Canadian Plant Disease Survey

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The *Canadian Plant Disease Survey* is a periodical of information and record on the occurrence and severity of plant diseases in Canada and on the assessment of losses from disease. Other original information such as the development of methods of investigation will also be accepted. Review papers and compilations of practical value to plant pathologists will be included from time to time.

L'Inventaire des maladies des plantes au Canada est un périodique d'information sur la fréquence des maladies des plantes au Canada, leur gravité, et les pertes qu'elles occasionnent. La rédaction accepte d'autres communications originales, notamment sur la mise au point de nouvelles méthodes d'enquête. De temps à autre, l'inventaire inclut des revues et des synthèses de rapports d'intérêt immediat pour les phytopathologistes.

EDITOR'S NOTE

It is with deep regret that we mourn the passing of Ross Jackson, Head of Graphics Section, Research Program Service, and *inter alia*, Production Manager for the Canadian Plant Disease Survey. Ross was 52 when he died this past May, and his expertise, professionalism together with the general excellence of his work will be sadly missed by all. His personal contribution in research, as well as his advice and help to research scientists was appreciated by many. Ross's contribution to photography was recognized by a number of international awards.

Quince rust of common juniper in Newfoundland

Pritam Singh and Gordon C. Carew[1]

This note is the first record of Quince rust of common juniper, *Juniperus communis*, caused by *Gymnosporangium clavipes* from Newfoundland. It also reports the distribution and severity of the disease, and its status in relation to the ornamental value of the host on the Island.

Can. Plant Dis. Surv. 60:2,3, 21-22, 1980.

Le présent article constitue la première mention de la rouille du cognassier causée par *Gymnosporangium clavipes* chez le genévrier commun (*Juniperus communis*) dans l'île de Terre-Neuve. Il fait également état de la distribution et de la gravité de la maladie, ainsi que de son importance en regard de la valeur ornementale du genévrier dans l'île.

The common juniper, *Juniperus communis* L., is a small tree which together with its shrubby varieties, is circumpolar in the Northern Hemisphere. It is native to many parts of Canada, including Newfoundland, and is used as an ornamental in many urban areas of the Island.

Quince rust, also known as rust galls, is caused by *Gymnosporangium clavipes* (Cke. and Pk.) Cke. and Pk., and is one of the most conspicuous stem diseases of *Juniperus communis* in the United States. In Canada, Quince rust is widespread and has been observed on several species and varieties of *Juniperus* and *Amelanchier*. In the summer of 1979 this disease was observed on ornamental shrubs of *Juniperus communis* var. *Suecica* Ait. in Mount Pearl and St. John's. The pathogen was also observed on one of its alternate hosts, smooth serviceberry, *Amelanchier laevis* Wieg., in forests at several locations in eastern Newfoundland. Records of the Newfoundland Forest Research Centre Mycological Herbarium shows that *G. clavipes* was collected on an *Amelanchier* species in 1961; and an unidentified *Gymnosporangium* species was collected on Bartram's serviceberry, *Amelanchier bartramiana* (Tausch) Roem; smooth serviceberry, *A. laevis*; and round leaf serviceberry, *A. sanguinea* (Pursh) DC in the same year. The latter rust has now been identified as *Gymnosporangium clavipes*. This article records the disease on *Juniperus communis*, reports its distribution and severity in insular Newfoundland, and discusses its status in relation to the ornamental value of this juniper in urban areas of the Island.

Information on the symptoms and the incidence and intensity of the disease is based on the observations and records made from a total of 13 infected ornamental shrubs of the juniper (1.2 - 1.8 m tall) and 30 wild growing bushes of smooth serviceberry in forests scattered across the eastern part of the Island. The number of infected live and infected dead shrubs; number of shrubs with infected stems, branches or both; number of galls per branch; number of nodal and internodal galls; and size of galls were recorded. Percentage of infected shrubs, stems, and branches was calculated. The identity of the pathogen was confirmed by comparing it with authentic descriptions of symptoms, aeciospores and teliospores (Ziller, 1974; Parmelee, 1965).

The incidence of disease on juniper was sporadic, but its intensity on individual shrubs was severe, infecting up to 100% of the shoots and causing a mortality of up to 40% of the young shoots and 10% of the older shoots. No shrub mortality was observed. The pathogen was always caulicolous and the infection was mostly confined to branches, rarely on the main stem. The characteristic fusiform swellings or galls were common on twigs and branches, and up to 11 galls were recorded on an infected shoot. These galls encircled the twigs or branches and at maturity ruptured irregularly with rough, black bark, exposing golden-orange or orange-brown, pulvinate telia. The galls varied from 1.3 cm to over 5.0 cm in length and induced a 2-3 times increase in the diameter of the shoot. The galls were both nodal and internodal in location.

The infection of the rust on serviceberry was mostly fructicolous, rarely caulicolous; it was not at all observed on leaves. Up to 60% of the berries on some bushes were infected, with an average of 25% infection. The caulicolous infection was only about 5%. Swelling (up to 2 or 3 times the normal size), deformation and mumification of berries was conspicuous. Fusiform galls (up to 5.0 cm long and twice the normal diameter of the branch) were observed on the nodes of some branches. Aecia produced delicate, cylindric spore horns on berries and on caulicolous galls, and released yellow aeciospores.

