BARLEY STRIPE MOSAIC IN THE CANADIAN PRAIRIES IN 1972[1]

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Abstract

In Alberta, Saskatchewan, and southeastern Manitoba, respectively, barley stripe mosaic (BSM) was detected in 42.9%, 11.1%, and 15.3% of the 2-row barley (Hordeum distichum) fields and in 16.7%, 5.1%, and none of the 6-row barley (H. vulgare) fields surveyed in 1972. The incidence of affected plants in these fields varied from a trace to 10%. In Alberta and Saskatchewan, the disease was encountered primarily in southern areas. The percentage of 2-row barley fields in which BSM was detected in southeastern Manitoba in 1972 declined markedly from the previous year. This was probably due to decreased planting of 'Herta' barley, the variety most commonly infected with barley stripe mosaic virus in this province, and increased planting of 'Fergus' barley, a newer 2-row variety which in 1971 appeared to be virus-free. In 1972, however, a trace of BSM was detected in two fields of 'Fergus' and thus even a complete change-over to this variety in Manitoba will probably only temporarily control the disease in 2-row barley.

Breeder seed of 18 barley varieties, including those grown most commonly in Canada, was sown in a field plot and the progenies were examined periodically for BSM symptoms. The disease was detected only in 'Compana' barley, in which 1% of the plants were affected.

Introduction

In 1971, the 2-row barley (Hordeum distichum L. emend. Lam.) crop in Manitoba consisted almost entirely of two varieties. 'Herta', released in 1956, comprised about three-quarters of the crop and 'Fergus', released in 1968, most of the remainder (2). In a survey conducted in Manitoba in 1971 (5), barley stripe mosaic (BSM) was found to occur commonly in growers' fields of 'Herta' but there was no evidence of the disease in fields of 'Fergus'. In recent years, BSM has been detected in only an occasional field of 6-row barley (H. vulgare L. emend. Lam.) in Manitoba (5).

BSM has been reported in growers' fields in Alberta and Saskatchewan for many years but the proportion of fields in which the disease was observed was either unspecified or generally low (4). In 1967, the disease was not detected in Saskatchewan but was relatively common in some fields of 2-row barley near Lethbridge, Alberta (7). Since 1967, there have been no reports of BSM in Saskatchewan or Alberta.

In 1953, McKinney (12) suggested that the presence of barley stripe mosaic virus (BSMV) in barley seed might account for the gradually declining yields exhibited by some varieties in the United States. In mechanical inoculation tests, yield reductions in BSMV-infected barley plants as high as 64% (9) and 90% (12) have been reported. Timian (15) has recently demonstrated that yield losses in 'Kindred' barley were approximately equal to the percentage of infected seeds up to about 30%; higher percentages of infected seeds did not result in addition yield reductions. In North Dakota, where BSM was common in the 1950's and early 1960's, the disease resulted in yield losses in barley as high as 3.5% per year, equivalent to about $3 million (15). In Montana, where BSM was also common for many years, the disease accounted for yield losses to barley of about $3.1 million in 1964 (14).

Yield reductions due to BSM in 'Herta' barley in Manitoba have probably generally been light, because in most fields examined less than 1% of the plants have been affected. Previous experience with the disease in North Dakota and Montana, however, suggested that it might become a serious problem in Manitoba and possibly elsewhere in the Canadian prairies. Theoretically the yield-reducing potential of BSM is greatest when the virus is established in breeder seed of a variety, because all pedigreed seed lots could be contaminated. However, there have been no previous reports on the status of BSMV in breeder seed of barley varieties grown in Canada.

To obtain current information on the distribution and intensity of BSM in the Canadian prairies, in 1972 a survey for the disease was conducted in Manitoba, Saskatchewan, and Alberta. In addition,

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breeder seed of 18 barley varieties grown in Canada was evaluated for the presence of BSMV.

Materials and methods

The survey for BSM in Manitoba, conducted from June 20-29, 1972, was confined to the same southeastern area in the province surveyed the previous year (5). Fields of 2- and 6-row barley in the early tillering to watery ripe stage were examined at intervals of about 5 and 15 miles, respectively, along preselected routes totalling about 1250 miles.

