Snow molds on winter cereals in northern Saskatchewan in 1974[1]

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Isolates of a nonsclerotial low temperature basidiomycete (LTB), a Typhula sp. (FW), and *Sclerotinia* borealis from grasses were pathogenic on four cultivars of winter wheat (*Triticum* aestivum) and one of rye (Secale cereale) in a field test at Saskatoon in the winter of 1973-74 when snow depth and duration was above average. In spring 1974 the same wheat and rye cultivars were killed by ***S.*** borealis and Typhula FW in a cooperative test at Loon Lake in northern Saskatchewan. S. borealis also caused damage in a similar test at Scott, while other tests showed light infections of *Fusarium nivale* and/or *S.* borealis or no apparent damage. No clear differential effects of pathogens on cultivars was noted. In winter wheat crops *S.* borealis, Typhula *incarnata* (a new record for Saskatchewan), Typhula FW, and an unidentified sclerotial fungus (*ORS*) were recovered from dead plants. Of 50 fall rye crops surveyed in northern Saskatchewan in spring 1974, 45 showed damage by *S.* borealis, ranging from a trace infection to over 50% kill. *F.* nivale also caused injury to some rye crops and the LTB was found damaging this crop for the first time in North America. The diversity of pathogens and their ability to cause epidemics or significant damage on winter cereals under suitable conditions indicate the need to define more precisely the components of winter killing. In the breeding of winter cereals for Saskatchewan attention must be paid to snow mold resistance.

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Des isolats d'un basidiomycete psychrophile a sclerote (LTB), d'une espece du genre Typhula (FW) et de Sclerotinia borealis preleves sur des graminées se sont révélés pathogenes a quatre cultivars de ble d'hiver (*Triticum* aestivum) et un de seigle (*Secale* cereale) lors d'une epreuve en plein champ qui s'est deroulee a Saskatoon au cours de l'hiver 1973-1974 dans des conditions d'enneigement plus important et plus long qu'a l'ordinaire. Au printemps 1974, les cultivars de ble et de seigle ont ete detruits par ***S.*** borealis et Typhula FW dans un essai cooperatif a Loon Lake dans le nord de la Saskatchewan. ***S.*** borealis a egalement cause quelques degdts au cours d'un essai semblable, a Scott, mais les autres essais n'ont révélé que des infections benignes de Fusarium *nivale* ou *S.* borealis ou aucun dommage visible. On n'a remarqué aucune difference nette dans l'effet des micro-organismes sur les cultivars. Les plants de ble d'hiver detruits renfermaient *S.* borealis, Typhula incarnata (la premiere manifestation de sa presente en Saskatchewan), Typhula FW et un champignon non identifie a sclerote. Sur 50 champs de seigle d'automne examines au printemps 1974 dans le nord de la Saskatchewan, 45 manifestaient de degdts commis par ***S.*** borealis, degdts variant de l'infection a l'état de trace a une destruction supérieure a 50%. *F.* nivale a egalement attaque certaines cultures de seigle ou l'on a constaté pour la premiere fois l'action du basidiomycete psychrophile. La diversite des micro-organismes pathogenes et leur capacite d'entrainer des épidémies ou de causer des dommages sensibles aux cereales d'hiver dans certaines conditions fait ressortir la necessite d'une etude plus detaillee sur les differents facteurs responsables de la destruction des cereales par l'hiver. La selection des cereales d'hiver destinees a la Saskatchewan devrait tenir compte de la resistance aux moisissures niveales.