This research note is the first record of the occurrence of Quince rust on *Juniperus communis*, a common orna-

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mental bush on the Island. It also describes the distribution of the disease in scattered patches at widely separated locations on the Island. It appears that the disease in all these areas did not originate from one source of infection. Funk (1974) remarked that sporadic occurrences of some diseases of forest and ornamental trees are completely unpredictable and sometimes they do cause a serious impact on the development and growth of trees. At present this disease does not cause any tree mortality, but the infected trees do appear unsightly because of numerous dead branches and twigs, and orange-colored fusiform galls.

Although Quince rust is of no importance to forestry in Newfoundland, it has been known to be a menace in some parts of eastern North America (Ziller, 1974), and its potential impact on ornamental trees of this species and other junipers on the Island should not be overlooked. With increasing interest in urban trees and shrubs, including this and the other related species in Newfoundland, this disease may become more important in future. Also, the host range of this fungus is wider than that of any other North American tree rust (Ziller, 1974) and its aecial stage is known to parasitize more than 480 host species belonging to more than 10 genera of the family Rosaceae (Crowell, 1935). In telial stage, it parasitizes junipers belonging to section *Oxycedrus* and section *Sabina* of the genus *Juniperus*. The disease is known to be specially detrimental to apple and juniper. It is suggested that special care must be taken when introducing seedlings of juniper and other susceptible hosts into Newfoundland and that the seedlings should be examined before shipment and transplanting in gardens; infected plants should be destroyed.

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Occurrence of soybean foliage diseases in eastern Ontario, 1979

P.K. Basu

Four foliage diseases of soybean (*Glycine max*), namely bacterial blight (*Pseudomonas glycinea*), brown spot (*Septoria glycines*), downy mildew (*Peronospora manshurica*), and powdery mildew (*Microsphaera diffusa*) were noted in field plots at Ottawa and growers' fields (76 ha) near Winchester, Ontario. Implications of the potential importance of these diseases are discussed.

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On a constaté la présence de quatre maladies foliaires du soja (*Glycine max*), soit la brûlure bactérienne (*Pseudomonas glycinea*) la tache brune (*Septoria glycines*), le mildiou (*Peronospora manshurica*) et le blanc (*Microsphaera diffusa*) dans certaines parcelles d'essai à Ottawa et champs de producteurs (76 ha) près de Winchester (Ontario). Les implications de l'importance de ces maladies sont discutées.

Introduction

At the Ottawa Research Station a breeding program is underway to develop soybean [*Glycine max* L. (Merril)] cultivars adapted to short-season areas such as eastern Ontario where the crop is gradually expanding. Since knowledge about diseases of soybeans in this area is meagre (4), a survey of the breeding plots at Ottawa and of several growers' fields in the Winchester, Ontario area was carried out in 1979. The results are reported here.

Methods

Each experimental plot consisted of four 5 m rows, 25 cm apart. Five plants, equally spaced from each other, were selected from the two middle rows. Growers' fields were sampled by following a W-pattern or a diagonal path (2). A sample of 50 plants was obtained from each field by collecting five plants from each of 10 sites on the sampling path. Plants in each sample were examined for foliage disease symptoms (1, 6, 7) and for presence of pathogens by using appropriate culture methods (3). The percentage of plants affected by each disease was determined and an estimate of disease severity on individual plants was made using a soybean leaf diagram indicating percent necrotic area (unpublished).

Results and discussion

In the regional soybean trial at Ottawa, plots containing 20 cultivars and lines were affected by two diseases, bacterial blight (*Pseudomonas glycinea* Coerper) and powdery mildew (*Microsphaera diffusa* Cke. Pk.). Bacterial blight was present at a low level (avg. <0.1%) necrotic area on leaves) in all plots throughout the growing season (May to September) while powdery mildew developed on only a few plants late in the season (August 31).

In the Winchester area, surveyed in early September, three foliage diseases: bacterial blight, brown spot (*Septoria glycines* Hemmi, Trans. Sapporo) and downy mildew [*Peronospora manshurica* (Naoum) Syd. ex Gaum] were found in seven soybean fields (76 ha). In two 20-ha fields of cv. Maple Arrow, 44% and 14% of the plants were affected by bacterial blight and downy mildew, respectively, (with an avg. 0.1% necrotic area on leaves). In two 10-ha fields of cv. Evans brown spot was present on all plants; and about 2% to 5% of the leaf area per plant was necrotic. A few bacterial blight lesions were detected also on some of these plants, but the predominance of brown spot made it too difficult to rate for bacterial blight. It was noted that none of the fields of Maple Arrow was as severely affected by brown spot as those of cv. Evans. The cause for such a difference in disease incidence remains to be determined since cultivar reactions to different diseases are not fully known.

The results of this survey suggest that diseases like bacterial blight and brown spot could become epiphytotic and be a potential threat to soybean production in eastern Ontario, if favorable conditions, such as cool, wet weather with frequent rain storms occur during the growing season, as reported in other studies (5, 6, 7). The sporadic occurrence of downy and powdery mildews does not appear to be a serious problem at the present time; however, reactions of more than one or two diseases on soybean cultivars warrant further investigation in order to develop suitable resistant lines or other control measures.

