

**PHYSIOLOGIC SPECIALIZATION IN GRAMINICOLOUS HELMINTHOSPORIA
(DRECHSLERA SPP.) AFFECTING MAIZE**

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Considerable variation occurs in *Helminthosporia* affecting graminaceous hosts and there is evidence of physiologic specialization in several species attacking crops of economic importance.

Variation is observed principally in respect of symptom expression on the host plant, morphological characters of the conidia, and the conidlophores, temperature, pH and nutritional requirements for optimum growth of the fungus, pigment production, pathogenicity, host range etc.

Although several species of *Helminthosporium* (*Drechslera* spp.) affect the maize crop, three are of considerable economic importance, viz., *H. turcicum* Pass. (= *Drechslera turcica*, Pass.) Subramanian and Jain, *H. maydis* Nisikado and Miyake (= *Cochliobolus heterostrophus* Drechsl.) Drechsl. and *H. carbonum* Ullstrup (= *Cochliobolus carbonum* Nelson). There is enough evidence of the existence of distinct physiologic races of these pathogens. The work is briefly reviewed here.

H. turcicum Pass. (= *Drechslera turcica*, Pass.) Subramanian and Jain. Earlier work on differences in strains within *H. turcicum* Pass. was that of Shaw (1921). He regarded the strains of *H. turcicum*, affecting corn to be different from those that attacked sorghum.

Mitra (1923) also recognised them as separate strains, differing culturally and pathogenically, but being the same morphologically. Nisikado and Miyake ('26) recognised differences in pathogenicity amongst different isolates of the fungus from Japan and U. S. A. Mitra ('31) cultured one hyphal tip isolate of this species that produced five saltants.

Definite evidence of physiological specialization in *H. turcicum* was first obtained by Robert (1952, 1960) She observed that single conidial and hyphal tip isolates of *H. turcicum* differed in their cultural characters. Mycelial sub-cultures from hyphal tip cultures differed from their parent cultures and from each other. Isolates of a single species were also found to differ in their pathogenic behaviour on a particular variety. Rodriguez (1961) also observed physiologic specialization in the species and morphological and cultural in different isolates.

Misra (1973) reported differences in 10 isolates of the pathogen from different parts of India in the size and septation of the conidiophores and conidia, colony characters and the growth of the fungus on different media, extent of sporulation and temperature and pH requirements for optimum growth.

Differences in pathogenicity of the isolates on 17 graminaceous hosts and 14 maize cultivars were quite marked (Tables 1 & 2).

Table 1. Reaction of 17 graminaceous hosts to 10 isolates* of *H. turcicum*

Hosts	ISOLATES									
	Z-20	Z-22	Z-23	Z-26	Z-34	Z-45	Z-48	Z-85	Z-141	Z-154
<i>Avena sativa</i>	-	-	-	-	-	-	-	-	-	-
<i>Gynodon dactylon</i>	-	+	-	-	-	-	+	-	-	+
<i>Dactyloctenium aegyptium</i>	-	-	-	-	-	-	-	-	-	-
<i>Eleusine coracana</i>	-	-	-	-	-	-	-	-	-	-
<i>E. indica</i>	-	+	-	-	+	+	-	-	-	+
<i>Euchlaena mexicana</i>	+	+	+	+	+	+	+	+	-	+
<i>Hordeum vulgare</i>	-	-	-	-	-	-	-	-	-	-
<i>Oryza sativa</i>	-	-	-	-	-	-	-	-	-	-
<i>Panicum taceum</i>	-	+	+	+	+	+	+	+	-	+
<i>P. mitiaceum</i>	-	+	+	+	+	+	+	+	-	+
<i>Pennisetum typhoides</i>	-	+	-	-	+	+	+	+	-	+
<i>Paspalum scrobiculatum</i>	+	+	-	-	-	+	-	-	-	-
<i>Setaria italica</i>	-	+	-	+	-	+	-	-	-	+
<i>Sorghum halepense</i>	+	+	+	+	+	+	+	+	-	+
<i>S. vulgare</i>	-	+	-	-	-	-	-	-	-	-
<i>Triticum aestivum</i>	-	-	-	-	-	-	-	-	-	-
<i>Zea mays</i>	+	+	+	+	+	+	+	+	+	+

— denotes no infection

+ denote presence of lesions

Isolates collected respectively from Ballia (U. P.), Hajipur (North Bihar), Kalimpong (West Bengal), Udaipur (Rajasthan), Almorah (U. P. Hills), Annamalainagar (Madras, T. N.), Chhindwara (M. P.), Sabour (South Bihar), Sarmaipur (Bihar) and Hyderabad (A. P.),

Table 2. Average disease rating (0-9 scale) of some of the selected maize varieties, inbred lines, composites, etc. to two isolates of *H. turcicum*

Varieties	ISOLATES	
	Z-22	Z-141
Sathi	6.8	4.2
NP Bulk 79	7.0	4.6
W. B. Late Bulk 34	7.2	4.2
Antigua 3 D	5.8	2.0
Cuba 11 J	7.6	3.6
Francisco flint	5.6	2.2
Dorales de tiquisate	5.6	2.6
Blx Cuba 11 J	5.4	2.2
Amber	5.0	1.0
Sona	5.4	2.8
CM 103	8.0	4.4
CM 112	5.8	3.6
CM 205	5.0	3.0
CM 300	5.8	2.0

Table 3. Reaction of selected maize varieties to two isolates of *H. maydis* (Average disease rating, 0-9 scale)