Snow molds, notably *Fusarium nivale* (Fr.)Ces., *Typhula* spp., and *Sclerotinia borealis* Bub. & Vleug. cause severe losses in winter cereals and grasses in Scandinavia, northern USSR, and Japan (4). In parts of Washington, Idaho, and Montana, *Typhula* spp. and ***F. nivale*** are important pathogens of winter wheat (12); in southern Alberta *F. nivale* was recorded in epidemic proportions on winter wheat in 1967 (5). *Typhula* spp. have been recorded causing occasional damage to winter wheat in the interior valleys and northern areas in British Columbia (3, 6). S. *borealis* was probably involved in damage to winter rye in Alaska and to wheat and rye in northern British Columbia in 1952 and 1971 respectively (2 and **J.** S. Horricks, personal communication, 14 June 1974), and it has been found once at high elevation in Washington (13). The host range of the nonsclerotial low-temperature basidiomycete, LTB, a pathogen perhaps unique to certain parts of western North America, includes winter wheat (1). In Saskatchewan, *F. nivale* and *S. borealis* were first noted as widespread pathogens of turf and road verge grasses in 1971 (8). Since then it has become apparent that they and a *Typhula* sp. designated FW are common snow **molds** on grasses in Manitoba, Saskatchewan, Alberta, and northern British Columbia (8, 9, 10, 11). *Typhula* FW is a different species from the *T. ishikariensis* Imai and *T. incarnata* Lasch ex Fries reported by Vaartnou and Elliott from northwestern Canada (15). Neither *T. idahoensis* Remsberg, which some workers consider synonymous with *T. ishikariensis,* nor *T. incarnata* has yet been recorded on grasses in Saskatchewan, although the latter was found frequently in disease surveys of turfgrasses in British Columbia, Washington, and Idaho in 1973 and 1974 (9 and unpublished).

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This note reports results of 1973-74 field tests to determine whether some of the snow mold fungi from grasses were pathogenic towards winter wheat and rye, and of disease surveys in winter cereals in Saskatchewan made in spring 1974 following a winter when snow depth was much above average.

Methods

Isolates of the LTB, S. *borealis, Typhula* FW, and a *Sclerotium* sp. isolated from grasses were grown on sterile rye grain, at 5°C for the first two species and at 12°C for the latter two, in the dark for periods of 10-14 weeks. In July 1973 inoculum of air-dried cultures of all but the LTB was applied by hand broadcasting to raked and levelled soil of individual plots in a randomized block layout with four replications. Each plot of 11 m^2 received 400 g of inoculum of S. *borealis* or *Sclerotium* sp. or *800* g of *Typhula* FW, which was then raked lightly into the soil surface. LTB inoculum was applied with the seed at 2:1 w/w when plots were sown in September with a V-belt seeder. There were four uninfested plots; 0.3m wide uninfested pathways reduced the risk of plot contamination. Four rows 3.3m long and 23 cm apart of each of the winter wheat cultivars Alabaskaja, Kharkov, Ulianovka, and Sundance and of the fall rye cultivar Frontier were sown at the rate of 1 g/m within each plot area. Two snow fences running north and south trapped snow on the test area (Fig. 1). Winter snowfall at Saskatoon for 1973-74 was 1704 mm and a snow cover persisted for 170 days from 31 October to 17 April. This is much above the average snowfall for the previous 33 winters of 1087 mm and 143 days snow cover (personal communication J. Maybank, Physics Department, Saskatchewan Research Council, 19 August 1974).

Results

Field tests

Injury to wheat and rye cultivars from all snow molds except the *Sclerotium* sp. was apparent soon after snow melt in mid-April 1974 (Fig. 1). An estimate of percent plant death per plot was made in mid-May. In plots inoculated with *Typhula* sp. this varied from 40% to 95%. Where kill was 95% only a few plants of Frontier rye survived. In LTB-inoculated plots, kill varied from 25% to 40% and in those with S. *borealis* inoculum plant death was 2-5%. No differential response of cultivars to the LTB or to *S. borealis* was apparent. Occasional plants in both infested and control plots showed typical leaf lesions caused by *F. nivale* (Fig. 3) and some plants died.

Surveys

Disease surveys of winter wheat and rye cooperative cultivar tests established by Agriculture Canada and the Crop Development Centre, University of Saskatchewan, at various centers in the province were made between late April and late June 1974. The locations and Crop Districts (CD) are shown in Figure 1a. The cultivars

