Correlation Between Resistance in Maize to Local and Systemic Infection by *Peronosclerospora sorghi* in Thailand

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ABSTRACT

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Local lesions on maize (*Zea mays*) seedlings caused by *Peronosclerospora sorghi* were rated, based on the extent of sporulation on the second leaf. The local-lesion ratings were positively correlated with the amount of systemic infection that developed later, which supports the hypothesis that local-lesion resistance to *P. sorghi* is associated with systemic infection resistance.

Peronosclerospora sorghi (Weston & Uppal) C. G. Shaw causes sorghum downy mildew (SDM) of maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* (L.) Moench). The conidia of this fungus produce both local and systemic infection in these hosts. Resistance in sorghum to the *P. sorghi* local-lesion phase is related to field resistance expressed as systemic infection (2). The purpose of our research was to establish whether a similar positive relationship exists for SDM in Thailand between resistance to local infection and resistance to systemic infection by *P. sorghi*.

MATERIALS AND METHODS

Experiments were conducted in 1981 in field plots at the Thai National Corn and Sorghum Research Center near Pak Chong, Thailand. Sixteen maize cultivars, representing a range in reaction to the systemic phase of SDM from fully susceptible to resistant to the pathogen, were used as test entries. We used only maize as test plants because the reaction of sorghum to the SDM pathogen in Thailand is normally hypersensitive (1), and systemic infections very rarely develop. Maize cultivar CM109 is susceptible to SDM and is an inbred line; Super Sweet DMR has some resistance to SDM and is an open-pollinated variety. The other 14 test entries were F_1 single-cross hybrids composed of S_4 or greater parental inbred lines, except Suwan 1, which was an S_3 line. The first experiment was sown on 22 May during the early rainy season and the second experiment on 9 September during the late rainy season. A randomized complete-block experimental design with four replicates was used. Plots were planted in single rows, 6.5 m in length and 25 cm between hills, with two seeds per hill. Row spacing was 75 cm. Fertilizer (50-62.5-0 kg/ha) was banded in each furrow before planting.

Three rows of SDM-susceptible maize were sown in 2-m alleyways perpendicular to the treatment rows, and a single row parallel to the treatment rows was sown every 20 rows to provide sources of inoculum. Five days after emergence, these plants were sprayed on four successive nights with a conidial suspension containing about 5×10^4 conidia per milliliter. The inoculum was produced by collecting diseased leaves from an inoculum-maintenance field plot at 1100 hours, gently washing away any adhering conidiophores, placing the leaves in 30×35 cm plastic buckets with the cut leaf bases in water a few centimeters deep, and allowing the leaf surfaces to dry. At 1300 hours, the buckets containing these infected, washed leaves were covered and incubated at about 22 C for 8 hr. During the time of incubation, the pathogen sporulated and the resulting conidia were washed from the leaves. Systemic infection, as evidenced by chlorosis extending upward from the leaf base within the whorl, began developing in the inoculated plants after 2 wk. At this time, the treatment rows were sown, and natural sporulation from the systemically infected inoculum source plants provided inoculum to the experimental plots.

Ten days after emergence, 10 plants per row in the first experiment and five plants per row in the second experiment were rated for local-lesion severity, based on the extent of sporulation of *P. sorghi* on the second leaf. For entries that sporulated, plants in the plot with the most obvious sporulation were chosen for rating. The following 1–9 rating scale was used: 1 = no sporulation; 3 = some sporulation at the leaf tip; 5 = sporulation extending about one-third the length of the leaf; 7 = sporulation extending about three-fourths the length of the leaf; and 9 = sporulation extending the entire length of the leaf, leaf tip necrotic. The ratings were made between 0700 and 0900 hours, when the conidiophores from the previous night's sporulation were still easily visible. The incidence of systemically infected plants in each plot was recorded 15 days after emergence. In the late-season planting, systemic infection was also recorded 30 days after emergence.

RESULTS AND DISCUSSION

We found a highly significant (P = 0.01) positive correlation between severity of local lesions on 10-day-old plants and incidence of systemic infection that developed later (r = 0.96 for the means of early and late plantings). This relationship was consistent for both experiments (Table 1), with r = 0.94 for the early-season experiment and r = 0.90 for the late-season experiment. These data support the hypothesis that host resistance to local lesions is associated with host resistance to systemic infection of the SDM pathogen.

