Observations on the 1976 barley yellow dwarf epidemic in eastern Canada[1]

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The 1976 barley yellow dwarf [barley yellow dwarf virus] epidemic was one of the most important in eastern Canada in the last 20 years. Primary infection was severe in oats near Fredericton, N.B., and at Sherbrooke, St-Hyacinthe, and Disraeli in Quebec. Secondary infection covered most of eastern Canada. Yield losses of 50% to 70% were reported in many areas. Oats, barley, and spring-sown wheat were affected. Ripening was accelerated about 1 week by the disease. Grain quality was affected in many ways: the thousand kernel weight and the hectoliter weight decreased, the percent hull increased, and fungal diseases to which virus-infected plants seemed especially predisposed darkened the grain color and may have contributed to lower germination.

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L'épidémie de BYDV (virus du nanisme jaune de l'orge) de 1976 a été l'une des plus importantes a survenir au cours des 20 dernières annees. Les sites majeurs d'infection primaire Btaient Fredericton, N.B., et Sherbrooke, St-Hyacinthe, Disraeli au Quebec. L'infection secondaire s'etendait au-delà des limites de l'Est du Canada. Des pertes de rendement de 50 a 70% ont été observées dans plusieurs régions. L'avoine, l'orge et le blé etaient affectés. La maturation des plantes a été accélérée d'environ une semaine par la maladie. La qualité du grain a été affectee de plusieurs façons: le poids de 1000 grains et le poids a l'hectolitre ont été diminués, le pourcentage d'écales augmenté, et les maladies fongiques auxquelles les plants atteints de virus semblaient particulierement prédisposés ont noirci le grain et ont probablement contribue a une baisse du taux de germination.

Barley yellow dwarf virus (BYDV) affects cereal crops in eastern Canada annually but the level of damage has not been assessed on a routine basis. In Quebec barley yellow dwarf was widespread in 1968 and 1971, and in 1976 it developed in most fields and caused serious losses.

Observations in farmers' fields

In late June and early July we observed a remarkably low level of predators (Coccinellidae, Syrphidae) and parasites in cereal fields, a fact which may indirectly be related to the BYD epidemic. During July, reports of high aphid populations came from many areas of Quebec, and aerial sprays were applied in the St-Hyacinthe area. On July 22, a trip through the Maritimes revealed an important area of primary infection extending about 100 miles east and west of Fredericton, N.B. Primary infection is easily recognized as it creates circular spots (0.5 to 3 m diameter) of dwarfed, discolored plants in oat fields.

In Quebec extensive areas of primary infection were observed on Aug. 4 in oats near the flowering stage in the St-Hyacinthe, Sherbrooke, and Disraeli areas (Fig. 1). In late-seeded oat fields visual estimates of loss averaged about 70% and were somewhat less in early-seeded fields. Secondary infection is not as striking because it does not create spots where yield is reduced to nothing, and because symptom expression is not always distinctive. However noteworthy levels of secondary infection were found in nearly all fields inspected in the province of Quebec and in most fields inspected in the Maritime provinces except for areas near Charlottetown, P.E.I., and Truro, N.S. The problem with assessing secondary infection is that damage is difficult to quantify by available methods. However we feel that losses in the areas visited must have been very impor-

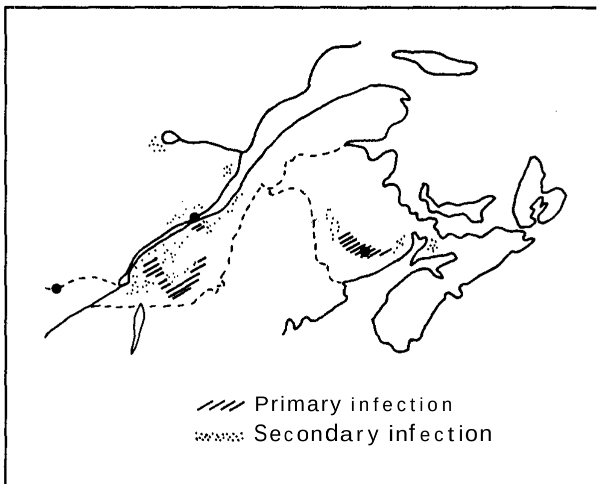

Figure 1. Observed distribution of primary infection (dark shaded) and secondary infection (light shaded) by BYDV in eastern Canada in 1976.

