Epidemiology of barley yellow dwarf virus in Ontario and Quebec in 1982 and 1983 [1]

Y.C. Paliwal [2] and A. Comeau [3]

An epidemic of barley yellow dwarf virus (BYDV) occurred in winter wheat and barley crops in most parts of Ontario and Quebec in 1982-83. Infection of winter wheat averaged 50% but up to 100% BYDV infection was evident in barley fields in south-central Ontario. A vector nonspecific strain of the virus was predominant in winter wheat although levels of a *Rhopalosiphum padi*-specific and a *R. maidis*-specific strains were also significant. The high incidence of BYDV in winter cereals in the autumn appears to have resulted from a large aphid migration in October. In the summer of 1983, there was little evidence of transfer of BYDV from the winter cereals to the spring grains in Ontario. In mid-August BYDV appeared rather suddenly in many areas of Quebec, causing some damage to late-seeded fields.

Can. Plant Dis. Surv. 64:1, 21-23, 1984.

Une épidémie du virus de la jaunisse nanisante de l'orge (VJNO) a atteint le blé d'automne et l'orge d'automne dans la majeure partie du Québec et de l'Ontario en 1982-83. L'infection moyenne du blé d'automne était de 50%, mais une infection de 100% était évidente dans l'orge d'automne de la zone centre-sud de l'Ontario. Une race nonspécifique de virus prédominait chez le blé d'automne, mais avec une présence significative d'isolats spécifiques à *Rhopalosiphum padi* et à *R. maidis*. Le niveau élevé de VJNO chez les céréales d'automne résultait apparemment d'une forte migration de pucerons en octobre. À l'été de 1983, le transfert de VJNO des céréales d'automne aux céréales de printemps a été peu évident en Ontario. Cependant, au milieu d'août, le VJNO apparut assez subitement dans plusieurs régions du Québec, causant des dommages aux champs semés tardivement.

Introduction

After the 1976 epidemic of barley yellow dwarf virus (BYDV) in eastern Canada (4, 7), the disease was present only at low levels in Quebec from 1977 to the summer of 1982. In Ontario, scattered infection reaching 10% occurred in 1979, and local problems developed in the southern part in 1981 and 1982, but no widespread epidemic was observed. However, during the autumn of 1982, the presence of BYDV increased over wide areas of Eastern Canada. The present report deals with observations on an epidemic affecting winter cereals in 1982-83, and an assessment of the transfer of BYDV from winter cereals to spring cereals in 1983.

Observations and Tests

Winter cereals, 1982-83

In Ontario, many warm spells occurred in the fall, and above average temperatures prevailed up to late November. Aphid populations in the maturing spring cereals, wild grasses and the winter wheat were low during the August-October period. A sudden increase in the numbers of aphids on winter wheat due to arrival of wind blown migrant aphids was noted in mid-October to early November. The first BYDV symptoms became visible in winter wheat from November 1 to 15 in different areas. Aphid counts in mid-November ranged from 15 to 150 aphids per meter of row, mostly *Rhopalosiphum padi* L. and some *R. maidis* (Fitch.). Samples of winter cereals were tested for the presence of BYDV and strains of the virus were identified following the procedures reported earlier (6, 7). An average of 50% infection was observed in wheat, and 69% of the field aphids were positive for BYDV. Three vector specific and a vector nonspecific strains of the virus were detected (Table 1).

In Quebec, abundant flights of *R. padi* were encountered between October 5 and 12 in the Quebec city area. The fallout of aphid alates was approximately 50 to 80 aphids per square meter per day for at least 4 consecutive days, according to counts made on five flats of 0.16 m^2 area containing about 60 *Agropyron* plantlets per flat. Eventually the population built up to more than 10 aphids per plant in nearby fields of winter cereals. By November 5, the winter barley plots were showing the severe BYDV symptoms with an estimated 100% infection. BYDV symptoms were common in winter wheat fields also. Triticale cultivar OAC Wintri and all rye lines appeared healthy. One area of 375 m^2 of winter wheat which was sprayed with pirimicarb in September initially looked virus-free but, by November 5, BYDV infected plants were abundant and 1-5 aphids/plant were counted in the field indicating significant BYDV infection despite the use of an aphid-specific insecticide. BYDV symptoms on wheat were also observed at St-Augustin (near Quebec city), La Pocatière, northeast of Quebec city, and at St-Hyacinthe, and all plants were infested with aphids. Three randomly collected wheat plants from La Pocatière were indexed for BYDV and were found to be infected.

