

Occurrence of Race 2 of *Exserohilum turcicum* on Corn in the Central and Eastern United States

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ABSTRACT

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One hundred sixty samples of northern corn leaf blight (NCLB)-infected tissue collected from inbreds and hybrids of *Zea mays* in seven states during the 1979, 1980, and 1981 growing seasons were tested to determine which races of *Exserohilum turcicum* were present. Races were determined by the reaction of corn inbreds B37, B37Ht, B37Ht2, and Oh43Ht3 after inoculation with spore suspensions from infected tissue. Race 1 was virulent only on inbred B37, whereas race 2 was virulent on both B37 and B37Ht. None of the isolates were virulent on B37Ht2 or Oh43Ht3; therefore, race 3 was not identified. Race 2 was identified from NCLB tissue collected in Florida, Illinois, Indiana, Iowa, Pennsylvania, Minnesota, and New York. Race 2 was widespread in Illinois (53 counties) and Indiana (24 counties).

Northern corn leaf blight (NCLB), caused by *Exserohilum turcicum* (Pass.) Leonard & Suggs (imperfect state of *Setosphaeria turcica* (Luttrell) Leonard & Suggs), was first observed by Passerini on corn (*Zea mays* L.) in Italy in 1876. In the United States, the disease was first reported in New Jersey in 1878 and the first serious outbreak was recorded in Connecticut in 1889. In the early 1900s, NCLB was repeatedly observed causing damage to corn in the New England and Middle Atlantic States (2). Considerable damage also occurred in the corn belt states in the early 1940s as susceptible hybrids replaced open-pollinated varieties (3). Reports of epiphytotics of NCLB continued until the discovery of a single dominant gene that conditioned resistance to *E. turcicum*. This gene, designated *Ht*, conditions a chlorotic lesion type of resistance to race 1 of the pathogen (5,6). It enabled breeders to develop resistant hybrids in the 1960s. Other specific genes for resistance (*Ht2*, *Ht3*, and *HtN*), as well as other races of the pathogen, have been identified (4,8-10,14). The first report of *E. turcicum* race 2, virulent on plants containing the *Ht* gene, came from Hawaii in 1972 (1). Other isolates of race 2 were found on inbred and hybrid corn plants having the *Ht* gene in fields near Brook, IN, in 1979 (15) and the following

year at several locations in Ohio (11). The purpose of this paper is to report the distribution of race 2 in Illinois and Indiana and its occurrence in other states.

MATERIALS AND METHODS

From 1979 through 1981, 160 samples of blighted tissue collected from cornfields in Florida, Illinois, Indiana, Iowa, Minnesota, New York, and Pennsylvania were evaluated for occurrence of differing races of *E. turcicum*. Collections were made during surveys and observations of corn seed production fields, variety yield trial plots, breeders' nurseries, commercial demonstration plots, and commercial grain fields. Evaluations of samples collected within each growing season were performed during the subsequent winter months. All race-determination tests were conducted at the Department of Plant Pathology, University of Illinois, Urbana.

The number of samples collected and counties surveyed varied among years and states. For Indiana, 47 samples from 29 counties were assayed. These included 15 samples from 13 counties in 1979, 18 samples from 17 counties in 1980, and 14 samples from 13 counties in 1981. A total of 97 samples from 61 counties in Illinois were tested. The majority of samples (89 samples from 60 counties) were collected during the 1981 growing season. A few samples collected in Illinois in 1979 (four samples from four counties) and 1980 (four samples from one county) were also tested. Other 1981 collections evaluated were from Minnesota (two samples from two counties), New York (three samples from one county), and Pennsylvania (seven samples from two counties). Three samples gathered in 1980 from one county in Iowa and one sample from one

county in Florida collected in 1979 were also tested.

Differences in virulence of *E. turcicum* isolates were determined using the following set of corn differentials: B37, B37Ht, B37Ht2, and Oh43Ht3. Corn inbreds were grown in 16-cm clay pots with one set of inbred differentials per pot. NCLB lesions were cut from leaves and induced to sporulate on moist filter paper in glass petri dishes (150 × 15 mm). A spore suspension of each isolate was prepared by washing conidia from infected leaf tissue and adjusting the concentration to about 20,000 spores per milliliter. Each spore suspension was sprayed on two replicates (two or three plants per replicate) of the inbred differentials. Inoculations were made when the plants reached the four- to five-leaf stage. After inoculation, plants were placed in a mist chamber for 12 hr in the dark, then moved to a greenhouse bench. Because of the number of samples collected, isolates were tested in groups of 20. A set of corn differentials similarly inoculated with spores of a known isolate of *E. turcicum* race 1 was included in each group as a check.

