USTILAGO TRICHOPHORA (H.F. LINK) F. KÖRNICKE, A FUNGUS NEWLY FOUND IN POLAND

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ABSTRACT

Ustilago trichophora, a smut fungus found for the first time in Poland, is characterized and illustrated. *Ustilago trichophora* affected *Echinochloa crus-galli* growing in the Lower Silesia voivodeship. In laboratory investigations, the germinability of teliospores, the morphological properties of promycelium, sporidia and colonies produced on potato dextrose agar, Sabouraud-glucose agar, and in water were determined. Attempts to infect seeds and seedling of *E. crus-galli* in a greenhouse pot experiment failed.

KEY WORDS: *Echinochloa crus-galli*, *Ustilago trichophora*.

INTRODUCTION

In Poland, the genus *Echinochloa* P. Beauv. of the family Poaceae is represented only by *E. crus-galli* (L.) Beauv. This plant is an annual spring weed growing in fertile, humid, sand-loamy or sand-humous soils of a low content of calcium. It needs a high temperature for germination and warm days at maturation (Mowszowicz 1976).

Literature data indicate that two species of the order Ustilaginales, i.e., *Moesziomyces bullatus* (J. Schröt.) K. Vánky and *Ustilago trichophora* (H.F.Link) F. Körnicke, are among the fungi associated with above-ground parts of *E. crus-galli* (Farr et al. 1989; Vánky 1994).

Moesziomyces bullatus has been found in Poland to parasitize on *E. crus-galli* growing in many sites (Kochman and Majewski 1973). According to Farr et al. (1989), other hosts of *M. bullatus* are species of the genera *Pennisetum* Rich. ex Pers., *Leersia* Sw., and *Paspalum* L. However, in Europe, this fungus affects only *Echinochloa* spp. (Vánky 1994).

Ustilago trichophora has been recorded in North America, south Europe, Africa, Asia, and Australia (Vánky 1994). The European host of this fungus is *E. crus-galli* (Vánky 1994).

During collection of diseased plants, *E. crus-galli* affected by a smuth fungus was found. Laboratory examination revealed the pathogen to be *U. trichophora*, a fungus found for the first time in Poland.

The aim of this paper is to characterize and illustrate *U. trichophora* based on its structures associated with the plants affected and investigations conducted in a laboratory and a greenhouse.

MATERIALS AND METHODS

The morphology of *U. trichophora*, its development in the host plant, and the properties of the infections formed were

examined with a naked eye and under a light microscope using sections cut from the diseased tissues.

The *in vitro* development of *U. trichophora* was observed on potato-dextrose agar (PDA; Difco), Sabouraud-glucose agar (SabA), and in water. Color names are from Kernerup and Wanscher (1983). Specimens are deposited in the Department of Plant Pathology (DPP), University of Agriculture, Szczecin, Poland.

To examine the development of the fungus in a plant, inoculation experiments were conducted in pot cultures. The inoculation was performed twice. At first, seeds of *E. crus-galli* were mixed with teliospores of *U. trichophora* coming from diseased plants and seeded. The inoculum of the second inoculation was a water suspension of sporidia produced on PDA. This suspension was sprinkled on 18-day-old seedlings of *E. crus-galli*. The plants grew at $23 \pm 2^\circ\text{C}$ and a day light for 34 days.

RESULTS AND DISCUSSION

Symptoms

Olive yellow (2D8) to yellowish brown (5F8), $8-14 \times 16-23$ mm, knobby outgrowths of a rougged surface, covered with a dense tomentum of the host plant are present on stems, especially directly above nodes (Figs 1, 2).

Development of sori

The development of sori begins with a local condensation of mycelium in the outer parenchymal cells. At these sites, the hyphal mycelium converts into a gel (Fig. 3) that then develops into sori with teliospores (Figs 4-6). The teliospores are subglobose; $6.1-9.6 \mu\text{m}$ diam; sometimes elliptic, $4.4-6.9 \times 8.1-12.7 \mu\text{m}$, of a greyish orange (5B3) to brownish yellow (5C7) colour (Fig. 9). The spore wall is ornamented with warts of a different size.

The properties of the teliospores correspond with those given by Brandenburger (1985), Blumer (1963), and Vánky (1994).