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Chemical control of snow mold in bentgrass turf in southern Ontario

S. G. Fushtey[1]

Field trials were conducted on bentgrass greens over a period of 2 years to study the efficacy of fungicides in controlling snow mold. The pathogens encountered in the snow mold complex were *Fusarium nivale* and 3 species of *Typhula: T. incarnata, T. ishikariensis* var. *canadensis* and *T. ishikariensis* var. *ishikariensis*. Trials were carried out at 8 different sites in 1977-78 and at 3 sites in 1978-79. Fungicides did not perform equally well at all sites. The variability is being attributed to the difference in disease incidence at the different sites. With low to moderate disease (less than 65% damage) all fungicides tested gave satisfactory control when used according to supplier's directions. Under conditions of severe disease (more than 75% damage) some of the fungicides failed to control the disease. Fungicides containing mercury provided the most reliable overall control at all sites. The other broad spectrum fungicides (chlorothalonil, quintozene and iprodione) gave satisfactory control when used at high dosage rates. The fungicides containing benomyl, chloroneb, carbathiins and thiram did not control the disease under severe disease conditions. Of the experimental fungicides, Baymeb 6447 gave promising results. One season's results with DPX 4424 are inconclusive.

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Pendant deux ans, on a effectué des essais sur des verts de golf constitués d'agrostide pour étudier l'efficacité de certains fongicides contre la moisissure des neiges. Les champignons rencontrés dans le complexe de la moisissure ont été *Fusarium nivale* et 3 espèces de *Typhula (T. incarnata, T. ishikariensis* var. *canadensis* et *T. ishikariensis* var. *ishikariensis*). Les essais ont porté sur 8 emplacements en 1977-1978 et sur 3 en 1978-1979. Les fongicides n'ont pas donné les mêmes résultats à tous les emplacements. Cette variabilité est due à la différence de la fréquence d'apparition de la maladie aux divers emplacements. Lors d'une fréquence faible ou modérée (moins de 65% de dégâts), tous les fongicides à l'étude ont donné des résultats satisfaisants lorsqu'ils étaient utilisés conformément au mode d'emploi. Dans les conditions de fréquence élevée (plus de 75% de dégâts), certains fongicides n'ont pu combattre la maladie. Ceux contenant du mercure se sont globalement révélés les plus efficaces à tous les emplacements. Les autres fongicides à large spectre d'activité (chlorothalonil, quintozène et iprodione) ont donné des résultats satisfaisants lorsqu'ils étaient utilisés à fortes doses. Les fongicides contenant du bénomyl, du chloronèbe, des carbathiines et du thirame ne se sont pas révélés efficaces dans les cas de maladie grave. Parmi les fongicides expérimentaux, le Baymeb 6447 s'est révélé prometteur. Les résultats du DPX 4424 portant une seule saison sont peu concluants.

Introduction

Snow mold, caused largely by *Fusarium nivale* (Fr.) Ces. and *Typhula* spp., is an important disease of turfgrass in most parts of Canada and other temperate regions of the world which experience appreciable snow cover during the winter. The disease is most destructive in fine turfgrasses such as *Agrostis palustris* L. (*A. stolonifera* var.) (creeping bentgrass) which is the principal species used in highly managed, fine turfgrass areas such as golf and bowling greens. Although proper cultural practices help reduce severity of damage, snow mold cannot be satisfactorily controlled in these fine turfgrasses without the use of fungicides.

Ever since Monteith (1927) demonstrated effective reduction of fusarium snow mold with corrosive sublimate (mercuric chloride) mercurials have occupied an important place in turfgrass disease control. According to Meiners (1955) the standard treatment for control of snow mold was the application of mercury chlorides (Calomel - corrosive sublimate) in the late fall before snow cover. He also reported that phenylmercury fungicides were superior to the then recommended inorganic mercury fungicides and that Cadminate (60 percent cadmium succinate) showed promise, but other fungicides tested such as Spergon† (chloranil), Tersan† (thiram) and Orthocide† (captan) were ineffective. Lebeau et al. (1961), found that from a list of some 12 fungicides tested, only the inorganic mercuries gave satisfactory control. Cadminate and phenylmercury preparations, also actidione and Dyrene had little effect. Fushtey (1961) obtained good control with both organic and inorganic mercuries and some control with actidione-thiram but dismissed the latter as not likely useful because there was evidence of phytotoxicity at the high dosages required. Fushtey (1975) reported that non-mercurials such as Daconil† (chlorothalonil) and Tersan SP† (chloroneb) were comparable to mercuries in effectiveness on a site where *Typhula* was predominant but less effective on another site where *Fusarium* was the dominant pathogen. On the other hand, Tersan 1991† (benomyl) gave good control of fusarium snow mold but had no effect on incidence of snow mold caused by *Typhula*. He also reported that significantly better disease control was obtained with treatments

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applied on November 5 than those applied on October 11, and supported the view that fungicides for snow mold control should be applied as late in the season as possible, probably not before November 1 in southern Ontario.

