Incidence of a "Take-All Like Fungus" recovered from the crowns, stems and roots of winter wheat grown in Manitoba1

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The occurence of winter wheat with take-all symptoms is reported for Manitoba in the 1983-84 growing season. Some of the different methods of measuring take-all in the field are discussed. The methodology used to characterize the main fungal components of the crown-root rot complex is outlined. Fungi isolated included a *Gaeumannomyces graminis* var. *tritici* "like" fungus, *Fusarium culmorum, F. avenaceum, F. equiseti,* and *Cochliobolus sativus*. The effects that different cropping systems had on the occurrence of take-all and the other principal fungi in the crown-root rot complex are briefly assessed.

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La présence de symptômes de pibtin-bchaudage sur le blé d'hiver au Manitoba est rapportbe pour la saison 1983-84. Quelques unes des diffbrentes mbthodes d'bvaluation sur champ du pibtin-bchaudage sont discutbes. La mbthodologie employée pour charactbriser les composantes cryptogamiques principales du piétin est dbcrite. Les micro-organismes isoles comprennent un champignon semblable à *Gaeumannomyces graminis* var. *tritici, Fusarium culmorum, F. avenaceum. F. equiseti,* et *Cochliobolus sativus.* Les effets des différents regimes de récoltes sur la frbquence pibtin-bchaudage et des autres principales composantes du complexe sont évalués brièvement.

Introduction

In recent years acreages of winter wheat, *Triticum aestivurn,* have increased in the prairie provinces of Canada with the introduction of the winter hardy variety Norstar and the development of improved management systems. With increased winter wheat production has come an increase in the incidence of take-all, a crown and root disease caused by the fungus *Gaeurnannornyces graminis* (Sacc.) Von Arx & Olivier var. *tritici* Walker. In the 1983-84 growing season, brief surveys assessing the extent of take-all in wheat fields in South-Western Manitoba found levels of the disease ranging from slight to moderately severe (unpubl. Sturz and Bernier). An early maturing winter wheat crop accelerated by dry conditions in the latter part of the growing season masked the true extent of the disease and take-all levels may well have been higher. This paper describes 1) some of the different methods used to assess the incidence of take-all in the field, 2) briefly outlines the methodology used to characterize the main fungal components in the crown-root rot disease complex found at the experimental winter wheat plots, Minto, Manitoba, and 3) reports on the effects that different cropping systems had on the occurrence of take-all and the other principal fungi in the crown-root rot disease complex at that site.

Materials and Methods

The incidence of take-all in fields and experimental plots was assessed by counting the number of diseased plants found within randomly selected blocks 20.7 m^2, comprising 14 rows of winter wheat. Plants were examined at approximately growth stage 10.54-11.1 Feekes. Estimations of disease incidence were based on whole plants not individual tillers. No attempt was made to assess disease severity in individual plants. Assessments were based on head-development criteria [(i) nil through (ii) rudimentary to (iii) white head being considered as presence of the disease and (iv) normal head development as absence] and presence or absence of the characteristic root-discoloration and/or stem-base blackening. Periodically, infected plants were removed so that symptomed tissue could be checked in the laboratory for the causal organism.

Surveys were made in a number of experimental plots growing winter wheat following different cropping sequences. Disease

Table 1. Occurrence of winter wheat with take-all symptoms, at growth stage 11 (Feekes) following different previous crops, in the growing season 1983-84, at the experimental ground, Minto.

Winter Wheat Sown On	Mean No. Plants Diseased	Mean No. Foci	Mean Size Largest Foci (M^2)	Mean Size Foci (M^2)	Mean No. Plants Per Foci	%** Area T.A.
Winter Wheat	22.5*	10	**0.4**	0.02	**1.8**	**3.7**
Barley	80.5	**70**	0.4	**0.007**	1.1	**3.5**
Rape	20.5	**13**	1.1	**0.007**	**1.7**	**6.0**
Flax	15.5	**13**	0.04	**0.007**	1.2	**0.5**
Oats	8.0	**8**	0.005	**0.005**	**1.0**	**0.3**

*Counts were taken from a randomly selected block of winter wheat 20.7 M^2.

**The size of a one plant take-all (T.A.) foci was estimated as 0.005 M^2.

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characteristics examined included the number of disease foci, the mean size of the largest and the average foci found, the number of diseased plants per foci, and the percentage area of wheat lost to take-all.

Infected tissue was surface sterilized with a 1-2% solution of sodium hypochlorite (Na O Cl) for 3 min, rinsed with sterile distilled water to remove chlorine and plated onto potato dextrose agar (amended with antibiotics). To reduce surface tension Tween 20 (polyoxyethelene sorbitan monolaurate) was incorporated into both the sodium hypochlorite solution and the sterile distilled water at approximately 0.1 parts per thousand. Plates were incubated in the dark at 22°C for 7 days.

A seedling-baiting technique (modified after Hornby 1969) was used to isolate the take-all causal organism and the other component fungi of the root-crown disease complex. The root, crown and lower stem tissues of wheat plants displaying take-all symptoms, as well as the rhizosphere soil and plant debris of winter wheat plants grown in different crop rotations, were studied. Fusaria were identified to the species level after the method described by Sturz and Johnston (1983).

Results

Higher levels of take-all were recorded after rotations of wheat, barley and rape as compared to oats or flax (Table 1). It was found that the incidence of take-all based on the

Table 2. Percent recovery of fungal species from the crown, root and stem tissues of Norstar winter wheat seedlings inoculated at the primary root with wheat stem sections displaying take-all symptoms.

