Phoma glomerata, a New Pathogen of Wheat and Triticales, Cultivar Resistance Related to Wet Period

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ABSTRACT

Phoma glomerata caused no leaf spotting on any of the tested Gramineae following a postinoculation wet (mist) period of 6 or 12 hours. Following a wet period of 24 hours it caused severe leaf spotting on spring wheat cultivars Red River 68, Taichung 2, Ring, Inrat 69, and Zafrani and on a triticale with Armadillo parentage. It caused slight spotting on Waldron spring wheat and Hercules durum. Only after a postinoculation wet period of 48 hours did it cause severe spotting on Waldron and moderate spotting on Hercules. The triticales Fasgro 418, Fasgro 419, NDT 24, and 209 were not spotted. After 72 hours in mist the fungus caused severe spotting on Tobari 66 spring wheat and Leeds durum, and slight spotting on Marquis spring wheat. It did not cause spotting on Chris, C306, ND495, and ND487 spring wheats, Wells durum, Larker barley, Caribou rye, or Lodi oats. Apparently the fungus required a postinoculation wet period to cause leaf spotting, and expression of susceptibility or resistance to leaf spotting was associated with the duration of the wet period.

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Additional key words: Peyronellaea glomerata, disease resistance.

Phoma glomerata (Corda) Wr. & Hochapf. has caused diseases of dicots and conifers; been isolated from soil and the rhizosphere of plants; disseminated in seed, soil and plant debris; associated with mycotic diseases of man, and found in many parts of the world (2, 12). It has caused 80% yield losses in vineyards where it was best controlled with copper preparations such as Bordeaux mixture (11, 14). It was pathogenic to potato tubers and leaves in one study (6) but not in another (1, 2). The fungus was found in flax seed in France (9) and in flax and oil seed rape plants in Canada (13, 15). It was isolated from subepidermal pycnidia on the inner surface of dry sheaths of the grass *Stipa tenacissima* L. from Bou-Saada, Algeria (7, 8). It was found in unidentified grass seeds (3). The fungus was detected in trace amounts in the seed of wheat, oats, and barley in Canada (10).

The objectives of this study were to identify a *Phoma* sp. in lesions on leaves of triticale (*Triticale hexaploide* Lart.), to determine pathogenicity, and to study the influence of postinoculation wet period on incidence and severity on leaf spotting.

MATERIALS AND METHODS.—The procedures used were those developed for the leaf spot fungi *Pyrenophora trichostoma* and *Platyspora pentamera* (4, 5). I found pycnidia (Fig. 1) with conidia (Fig. 2) of a *Phoma* species and dictyochlamydospores (Fig. 3) in grey-to-dark-brown lesions on the inner and outer surfaces of green leaf sheaths of triticale sent by F. J. Zillinsky from plants growing at Toluca, Mexico. Isolates from the pycnidia, each isolate derived from a group of three to four conidia, were grown on potato-dextrose agar (PDA) and malt agar (2). Isolates Mex 1 and Mex 2 from different pycnidia were tested for pathogenicity. In the pathogenicity tests, cultures of mycelium, conidia, and dictyochlamydospores that had just covered the surface of PDA in petri plates were chopped into small pieces and suspended in water. Cereal plants in the three-leaf to flag-leaf stage of development were inoculated by dipping them into the fungal suspension. The inoculated plants and noninoculated check plants were incubated in a mist chamber at 23 ± 5 C for 6, 12, 24, 48, or 72 hours. A minimum of ten inoculated and ten noninoculated plants of each cereal selection were used in each trial. Seventeen trials were completed. Some tested cereals were not in some trials nor in some postinoculation wet periods. Following the wet periods, the plants were dried with a fan and placed on a glasshouse bench at 23 ± 5 C. Six days after inoculation, the plants were rated for disease severity by using a rating system developed for other leaf spot fungi (4, 5).

RESULTS AND DISCUSSION.—*Identity of the fungus.*—The fungus produced dense, dark, grey-green colonies on PDA and malt agar. In their low, dense aerial mycelium and on the agar the colonies formed abundant pycnidia (Fig. 1) containing many (Fig. 2-A), rarely conjugating (Fig. 2-B) conidia, like those on the triticales. There, they also formed chlamydospores (Fig. 4) and very abundant dictyochlamydospores individually on tips of hyphae (Fig. 5), on intercalary hyphal cells (Fig. 6), alternately on a hypha (Fig. 7), in short chains (Fig. 8), on hyphal strands (Fig. 9) or in clusters developing from an older dictyochlamydospore (Fig. 10). Newly formed dictyochlamydospores were light- to dark-brown, but quickly became covered with a black coating (Fig. 6-10) that obscured their color and multicellular nature. Their dimensions were 23.5-77.0 × 14.3-36.4 μm, averaging 24.8 × 42.8 μm.

