Sorghum rust[1]

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ABSTRACT

Four grain sorghum (*Sorghum bicolor* (L.) Moench.) lines showing distinct reactions to sorghum rust (*Puccina purpurea* Cooke) were planted under subhumid tropical oceanic conditions in northwestern Puerto Rico in an oxisol of pH 5.5 in May 1985. Disease development was periodically monitored until harvest. Rust levels were established using either no application or two applications each of either oxycarboxin, triadimefon or mancozeb fungicide. Noticeable rust was found at boot stage and increased with maturity. Rust differences were most apparent at physiological maturity. At that stage foliar rust coverage was estimated at 20, 16, 1 and 0% for SC 212, SC 307, TAM 428, and SC 120, respectively. Greatest rust control was found for oxycarboxin, triadimefon, and mancozeb in that order of efficacy. Oxycarboxin treatment resulted in over 80 and 60% less rust; 25 and 40% more grain yield; 0 and 20% greater seed density; and 80 and 71% more foliar sorghum anthracnose in SC 307 and SC 212, respectively, in comparison with those of nontreated plots. Fungicide treatments did not increase yields of either TAM 428 or SC 120, sorghum cultivars showing moderately resistant and very resistant rust reactions, respectively.

INTRODUCTION

Whenever sorghum [*Sorghum bicolor* (L.) Moench.] is grown, rust (*Puccinia purpurea* Cooke) can infect leaves, sheaths, peduncles and stems (2, 3, 4, 6). Although rust is widespread on sorghum, little has been done to determine its role in field production of sorghum. Tarr (6), from Africa, suggested rust seldom has significant effects on sorghum production. Bergquist (1) reported rust as a major problem in Hawaii, causing serious losses to sorghum. To better determine the role of rust in sorghum production, experiments were conducted establishing variable levels of rust and associating these with crop quality and yield. Natural rust epidemics were used with fungicide treatments and variable rust resistance levels to create levels of rust for yield and quality loss analysis.

MATERIALS AND METHODS

Four grain sorghum lines (SC 212, SC 307, TAM 428, and SC 120) were planted May 1, 1985 to determine their yield under different levels of sorghum rust in Isabela, Puerto Rico, in the northwest sector of the

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island. The location has a subhumid tropical climate with lowland heat moderated by tradewinds. Mean annual rainfall and temperature are 1,675 mm and 24.5° C, respectively. The soil is a Coto clay, Oxisol (Tropeptic Haplorthox) characterized by moderate variable soil acidity (mean 5.5 pH with a range of 4 to 8) and low natural fertility with a cation exchange capacity of <10 meq/100 g soil. Fields are extensively used for field plot investigation and sorghum winter nurseries, with 2 or 3 cropping cycles common each year. Rust is found year round on rust susceptible genotypes and on wild sorghums which are widely dispersed and commonly harbor a heavy rust population.

A split plot design was used. Main plots were the fungicide treatments (triadimefon, oxycarboxin, mancozeb, and the nontreated control); the subplots were sorghum lines. Main plots were replicated 3 times in a randomized complete block design. Each subplot consisted of four 4.5-m rows planted 80 cm apart.

Sorghum lines were selected on the basis of rust reactions from previous experiments. Classification, origin and susceptibility:

Line designation	*Class*	*Rust reaction*
SC 212 IS 1526C	Durra	Very Susceptible
SC 307 IS 2198C	Dochna	Moderately Susceptible
TAM 428 IS 2610C	Zerazera	Moderately Resistant
SC 120 IS 2816C	Zerazera	Very Resistant

All lines were 3- or 4-dwarf photoperiod insensitive lines converted from tall photoperiod sensitive tropical germplasm through the Sorghum Conversion Program (5). TAM 428 was derived from SC 110. Sorghum lines were machine planted at a rate of 1 g of seed per linear m of row and thinned after emergence to approximately 12 to 15 plants/meter row. Fungicide treatments were applied foliarly at boot stage and 17 days thereafter. Plants were sprayed with a backpack hand sprayer until droplets coalesced and drained from foliar surfaces with low pressure to prevent drift. The following fungicides were selected for differential rust efficacy:

