# Races of *Puccinia graminis* f. sp. *tritici* in the United States in 1979

A. P. ROELFS, Research Plant Pathologist, D. H. CASPER, Research Technician, and D. L. LONG, Plant Pathologist, Cereal Rust Laboratory, AR, SEA, USDA, University of Minnesota, St. Paul 55108

**ABSTRACT**

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Wheat stem rust was not severe in 1979. Little rust overwintered in the southern states. Spring generally provided marginal conditions for disease development in the winter wheat area. Lack of exogenous inoculum and the use of resistant cultivars prevented disease development in the spring and durum wheat area. Race 15-TNM comprised 38% of 419 isolates obtained from 169 rust collections; 151-QFB, 19%; 151-QSH, 9%; 15-TDM, 6%; 113-RKQ, 6%; 15-TLM, 4%; 56-MBC, 4%; 11-RCR, 3%; and 151-QCB, 113-RTQ, 17-HNL, 17-HDL, and 29-HJC, 2% each. Wheat lines with genes *Sr*13, 22, 24, 25, 26, 27, 29, 30, Gt, Tt-2, and Wld-1 and the cultivars Era, Olaf, Cando, and Ward were resistant to all cultures obtained.

Wheat stem rust, caused by *Puccinia graminis* Pers. f. sp. *tritici*, was the scarcest in recent years throughout the United States in 1979. Overwintering rust was found in only three nurseries (in southern Texas, northeastern Louisiana, and south central Georgia). Conditions for disease development in the winter wheat regions were generally marginal, resulting in little disease and little inoculum buildup. In the spring and durum wheat area of the northern Great Plains, environmental conditions were generally favorable for disease increase; however, the lack of inoculum from the south and the use of resistant cultivars prevented disease losses. Terminal severities from 60 to 90% were observed, however, in some trap plots in Minnesota and the eastern Dakotas.

## MATERIALS AND METHODS

A collection consisted of a varying number of stems or leaves bearing *P. graminis* f. sp. *tritici* uredia from a field, nursery, or individual plant or cultivar. Upon receipt of uredial collections, two spore samples were collected. One portion was used to inoculate 7-day-old seedlings of wheat (*Triticum aestivum* L.) cultivar McNair 701 (CI 15288) treated with maleic hydrazide to enhance spore production. After 12–14 days, up to four leaves bearing or pruned to bear a single uredium were saved and reincubated to germinate loose uredospores. Uredospores were collected separately 3–4 days later from up to three uredia (each an isolate); each provided enough spores to inoculate a differential host series. Wheat lines with genes *Sr*5, 6, 7b, 8, 9a, 9b, 9d, 9e, 10, 11, 13, 15, 16, 17, Tt-1, and Tmp were evaluated (2).

The second portion of spores was bulked with those from other collections made in the same area at approximately the same time and was used to inoculate the "universally" resistant series—lines with the host genes *Sr*22, 24, 25, 26, 27, 29, 30, Gt, Tt-2, and Wld-1 and the cultivars Era, Cando, Olaf, and Ward. These lines and cultivars have been selected over a period of years as resistant to stem rust.

A lightweight mineral oil served as a spore carrier. Inoculated plants were placed in a dew chamber overnight at 18 C, followed by 3 hr of fluorescent light (10,000 lux) as the temperature gradually rose to 30 C. Plants were then placed in an 18–28 C greenhouse. Infection types were observed after 10–14 days. Races were described using the Cereal Rust Laboratory host differentials (Table 1).

The data were arranged into eight ecological areas (Fig. 1) based on the geographic location of collections. Area 1S has mainly fall-sown spring wheats; area 1N, mixed wheat types; area 2, mostly southern soft red winter wheat; area 3, southern hard red winter wheat; area 4, soft red winter wheat and scattered barberries; area 5, mixed wheat types; area 6, hard red spring and durum wheat; and area 7, northern hard red winter wheat. No collections were obtained west of the Rocky Mountains (area 8).