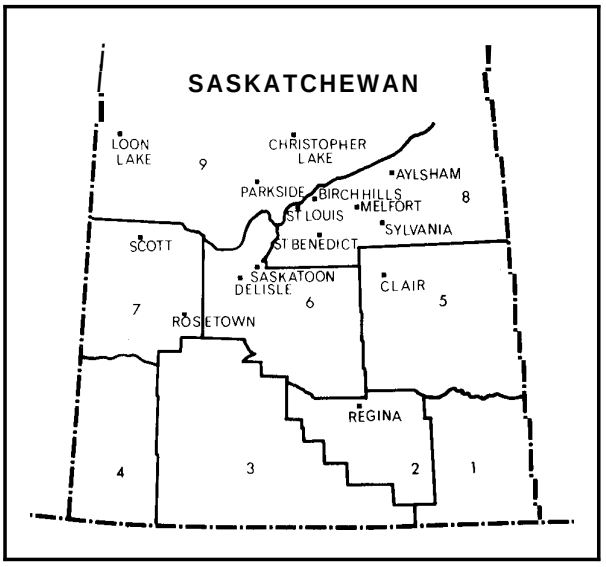
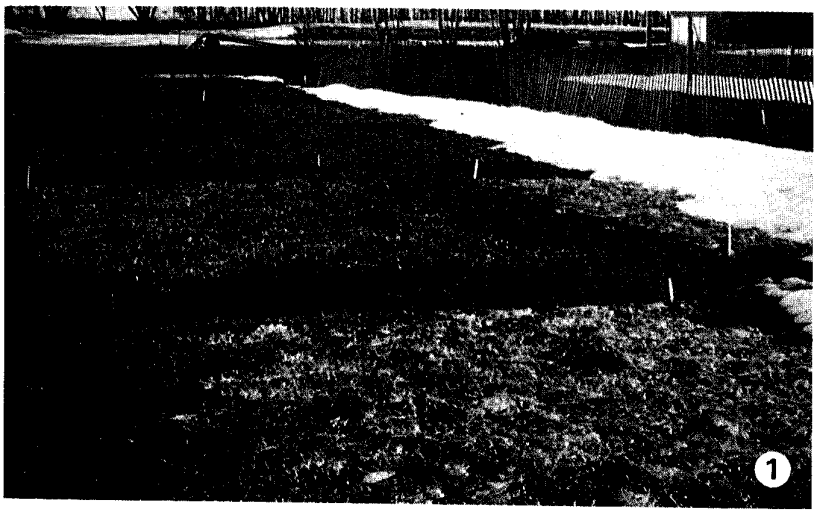


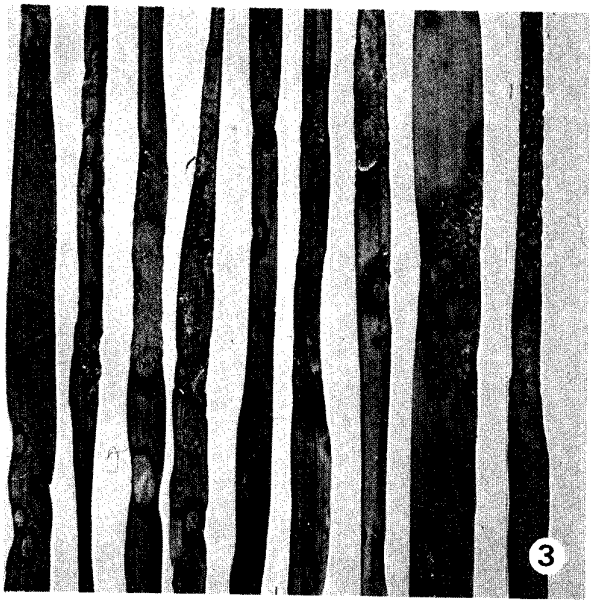
Figure 1a. Saskatchewan crop districts, locations of test plots and survey fields.