		Control	
Common chemical name	*Dose (kg ai/ha)*	*Expected efficacy*	*Spectrum*
Triadimefon	0.5	Excellent	Broad
Oxycarboxin	1.0	Good	Specific
Mancozeb	2.0	Fair	Broad

Triadimefon was applied as Bayleton[3] (50%-(4-chlorophenoxy)-3,3-dimethyl-1-(1H-1,2,4-triazol-1-yl)-2-butanone) registered trademark (RT), Mobay Chemical Co., Kansas City, Missouri 64120. Oxycarboxin was

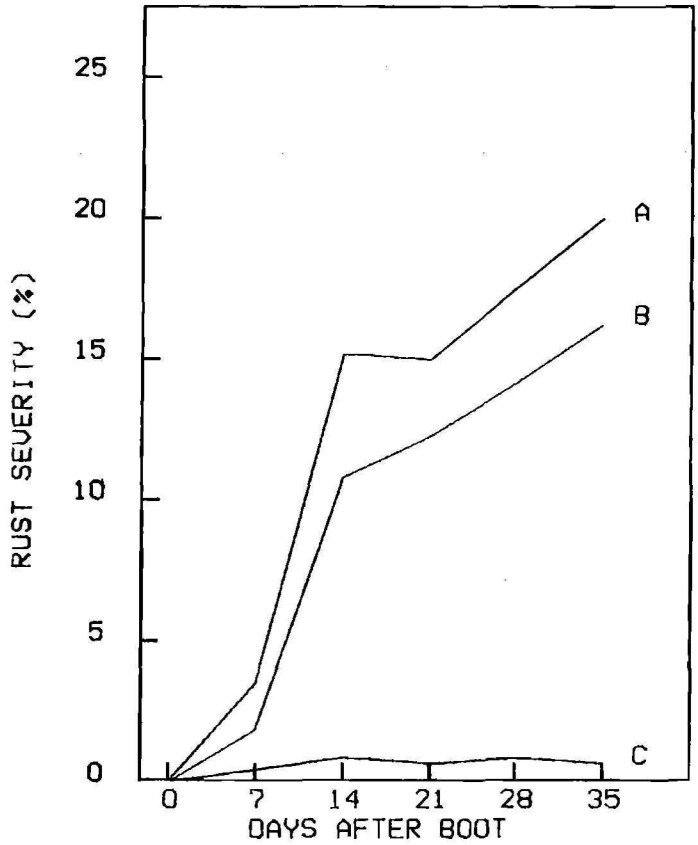

FIG. 1.—Sorghum rust development from sorghum boot stage to physiological maturity in A) SC 212, B) SC 307, and C) TAM 428 sorghum lines during a rust epidemic from June through July 1985 in Isabela, Puerto Rico.

applied as Plantvax 75W (5,6-dihydro-2-methyl-1,4-oxathiin 3-carboxanilide-4,4-dioxide) RT, Uniroyal Chemical Co., Naugatuck, CT 06770; mancozeb was applied as Dithane M45 80W (16% manganese, 2% zinc and 62% ethylenebisdithiocarbamate) RT, Rohm and Haas Co., Philadelphia, PA 19105.

TABLE 1.—*The nature of yield response to fungicide treatments in sorghum lines with variable rust resistance*

Fungicide treatment[2]	Rust reaction[1]			
	Very susceptible SC212	Mod. susc. SC307	Mod. res. TAM428	Very res. SC120
Oxycarboxin	+[3]	+	–	–
Triadimefon	–[4]	+	–	–
Mancozeb	–	–	–	–

[1]Sorghum lines (SC212, SC307, TAM428, and SC120) had 20, 16, 2, and approximately 0% rust coverage at physiological maturity.

[2]Two foliar sprays at boot stage and 17 days thereafter. Dosages for oxycarboxin, triadimefon, and mancozeb were 1, 0.5, and 2.0 kg a.i./ha per application, respectively.

[3]+ = Statistically significant yield increase ($P = 0.5$) of treatment compared to non-treated control.