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tant because losses in experimental fields were well above visual estimates, as will be discussed below. Late-sown fields were more visibly damaged by primary and secondary infection.

Aphid vectors appeared to be mostly ***Rhopalosiphum padi,*** although ***R. maidis*** and ***Macrosiphum avenae*** were also easy to find in the Quebec City area. Wheat had the highest observed aphid populations, oats being intermediate, and barley the lowest at the time we made our observations. The highest aphid numbers were found in wheat fields that had received more nitrogen fertilizer than average, supporting Coon's (5) idea that nitrogen may promote aphid reproduction. Aphid numbers appeared to peak during the elongation growth phase, as noted in New Brunswick (1).

After harvest, grain color, germination, and bushel weight were regarded as worse than average by farmers. However, in many fields in Quebec and New Brunswick overall yields seemed near normal, indicating that other factors, such as timely rainfall, may have compensated for losses in yield from BYD.

Observations in cereal trials

Various yield trials in breeding and evaluation projects were examined for the effects of the natural epidemic of BYD on yield, disease symptoms, and grain quality. Notes were taken to establish the relationship between yield losses and disease symptoms. At La Pocatiere, primary infection was rare, but 60% of single plants seeded on May 25 had more than 50% yield loss from secondary infection. In other trials some secondary infection was present but we could not evaluate the yield loss. It is commonly found that thin stands or single-plant nurseries suffer heavier damage than plots seeded at the regular seeding rate (10).

At Fredericton, wheat, barley, and oats were all heavily infected in evaluation trials. Oats had losses reaching as high as 98% in certain lines. In the Fredericton Co-op Oat Test the average yield of the check varieties Dorval, Garry, Scott, and Stormont for the 3-year period 1973-1975 was 2845 kg/ha. In 1976, under BYDV infection, these four varieties produced on average 776 kg/ha, that is, 73% less than in the previous years. From 1976 data, we could also pinpoint BYDV-tolerant lines in the Fredericton tests that yielded 2387 kg/ha (Q.O. 158.37 in the Oat Screening Test) and 2007 kg/ha (0.A.338 in the Co-op Oat Test) indicating that BYD and not weather conditions was largely responsible for the 73% loss in the four check varieties. If we consider the fact that Q.0.158.37 and 0.A.338 are not fully resistant and did suffer damage, we can assume that losses from BYD damage in the Fredericton trials were indeed at least 70%.

Symptoms in oats were quite obvious at Fredericton as they resulted from primary infection. However, in barley and wheat the symptoms were not as distinct, although yield losses must have occurred. Barley and wheat plants often go through a shock phase after acquiring BYDV and develop visible symptoms, but then further growth produces near-normal leaves with no symptoms, hiding the older diseased leaves. This pattern is occasionally noticed in oats also, especially in certain ***Avena sterilis*** lines (Comeau, unpublished). The barley trials were not harvested due to bird damage. In the wheat trials (Maritime-Quebec Co-op) the check varieties Opal and Glenlea yielded 1926 and 1789 kg/ha, or 44% and 30% less respectively than the average of the previous 3 years at Fredericton. Unfortunately there were no varieties with known tolerance to BYDV in these tests to confirm whether or not BYDV alone was responsible for this yield difference. It was noted that Fielder wheat, generally a low yielder in eastern Canada, came out with top yield (2490 kg/ha) under virus infection, probably due to some BYDV tolerance.

In the Laval University trials at St-Louis-de-Pintendre, near Quebec City, there was a slight amount of primary infection, mixed with a lot of secondary infection. Symptoms were nearly invisible in barley and wheat, and were more or less visible in oats depending on seeding date. The fact that there was a virus epidemic in that field could easily have gone unnoticed; in fact, observers unfamiliar with BYD noted only that the crop ripened too fast to allow for proper grain filling, and they attributed the damage to excessive rainfall. However, the extent of BYD damage was revealed in a test including 5 check varieties, 15 susceptible entries, and 20 BYDV-tolerant entries. The checks averaged 155 grams per plot, the susceptible lines 139 grams per plot, and the BYDV-tolerant lines 216 grams per plot. The best check was Alma (181 g/plot) and the top tolerant line Q.O.158.43 (267 g/plot). Once again we must be reminded that Q.O.158.43 did suffer damage which is difficult to quantify. Also, the yield potential of Q.O.158.43 has been rather poor in other areas or in years when BYD was not prevalent. In fact in 1975 for three stations it was 9% below the checks, and in 1976 at La Pocatiere where BYD damage was not heavy, it yielded 13% below the checks. So the 38% difference between tolerant lines and susceptible checks (216 g vs. 155 g) is believed to underestimate the damage.