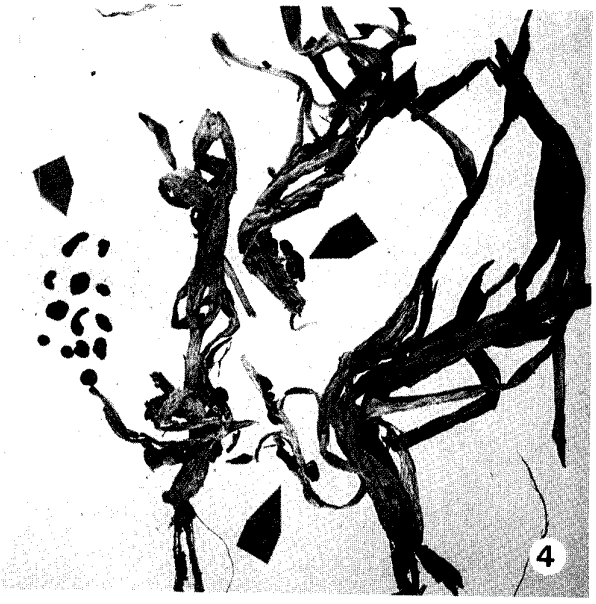
included those in the pathogenicity test at Saskatoon. In late April, at Loon Lake (CD 9) all cultivars of wheat and rye showed heavy infection with S. *borealis* (Fig. 4). Sclerotia of *Typhula* FW and of a fungus with orange sclerotia, designated ORS (8,9, 11) were also found. None of the wheat or rye plants survived. The Rosetown (CD 7) test showed severe winter damage but neither S. *borealis* nor other snow molds were noted. The Scott test (CD 7) showed *S. borealis* infection and winter damage. No clear differential effects on cultivars were evident at Loon Lake, Scott, or Rosetown. At Saskatoon (CD 6) light infections with S. *borealis* and *F. nivale* occurred on winter wheat in tests at two of three locations. Snow mold damage was not found in late June in the tests at Parkside (CD 9), Melfort (CD 8), and Clair (CD 5). In commercial fields of Winalta winter wheat in CD 8, S. *borealis, T. incarnata* (a new record for Saskatchewan), *Typhula* FW, and the ORS fungus were recovered from dead plants at Aylsham, and S. *borealis* and *Typhula* FW from a crop at Sylvania. Three

Figures 1–4. Snow mold damage to fall-planted crops of wheat and rye, Saskatchewan, April–May 1974:

1) Snow mold pathogenicity test, Saskatoon, mid April: on rows of winter wheat and rye, foreground plot *Typhula* FW. next plot LTB
2) *Fusarium nivale* damage to rye, natural infection, St. Louis.
3) *Fusarium nivale* leaf spots on Yogo winter wheat.
4) Winter wheat plants killed *by Sclerotinia borealis:* note sclerotia (arrows), X 0.5.







