# Physiologic Specialization of *Septoria tritici* in Morocco

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**ABSTRACT**

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Nineteen isolates of *Septoria tritici*, collected from all wheat-growing areas in Morocco, were inoculated to a set of seven wheat cultivars. Physiologic specialization of the pathogen was clearly demonstrated as a result of the differential interaction between cultivars and isolates. The 19 isolates could be grouped into three distinct races. The scope of physiologic specialization of *S. tritici* and its implications for breeding for disease resistance are discussed.

Speckled leaf blotch, caused by *Septoria tritici* Rob. ex Desm., is a serious threat to wheat production in Mediterranean countries, where it has dramatically gained in importance with the introduction of high-yielding dwarf cultivars from Mexico (16,20). Favored by unusually high humidity, a devastating *Septoria* epidemic occurred in Northern Morocco during the 1968–1969 season and caused entire fields of Siete Cerros to be left unharvested (8,18). Although the worsening of *Septoria* epidemics is often linked with dwarf wheats, the evidence available suggests that the introduction of the dwarf wheats did not create the *Septoria* problem in the Mediterranean zone, because the disease had been reported from Mediterranean countries many decades earlier (4,16). Rather, the dwarf wheats merely drew attention to the *Septoria* disease because they, unlike old local cultivars, are usually grown at higher plant densities and with larger amounts of fertilizer, both factors that favor *Septoria* epidemics (5,16). Infection may also be favored by short straw, which facilitates upward spread of the disease (7).

Breeding for resistance is generally considered the best method of control. Resistance has been reported by several researchers (2,3,6,9,13,15,21). Tolerance, as defined by the ability of a wheat cultivar to yield well in spite of severe *Septoria* attack, has also been reported (23).

Inheritance of resistance has been studied by various researchers, and different patterns of inheritance have been reported, including monogenic control (11,12,14) and control through two additive genes (11) and at least three recessive genes (14).

Physiologic specialization has not been studied extensively enough. Most investigators who studied this question could not identify distinct races of the pathogen (1,10,19). This appears to agree with repeated observations that wheat genotypes usually react similarly to the disease in different parts of the world (16). It is noteworthy that the perfect stage of the fungus, which has been identified as *Mycosphaerella graminicola* (Fuckel) Sanderson comb. nov. (17), does not seem to be widespread worldwide or to play an important role in the life cycle of the pathogen (19). However, occurrence of clear-cut physiological races has also been reported (4).

In view of the importance of knowledge of physiologic specialization for a sound breeding program and the inconclusive evidence pertaining to the matter, the present study was undertaken to determine whether physiological races of *S. tritici* occur throughout Morocco.

## MATERIALS AND METHODS

Nineteen isolates of *S. tritici*, designated St1 to St19, were collected from all wheat-growing areas throughout the country (Fig. 1) and inoculated to a set of seven wheat cultivars used as differentials. No attempt was made to record the wheat genotypes from which the isolates originated because they were collected at random, primarily from infected leaf residues after the summer harvest.

Monopycnidial cultures were raised on cornmeal Bacto-peptone dextrose agar (20 g of each compound in 1 L of water). The fungus showed a yeastlike growth on this medium as typical pink, creamlike clumps of conidia without any mycelium, which is very suitable for inoculation purposes. This medium was preferred because of its simplicity and the easy availability of its ingredients compared with media used by other investigators (4,6).

A set of four bread and three durum wheat cultivars were used as differentials (Table 1). The bread wheat cultivars were Siete Cerros, a dwarf high-yielding