**Table 1.** Cereal Rust Laboratory races of *Puccinia graminis* f. sp. *tritici*

| Code | Response of host with *Sr* genes[b] | | | |
|---|---|---|---|---|
| Set 1[a] | 5 | 9d | 9e | 7b |
| Set 2 | 11 | 6 | 8 | 9a |
| Set 3 | Tt-1 | 9b | 13 | 10 |
| B | R | R | R | R |
| C | R | R | R | S |
| D | R | R | S | R |
| F | R | R | S | S |
| G | R | S | R | R |
| H | R | S | R | S |
| J | R | S | S | R |
| K | R | S | S | S |
| L | S | R | R | R |
| M | S | R | R | S |
| N | S | R | S | R |
| P | S | R | S | S |
| Q | S | S | R | R |
| R | S | S | R | S |
| S | S | S | S | R |
| T | S | S | S | S |

[a] Combination of host response from set 1 determines the first letter of code, set 2 the second, and set 3 the third.

[b] R = host not susceptible; S = host susceptible.

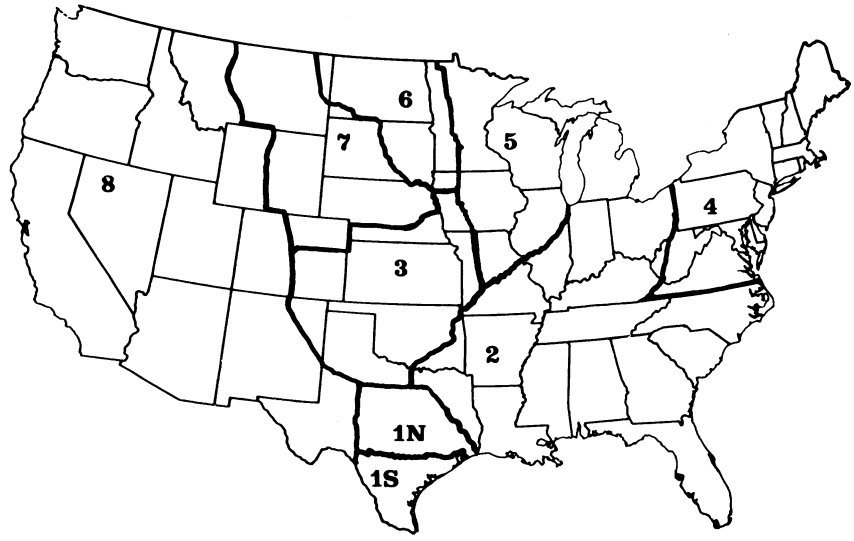


**Fig. 1.** Ecological areas of collections of *Puccinia graminis*.

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## RESULTS AND DISCUSSION

Data from the 1979 race survey (Table 2) are presented for the eight ecological areas and the U.S. total. Data from collections made from commercial fields and naturally occurring hosts were separated from those from nurseries and plots. No data were included from collections made in or near known inoculated nurseries.

The most prevalent race was 15-TNM, 38% of all isolates. This race was the most prevalent in all areas except 1S, 1N, and 2. TNM has been the most common race since 1970. Three related races—15-TLM, -TDM, and -TBM—were isolated in 1979, from 4, 6, and less than 0.5% of the isolates, respectively. These four races are virulent on *Sr*16 and Tmp and avirulent on *Sr*15. Most cultures of these races were avirulent on *Sr*17, except 11% of the isolates of TNM. These races are probably among the best adapted environmentally, based on their prevalence; however, they lack the necessary combination of virulence on *Sr*6 and 17 to threaten many of the spring bread wheats.

