90	63	76	91	32	53	0.12
7/28	Bonita	82	65	70	93	54	85	0.63
"	Cochise	86	66	71	95	51	84	1.46
"	Elfrida	87	66	71	91	43	81	0.14
7/29	Bonita	80	65	71	92	71	87	0.24
"	Cochise	80	64	70	95	72	90	0.15
"	Elfrida	80	65	69	91	70	87	0.21
7/30	Bonita	83	65	70	92	63	85	0.14
"	Cochise	86	65	72	94	53	82	0.02
"	Elfrida	88	63	72	91	41	80	0.07
7/31	Bonita	88	66	76	92	42	76	0.00
"	Cochise	87	67	75	93	49	75	0.00
"	Elfrida	91	65	76	91	33	72	0.05
8/1	Bonita	88	66	76	92	44	73	0.00
"	Cochise	87	66	74	91	52	75	0.03
"	Elfrida	90	67	76	90	41	71	0.00

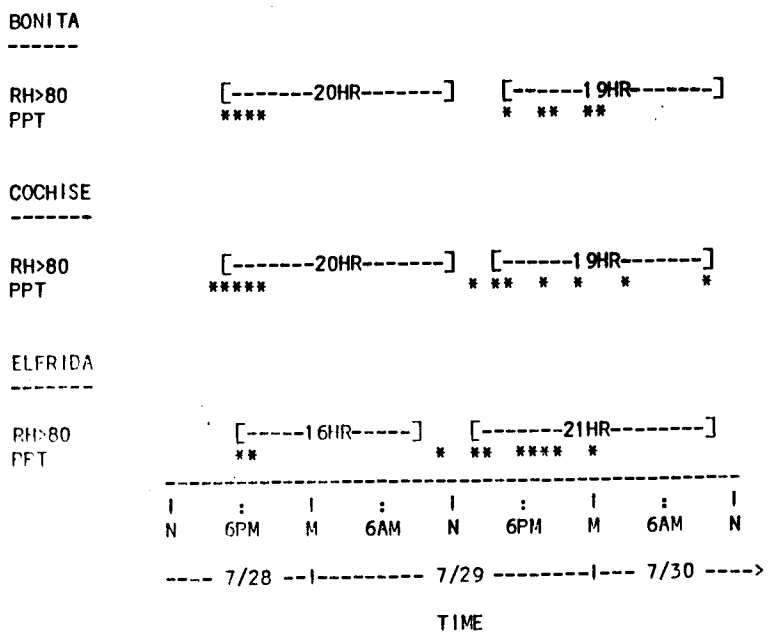

Figure 1. Periods of high RH and precipitation between noon (N) on 28 July and noon on 30 July. Asterisks (*) indicate hours during which measurable precipitation was recorded. The number of consecutive hours (HR) of RH>80% are labeled.

CONCLUSIONS

Southwestern rust of cotton appeared following an extended period of wet, humid conditions. Identifying the actual day when conditions allowed rust infection to proceed was difficult due to the length of the wet-weather period. However, in excess of 16 hours of wet canopy/high humidity conditions were observed on two consecutive days between 5 and 7 days prior to the appearance of rust, and afternoon rain showers were critical to the development of these conditions.

REFERENCES

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