Pycnidia were light- to dark-brown, subglobose, single or in clusters, and had either none or only short necks. They ranged from 33.8 to 221.0 μm in diameter, averaging 102.0 μm. Ostiole diameters ranged from 5.2 to 39.0 μm, averaging 17.5 μm. The numerous conidia were exuded through the ostiole in a cirrhus. Conidia were hyaline, with two or more guttules, mostly ovoid to ellipsoid, and single-celled. Their dimensions were 3.9-12.7 × 1.9-4.4 μm, averaging 7.2 × 3.2 μm.

The fungus most closely resembled descriptions of *Phoma glomerata* (2, 12) with dictyochlamydospores in chains, single chlamydospores, and intermediate stages that alternated between chlamydospores and dictyochlamydospores. However, it also produced terminal dictyochlamydospores on hyphal branches, single chlamydospores in chains, and dictyochlamydospores laterally from hyphal strands, characteristics used by Boerema et al. (2) to separate two other species from *P. glomerata*. I concluded that the fungus isolated from triticales was a form of *P. glomerata*.

Pathogenicity and resistance.—Following a postinoculation wet (mist) period of 6 and 12 hours none of the tested Gramineae developed leaf spots. After a 24-hour postinoculation wet period only the spring wheats (*Triticum aestivum* L.) Red River 68 (C.I. 14193), Taichung 2 (C.I. 278740), Ring (P.I. 277056), Inrat 69 (D58-25A, P.I. 324939) and Zafrani (P.I. 321744) and the CIMMYT triticale Armadillo x-308-y-16M-OX-304B-ON-OB-ON became severely damaged, with 30 to 50% of their leaf surface spotted. The spring wheats Waldron (C.I. 13958) and ND495 and the durum Hercules (*Triticum turgidum* L., C.I. 14559) were slightly spotted, with 1-5% of their foliage covered by spots.

Following a 48-hour wet period Waldron, ND495, and Hercules became severely spotted with 20-50% of its foliage covered by spots. The triticales Fasgro 418, Fasgro 419, NDT 24, and 209 were not spotted.

After 72 hours in mist, the spring wheat Tobari 66 (C.I. 14194) and the durum wheat Leeds (C.I. 13768) became severely spotted, with 30 to 40% of their foliage damaged. Waldron and most other wheats that were severely spotted after shorter periods in mist were severely spotted. The spring wheat Marquis (C.I. 3641) was slightly spotted. The spring wheats Chris (C.I. 13751), C306 (P.I. 322275), and ND487, the durum Wells (C.I. 13333), the barley Larker (*Hordeum vulgare* L., C.I. 10648), the rye Caribou (*Secale cereale* L., C.I. 14005) and the oat Lodi (*Avena sativa* L., C.I. 7561) were not spotted after 72 hours of postinoculation misting.

The leaf spots were irregular, yellow-to-light-brown, and were visible to the naked eye four days after inoculation. After six days, they were fully expressed (approximately 1-6 mm long by 1 mm wide). No differences were detected in the spotting caused by the two fungal isolates. Noninoculated check plants produced no spots. Using isolation procedures developed for other leaf spot fungi (4, 5), *P. glomerata* was consistently reisolated from the spots. It was not reisolated from unspotted, inoculated plants, or check plants.