The sori are covered with 6-15 layers of parenchymal cells deformed due to hypertrophy and hyperplasia. The cells are almost hyaline, lack cytoplasm, and usually contain remnants of the mycelium. The integuments, even wider than 50 µm, burst when teliospores are mature.

The living cells neighbouring the sori are colonized by hyphae developing only intracellularly. The hyphae are hyaline, 2.0-3.5 µm wide, and have many short branches ended with haustoria of different shapes (Figs 7, 8). According to Vánky (1994), *U. trichophora* forms intercellular hyphae with ramified haustoria.

The cells located some centimeters from the swellings lack hyphae of the parasite. Thus, *U. trichophora* probably colonizes locally its host plant, similarly as, e.g., *U. maydis* (A.P. de Candolle) A.C.I. Corda.

Collection examined: Poland, Rakowice Wielkie, the Lwówek administrative district (the Lower Silesia voivodeship), on stems of *E. crus-galli* growing as a weed in a culture of *Beta vulgaris* L.; leg.: Anna Skwarkowska, in the third decade of August of 1999. Specimens of *E. crus-galli* collected in the Westpomeranian voivodeship in 1999 did not harbour neither *M. bullatus* nor *U. trichophora*.

Distribution

In Poland, *U. trichophora* was found associated with *E. crus-galli* growing in Rakowice Wielkie. According to Vánky (1994), this fungus has a worldwide distribution.

In vitro development

The germinability of teliospores on PDA, SabA and in water after 6 months of storage in dry conditions ranged from 14 to

Figs 1-6. *Ustilago trichophora*. 1 and 2. Sori in infected stems of *Echinochloa crus-galli*, $\times 2$. 3-6. Stages of development of sori from a gel form (3) to differentiating teliospores (6); Fig. 3, bright field microscopy (BFM), $\times 720$; Figs 4 and 5, differential interference contrast (DIC), both $\times 1070$; Fig. 6, DIC, $\times 1428$.

Figs 7-12. *Ustilago trichophora*. 7 and 8. Branched haustoria, DIC, $\times 1428$. 9. Teliospores, DIC, $\times 1428$. 10. Germinated teliospore with promycelium (P) and sporidia (S), BFM, $\times 1125$. 11 and 12. Colonies on PDA and SabA, respectively, both $\times 1.8$.

35%. The percent of germination was higher when the teliospores occurred in aggregates. Single teliospores germinated infrequently. On PDA, SabA, and in water, the teliospores produced a promycelium after 16-24 h. The promycelium usually is one-celled; sometimes it is branched at the spore base (Fig. 10). Sporidia form at the tip of the promycelium by budding. Setchall and Brefeld (in Vánky 1974) informed that the promycelium of *U. trichophora* is two-celled. The promycelium subsequently developed into colonies.

On PDA, after 3 weeks of growth, *U. trichophora* produced yellowish white (4A2) to orange white (5A2), compact, surface colonies of a diameter of 3-3.5 cm (Fig. 11) with a cream (4A3) to butter yellow (4A5) reverse. The aerial mycelium of these colonies formed branched, hyaline hyphae, 2-2.5 μm wide, consisting of longitudinally ellipsoidal, hyaline cells with a granular content. With age, the colonies became leathery, and their aerial mycelium produced numerous globose to oval conglomerations due to the fragmentation of the hyphae.

On SabA, the colonies of *U. trichophora* were compact, powdery to slimy, of an orange (5B8) to yellowish brown (5D8)

colour (Fig. 12); with age, their aerial mycelium also fragmented into globose, hyaline to flavus pieces.

The attempts to infect *E. crus-galli* by both the inoculation of seeds with teliospores and seedlings with a water suspension of sporidia failed.

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STRESZCZENIE

Scharakteryzowano i zilustrowano *Ustilago trichophora*, grzyba głowniowego znalezione po raz pierwszy w Polsce. *Ustilago trichophora* występowała na *Echinochloa crus-galli* rosnącej na Dolnym Śląsku. W badaniach laboratoryjnych określono zdolność kiełkowania zarodników, cechy morfologiczne promycelium, sporidiów i kolonii wyrosłych na agarze dekstrozowo ziemniaczanym, podłożu Sabourauda z glukozą i w wodzie. Próby zainfekowania nasion i siewek *E. crus-galli* w doświadczeniach szklarniowych nie powiodły się.

SŁOWA KLUCZOWE: *Echinochloa crus-galli*, *Ustilago trichophora*.