Races 151-QFB, 19% of all isolates, and -QCB, 2%, were the second most commonly isolated group of races. QFB was the most common race in south Texas and the soft red winter wheat area. Race 151-QSH, 9% of the isolates, occurred in areas 2, 3, 5, and 6. QSH is virulent on *Sr*6 and 17; however, it comprised only 5–20% of the isolates identified each year during the past 7 yr, which may indicate a lack of aggres-

**Table 2.** Summary of the identified races of *Puccinia graminis* f. sp. *tritici* by area and source of collection in 1979

| Area[a] | Source | Number of Collections | Number of Isolates | Percentage of isolates of each race[b] 15 TNM | 15 TLM | 15 TDM | 15 TBM | 151 QFB | 151 QSH | 151 QCB | 113 RKQ | 113 RTQ | 113 RPQ | 11 RCR | 29 HJC | 17 HNL | 17 HDL | 56 MBC | 32 RJC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| USA | Field | 55 | 129 | 43 | 8 | 2 | 1 | 17 | 5 | ... | 5 | 1 | ... | 6 | 4 | 2 | 1 | 6 | 1 |
| | Nursery | 116 | 291 | 36 | 3 | 8 | ... | 19 | 11 | 2 | 7 | 2 | * | 1 | 1 | 3 | 3 | 2 | * |
| | Total | 171 | 420 | 38 | 4 | 6 | *[c] | 19 | 9 | 2 | 6 | 2 | * | 3 | 2 | 2 | 2 | 4 | * |
| 1S | Nursery | 12 | 20 | 5 | ... | ... | ... | 45 | ... | ... | ... | 15 | 5 | ... | 15 | 10 | 5 | ... | ... |
| 1N | Nursery | 3 | 9 | ... | 22 | ... | ... | 11 | ... | ... | ... | ... | ... | 33 | ... | ... | 33 | ... | ... |
| 2 | Field | 3 | 9 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 66 | 33 | ... | ... | ... | ... |
| | Nursery | 14 | 36 | 14 | ... | ... | ... | 44 | 8 | 19 | ... | ... | ... | 3 | ... | 6 | 6 | ... | ... |
| | Total | 17 | 45 | 11 | ... | ... | ... | 36 | 7 | 16 | ... | ... | ... | 16 | 7 | 4 | 4 | ... | ... |
| 3 | Field | 1 | 3 | 66 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 33 | ... |
| | Nursery | 16 | 40 | 42 | 12 | 8 | ... | 8 | 15 | ... | 12 | ... | ... | ... | ... | ... | ... | ... | 2 |
| | Total | 17 | 43 | 44 | 12 | 7 | ... | 7 | 14 | ... | 12 | ... | ... | ... | ... | ... | ... | 2 | 2 |
| 4 | Field | 4 | 7 | 57 | ... | ... | ... | 28 | ... | ... | ... | ... | ... | ... | ... | ... | 14 | ... | ... |
| 5 | Field | 26 | 69 | 48 | 6 | ... | ... | 17 | 10 | ... | 7 | ... | ... | ... | 1 | 3 | ... | 6 | 1 |
| | Nursery | 15 | 43 | 35 | 2 | ... | ... | 21 | 7 | ... | 9 | 9 | ... | ... | 2 | 7 | ... | 7 | ... |
| | Total | 41 | 112 | 43 | 4 | ... | ... | 19 | 9 | ... | 8 | 4 | ... | ... | 2 | 4 | ... | 6 | 1 |
| 6 | Field | 19 | 37 | 41 | 16 | 5 | 3 | 22 | ... | ... | 3 | 3 | ... | ... | 3 | ... | ... | 5 | ... |
| | Nursery | 54 | 137 | 46 | ... | 14 | ... | 13 | 14 | ... | 7 | ... | ... | ... | ... | 1 | 2 | 3 | ... |
| | Total | 73 | 174 | 45 | 3 | 13 | * | 15 | 11 | ... | 6 | * | ... | ... | * | * | 2 | 3 | ... |
| 7 | Field | 2 | 4 | 25 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 50 | ... | ... | ... | 25 | ... |
| | Nursery | 2 | 6 | 67 | ... | ... | ... | ... | ... | ... | 33 | ... | ... | ... | ... | ... | ... | ... | ... |
| | Total | 4 | 10 | 50 | ... | ... | ... | ... | ... | ... | 20 | ... | ... | 20 | ... | ... | ... | 10 | ... |

[a] See text and Fig. 1 for description of areas.
[b] Cereal Rust Laboratory races (see Table 1).
[c] * = less than 0.6%.