[4]– = No statistical significant yield increase ($P = 0.05$) of treatment compared to non-treated control.

Plants were exposed to natural infection with TAM 430 (SC 170 der.) planted in between each block to help spread rust infection evenly within the plots. Rust was assayed with a modified Petersen scale (5 points) with 5 as 100% rust saturation or approximately 24% foliar coverage. Disease readings were taken at boot stage and 7, 14, 21, and 35 days thereafter. For yield determination, 6 random plants were identified in each of the 2 center rows and bagged to prevent bird predation. Mature panicles were hand harvested, dried under forced air, and threshed.

RESULTS

Figure 1 shows rust epidemics for 3 sorghum lines. In SC 120 rust never exceeded 0.1% and no disease progress is shown. TAM 428, moderately resistant to rust, reached almost 1% rust severity (fig. 1). Fungicide treatments stimulated yield of SC 212 and SC 307. Statistically significant yield improvements were noted for oxycarboxin and triadimefon and a tendency to improve (not different statistically) was found for mancozeb (table 1). Grain yields fluctuated from about 2,100 to 3,000 kg/ha for SC 212, and from 2,500 to 3,200 kg/ha for SC 307 (table 2). In both lines, the greatest yield came from the oxycarboxin treated plants, with increases of 41 and 27% for SC 212 and SC 307, respectively. In SC 212, oxycarboxin and triadimefon resulted in higher test weights (table 3).

Fungicide Efficacy

Rust was assessed at boot stage and 7, 14, 21, and 35 days, thereafter (table 4). Traces of rust were evident on sorghum at the boot stage but differences in chemical control were not apparent until 10 to 14 DAB. Seven to 14 DAB was the period of greatest rust increase. Rust reactions were most definable at physiological maturity (PM) (table 4). Rust con-

TABLE 2.—*Grain yield (kg/ha) and yield increases (% over control) of two rust susceptible to control rust (*Puccinia purpurea *Cooke) associated with treatment during the summer of 1985 in Isabela , Puerto Rico*

Treatment[1]	Seed yield (kg/ha[2]		Percentage increase	
	SC212[3]	SC307[4]	SC212[3]	SC307[4]
Oxycarboxin	2,973	3,200	40.5%	27.2%
Triadimefon	2,023	3,133	–0.4%	24.5%
Mancozeb	2,317	2,583	9.4%	2.6%
Nontreated	2,117	2,517	0.0	0.0
FLSD .05	252	216		
.01	389	353		

[1] Two foliar sprays, at boot stage and 17 days thereafter. Oxycarboxin, triadimefon, and mancozeb dosages were 1.0, 0.5, and 2.0 kg a.i./ha per application, respectively.

[2] Seed yield in terms of cleaned grain at 14% moisture.

[3] Nontreated, mancozeb, triadimefon and oxycarboxin rust severity at physiological maturity were approximately 20, 12, 13, and 7%, respectively.

[4] Nontreated, mancozeb, triadimefon, and oxycarboxin rust severities were 16, 12, 7 and 2%, respectively, at physiological maturity.

trol at PM calculated from comparison of nontreated and oxycarboxin treated plots were 63, 88, and 66% in TAM 428, SC 307, and SC 212, respectively. Triadimefon was least effective in controlling sorghum rust; mancozeb followed.

DISCUSSION

Puccinia purpurea Cooke, sorghum rust, can severely limit sorghum grain yield in susceptible lines in northwest Puerto Rico. Seed density as well as yield was reduced in SC 212. Low seed density consistently correlates with poor emergence and vigor of sorghum seed.

Differences between the yields of fungicide protected and nontreated plots were used in determining sorghum rust losses in northwestern

TABLE 3.—*Influence of fungicide treatments on seed test weight (g/25 cm³) in 4 sorghum lines showing variable susceptibility[1] to rust (*Puccinia purpurea *Cke) when grown under a rust conducive environment in Isabela, Puerto Rico during the summer of 1985*

Fungicide treatment[2]	Seed test weight (g/25 cm³)			
	SC212	SC307	TAM428	SC120
Oxycarboxin	17.7	20.2	18.7	17.5
Triadimefon	17.9	19.8	18.5	17.3
Mancozeb	15.7	19.8	18.8	17.2
Nontreated	15.3	20.2	19.2	17.9
FLSD .05	1.7	NS	NS	NS
.01	2.6	NS	NS	NS

[1] SC212, SC307, TAM428, and SC120 showed 20, 16, 2, and approximately 0% rust coverage, respectively, at physiological maturity.