Fungal Spp. Isolated	Inoculated %	Control %
Microdochium bolleyi	2.5[++]	0
"Ggt"[+]	95	0
Fusarium equiseti	15	0
Other fusaria[+++]	10	0
Cochliobolus sativus	5	0
Alternaria spp.	0	90
Trichoderma spp.	0	10
Other fungi	0	70
Plants with crown/stem rot symptoms	65	0

[+] "Ggt" *Gaeumannomyces graminis* var. *tritici* 'like' fungus.
[++] Sample of 40 seedlings.
[+++] *F. avenaceum, F. acuminatum* Ellis & Everhart, *F. solani* and unidentified fusaria.

Table 3. Percent recovery of fungal spp. from the root, crown and stem tissues of Norstar winter wheat seedlings sown in soil and plant debris taken from the rhizospheres of winter wheat plants grown after different crop sequences.

Fungal Spp. Isolated	Wheat Stems with Take-all Symptoms" Only (%)	Soil and Plant Debris from the Rhizosphere of Winter Wheat Grown in Plots after Different Crop Sequences**				
		Winter Wheat (%)	Barley (%)	Oat (%)	Flax (%)	Rape (%)
"Ggt"[+]	50[***]	–	–	–	–	17
Microdochium bolleyi	17	**83**	42	42	75	**33**
Fusarium oxysporum	**33**	–	–	–	–	–
F. avenaceum	25	**33**	**33**	8	42	17
F. culmorum	17	17	**33**	17	–	–
Other fusaria[++]	8	–	17	–	–	8
Cochliobolus sativus	–	–	–	–	–	8
Rhizoctonia cerealis	–	–	17	–	41	–
Other fungi[+++]	–	58	41	**33**	25	17
Plants with crown/stem rot symptoms	42	8	17	0	8	8

[+] "Ggt" *Gaeumannomyces graminis* var. *tritici* 'like' fungus.
[++] *F. equiseti, F. arthrosporioides* (?), *F. sporotrichioides.*
[+++] *Alternaria* spp., *Trichoderma* spp., *Mucor* spp., *Rhizopus* spp.
*Debris ≥ 2.0 mm.
**Rhizosphere soil and plant debris < 2.0 mm.
***Sample of 12 seedlings.

parameter, number of diseased plants per plot did not correspond well with those estimates of incidence measured as the percent aea of wheat lost to take-all.

Recovery of the take-all organism (*Ggt*) proved to be extremely difficult. Isolations from the crown and stem sections of 20 wheat plants displaying take-all symptoms, yielded only ***Fusarium equisefi*** (Corda) Sacc. (55%), ***F. solani*** (Mart.) Sacc. (25%). F. ***oxysporum*** Schlect (30%) and small amounts of ***Cochliobolus sativus*** (Ito & Kurib.) (15%). The seedling-baiting technique (modified after Hornby, 1969) was more successful (Table 2). By this method a *Ggt* "like" fungus (95%) was recovered from 'inoculated' seedlings. ***Microdochium bolleyi*** (Sprague) de Hoog (2.5%) was also recovered along with isolates of ***F. equisefi*** (15%). Of 40 seedlings baited after this method, 65% developed typical take-all stem and root blackening symptoms.

Repeating the Hornby technique, using as an inoculum source the rhizosphere soil and plant debris of wheat plants grown following different crop sequences, higher levels of ***M. bolleyi*** were isolated [winter wheat following-winter wheat (83%), — barley (42%). — oats (42%) — rape (75%) and — flax (33%)] (Table 3). Species of fusaria were also recovered and included ***F. culmorum*** (W.G.Sm.) Sacc. (17-33%), F. ***avenaceum*** (Fr.) Sacc. (25-44%), ***F.equiseti*** (7%) and ***F. sporofrichioides*** Sherb. (7%). The *Ggt* "like" fungus and C. safivus were only recovered from winter wheat following rape (17% and 8% respectively). ***Rhizocfonia cerealis*** van der Hoeven was recovered in winter wheat following barley (17%) and winter wheat following flax (41%) rotations.

Discussion

In this study disparities between the different assessment methods were thought to be mainly attributable to seedling and early plant mortality, thereby lowering the accuracy of those methods involving counts of visibly diseased plants. However, diseased plant counts when related to mean number of foci and mean foci size were superior to percent area take-all assessments in estimating the spatial distribution of the disease. "Residue effects" resulting in differences in the maturing times of winter wheat following different crop sequences contributed to the problems of devising a uniformly accurate method for assessing this disease in the field. It is concluded that additional earlier measurements, where possible, would be advantageous in estimating the incidence of the disease.

Difficulties encountered in isolating the take-all causal organisms are ascribed primarily to the age and dried state of symptomed material at the time of sampling. Fusaria such as ***F. culmorum, F. avenaceum*** and ***F. equisefi,*** are all documented as severe pathogens of the crowns and roots of overwintering cereals. Differences in recovery levels of the *Ggt* "like" fungus from rhizosphere soils and associated plant debris as compared to wheat stem fragments may in part be due to the better survial of the *Ggt* "like" fungus in the larger wheat debris fractions. It cannot be inferred from these results that the *Ggt* "like" fungus is absent from the rhizosphere fractions of the soils tested, only that it is absent from soil particles and plant debris $<$2.0 mm in size.

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