Evaluations of seedling disease reactions were made 10-14 days after inoculation and were based on lesion types. Resistant reactions were characterized by yellowish chlorotic lesions (5,6). Lesions on susceptible inbreds were elliptical and grayish or olivaceous green to tan (5,6). Race identifications were based on seedling disease reactions and the inbred genotype. The *Ht* gene conditions resistance to race 1 and the *Ht2* and *Ht3* genes condition resistance to both races 1 and 2 (5,6). Thus, race 1 produced susceptible lesions only on inbred B37, whereas race 2 produced susceptible lesions on both B37 and B37Ht.

RESULTS

Greenhouse inoculation tests confirmed the presence of *E. turcicum* race 2 in Indiana in 10 counties in 1979, 14 counties in 1980, and 11 counties in 1981 (Fig. 1). In a few counties, more than one isolate of race 2 was identified. None of the isolates were virulent on plants with the *Ht2* or *Ht3* genes. One isolate collected from a field in Jasper County in 1981 produced both susceptible and resistant lesions on B37Ht inbreds, indicating the presence of both races 1

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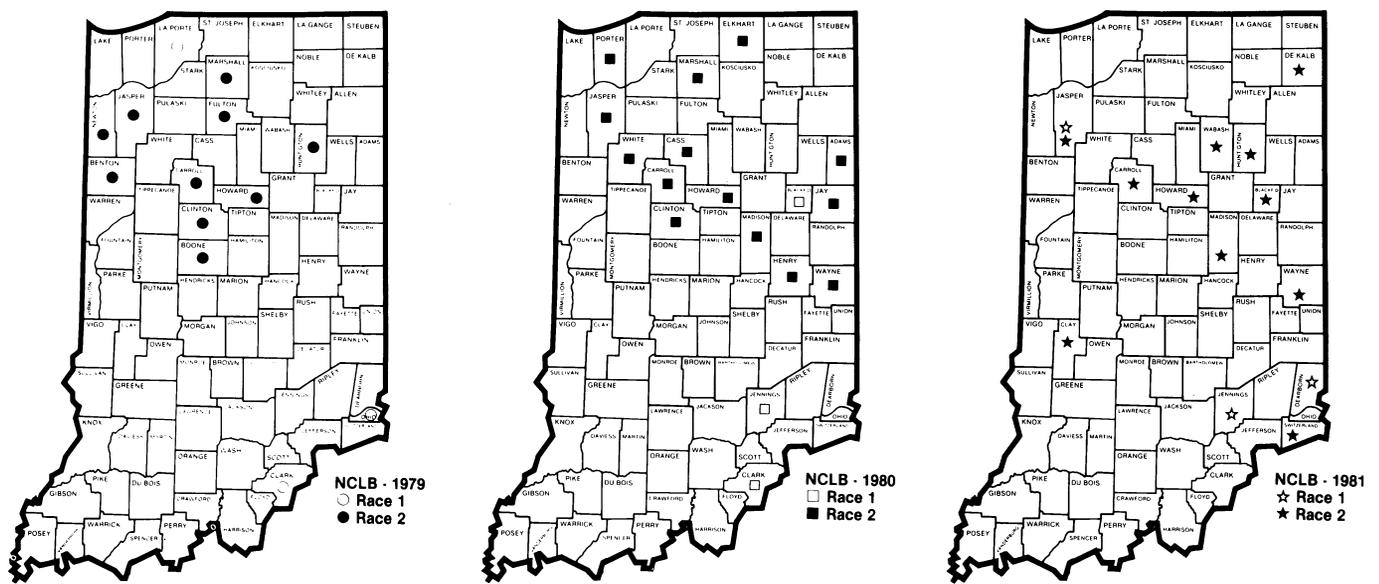


Fig. 1. Distribution of races 1 and 2 of *Exserohilum turcicum*, cause of northern corn leaf blight (NCLB), in Indiana from 1979 through 1981.



Fig. 2. Distribution of races 1 and 2 of *Exserohilum turcicum*, cause of northern corn leaf blight (NCLB), in Illinois in 1981.

and 2. Race 2 was found in Carroll, Howard, and Jasper counties every year and in Marshall, Wayne, and Clinton counties in 2 yr. Each year, race 1 was found in only three counties. In all, race 2 was confirmed from 24 counties in Indiana from 1979 through 1981.

Four samples of NCLB tissue collected in the Illinois counties of St. Clair, Grundy, Iroquois, and Vermillion during the 1979 growing season were tested. The four isolates were avirulent on plants carrying the *Ht*, *Ht2*, or *Ht3* genes and thus were identified as race 1. Race 2 was first confirmed in Illinois in 1980 from

blighted leaf tissue collected in Iroquois County in the eastern part of the state. Three of the four *E. turcicum* isolates from this county were virulent on the B37*Ht* inbred. One isolate produced both resistant and susceptible lesions on B37*Ht*. Seventy-two of 89 isolates of *E. turcicum* collected in 1981 were identified as race 2. Isolates collected from fields in Adams, Coles, Crawford, Dewitt, Macoupin, Mclean, Morgan, and Tazewell counties in 1981 produced both susceptible and resistant lesions on B37*Ht* inbreds. No susceptible lesions were produced on inbreds B37*Ht2* and Oh43*Ht3*. Race 2 was confirmed in 53 counties in the northern two-thirds of Illinois in 1981 (Fig. 2).