This pathogen's requirement for long periods of free

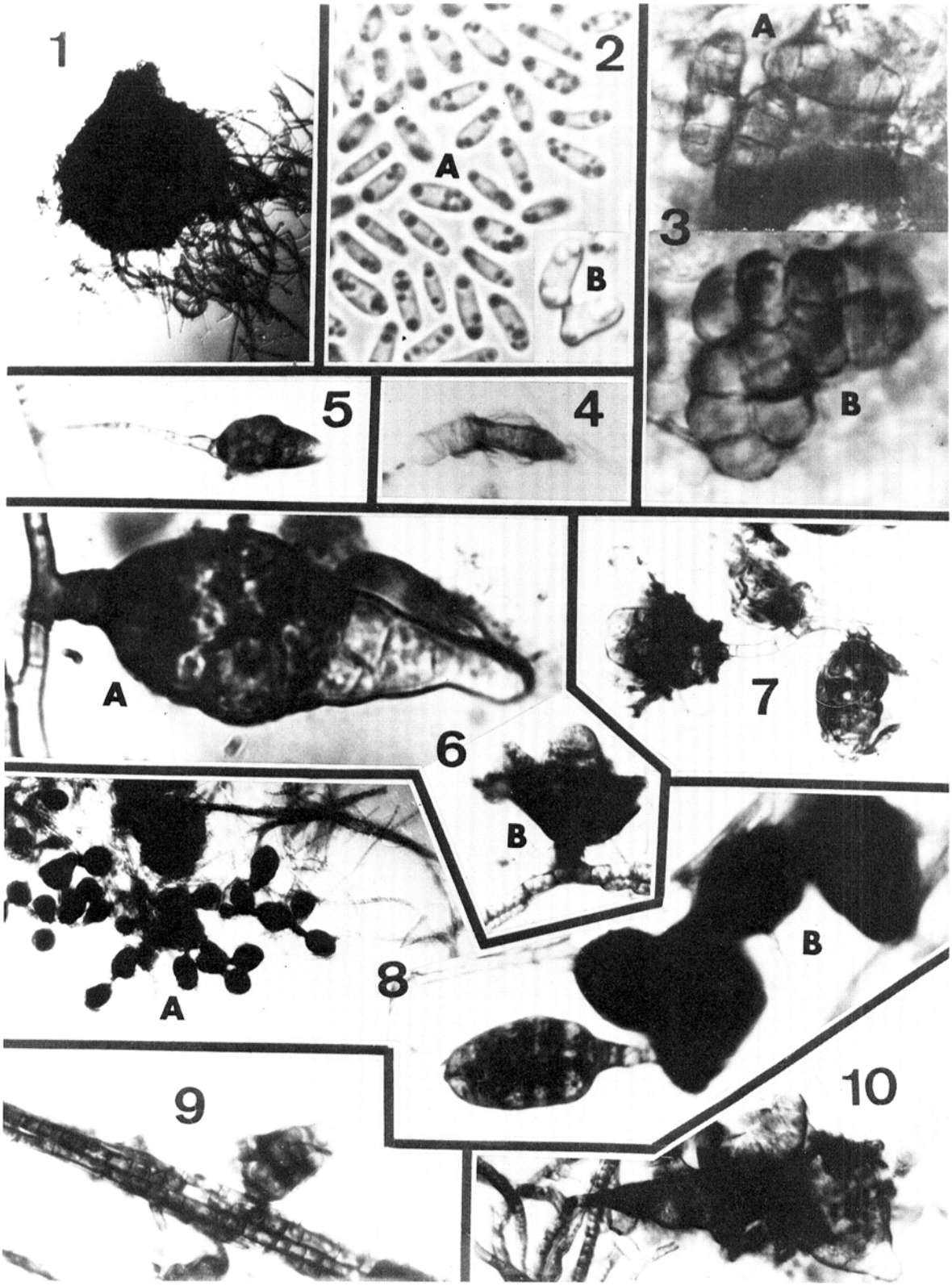

Fig. 1, 2-(A,B), 3-(A,B), 4, 5, 6-(A,B), 7, 8-(A,B), 9, 10. *Phoma glomerata.* **1)** Pycnidium (× 159). **2)** Conidia (A) (× 734), (B) conjugation (× 1,395). **3)** Dictyochlamydospores in lesions on triticales leaf sheaths (A) (× 563) (B) (× 1,236). 4) to 10) Grown on potato dextrose or malt agar. **4)** Chlamydospore (× 563). 5) to 10) Dictyochlamydospores, slightly to completely covered with a black coating. **5)** On hyphal tip (× 536). **6)** On intercalary hyphal cells (A) (× 1,358), (B) (× 563). **7)** Produced alternately on a hypha (× 566). **8)** In branching chains (A) (× 158), (B) (× 596). **9)** On a hyphal strand (× 469). **10)** In a cluster developing from an older dictyochlamydospore (× 477).

water to cause leaf spotting suggest that it might only become a problem in wetter seasons and wetter wheat growing areas on the more susceptible wheat or triticales cultivars. Since it is present in many parts of the world (2, 12), and recently has been destructive on some crops (11, 14) and found in wheat seed (10) it is potentially a problem pathogen of wheat and triticales. It is also the third leaf-spotting fungus for which the expression of cultivar resistance in wheat has been related to the duration of the postinoculation wet period. The other two fungi have been *Pyrenophora trichostoma* (4) and *Platyspora pentamera* (5). This suggests that wet period related cultivar resistance may be a common phenomenon. Since the susceptible and resistant cultivars differ with each of the three fungi (this article, and cited references 4 and 5) different genes may be operative in each of the host-parasite relationships.

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