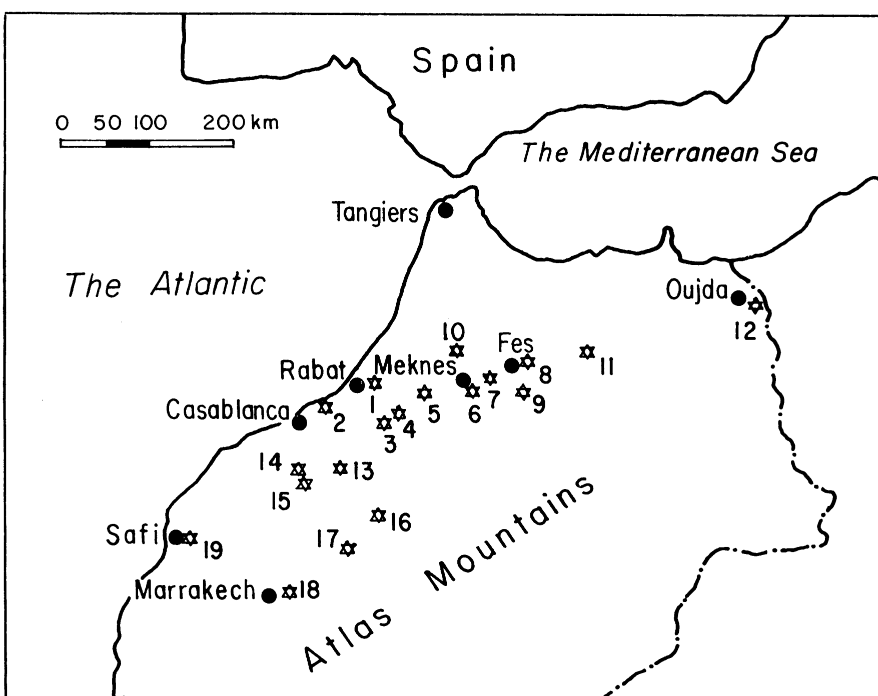


**Fig. 1.** Origin of *Septoria* isolates in northern Morocco.

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**Table 1.** Virulence patterns of isolates of *Septoria tritici* on host wheat cultivars

| | Wheat cultivars | | | | | | |
|---|---|---|---|---|---|---|---|
| **Virulence groups** | **Siete Cerros** | **Nasma** | **BT 2306** | **BT 908** | **BD 2909** | **Cocorit** | **Kyperounda** |
| I | S[a] | S | S | R | R | R | R |
| II | R | R | R | R | S | S | S |
| III | R | R | R | R | S | S | R |

[a] S = susceptible, less than 20% leaf area necrotic with few pycnidia; R = resistant, more than 20% leaf area necrotic, moderate to dense pycnidial coverage.

**Table 2.** *Septoria* disease scores on selected cultivar × isolate combinations

| | Isolates | | |
|---|---|---|---|
| **Cultivars** | **St10** | **St16** | **St19** |
| Nasma | 7.3[a] | 0.7 | 1.7 |
| BD 2909 | 0.7 | 5.7 | 5.3 |
| Kyperounda | 1.7 | 2.0 | 5.7 |
| LSD ($P = 0.05$) | | 0.98 | |

[a] Each score is an average of three replicates.

cultivar from CIMMYT, Mexico; Nasma, a recent selection of the Moroccan wheat-breeding program and the most popular bread wheat cultivar in the country; BT 2306, an old Moroccan land race; and BTR 908, an awnless cultivar of Italian origin and known for its *Septoria* resistance. The durum cultivars were Kyperounda, an old cultivar from Cyprus and by far the most widely grown durum cultivar in Morocco; Cocorit, a dwarf cultivar from CIMMYT; and BD 2909, an old land race from Algeria. Although the exact pedigree of these cultivars could not be determined, they were chosen from wide geographic origins to enhance the chance of detecting races.

The cultivars were grown in the greenhouse at temperatures of 24 C during the day and 18 C at night. Seedlings were reared in 10-cm-diameter clay pots at a rate of six seedlings per pot. A completely randomized design with three replicates was used, with one pot considered as a replicate. The seedlings were inoculated at the fifth-leaf stage by spraying with a spore suspension of $10^6$/ml, as determined by hemacytometer counting, and subsequent enclosure in moistened plastic bags for 4 days to ensure saturated humidity.