One sample of NCLB tissue collected from a sweet corn field in 1979 in Palm Beach County in southwestern Florida and three samples of NCLB tissue collected in 1980 in Iowa County in east central Iowa were confirmed as race 2. In addition, one isolate from a commercial grain field in Wright County in southeastern Minnesota in 1981 also was identified as race 2. Other *E. turcicum* race 2 isolates found in 1981 were from fields in western New York in Ontario County, in north central Pennsylvania in Lycoming County, and in south central Pennsylvania in Blair County. Included in the New York and Pennsylvania collection of NCLB tissue identified as race 2 were samples from Lycoming County, PA, from the hybrid W64*AHt* × A654*Ht* and the inbred A632*Ht*, the latter growing in seed production fields, and samples from the hybrid A634*Ht* × Mo17*Ht* growing in demonstration plots in Ontario County, NY, and Blair County, PA.

DISCUSSION

NCLB caused by race 2 of *E. turcicum* was first reported in Hawaii in 1972 (1). It was reported in Indiana and Pennsylvania

in 1979 (15) and in Ohio in 1980 (11). This is the first report of the occurrence of race 2 in Florida, Illinois, Iowa, Minnesota, and New York. Assays of numerous samples of NCLB tissue from Illinois and Indiana indicate that race 2 is widespread in both states. Based on these findings and previous reports, it appears that race 2 of *E. turcicum* is widespread throughout the U.S. corn belt, extending east into the mountain valleys of Pennsylvania and New York and south to the sweet corn production areas of Florida.

The United States has a long history of epiphytotic of NCLB dating back to the late 1800s. However, the importance of NCLB was almost eliminated 20 yr ago with the discovery of the *Ht* gene and subsequent development of inbreds and hybrids resistant to race 1 of *E. turcicum* (5). The appearance of race 2 once more makes NCLB a potential threat to corn production in the United States. Outbreaks of NCLB require favorable environmental conditions, a susceptible host, and a virulent race of the pathogen. These conditions prevailed in 1981 in the mountain valleys of New York and Pennsylvania. Heavy dews, cool temperatures, and frequent rains created favorable environmental conditions for buildup of NCLB and race 2 of *E. turcicum* in seed production fields on susceptible early maturing inbreds such as A632*Ht* and A634*Ht*. These early maturing inbreds are very susceptible to race 2 infection. In these areas, race 2 was also found on hybrids such as A634*Ht* × Mo17*Ht* and W64*AHt* × A654*Ht* in commercial fields. If weather conditions similar to those in 1981 prevail in the Northeast, repeated outbreaks of NCLB can be expected in this area.

Outbreaks of NCLB occur sporadically in Illinois and Indiana. In 1979, race 2 of *E. turcicum* was found in a seed corn production field near Brook, Newton County, IN, on a susceptible inbred

closely related to A632 and having the *Ht* gene (15). The pathogen caused considerable damage in this field as witnessed by the first author. This was not the first report of a severe outbreak of NCLB in this area. In the same vicinity in 1949, the worst outbreak of NCLB in Illinois was reported on susceptible open-pollinated corn varieties. Fields around Watseka, Iroquois County, IL (less than 25 miles from Brook, IN), were severely blighted by the end of August (12).

In commercial fields of hybrid corn in Illinois and Indiana, NCLB lesions usually appear late in the growing season, when cooler temperatures favor disease development. Because green leaf tissue is required for growth and sporulation of the fungus pathogen, incidence and severity of the disease increases in areas where corn maturity is delayed because of late planting or cool, wet weather during the growing season. Natural senescence of the plant, however, usually prevents the disease from causing substantial injury and any yield loss.

At present, NCLB does not appear to be a major problem in commercial fields of hybrid corn in the central and southern parts of the corn belt because most commonly grown hybrids have polygenic resistance to race 2 (7). The greatest

threat is in the northern part of the corn belt, where hybrids have been developed from more susceptible early maturing inbreds. Several sources of chlorotic lesion resistance to race 2 of *E. turcicum* have been identified (13). Incorporation of this resistance into commercial hybrids will prevent race 2 from causing yield losses. Further testing of *E. turcicum* isolates is needed to determine not only race changes but other physiological changes as well. Scientists from all corn-producing areas are encouraged to take an active part in NCLB surveys and research.

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