In Saskatchewan and Alberta, the survey for BSM was conducted from July 6-12, 1972, along a preselected route of about 1600 miles. The route passed throught crop districts in which about 85% and 60% of the 1972 barley crop in these respective provinces was grown (3). Fields of either 2- or 6-row barley in the early tillering to milky ripe stage were examined at intervals of about 10 miles.

Breeder seed of 18 barley varieties was evaluated for BSMV infection by sowing samples in a field plot at Winnipeg on May 26, 1972, and examining the progenies for BSM symptoms periodically until July 17, when plants of all varieties had developed heads. Varieties of 6-row barley examined included 'Bonanza', 'Brock', 'Conquest', 'Galt', 'Gateway 63', 'Jubilee', 'Keystone', 'Olli', 'Paragon', 'Parkland', and 'Trent' while 2-row varieties included 'Betzes', 'Centennial', 'Compana', 'Fergus', 'Hannchen', 'Herta', and 'Palliser'. Breeder seed of 'Olli', 'Trent', 'Fergus', and 'Brock' consisted of 89, 100, 132, and 138 separate lines, respectively, whereas breeder seed of the remaining varieties was each maintained in single lots. For breeder seed of each variety consisting of separate lines, 250 seeds of each line were sown, and for each variety maintained as single lots, 1000 seeds were sown. Seeds were sown with a power seeder in 4.3 m rows spaced 0.3 m apart at a rate of about 58 seeds per m.

Leaf samples were collected from plants with suspected symptoms of BSM in both the field plot and growers' fields, assayed for infectivity on 'Black Hulless' barley test plants, and extract from test plants that developed symptoms was tested serologically against BSMV antiserum (5). Samples collected in Manitoba were tested for infectivity the same or following day, whereas those collected in Saskatchewan and Alberta were tested 3-8 days later. A sample was considered to be infected with BSMV only if extract from infected test plants reacted with BSMV antiserum.

Additional tests were conducted to detect BSMV in breeder seed of 'Herta' barley. Seeds were planted in a 4:1 mixture of soil and sphagnum peat moss in both a greenhouse and growth cabinets at about 27° C. One random sample of 1048 seeds were sown in a growth cabinet and samples of 1048 of the thinnest seed (screened to less that 2 mm diam) were sown in both a greenhouse and a growth cabinet. Seedlings in growth cabinets were provided a 15 hr photoperiod of 2800-3600 ft-c with fluorescent and incandescent lights, and those in a greenhouse were provided supplemental fluorescent light from 6 am to 9 pm daily. Seedlings were examined periodically for symptoms until they reached the 2-3 leaf stage, 11-13 days after seeding. At this time, juice was extracted from each seedling exhibiting chlorosis, necrosis or stunting, and was tested serologically against BSMV antiserum (5).

Table 1. Occurrence of barley stripe mosaic in fields of 2- and 6-row barley in the Canadian prairies in 1972

Province	Type of barley	Fields		
		No. examined	No. with BSM*	% with BSM
Alberta	2-row	21	9	42.9
	6-row	24	4	16.7
Saskatchewan	2-row	27	3	11.1
	6-row	39	2	5.1
Manitoba	2-row	118	18	15.3
	6-row	39	0	0.0

* BSMV transmitted to 'Black Hulless' barley and reacted with BSMV antiserum.

Results and discussion

In 1972, BSM was detected more frequently in Alberta than in Saskatchewan or Manitoba (Table 1). In Alberta and Saskatchewan, the disease was more common in fields of 2-row barley than in fields of 6-row barley; in Manitoba it was detected only in fields of 2-row barley. In 2-row barley, BSM affected 5% and 10% of the plants in 2 fields in Alberta and 2-10% of the plants in 8 fields in Manitoba. In other fields where the disease was observed in either 2- or 6-row barley, only a trace of the plants were affected.