Despite extensive testing by industry, university and government researchers prior to registration of a pesticide, reports of unsatisfactory control of snow mold by registered fungicides are rather common. One of the objectives of the present study was to find some reasons for this inconsistency. Secondly, due to pressures to further restrict or ban the use of mercurials, information was needed to determine whether mercurials can be satisfactorily replaced by non-mercurials which are presumably less environmentally hazardous.

A complementary objective was to establish, more specifically, the identity of the fungi involved in the snow mold complex in this part of Ontario. Smith (1973) reported that, in Saskatchewan, snow mold is caused by *Fusarium nivale, Sclerotinia borealis,* Bubak & Vleugel, *Typhula* spp. and two unidentified low-temperature basidiomycetes designated as (LTB) and (SLTB) either singly or in combination with one or more of the other fungi. In Ontario, *Fusarium nivale* and *Typhula* sp. are known to be involved in this disease complex (Fushtey, unpublished) but the identity of the *Typhula* species had not been determined nor have studies been made to determine whether fungi other than *F. nivale* and *Typhula* sp. are involved.

To achieve these objectives a series of trials was conducted during 1977-78-79 on a number of sites which, on the basis of prior observations, represented a range of pathogen combinations, from pure *Typhula* to a mixture of *Typhula* and *Fusarium* to predominantly *Fusarium* as the causal organisms.

Materials and methods

The 1977-78 tests were conducted on golf practise greens or nursery sod areas at 8 different sites as described in Table 1.

Fungicides were applied to test plots 1.23 x 3.74 m (4 x 12.5 ft) replicated 4 times. Wettable powders were applied with a hand sprayer using a T-jet nozzle and 0.6 l water per plot (3 gal/1000 ft^2). Granular formulations were applied with a Scott's 75 drop-type spreader. The fungicides used are listed and described in Table 2.

Disease ratings were made soon after the snow melted (April 6-25, as given in Table 1). A visual estimate was made of the percentage of turf affected by the disease in each plot according to the Barratt-Horsfall grading system (3) and the scores for the 4 replicates for each treatment were then converted to percent disease using conversion tables of Redman, King and Brown (7).

A similar procedure was followed in 1978-79 using 3 sites, two of which were the same as in the previous year, namely sites 2 and 8. The third was a bowling green in Lawrence Park (Toronto) with a record of fusarium snow mold incidence.

At the time disease readings were made in 1978 a visual diagnosis of the fungi was made on the basis of signs and symptoms. Suspected *Typhula* was confirmed by close examination for the presence of sclerotia which were collected and samples sent away for identification to species. Suspected *Fusarium* was subjected to microscopic examination which usually revealed the presence of typical spore masses or the fungus *Fusarium nivale* was isolated into pure culture on PDA medium.

Results and discussion

The summarized disease results for 5 of the 8 sites in 1977-78 are given in Table 3. The results for the remaining 3 sites are not given because circumstances at these sites did not permit satisfactory assessment of disease control. At one site disease level was too low (less than 3 percent) to observe any differences among treatments. At the other 2 sites severe damage due to desiccation made it impossible to estimate the damage due to snow mold.

Under conditions of low disease intensity, as was experienced at sites 4 and 5, nearly all the fungicidal

Table 1. Site details 1977-78 Trial.

Site No.	Location of trial	Date of treatment	Date of snow mold readings	Kind of snow mold*
1.	Barrie G.C. (Barrie)	Oct. 31	Apr. 25	*Typhula* only
2.	Puslinch Lake G.C. (Cambridge)	Oct. 27	Apr. 14	*Typhula* only
3.	Elmira G.C. (Elmira)	Oct. 27	Apr. 17	*Typhula* only
4.	Board of Trade (Woodbridge)	Nov. 1	Apr. 6	*Fusarium* + *Typhula*
5.	St. George's G.C. (Etobicoke)	Nov. 3	Apr. 5	Mostly *Fusarium*
6.	Cambridge Research Station	Nov. 4	Apr. 13	Mostly *Typhula*
7.	Galt G.C. (Cambridge)	Nov. 8	Apr. 14	Mostly *Typhula*
8.	Cutten G.C. (Guelph)	Nov. 10	Apr. 18	*Fusarium* + *Typhula*

**Fusarium* + *Typhula* = Both in roughly equal amounts with Fusarium somewhat more abundant.
Mostly *Fusarium* = Predominantly *Fusarium* with some *Typhula* present.

Table 2. Fungicides used in snow mold trials.

Produce Name	Active ingredient and formulation	Source
1. Tersan 1991	benomyl 50 WP	Dupont
2. Tersan SP	chloroneb 65 WP	Dupont
3. Arrest	thiram 50 + carbathiin 20 + oxycarbathiin 5 WP	Uniroyal
4. Quintozene	quintozene (PCNB) 75 WP	Plant Products
5. Rovral	iprodione 50 WP	May & Baker
6. Caloclor	mercurous chloride 50 mercuric chloride 30 WP	Mallinckrodt
7. Bravo	chlorothalonil 54 flowable	Diamond Shamrock
8. Baymeb 6447	experimental 50 WP	Chemagro
9. Proturf Broad Spectrum	PMA 0.69 + thiram 4.65 gran.	Scotts
10. Proturf F II	chloroneb 6.25 gran.	Scotts
11. Lawn Disease Control	quintozene (PCNB) 16.9 gran.	Scotts
12.* DPX 4424	experimental 50 WP	DuPont
13.* Mersil	mercurous chloride 28 mercuric chloride 14 WP	May & Baker

*used in 1978-1979 only.

treatments yielded an acceptable degree of control (a recorded rating of less than 3 percent represents a situation where 1 or more of the 4 replications were disease free). The two instances where disease exceeded the 3 percent level occurred at site 4 where snow mold was caused by both *Fusarium* and *Typhula*. The lack of better control in these instances can be explained on the basis that: (1) Tersan 1991† (benomyl) does not control *Typhula*. (2) In treatment 18, Proturf FII† (chloroneb) was applied at the single dosage rate which is that prescribed for control of summer disease. In treatment 17, where the recommended double dosage was used adequate control was achieved.