**Table 3.** Incidence of virulence in *Puccinia graminis* f. sp. *tritici* isolates with the resistance of the single gene differentials used in the 1979 survey

| Area[a] | Percentage of isolates virulent on *Sr* gene 5 | 6 | 7b | 8 | 9a | 9b | 9d | 9e | 10 | 11 | 15 | 16 | 17 | Tt-1 | Tmp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1S | 70 | 30 | 55 | 100 | 65 | 20 | 100 | 5 | 20 | 35 | 95 | 100 | 80 | 40 | 5 |
| 1N | 67 | 0 | 89 | 44 | 44 | 33 | 100 | 22 | 56 | 22 | 78 | 100 | 44 | 89 | 22 |
| 2 | 84 | 13 | 42 | 69 | 67 | 33 | 100 | 11 | 40 | 22 | 89 | 100 | 80 | 36 | 11 |
| 3 | 100 | 28 | 79 | 86 | 19 | 26 | 98 | 63 | 81 | 70 | 37 | 100 | 32 | 74 | 65 |
| 4 | 86 | 0 | 71 | 100 | 28 | 0 | 100 | 57 | 57 | 57 | 43 | 100 | 28 | 71 | 57 |
| 5 | 93 | 23 | 72 | 90 | 30 | 20 | 95 | 47 | 64 | 65 | 53 | 100 | 42 | 64 | 53 |
| 6 | 97 | 18 | 74 | 92 | 21 | 17 | 96 | 61 | 76 | 60 | 38 | 100 | 37 | 70 | 65 |
| 7 | 100 | 20 | 100 | 70 | 40 | 40 | 90 | 50 | 80 | 50 | 50 | 100 | 80 | 90 | 60 |
| United States 1979 | 93 | 20 | 71 | 88 | 31 | 20 | 97 | 48 | 60 | 56 | 51 | 100 | 45 | 65 | 52 |
| United States 1978[b] | 99 | 18 | 82 | 96 | 15 | 19 | 99 | 71 | 84 | 74 | 29 | 100 | 44 | 80 | 72 |
| United States 1972–1978 | 98 | 15 | 79 | 87 | 21 | 14[c] | 98 | 69 | 83[c] | 75 | 26[d] | 100[d] | 32[d] | 78[c] | 74[d] |

[a] See text and Fig. 1 for description of areas.
[b] Roelfs et al (1).
[c] Mean 1973–1978.
[d] Mean 1975–1978.

siveness over the range of environmental conditions present.

Races 113-RKQ, -RTQ, and -RPQ, like QSH, remain a small part of the population (less than 4%) in the isolates identified in the past 7 yr. Races RKQ and RTQ are virulent on *Sr*6, and 35 and 38%, respectively, were virulent on *Sr*17. The *Sr*17-virulent cultures of RKQ and RTQ as well as race QSH are often isolated from the few pustules found in commercial spring wheat fields. These collections were most frequently made near plant maturity.

No virulence was detected for seedling wheats with *Sr*13, 22, 24, 25, 26, 27, 29, 30, Gt, Tt-2, or Wld-1. The important spring wheat cultivars Era and Olaf and durum wheat cultivars Cando and Ward were also resistant as seedlings. The incidence of virulence for the differential host resistance genes tested is shown in Table 3. Differences between these results and those of 1978 (1) are principally due to the reduction of race TNM from 57 to 43% of the isolates. This difference is also seen in Table 3 by comparing the 1979 and 4- to 7-year means.

**ACKNOWLEDGMENTS**

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**LITERATURE CITED**

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