Germination tests showed that on average susceptible seed germinated 89% and BYDV-tolerant 92%. Gill (6) previously reported a similar difference in germination for BYDV-affected and healthy Herta barley (84% vs. 87%). This slight loss in germination is accompanied by a more important loss in seedling vigor (6) which can reduce subsequent yield. Martens and McDonald (8) divided plants according to their infection level and demonstrated clearly the damaging effect of BYDV on oat germination (84.5% for moderately diseased, 93.8% for healthy, average of two cultivars).

In pre-observation trials at St-Louis de Pintendre some barley lines possessing the Yd, gene for tolerance to BYDV yielded 30% above Laurier, which was the top-yielding susceptible variety.

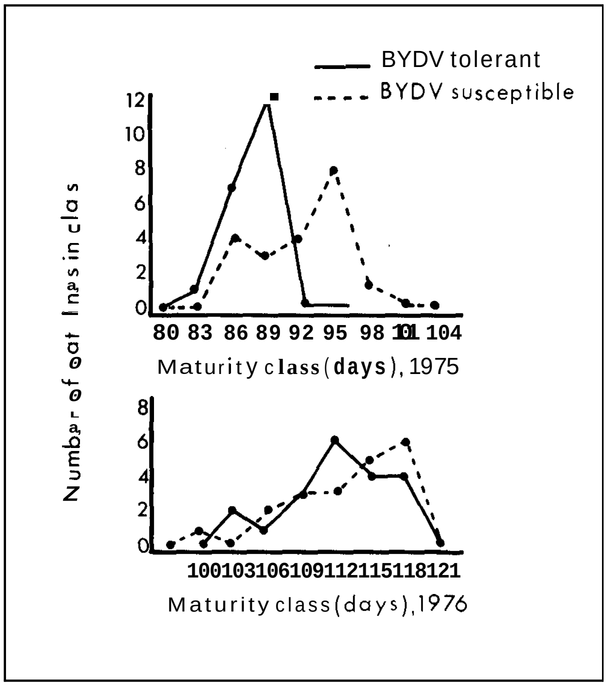

Figure **2.** Maturity range of susceptible and tolerant oat lines in **1975** and **1976,** showing that the maturity of susceptible lines was accelerated by the disease in **1976.**

The widely noted fact that many cereal crops senesced before filling the grain in 1976 may be due mostly to the prevalence of BYDV. This accelerated senescence has been noted before (3,7) and is illustrated in Figure 2; in 1975, the susceptible lines in the Laval University oat trial tended to mature about a week later than the tolerant, but in 1976 both groups were in about the same maturity range because BYD accelerated the senescence of the susceptible group. However this virus effect was not enough to overcome the effect of rainy weather, and the 1976 crop matured late. Premature senescence is damaging because it occurs during grain filling. BYD generally does not alter the heading and flowering dates significantly; only ripening is affected.

Oat plants attacked by BYDV late in the season (secondary infection) may present few or none of the typical symptoms (9), such as reddening of the leaves. In some cultivars, all that will be noted is a whitish tint of the glumes before ripening occurs. Also noted is the predisposition of BYD-affected plants to fungal diseases such as septoria leaf blotch (4). In Fredericton at harvest time the diseased oat plots became black and sooty, apparently from attack by fungi. Grain quality in nearby farmers' fields was below normal, and the grain was dark-colored in many instances.

In the 1976 eastern cooperative oat trials all across eastern Canada there were a few oat lines known for their tolerance to BYDV, especially O.A.236, O.A.240-7, and O.A.338. They ranked respectively 1st, 6th, and 16th (out of 30) for yield (including the Fredericton data, and 1st, 2nd, and 3rd, for hectoliter weight (excluding the hulless oats); we believe that BYDV tolerance has contributed to this performance. It is unfortunate that hectoliter weights were not noted in previous years.

The extent to which the reserve of BYDV in susceptible perennials (timothy, brome, etc.) has increased due to the 1976 epidemic is unknown and deserves investigation. It is logical to expect an increase, but this in itself is not enough to forecast a BYDV epidemic in 1977, as it will depend on the number of aphids flying to disseminate the disease; the level of aphid population within a field also would be expected to influence the amount of damage occurring (2).

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