Under conditions of severe disease, as in sites 1, 2 and 8, the degree of control was highly variable. At site 1, where snow mold was due to an extremely heavy infestation of pure *Typhula*, only those fungicides containing mercury (Caloclor and Proturf Broad Spectrum†) and chlorothalonil (Bravo† at the high dosage) gave satisfactory control. Quintozene at the higher dosage gave substantial but inadequate control. In one plot (not evident from the tabulated results) where the two dosage portions (180 g + 270 g) were applied to the same plot in error, total control was achieved. At site 2, where damage was also due to *Typhula* alone but not quite as severe an infestation, the results were quite different. All but 2 of the treatments gave satisfactory control. Treatment 2 (benomyl) was ineffective but this was expected because benomyl is known to be ineffective against *Typhula*. Treatment 12 (iprodione) was ineffective but treatment 13 (iprodione at twice the dosage of 12) gave satisfactory control. The results at site 8 were somewhat similar to those at site 1 although the heavy snow mold at site 8 was caused by both *Typhula* and *Fusarium*, with *Fusarium* possibly predominating, as compared to pure *Typhula* at site 1. Satisfactory control was obtained with quintozene and fungicides containing mercury at both sites. Bravo† (chlorothalonil) which gave good control at site 1 did not give satisfactory control at site 8. On the other hand, the experimental fungicide Baymeb 6447† which gave no measurable control at site 1 gave promising control at site 8.

In the 1978-79 trials no snow mold developed on 2 of the 3 sites used. This was unexpected because one of these (site 8) was virtually devastated by a *Fusarium-Typhula* complex the previous year. The results from the third site (site 2, in the previous year) are given in Table 4. No attempt was made to analyze these results statistically because of the uneven distribution of

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disease. The disease was concentrated within about one-third of the plot area which corresponded roughly to that part under heavy snow cover in the winter.

According to the results in Table 4, good control of snow mold was achieved with Tersan SP†, Quintozene, Arrest†, Mersil† and Rovral† at the higher dosage. Of the experimental fungicides used, Baymeb 6447† gave excellent control but DPX 4424 was inadequate at the dosage used.

Concerning the identity of the *Typhula* species encountered, the sclerotia collected from the various sites were identified as follows:-

site 1 - *Typhula ishikariensis* var. *canadensis*.

site 2 - *T. ishikariensis* var. *ishikariensis*

sites 3, 4, 5 & 7 - (no sclerotia collected).

site 6 - *Typhula incarnata*.

site 8 - *T. ishikariensis* var. *canadensis*.

Table 3. Effect of fungicides on percent snow mold. April, 1978.

	Treatment	Dosage (product)		Mean percent snow mold (4 reps)				
		oz per 1000 ft^2	g per 100 m^2	Site 1	Site 2	Site 4	Site 5	Site 8[a]
1.	Check (no treatment)	-	-	95 d	65 d	7.0 c	6.4 b	85 c
2.	Tersan 1991	4	120	84 d	71 d	3.5 c	1.8 a	65 c
3.	Tersan SP	8	240	92 d	4 b	1.2 b	0.0 a	38 ab
4.	Tersan 1991 + SP	3+6	90+180	91 d	4 b	1.2 b	0.0 a	68 c
5.	Arrest	8	240	93 d	6 c	2.3 b	1.2 a	57 bc
6.	Arrest	12	360	93 d	3 b	1.2 b	0.6 a	65 c
7.	Quintozene	6	180	35 b	6 b	0.6 ab	1.2 a	3 a
8.	Quintozene	9	270	18 ab	3 b	*0.0 a	*1.2 a	2 a
9.	Bravo	8	240	31 b	-	1.8 b	0.6 a	64 c
10.	Bravo	12	360	4 a	-	1.2 b	0.6 a	25 ab
11.	Caloclor	3	90	0 a	1 a	*0.0 a	*0.0 a	4 a
12.	Rovral	2	60	52 c	48 d	1.2 b	1.8 a	38 ab
13.	Rovral	4	120	80 d	7 c	0.6 ab	0.6 a	55 bc
14.	Baymeb 6447	4	120	70 c	1 a	0.0 a	0.0 a	8 a
15.	Lawn Disease Control	(2X)		17 ab	1 a	*0.0 a	*0.0 a	4 a
16.	Proturf Broad Spectrum	(2X)		5 a	3 b	0.0 a	1.2 a	2 a
17.	Proturf FII	(2X)		93 d	1 a	0.6 ab	0.0 a	35 ab
18.	Proturf FII	(1X)		92 d	-	3.5 c	-	-
19.	Lawn Disease Control	(1X)		16 ab	-	0.6 ab	-	-

[a]Based on 3 reps with some missing values due to severe dessication damage.
*Turfgrass somewhat discolored in comparison to other plots, indicating slight phytotoxicity.
-No test.
Values followed by the same letter are not significantly different according to Duncan's Multiple Range Test at the 5% level

Table 4. Effect of fungicides on percent snow mold. Puslinch Lake G.C. March 20, 1979.

