

# Factors Affecting the Overwintering of *Trichometasphaeria turcica* on Maize

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## ABSTRACT

The ability of *Trichometasphaeria turcica* (*Helminthosporium turcicum*) to overwinter saprophytically on maize is influenced in part by the genotype of the host on which the pathogen overwinters. Races of the pathogen have differing abilities to survive per se in the overwintering stage, and have differing abilities to survive on different host genotypes. Although van der Plank states that the saprophytic medium is the factor operative in stabilizing

selection in nonobligate parasites in favor of simple races, the apparent greater survival ability of the complex race used in these studies suggests that the rationale for stabilizing selection may not be appropriate. If the saprophytic medium serves as a stabilizing factor, it may be more appropriate to state that the *nature* of the saprophytic medium may determine whether stabilizing selection is operative. *Phytopathology* 60:369-370.

The ability of a biotic plant pathogen to overwinter saprophytically in a given area may be a significant epidemiological factor conditioning the frequency, prevalence, and severity of the disease that it incites. The dependency on introduced inoculum from other areas for primary infection influences the regularity with which the disease occurs from year to year as well as the severity, at least in instances where disease severity is determined by the stage of maturity of the plant at the time the disease becomes established. Northern leaf blight of maize (*Zea mays* L.), caused by *Trichometasphaeria turcica* Lutt. (*Helminthosporium turcicum* Pass.), may serve as an example to illustrate these points. The disease occurs annually in the southeastern states with variable severity, and sporadically in the more northern states, such as Minnesota, Wisconsin, Pennsylvania, and New York. When environmental conditions are conducive for disease, losses sustained are influenced markedly by the time of primary infection. Severe losses occur when infections are heavy before tasseling, while grain yields are seldom affected when the disease does not become severe until the plants are nearing maturity.

Robert (4) states that *T. turcica* overwinters in infected maize leaves in the field, although she did not discuss whether such was the case for certain or all areas in which the fungus is present. Hoppe (1) was unable to recover the fungus in Wisconsin from maize that had been exposed under natural conditions, and concluded that the sporadic occurrences of northern leaf blight of maize were initiated by wind-blown inoculum from the south.

We have determined that *T. turcica* can survive in Pennsylvania on maize residue exposed naturally to overwintering conditions. Two factors appear to be prime determinants conditioning the ability of the fungus to overwinter, i.e., the variety of maize and the race of the pathogen. This paper summarizes our study and discusses the importance of these factors from the standpoint of overwintering and in relation to van der

Plank's concept (6) of stabilizing selection in non-obligate parasites.

As part of a 1968 field study on stabilizing selection, the center of a plot of maize inbred line R4 was inoculated with equal amounts of inoculum of races 13a and R58 of *T. turcica* to determine the relative prevalence of races in mixed populations. *T. turcica* is a heterothallic fungus whose mating type is controlled by a single major gene locus designated as *A-a* in allelic form (3). Race R58 was identified for mating type as *A* and race 13a as *a*. Since the fungus occurs only in the asexual or conidial stage during the disease cycle, the mating type of the races remained constant. The racial association with a known mating type made it possible to determine which isolate caused a given lesion by isolating from the lesion and mating the resulting culture with known *A* and *a* isolates.

The plot of inbred line R4 was bordered on one side with rows of the maize hybrid SX60 and on the opposite side with rows of the maize hybrid (Pa 54 × Pa 11) × 703. An adjacent plot was planted to maize hybrid Pa 290. The inbred line and all three maize hybrids were susceptible to both races R58 and 13a. Inbred line R4 was considerably more susceptible than the three hybrids and is, in fact, considered to have no genes for resistance to *T. turcica* (2). Plants of *Agropyron repens* (L.) Beauv. and *Festuca elatior* L. occurred naturally around the plots.

By maturity, the disease was present in abundance on all plants in the R4 plot and to a frequent, but lesser, extent on plants of the border hybrids and Pa 290. Samplings from lesions on R4 plants indicated that race 13a comprised more than 75% of the racial population on R4. Although the prevalence of the two races on the border hybrids and Pa 290 was not determined, it seems reasonable to assume that race 13a may have occurred with a greater frequency than race R58, since all of the corn lines were susceptible to both races.