Germination of breeder seed of 18 barley varieties evaluated for the presence of seed-borne BSMV in the field varied from 36% to 73% and averaged 58%. BSM was detected only in 'Compana' barley, in which 1% of the plants were affected. In 1972, 'Compana' comprised only about 1% of the total barley acreage in the Canadian prairies and was grown primarily in southern Alberta and southwestern Saskatchewan (3). In southern Alberta, BSM was recognized in growers'

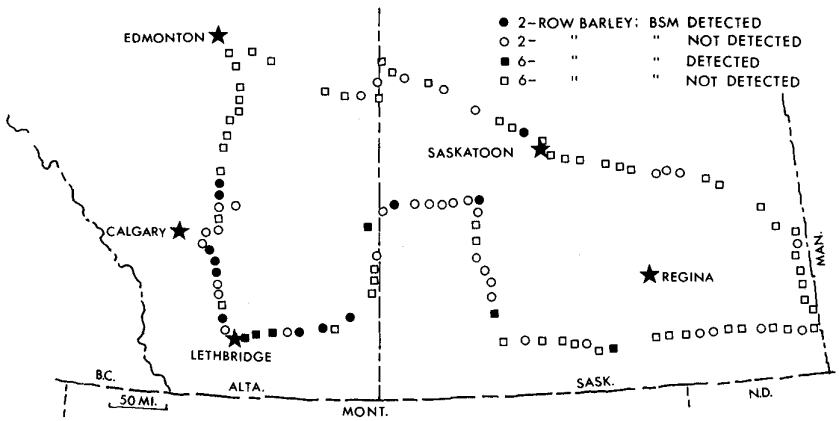

Figure 1. Distribution of barley stripe mosaic in fields of 2- and 6-row barley in Alberta and Saskatchewan in 1972.

fields of 'Compana' as early as 1953 (4). In Montana, where 'Compana' has been widely grown, BSMV was detected in 54.8% of 219 seed lots of this variety in 1954 and 1955; in seed lots containing the virus, an average of 9.2% of the seeds were infected (1).

Germination of a random sample of breeder seed of 'Herta' barley sown in a growth cabinet was 96%. Germination of seeds thinner than 2 mm diam from the same source was 79% in a growth cabinet and 83% in a greenhouse. None of the seedlings developed characteristic BSM symptoms and extract of each seedling that appeared in any way abnormal failed to react with BSMV antiserum.

Although larger samples of breeder seed might have resulted in detection of BSM in barley varieties other than 'Compana', the virus is probably either not present or very rare in breeder seed and rare or absent in other classes of pedigreed seed (i.e. select, foundation, registered, and certified) of varieties grown commonly in Canada. The failure to commonly detect BSM at high levels in growers' fields in Canada also supports this conclusion.

In Alberta and Saskatchewan, BSM was encountered primarily in southern areas and most commonly in southern Alberta (Fig. 1). The exact reason for the apparent localization of the disease is unknown. However, development of BSM symptoms is enhanced by high light intensities and high temperatures (10, 11, 13) and either or both of these factors may be more favorable for symptom expression in southern than in northern areas. In northern areas, symptoms of the disease could conceivably be masked.

Varieties of 2- and 6-row barley in fields where BSM was detected in Saskatchewan and Alberta in 1972 were not identified. Since BSMV was present in breeder seed of 'Compana' barley, the virus probably occurred in most fields of this variety. However, because 'Compana' was grown on a relatively small proportion of the acreage of 2-row barley in these provinces, it is improbable that it was the only 2-row variety affected with BSM in grower's fields.

In southeastern Manitoba, the percentage of 2-row barley fields in which BSM was detected in 1972 declined markedly from 1971 (Fig. 2-A). This was attributed to a reduction in acreage of 'Herta' barley and an increase in the acreage of 'Fergus' barley in 1972 (Fig. 2-B). During the winter of 1972, Manitoba Department of Agriculture extension workers provided information to growers of the potential problem with BSMV in seed of