Treatment	Dosage (product)		Percent snow mold			
	oz per 1000 ft^2	g per 100 m^2	Rep 1	Rep 2	Rep 3	Rep 4
Tersan SP	8	240	2*	0	0	0
Tersan SP + 1991	8+4	240+120	2*	0	0	0
Quintozene	8	240	2*	0	0	0
Quintozene	12	360	0*	0	0	0
Arrest	8	240	5	5	5*	0
Arrest	12	360	0	0	5*	0
Check (no treat)	-	-	5	5	60*	95*
Rovral	4	120	0	20*	0	2
Rovral	8	240	0	2*	0	0*
DPX-4424	4	120	0	10*	0	10*
Bay-6447	4	120	0	0*	0	0*
Mersil	4	120	0	0	0	5*

*Plots located within heavy snow mold area, corresponding to heavy snow cover.

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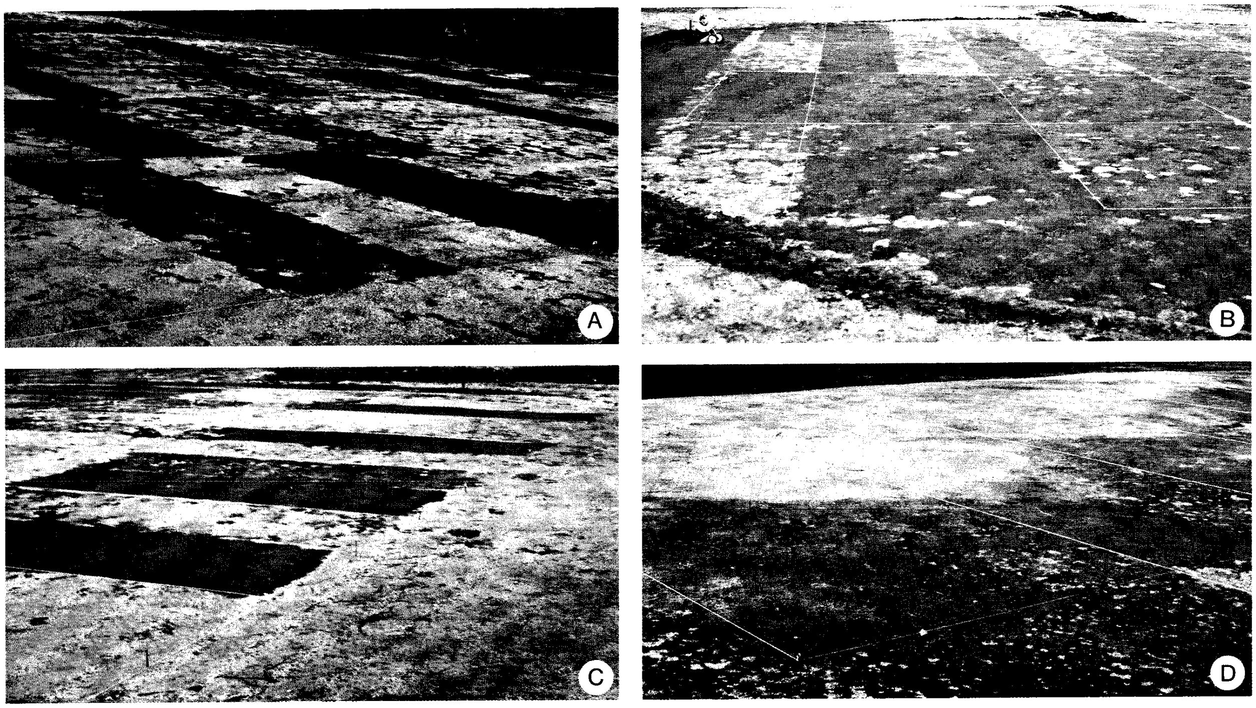

Figure 1 (A to D). Snow mold test plots. April, 1978. (A), Site 1. Severe Typhula blight; an estimated 95% damage in untreated plots and varying degrees of control. Caloclor was the only fungicide that gave satisfactory control at normal dosage. (B), Site 2. Less severe infestation of Typhula blight; an estimated 65% in untreated plots. Satisfactory control was achieved with a number of fungicides including mercurials. (C), Site 8. Severe snow mold caused by a complex of *Typhula* sp. and *Fusarium nivale*. Only the mercurials and quintozene gave satisfactory control. (D), Site 8 at the lower end of the experimental green which was blown free of snow most of the winter. Damage due to snow mold was slight but severe damage occurred due to desiccation. Note the patches of snow mold in the lower left corner: typical bleached patches caused by *Typhula* sp., light reddish-brown patches due to *Fusarium nivale.*

Although experimental areas were carefully examined for presence of the other fungi reported to cause snow mold in Western Canada none other than *Typhula* spp. and *F. nivale* were encountered.