Varieties	ISOLATES	
	Z-26	Z-30
Sathi	7.2	4.8
W. B. late bulk	9.6	5.2
Antigua 3 D	5.8	2.2
Cuba 11 J	9.4	3.6
Cuba 23	10.0	3.6
Francisco flint	7.0	2.8
Histarch	4.6	6.0
Ganga Safed 2	5.6	3.4
Jaunpur maize	9.4	4.0
Amber	7.4	2.8
CM 103	9.6	3.4
CM 104	9.4	4.4
CM 105	2.3	6.8
CM 110	9.2	2.4
CM 111	9.8	1.6
CM 112	9.6	2.4
CM 200	8.0	2.8
CM 201	9.6	2.8
CM 202	5.8	2.8
CM 400	6.0	2.8

Isolate Z 22 from Hajipur (Bihar) and Z 141 from Sarmaspur (Bihar).

There was thus definite evidence of the existence of distinct races of the pathogen in India.

H. maydis Nisikado & Miyake

(= *Cochliobolus heterostrophus* Drechs.) Drechs.

Ullstrup (1941) reported two morphologically identical races of *H. maydis* on the basis of host specialization, symptoms produced and virulence.

Misra (1973) reported appreciable differences in 17 isolates of *H. maydis* collected from different parts of India, in respect of spore measurements, colony characters, growth of the fungus on different media, optimum pH requirements for mycelial growth, saftating ability, extent of sporulation, toxicity of the culture filtrates to seeds and seedlings of maize and the viability of spores. Marked contrast was observed in the isolate Z-30 from Kalyani (West Bengal) in which the colony was cottony white, as against light to dark grey in others. Sporulation was also minimum in this isolate.

Marked differences were observed in some isolates in their host range and pathogenicity on different varieties of the host plant.

On 17 graminaceous hosts (listed in Table 1), isolate Z-26 from Udaipur (Rajasthan) infected 16 hosts, but the isolate Z-30 from West Bengal infected only 3. Z-26 was also most virulent and Z-30 least pathogenic. Of 35 varieties, inbred lines and composites, 30 were susceptible to isolate Z-26, as against only 7 to isolate Z-30. The differential reaction of the two isolates to some of the selected maize germ plasms is presented in Table 3. Similar differences were observed in other isolates.

Recently Hooker (1974) described marked differences between races T and O of *H. maydis* in respect of cytoplasm specificity, toxin production and symptomatology on the host. As the fungus is heterothallic, the origin of new races is likely to take place by mating of the compatible isolates and subsequent segregation, viz, the two markedly different isolates Z-26 and Z-30 from Udaipur and Kalyani respectively when crossed (according to the method described by Nelson, 1957), gave three distinct classes of monoascosporic progenies in F₂ generation, as regards their mycelial colour, dark grey, white and intermediate. The segregation was in the Mendelian ratio of 1 dark : 2 medium : 1 white (Misra and Singh, 1972).

The F₁ colonies showing dark mycelium were also heavily sporulating. Monoascosporic progenies derived from perithecia produced in crosses between Z-26 and Z-30 showed differences in pathogenicity on maize. White mycelial isolates were predominantly non-pathogenic, as compared to dark-coloured progenies.

Isolate Z-26 from Udaipur, which was the most virulent of all isolates, when crossed with an isolate Em 1 from teosinte, gave progenies, which showed differences in pathogenicity and the segregation was in the ratio of 1:1:1:1, one pathogenic to maize, 1 pathogenic to teosinte and 1 pathogenic to none of the two hosts.

This partially explains the variability in those species of *Helminthosporium*, where compatible strains exist.

H. carbonum Ullstrup (= *Cochliobolus carbonum*, R. R. Nelson)

Ullstrup (1944) observed that one of his isolates was different from *H. maydis* in its morphology and he proposed the binomial *H. carbonum* Ullstrup consisting of two races 1 and 2.

Misra (1973) studied two isolates 144 and Z 14B, collected from Darbhanga, Bihar. These were compatible and produced perithecia of typical *Cochliobolus carbonum* Nelson. The isolates differed somewhat in their pathogenicity on certain varieties, viz., H. B. Bulk 79 and W. B. Late Bulk-34 rated as resistant to Z 14 A were susceptible to Z-14 B; Antigua ID, which gave intermediate reaction to Z-14 A proved susceptible to Z-14 B.

The culture filtrates also showed differences in their toxicity to seeds and seedlings of maize.

DISCUSSION

Helminthosporia are noted for their extreme variability, in morphological and cultural characters, physiology, saltating ability, compatibility, toxin production, pigmentation of the medium, pathogenicity and host range. Variation has been reported even among the monoconidial cultures of the same isolates and the hyphal tip isolates from a single germinating spore (Robert and Jenkins, 1949 and Robert 1952). In some cases monoascosporic progenies taken from the same ascus or perithecium have also been observed to vary in their pathogenicity. Even their progenies have been found to differ in their host range and virulence as compared to their parents. Differentiation of physiological races, therefore is not always practicable. In the absence of sharply differentiating disease reactions (infection types, as in case of cereal rusts), a selection of different species of graminaceous hosts, besides selected differential varieties of the host species and formulation of sets of differentials may prove extremely helpful. Besides, sharp differences in cultural characters on standard media and pigment production may form supplementary differentiating criteria. But, due to the highly mutable nature of the fungus and the cross ability of compatible strains, the physiologic race flora is likely to vary continuously.

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