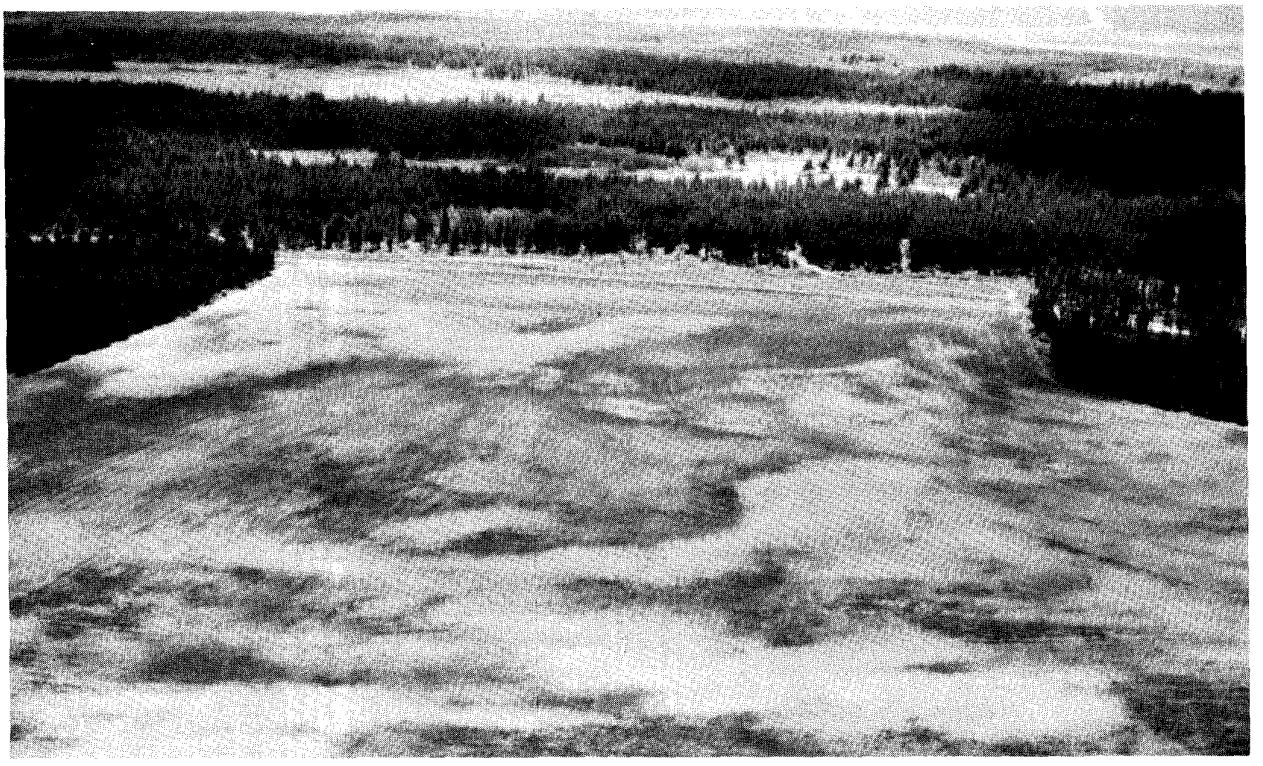


Figure 5. Extensive bleached areas of *Sclerotinia borealis* damage to rye, Prince Albert: aerial photograph June 1974.

crops of Sundance winter wheat in the St. Benedict and Birch Hills areas had no snow mold symptoms in early Mav.

From 30 April to 16 May surveys of rye fields and other plot tests in Saskatchewan crop districts 6, 8, and 9 (Fig. la) were made. Of 50 rye sites examined, 45 showed plants killed by *S. borealis*. Severity ranged from trace to more than 50% kill on 60 acres at Christopher Lake and on 100 acres near Prince Albert (Fig. 5). *F. nivale* was an occasional pathogen in crops except at St. Louis where damage was locally severe (Fig. 2). The LTB fungus was isolated from diseased rye at Delisle where it was apparently causing damage in association with S. *borealis.*

Discussion

Winter wheat production in Saskatchewan has been confined to a few thousand acres in the southwest and scattered fields in the parkland region. Fall rye, a more important crop than winter wheat, occupied about 1.5% or 328,000–502,000 acres of the total cereal acreage in the years 1968-1971 (7). Fall rye is a useful crop on light land for erosion and weed control, spring grazing, and grain production. Winter killing is regarded as a hazard unless the winter-hardy cultivars Frontier, Puma, or Antelope are used and plants are well established by freeze-up (14). Comparatively little attention has been given to the pathology of the rye crop in Canada but the finding for the first time in this province of S. *borealis* and *F. nivale* on heavily damaged stands suggests that an attempt should be made to define more precisely the components of the portmanteau term "winter-killing". The virulence of *Typhula* FW and LTB isolates from Saskatchewan grasses on rye and wheat in the Saskatoon tests and the isolation of the LTB fungus from a field of rye, a new record for western North America, suggest that the hazards of snow mold on this crop require closer examination.

Although the 1974 survey was limited to crop districts 6, 8, and 9, the pathogens obtained, namely *F. nivale, S. borealis, Typhula* FW, and the LTB, are known to be widespread on grasses of the province and generally in western Canada. S. *borealis* was also found in several rye crops in a survey in northern and western Manitoba in July 1974 (Smith, unpublished). In turfgrasses in particular, in western Canada these snow molds cause epidemics only when suitable microclimatic conditions develop. For example, *F. nivale* appears from summer to fall after a rainy, cold period or nonpersistent snow; S. *borealis* and *Typhula* FW seem to need prolonged, deep snow covers. The LTB appears to be able to cause damage even under a shallow, shorter duration snow cover than favors S. *borealis* or *Typhula* FW although it can also reach epidemic proportions under protracted snow covers (9, 10). Probably conditions suitable for snow molds could occur on winter cereals in many areas

of Canada. In the winter of 1973-74, attacks of S. *borealis* on cereals in Saskatchewan appear to have been favored by the prolonged, deep snow cover. Winter wheat is little grown at present in northern Saskatchewan so the survey was limited. However, winter hardy North American and Russian wheat cultivars were eliminated at Loon Lake, largely by *S. borealis,* and were damaged elsewhere by this pathogen and by ***F. nivale.*** Attempts to extend the range of winter wheat through the use of improved varieties and cultural practices should not overlook snowmold problems intimately related to winter hardiness.

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