The winter of 1982-83 was unusual in having high temperatures in the later half of December, with rain that caused ice accumulation in many fields. The spring was very cold and rainy at first, and these factors combined with BYDV

---

[1] *Contribution No. 1449, Chemistry and Biology Research Institute.*

[2] *Chemistry and Biology Research Institute, Agriculture Canada, Ottawa K1A OC6.*

[3] *Station de recherches, Agriculture Canada, Sainte-Foy, Québec G1V 2J3*

Accepted for publication February 28, 1984

Table 1. Barley yellow dwarf virus in cereals in Eastern Ontario, 1982-1983

Location (County)	Field Sample Type (Plant/Aphid)	No. infected/ No. tested*	Virus strains† identified				
			NS	RPS	RMS	SAS	Total[c]
Winter Wheat (Nov. 1982)							
Ottawa-Carleton	Wheat	9/18	4	3	1	1	9
Ottawa-Carleton	*Rhopalosiphum padi*	3/ 5	2	2	0	0	4
Ottawa-Carleton	*R. maidis*	4/ 5	1	0	4	0	5
Renfrew	Wheat	2/ 4	2	0	1	0	3
Renfrew	*R. padi*	4/ 6	3	2	0	0	5
Total		22/38	12	7	6	1	26
Winter Wheat (June, 1983)							
Ottawa-Carleton	Wheat	15/17	–	–	–	–	–
Spring Cereals (June-July, 1983)							
Ottawa-Carleton	Barley	2/15	2	0	2	0	4
Ottawa-Carleton	Oats	1/16	1	0	0	0	1
Glengarry	Wheat	4/18	1	0	0	4	5
Total		7/49	4	0	2	4	10

* Number of randomly collected field plant samples found infected with the virus/number of samples tested in transmission tests with four species of aphid vectors (Paliwal 1982a, b). In case of aphid samples from the fields, the figures represent number of plants infected/ number of plants infested with two field aphids per plant.

† NS, vector nonspecific; RPS, *R. padi* specific; RMS, *R. maidis* specific; SAS, *Sitobion avenae* specific strains.

c Total number of virus strain types recovered from the field samples or from plants infected in tests of field aphids are sometimes greater than the number of infected plants used as sources for strain identification due to recovery of more than one strain from some samples.

infection resulted in high winter kill (60-100%) of winter cereals in most parts of the Quebec province. A limited survey of winter cereals in Quebec and Ontario on June 15 and 16 revealed that at Ste-Rosalie, Que., winter wheat showed heavy winter damage and many surviving plants had BYDV symptoms. Winter rye observed at Ste-Rosalie, Guelph, Ont. and Chatham, Ont. did not show BYDV symptoms. Significant levels of BYDV infection was also noted in many winter wheat fields between Toronto and Chatham. Late-seeded winter wheat fields showed less BYDV damage than the early-seeded fields, similar to that reported in U.S.A. (2). In the Guelph University fields near Guelph, the rate of BYDV incidence in winter barley was nearly 100%, although the severity of symptoms was variable probably due to the presence of several strains of the virus. Overall disease severity was so high that a yield loss of about 90% could be realistically predicted. The winter triticales showed some evidence of BYDV infection, but generally they appeared more tolerant than winter wheat. The interpretation of BYDV incidence in winter wheat was complicated by the presence of some advanced symptoms of wheat spindle streak mosaic virus. The late-seeded wheat seemed to have largely escaped damage in the Guelph area, similar to what was observed in other parts of Ontario. Randomly collected winter wheat plants were indexed for BYDV in the Ottawa-Carleton in June 1983, and the rate of infection observed was very high (Table 1).

Spring cereals, 1983

Many fields of spring cereals were planted at unusually late dates in Ontario. In mid-June, there was no evidence of transfer of BYDV from winter wheat to spring cereals in Ontario. Small numbers of aphids were present in winter wheat near Chatham [*R. padi* and *Sitobion avenae* (Fab.)] and about 5% of nearby oats at the tillering stage showed BYDV symptoms. Infection became somewhat more widespread later in the summer. Incidence of aphids was low in other parts of Ontario also. Apparently, the hot weather prevailing from June 10 to July 15 retarded the development of aphids, so that BYDV was not transferred from winter cereals to spring cereals. This assessment is based on visual observations and on evidence obtained by indexing random samples of Ontario spring cereals for the presence of BYDV which yielded a 14% infection estimate (Table 1). Also, the spectrum of BYDV strains identified from the winter wheat and those detected in spring cereals was different.

In Quebec, the authors did not monitor closely the June aphid migrations, but casual observations indicated that little migration occurred. On July 15, scattered individuals of *R. padi* were observed at Deschambault with less than 1% BYDV infection in the fields, but in the Montreal area there were up to 30 aphids per meter of row of oats, and about 20% BYDV infection of plants at flowering to early milk stages was recorded. In early August, reports of BYDV symptoms came from Témiscamingue, Lac St-Jean and Eastern Townships (Cantons de l'Est) and the Québec-Montmagny area. BYDV infected plants were widespread in the oat fields in Lac St-Jean and Eastern Townships area. Late seeded fields suffered significant damage. Since there was no evidence of primary infection, this BYDV incidence is believed to be due to a late but substantial migration of viruliferous aphids over a wide area in mid-July. At that time, the spring cereals in Ontario were ripening and winter cereals had largely been harvested.