The disease was scored after full symptom development 20 days after inoculation. A 10-step scale ranging from 0 = immune to 9 = 100% leaf area destroyed, and combining both disease severity and pycnidial coverage of the necrotic tissue, was used for disease scoring. Intermediate steps were defined as follows: 1 = less than 10% of leaf area necrotic, with or without a very sparse pycnidial coverage; 3 = 15–20% of leaf area necrotic, few pycnidia; 5 = 30–40% of leaf area necrotic and well covered with pycnidia; and 7 = 50–65% of leaf area necrotic, dense pycnidial coverage. This scale is thought to give the best assessment of disease reactions because it combines both disease severity and pycnidial coverage. Other scales were used, based on pycnidial density as the sole criterion for disease scoring (4). Such scales, however, would underrate susceptibility of host tissue with extensive necrosis but comparatively less pycnidial production. For statistical analysis, the standard analysis of variance was performed, with the main emphasis on the isolate × cultivar interaction.

## RESULTS

All 19 cultures successfully infected the wheat cultivars, with disease scores ranging from 0 to 7.8. The analysis of variance revealed highly significant differences both in disease reactions of the wheat cultivars and in virulence of the *Septoria* isolates. More important, however, was the highly significant cultivar × isolate interaction, which demonstrates physiologic specialization of the pathogen.

To group the isolates into distinct races, the disease scores were divided into two classes: resistant if lower than 3 and susceptible if 3 or higher. The 19 isolates were then divided into three virulence groups (Table 1). Group I, by far the most prevalent, included 14 isolates: St1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 15, and 18. Group II, which comprises the two isolates St13 and St19, manifested a virulence pattern exactly opposite of that of group I on six of the differential cultivars. Group III contained the three isolates St9, St16, and St17.

It is noteworthy that among the seven wheat cultivars used as differentials in this study, three of the bread wheat cultivars, Siete Cerros, Nasma, and BT 2306, reacted similarly to all isolates, as did two of the durum cultivars, BD 2909 and Cocorit. Bread wheat cultivar BT 908 was resistant to all 19 isolates.

To test stability of virulence of the *Septoria* isolates and confirm the previous results, a second cycle of inoculations was performed on a smaller scale, including the cultivars Nasma, BD 2909, and Kyperounda and the isolates St10, St16, and St19, which were reisolated from infected seedlings during the first trial and selected to represent the three identified virulence groups. Once again, the disease scores recorded on the different cultivar × isolate combinations showed very marked differences (Table 2). The cultivar × isolate interaction was again highly significant, and the results were in very close agreement with the first trial. It is therefore concluded that the virulence groups identified in this study can be considered as physiological races of *S. tritici*.

## DISCUSSION

Contrary to most reports dealing with physiologic specialization of *S. tritici*, the evidence presented in this paper clearly shows that the isolates of *S. tritici* interacted differentially with the wheat cultivars used as differentials. Isolates capable of such a differential interaction with the host constitute true physiological races in the conventional sense and not mere "aggressive races" (22). The latter may differ in virulence or "aggressiveness" but would not interact differentially with the host and would follow the same ranking in virulence on all cultivars.

The isolates of *S. tritici* differed markedly in virulence on the bread and durum wheat cultivars. This agrees with another report (4), which found a culture from durum wheat most distinctive from all other cultures. This suggests that durum wheat might carry genes for resistance to *S. tritici* different from those in bread wheat.

It is noteworthy that race identification was based mainly on contrasting virulence patterns on the durum and bread wheat cultivars. Furthermore, only a few races could be identified from all the isolates used in the study. This suggests that *S. tritici* might not show as high of a pathogenic variability as other cereal pathogens such as rusts. Resistance to *S. tritici* might hence be more durable. On the other hand, it must also be pointed out that the "differentials" used here might not reveal all the pathogenic variability that might occur within *S. tritici*. A standard set of differential cultivars has yet to be developed for race identification in *S. tritici* worldwide.

The occurrence of distinct races of *S. tritici* suggests that breeding for resistance to the pathogen might not be as straightforward as previously believed. It is therefore highly advisable to intensify research in such areas as physiologic specialization, inheritance of resistance, and search for effective sources of resistance to *S. tritici* in order to control this important disease and hence allow new high-yielding wheat cultivars to express their full yield potential.

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