All of the test plants developed local lesions, including the entries resistant to the SDM systemic phase of *P. sorghi*. The initial infection of the tissue was apparently unhindered, as was found in a histological study with sorghum (5) in Texas; however, the extent of sporulation after infection was variable. Only by rating the extent of this sporulation on the second leaf could levels of local lesion severity be easily differentiated. Under our experimental conditions, using a constant inoculum source, the degree of colonization could not be rated. Chlorotic stippling, presumably an indicator of initial fungal colonization, was quite similar for most of the entries. This symptom therefore did not provide a valid criterion for the development of a rating system. With a very similar disease, Philippine downy mildew (PDM) caused by *P. philippinensis* (Weston) C. G. Shaw, Yamada and Aday (4) observed that "there is no difference between local lesions on susceptible and resistant materials." They did not specify their

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Table 1. Percent systemic infection and ratings for local lesions caused by *Peronosclerospora sorghi* for maize lines in early (E) and late (L) rainy seasons in Thailand in 1981

	Systemic infection (%)[a]			Local lesion rating[b]		
Pedigree	**E**	**L**	**Mean**	**E**	**L**	**Mean**
Narino 330 × Genjah Waranjan	10.3	5.0	7.7	1.5	1.2	1.4
MIT × Suwan 1	13.8	1.8	7.8	2.5	2.6	2.6
Tuxpeno × Suwan 1	14.8	7.6	11.2	2.7	3.0	2.9
Narino 330 × Tuxpeno	15.2	7.5	11.4	3.1	3.6	3.4
CM105 × Narino 330	17.7	15.2	16.5	1.9	2.6	2.3
CM105 × Ph.9 DMR	32.0	6.1	19.1	2.9	4.6	3.8
CM105 × Penjalinan	24.7	19.4	22.1	3.1	3.3	3.2
Penjalinan × Suwan 1	43.6	11.1	27.4	2.5	2.9	2.7
Penjalinan × MIT	43.3	23.9	33.6	3.6	3.5	3.6
Ph.9 DMR × Penjalinan	57.8	28.1	43.0	4.5	4.6	4.6
Super Sweet DMR	53.1	43.1	48.1	3.8	6.2	5.0
Suwan 1 × Super Sweet	64.6	38.1	51.4	3.2	6.8	5.0
Narino 330 × Super Sweet	80.8	51.4	66.1	5.5	6.1	5.8
MIT × CM109	96.9	92.7	94.7	6.8	7.4	7.1
CM109 × Narino 330	100.0	89.3	94.7	7.4	7.1	7.3
CM109	100.0	94.4	97.2	8.8	8.9	8.9
LSD ($P = 0.05$)[c]	5.9	9.3		0.7	1.3	

[a] Systemic infection 15 days after emergence. In the late season, systemic infection was also recorded 30 days after emergence and showed a significant correlation with the local lesion rating ($r = 0.91$).

[b] Rating based on the extent of sporulation on the second leaf 10 days after emergence. The following rating scale was used: 1 = no sporulation; 3 = some sporulation at the leaf tip; 5 = sporulation extending about one-third the length of the leaf; 7 = sporulation extending about three-fourths the length of the leaf; 9 = sporulation extending the entire length of the leaf, leaf tip necrotic.

[c] Data for systemic infection was transformed using arc sine square root percentage before doing the analysis of variance.

rating method, but if the degree of sporulation were rated, perhaps differences could also be found with PDM.

Rating local lesions based on the extent of sporulation might be of practical use to plant breeders for differentiating relative levels of resistance to SDM under conditions of high inoculum of *P. sorghi*, when the percentage of systemic infection is too high to allow effective selection. For example, the inbreds MIT and Narino 330 are both resistant to SDM (3), but the F_1 hybrid combinations between these two inbreds and the CM109 inbred are highly susceptible to SDM (Table 1). Based on the mean percentage systemic infection for both seasons, 97.2 for the CM109 inbred and 94.7 for MIT × CM109 and CM109 × Narino 330, the three entries do not differ statistically. The local-lesion ratings, however, are significantly ($P = 0.05$) less for the latter two hybrids than for CM109, so these two hybrids can be differentiated as having more genes for resistance to SDM than CM109. In addition to its possible use as a selection tool, rating SDM local lesions may be useful in genetic studies because individual plants can be rated.

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