Observations made during the course of this study confirm those made in previous years that snow mold in the southern part of Ontario is a complex disease caused by at least two fungi, *Fusarium nivale* and *Typhula* sp. and that efficacy of fungicides varies with the kind of fungus and intensity of disease pressure. Smith (1976) made a similar observation when he stated that in evaluating the effectiveness of fungicides against snow molds in tests on golf greens under playing conditions the main difficulty is related to the occurrence of complexes of pathogens and that the balance of these pathogens shifts from year to year under influence of climatic factors. This kind of behavior was particularly evident at site 8 which was under observation for a number of years prior to the present study. When first examined (about 8 years ago) *Fusarium nivale* was by far the dominant pathogen, with *Typhula* occurring as occasional spots on some greens. At the time of the 1977-78 trial *Typhula* was the dominant pathogen on the playing greens but a roughly equal proportion of both pathogens, in great abundance, was present on the test practise green. In 1978-79, although there was abundant snow cover there was no snow mold on this test green, but the green was severely damaged by what was diagnosed as hydration injury.

There was considerable difference in fungicide efficacy at some sites and this was apparently not due to difference in kind of pathogen present but rather due to difference in disease severity. The most striking difference in efficacy was between sites 1 and 2 where the snow mold was due to *Typhula* sp. only (no *Fusarium*) at both sites. Identification of the fungi to species did reveal a difference in variety of pathogen: *T. ishikariensis* var. *canadensis* vs. *T. ishikariensis* var. *ishikariensis*, but it is not likely, although not impossible, that this small difference could result in such marked differences in fungicidal efficacy. However, difference in severity of disease between those two sites was substantial and probably sufficient to affect fungicidal efficacy.

Assessment of efficacy must be based on control to a practical level; a level where damage is negligible. With fine turfgrass this needs to be somewhat less than 5% damage. With 7% disease (site 4) this is achieved with less than 50% control; with 65% disease (site 2) about 90% control is required; and with 95% disease (site 1) more than 95% control is needed. Thus, a much higher degree of control is necessary under conditions of high disease incidence than when disease is moderate to low. How this operates in practise is illustrated by the performance of Bravo† (chlorothalonil) as given in Table 3. Satisfactory control was achieved at the low dosage rate (240 g) at sites 4 and 5 where disease incidence was low, but no practical control at sites 1 and 8 where disease incidence was exceptionally high. However, at the higher dosage (360 g) satisfactory control was achieved at site 1 and a significant degree of control, although inadequate at site 8. Increased dosage increased efficacy under high disease pressure. Thus, disease pressure is probably the main factor responsible for the difference in fungicidal performance among the different sites in this study, and higher disease pressure requires higher fungicide dosage if satisfactory control is to be achieved.

Acknowledgements

Thanks are extended to the course superintendents and management of the seven golf clubs listed in Table 1 for their cooperation in providing suitable turfgrass areas for this study. Thanks are also due to J. Drew Smith for identifying the collection of *Typhula* sclerotia to species. Financial assistance in the form of a research grant from the Pesticide Advisory Committee of the Ontario Ministry of the Environment is also gratefully acknowledged.

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Incidence of Phytophthora root-rot of soybeans in Essex County, Ontario in 1979[1]

T.R. Anderson[2]

Thirty-six soybean fields in Essex County, Ontario were surveyed in 1979 to determine the incidence of root-rot caused by *Phytophthora megasperma* var. *sojae* Hildeb. (*Pms*). The average incidence of dead plants varied from 0-1.7% in fields and from 0-4.4% in headlands. Races 3, 4, 5, 7 and 9 composed 23, 2, 4, 50 and 21% respectively of the *Pms* isolates obtained during the survey. Races 1, 2, 6 and 8 were not isolated.

Can. Plant Dis. Surv. 60:2,3, 33-34, 1980.

Nous avons examiné 36 champs de soja dans le comté d'Essex (Ontario), en 1979, afin d'y déterminer le taux d'infestation par le mildiou du pied *Phytophthora megasperma* var. *sojae* Hildeb. La mortalité moyenne variait de 0 à 1,7 % dans le milieu des champs et de 0 à 4,4 % dans les tournières. Les races 3, 4, 5, 7 et 9 constituaient respectivement 23, 2, 4, 50 et 21 % des prélèvements du pathogène. Les races 1, 2, 6 et 8 étaient absentes.

Introduction

Root-rot of soybean caused by *Phytophthora megasperma* var. *sojae* Hildeb. (*Pms*) has been an endemic disease in southwestern Ontario since 1954 (4). The prevalence of the disease was restricted from 1965 to 1973 by cultivation of soybean cultivars resistant to *Pms* race 1. Since 1973, several new races of the pathogen have been identified which attack these cultivars (3). The presence of these races has prompted the development of tolerant soybean cultivars which exhibit low plant losses in the presence of *Pms* under conditions favourable to disease development. At present, such tolerant cultivars constitute the majority of soybeans grown in Ontario, particularly in Essex County. During the summer of 1979 a survey of soybean fields was conducted to estimate the effectiveness of tolerant cultivars in reducing the incidence of root-rot. Isolates of *Pms* obtained during the survey were identified to determine if race composition has changed since the last survey conducted during the years 1973-76 (1).