The R4 and Pa 290 field plots, as well as the border

rows, were allowed to remain as they were through the winter of 1968-69. The winter was characterized by relatively little snow, and thus the plants had virtually no cover. Prolonged periods of low temperatures occurred frequently throughout the winter. In March 1969, leaf samples of the four maize lines were collected from plants standing in the field and from leaves on the ground. Leaf specimens were collected also from plants of *A. repens* and *F. elatior*. Lesions on leaf material collected from R4 plants were not easily recognized, but were clearly identifiable from material of the other three lines. Small sections of lesions sampled at random were placed on moistened filter paper in petri dishes, and fungal species present were allowed to sporulate. Single spore isolates of *T. turcica* were made from all colonies sporulating on the leaf section. Portions of the remaining leaf materials were ground into powder which was placed in whorls of plants of inbred R4 in the greenhouse. The plants were incubated for 2 weeks with regular moisture intervals in a mist chamber. Isolates from lesions occurring on the R4 plants were obtained in a manner similar to that described previously.

*T. turcica* was isolated from leaf material of three of the four maize lines from *A. repens* and *F. elatior*, demonstrating that the fungus can overwinter in Pennsylvania on corn and other grass species. A total of 171 isolates was obtained from 200 sampled lesions of hybrid SX60. However, despite repeated isolation and inoculation attempts, a total of only three isolates each was obtained from material of Pa 290 and inbred R4, and no isolate was obtained from hybrid (Pa 54 × Pa 11) × 703. Nine isolates were obtained from *F. elatior* and four from *A. repens*.

Of the 171 isolates obtained from hybrid SX60, 142 were identified by mating studies as race R58, and 29 as 13a. The three isolates from Pa 290, two of three from R4, eight of nine from *F. elatior*, and all four from *A. repens* also were identified as race R58. Thus, the lesser prevalent race during the parasitic phase was the most prevalent after overwintering in the saprophytic phase.

Two conclusions pertinent to the overwintering of *T. turcica* can be drawn from these studies. The results indicate that the ability of the fungus to overwinter is influenced strongly by the nature of the host material. In these studies, lines Pa 290, R4 and (Pa 54 × Pa 11) × 703 were poor hosts for the fungus, while hybrid SX60 appeared to be an excellent host. The results also indicate that races have differing abilities to survive per se in the overwintering stage, and also have differing abilities to survive on different host genotypes.

These results may provide an explanation for Hoppe's inability to recover *T. turcica* from naturally overwin-

tered maize debris. If his studies utilized a line of maize that was not conducive for the fungus to overwinter on (such as [Pa 54 × Pa 11] × 703) and/or a strain of the fungus that had poor survival attributes (such as 13a), it may not be surprising that he could not recover the fungus.

These studies may have an important application to field programs concerned with breeding for disease resistance. It is not an uncommon practice to plant border rows in disease nurseries with highly susceptible lines and collect the diseased material for use as inoculum for the subsequent year's nursery. Should the susceptible line(s) prove to be a poor host for the fungus to survive saprophytically, or should the host serve as a selective medium for strains with better survival abilities, the amount or nature of the available inoculum may not be appropriate for selecting maximum resistance. There is no evidence available from which to presume categorically that better survival abilities are associated with increased virulence.

Discussion of these studies in relation to van der Plank's concept of stabilizing selection in nonobligate parasites is appropriate. Van der Plank states that stabilizing selection in favor of simple races and against complex races of nonobligate parasites occurs during the saprophytic stage; i.e., the saprophytic medium is the stabilizing factor (6). Previous studies have shown that race 13a qualified as a simple race and R58 as a complex race on inbred R4, which, in turn, meets all criteria of a simple variety (5). The apparent greater survival ability of complex race R58 suggests that the simple, generalized rationale for stabilizing selection offered by van der Plank may not be appropriate. Furthermore, even if the saprophytic medium does serve as a stabilizing factor, the present studies indicate that it may be more accurate to state that the nature of the saprophytic medium may determine whether stabilizing selection is operative.

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