[2] Applied as two foliar sprays, one at boot stage and another 117 days later. Dosages for oxycarboxin, triadimefon, and mancozeb were 1.0, 0.5, and 2.0 kg a.i./ha per application, respectively.

TABLE 4.—*Sorghum rust severity during a late June to early August epidemic in fungicide treated and nonsprayed plots of sorghum lines showing variable resistance in Isabela, Puerto Rico in 1985*

Sorghum lines[1]	Fungicide treatment [2]	Rust severity (% area)[3] Days after boot stage			
		7	14	21	35
SC212	Oxycarboxin (O)	4.2	7.0	8.0	6.7
	Triadimefon (T)	2.0	11.0	11.3	13.0
	Mancozeb (M)	3.3	12.3	13.3	12.7
	Nontreated (N)	3.7	15.3	15.0	20.0
	FLSD 0.05	NS	7.7	NS	12.7
	0.01	NS	NS	NS	NS
SC307	O	2.8	1.3	3.0	2.2
	T	3.3	3.9	5.7	6.8
	M	4.0	11.0	8.7	12.0
	N	2.0	11.0	12.3	16.3
	FLSD .05	NS	4.9	5.9	4.9
	.01	NS	6.6	9.1	7.8
TAM428	O	0.5	0.1	0.3	0.3
	T	0.2	0.5	0.3	0.6
	M	0.4	0.6	0.7	0.7
	N	0.5	1.0	0.8	0.8
	FLSD .05	NS	NS	NS	NS
	.01	NS	NS	NS	NS

[1]Sorghum SC120 was not included since trace levels of rust never exceeded 0.1% in any assessment.

[2]Applied as two foliar sprays, one at boot stage and another at 17 days later. Dosages for oxycarboxin, triadimefon, and mancozxeb were 1.0, 0.5, and 2.0 kg a.i./ha per application, respectively.

[3]Based on a modified Peterson rust scale of 5 points expressed in estimated percentage leaf area covered by pustules.

Puerto Rico. When broad spectrum fungicides, such as mancozeb or chlorothanil are used, and when several diseases occur together, the interpretation of this type experiment is difficult. This quandary was avoided with sorghum lines of variable rust resistance, and fungicides such as oxycarboxin, which have specific action toward basidiomycetes. This procedure aided experimental interpretation and gave information on the feasibility and economics of chemical control.

RESUMEN

La roya del sorgo

La roya del sorgo causada por *Puccinia purpurea* Cooke causó pérdidas considerables en rendimiento de grano en 2 de 4 cultivares evaluadas en Isabela en 1985. Se establacieron diversos grados de severidad de la roya con diferentes fungicidas foliares con eficacia variable. Las líneas experimentales se seleccionaron por diferencia en resistencia. La epidemia de

roya empezó en el estadio de hoja bandera y aumentó drásticamente después de la floración. Las diferencias de los tratamientos se notan más claramente en la maduración fisiológica. En esta etapa, la roya cubrió un 20, 16, 1 y 0% del follaje de SC 212, SC 307, TAM 428 y SC 120, respectivamente. Oxicarboxin fue el fungicida más eficaz contra la roya. Le siguieron triadimefon y mancozeb en ese orden. Al comparar los tratados con oxicarboxin con los sin tratar la roya disminuyó de 80 a 60%; el rendimento de grano aumentó 25 y 40% y la densidad de las semillas de 0 a 20% en las variedades de sorgo SC 307 y SC 212, respectivament. Las variedades TAM 428, que es moderadamente resistente a la roya, y SC 120, que es muy resistente, no mostraron mejoría al tratarlas con los fungicidas.

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