Materials and methods

Thirty-six sites on clay or clay-loam soil were chosen at random. An attempt was made to obtain equal numbers of fields with soybeans considered tolerant (T) moderately tolerant (MT) and moderately susceptible (MS) to *Pms* root-rot. Tolerance rating was based on relative plant losses in the tolerance test area at Woodslee, Ontario. Each field was surveyed in early July and again in early August. In each field, counts were made of the number of dead plants per 200 m of row in 20 rows either 5 or 10 rows apart. In addition, dead plants were counted in 4 headland rows in each field. Length of headland rows surveyed varied from 50 m to 75 m. Growers at each survey site were asked to complete a questionnaire concerning cultural practices.

Isolates of *Pms* were obtained from dying plants at each site or from infected soybean plants (cv. Harosoy) grown in potted soil collected from each survey field. Isolations were made from plant tissue by plating segments of surface sterilized stems on Difco corn meal agar (CMA) amended with 100 μg/ml pimaricin (1). Race determinations were made by inoculating 8 differential varieties: Harosoy, Sanga, Harosoy 63, Mack, Altona, PI 103.091, PI 171.442 and Tracy (5). Isolates of *Pms* were cultured 10-14 days on 1.0% CMA at 25 C prior to inoculating 10 plants of each differential. Inoculum was loaded into 10 cc syringes and expelled through a 1 mm hole in the tip of the plastic guard of each syringe over slits made in the upper hypocotyl of test plants. Inoculated plants were covered with plastic bags for 24 h. Plants were maintained at 20-25 C and classified as susceptible (dead) or resistant (no infection) 5-6 days after inoculation.

Results and discussion

The majority of soybean fields were found to be planted with tolerant varieties. As a result, the cultivars Harcor, Dawn, Premier and Hodgson (T) composed 24 of 36 sites surveyed. Six fields were planted with Amsoy 71 and Wells (MT) and only one field was planted with Harosoy 63 (MS).

The average planting date of the fields surveyed was May 19, the earliest on May 12 and the latest on June 20. The average row width was 59 cm. Five of the fields were broadcast seeded. Fertilizer, generally in the form of 8-32-16 ($N:P_2O_5:K_2O$) was applied in 15 fields at an average rate of 160 kg/ha. All fields except two were

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fall-ploughed and spring-disked and all fields except two were tile-drained with an average tile spacing of 11.4 m. The soil type of most fields was Brookston clay loam. The average seeding rate was 84 kg/ha; minimum and maximum seeding rates were 56 and 112 kg/ha respectively.

The average incidence of plants killed by *Pms* root-rot was found to be low (Table 1). Variation in the incidence of root-rot was noted among sample fields, regardless of cultivar tolerance rating, fertilizer application, crop rotations or other cultural practices. In general, a decrease was observed in the percentage of dead plants/ha between the July and August surveys. This suggests that plants killed early in the growing season were not detected by survey personnel after the crop canopy had closed. Percentage of dead plants in headlands was higher than in fields regardless of survey date but differences were not significant. The incidence of root-rot varied from 0-1.7% in fields and from 0-4.4% in headlands.

Table 1. Incidence of Phytophthora root-rot of soybeans in Essex county in 1979

Number of fields sampled	% dead plants/ha*			
	July		August	
	Field	Headland	Field	Headland
36	0.2	0.5	0.07	0.2

*Based on an estimated average plant stand of 300,000 plants/ha.

Application of fertilizer appeared to favour development of root-rot. For example, the average number of dead Harcor plants in twelve unfertilized fields and seven fertilized fields was 341 and 1011 plants/ha respectively. In headlands of the same fields the average numbers of dead plants per hectare were 436 and 1941 respectively. However, differences were not significant when compared by t-test analysis. An increase in root-rot caused by *Pms* following applications of urea and ammonium nitrate was reported recently (2).

Average plant losses were less in T and MT cultivars than in the MS cultivar surveyed at one location; however, the low incidence of root-rot in all cultivars and unequal sample number prevented an accurate assessment of the effectiveness of tolerant cultivars in reducing root-rot under field conditions. In general, the disease was not economically significant in Essex county in 1979. Economic losses may have occurred in some fields in which dead plants were found in localized areas but such areas were not observed in the present survey.

Table 2. Composition of *Pms* races isolated in Essex county in 1973-76 and 1979

Year	Number of isolates	Race (% of isolates)								
		1	2	3	4	5	6	7	8	9
1973-76*	45	0	0	11	7	2		80**		
1979	52	0	0	23	2	4	0	50	0	21

* Buzzell, R. I. *et al* (1).
**Total of races 6-9.

The composition of *Pms* races in Essex county changed only slightly during the past three years (Table 2). Twenty-three percent of 52 isolates characterized in the 1979 survey were race 3 compared to 11% during the period 1973-76 (1). The percentage composition of races 4, 5 and 6-9 was similar to that found in the earlier survey. In the present survey, races 6, 7, 8 and 9 composed 0, 50, 0 and 21% of the total number of the 52 isolates. The frequency of these races in Essex county was not determined previously.

Acknowledgments
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