The summer months in Quebec and Ontario were characterized by above average temperatures and drought which also adversely affected the yield of spring cereals. In fields most severely affected by drought, the BYDV symptoms were masked by the effects of the drought. Aphid populations and migrations in September and October of 1983 were lower than average, and the incidence of BYDV winter wheat fields in Quebec and Ontario was low.

Discussion

Large, unpredictable aphid migrations are increasingly evident as the main cause of BYDV epidemics and short-range transport of BYDV seems to have only minor importance (7 and the present study). Development of heavy aphid populations within a field is generally prevented mainly by biological control agents, but when aphids migrate, they apparently escape to some extent from one part of the biological control complex, namely the Coccinellids, the Syrphids and the Cecidomyids. The alates may include some individuals parasitized by young larvae of Aphidiid wasps, and it is quite possible that this parasitism results in a reduced ability of the aphid for sustained flight, so that the migrants may end up with reduced levels of parasitism also. The end result is that after migrants alight on a new crop, often hundreds of kilometers away from their starting point (8), they may enjoy a few days of near-optimal reproduction conditions without much interference from their natural enemies.

The geographic area of origin of the aphids affecting Ontario and Quebec winter wheat in the fall of 1982 and the Quebec spring cereals in the summer of 1983 cannot be pinpointed accurately, as there is no systematic aphid trapping system established for this purpose in North America. However, wind directions data contains a dominant south-west or west component from May to September in Quebec and Ontario, according to 30-year averages for most stations in the cereal-growing areas. In the first weeks of October 1982, when the aphid migration was observed, a steady southwesterly wind was encountered in Quebec.

The presence of a heavy epidemic on winter-cereals in 1982-83 did not result in a general BYDV epidemic in Ontario spring cereals despite the fact that there are more winter cereals than spring cereals in Ontario. Aphids migrating out of Ontario winter wheat, if present there in significant numbers, could have been regarded as a serious threat, as in France, aphids coming from small grain cereals contain much more BYDV than aphids coming from maize (1, 5). In Quebec, winter cereals represent very small areas and have no importance as a BYDV reservoir. The fact that BYDV reached rather high levels in many localities of the province of Quebec about mid-July of 1983 indicates that short-range contamination may have much less importance than long-range migrations between localities along the axis of prevailing winds.

Aphid numbers alone are not a good predictor of BYDV epidemic as in the fall of 1979 there was also a heavy aphid migration and a buildup reaching 40 aphids per plant on winter cereals in parts of Quebec but the aphids were essentially virus-free. This may be related to the nature of the crop on which these aphids were previously feeding, as maize for example contains low levels of BYDV and a limited range of virus strains (5, 7).

The routine use of insecticides on winter cereals to control aphids does not seem logical, considering the actual frequency of BYDV epidemics in Eastern Canada and the fact that in many instances the aphids may be predominantly virus-free. However, these observations indicate a need for closer monitoring of aphid migrations and for rapid indexing of aphid populations to determine the percentage of viruliferous aphids so that aphicide applications can be accurately timed and applied only if warranted in order to arrest an aphid population explosion leading to a BYDV epidemic.

Acknowledgements

The authors thank Lloyd Seaman, Luc Couture and J.P. Dubuc for some of the observations and for supplying some field samples.

Literature cited

1 Bayon, F., J.-P. Ayrault and P. Pichon. 1982. La jaunisse nanisante de l'orge. Phytoma — Défense des Cultures, Nov. 1982, p. 17-21.
2 Carrigan, L.L., H.W. Ohm, J.E. Foster and F.L. Patterson. 1981. Response of winter wheat cultivars to BYDV infection. Crop Sci. 21: 377-380.
3 Comeau, A. and C.-A. St-Pierre. 1984. Report no. 5. Trials on the resistance of cereals to barley yellow dwarf virus (BYDV). Agriculture Canada, Sainte-Foy, Québec.
4 Comeau, A. and J.-P. Dubuc. 1977. Observations on the 1976 barley yellow dwarf epidemic in Eastern Canada. Can. Plant Disease Survey 57: 42-44.
5 Lapierre, H. 1980. Les virus des céréales à paille. Phytoma — Défense des Cultures, Sept.-Oct. p. 34-38.
6 Paliwal, Y.C. 1982a. Identification and annual variation of variants of barley yellow dwarf virus in Ontario and Quebec. Can. J. Plant Pathol. 4: 59-64.
7 Paliwal, Y.C. 1982b. Role of perennial grasses, winter wheat, and aphid vectors in the disease cycle and epidemiology of barley yellow dwarf virus. Can. J. Plant Pathol. 4: 367-374.
8 Wallin, J.R. and D.V. Loonan. 1971. Low level jet winds, aphid vectors, local weather, and barley yellow dwarf virus outbreaks. Phytopathology 61: 1068-1070.