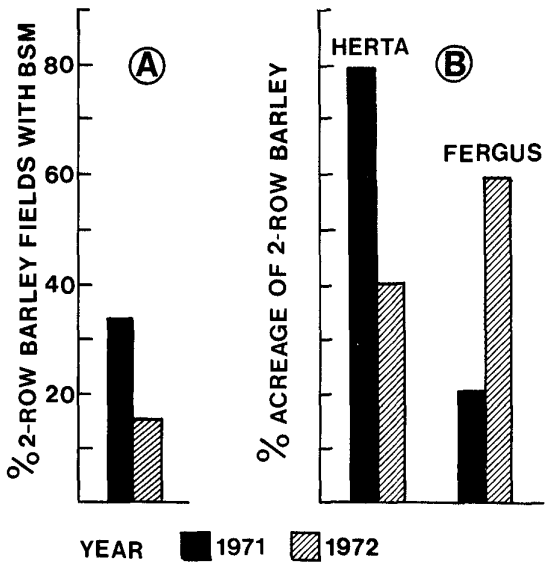

Figure 2. A) Percentage of 2-row barley fields in which barley stripe mosaic was detected in southeastern Manitoba in 1971 and 1972.
B) Percentage of acreage of 2-row barley occupied by the varieties 'Herta' and 'Fergus' in southeastern Manitoba in 1971 and 1972. Acreages were obtained from barley variety surveys (2, 3) in Manitoba crop reporting districts 3, 4, 5, 6, and 12.

'Herta' and of the probability that seed of 'Fergus' was nearly or completely virus-free. This action was probably mainly responsible for the pronounced differences in acreages of the two varieties grown in Manitoba in 1971 and 1972.

The origin of BSMV in growers' fields of 'Herta' barley in Manitoba remains to be determined. If the virus originated in breeder seed of 'Herta', it may be present in such a low percentage of seed that the increase plot would have to be inspected to detect the virus. There may, however, be at least three additional avenues by which the virus could become established in growers' fields. First, the virus might occasionally be transmitted from one barley field to another by pollen (8). Second, wild grasses, some of which have been reported to be susceptible to BSMV (16), might serve as reservoirs of the virus in nature. The virus might be transmitted mechanically from wild grasses to barley, either by natural contact or by machinery during cutting operations along edges of fields. Third, growers might inadvertently contaminate virus-free seed lots with infected ones.

In Manitoba, traces of 6-row barley plants were sometimes noted in fields of 2-row barley where BSM was detected in 1971. The 6-row barley contaminants were sometimes also affected with the disease. It thus seemed possible that BSMV might have been introduced into seed lots of 'Herta' barley by accidental mixing with seed of an infected contaminant. In 1972, all 2-row barley fields examined for BSM in Manitoba, were also inspected for the presence of contaminating crop plants but the data obtained did not support the aforementioned hypothesis. Contaminating 6-row barley and common wheat (Triticum aestivum L.) plants were observed in only 4 fields and 1 field, respectively, of 18 fields in which BSM was detected in 2-row barley. Some wheat contaminants were also infected with BSMV, while infected 6-row barley contaminants were noted in 3 of the fields.

In North Dakota and Montana, BSM has been controlled by different procedures. Barley seed certified to be free of BSMV was initially made available to growers in North Dakota in 1958 and new virus-free varieties with improved agronomic characteristics were released in 1961 and 1964. Growers changed rapidly to the new varieties and, consequently, BSM has not been detected in this state since 1966 (15). In Montana, complete varietal changes have not been made but pedigreed barley seed has been tested for BSMV for many years; no infection has been allowed in foundation and registered seed and a maximum of 5% infection has been allowed in certified seed (6). Since implementing this program, the incidence of the virus in Montana has declined to the point where it was not detected in any certified seed samples tested in 1970 (D. J. Davis, personal correspondence).

Because of the probable absence or low incidence of BSMV in pedigreed seed of barley varieties grown commonly in Canada, an extensive seed certification program to control the virus in this country is presently unwarranted. However, until virus-free seed of 'Compana' barley is made available, the use of this variety should be discouraged. Growers encountering a high incidence of BSM in fields of most other varieties, could probably avert or minimize yield losses simply by planting registered or certified seed. Contacts with Manitoba growers of 'Herta' barley known to be infected with BSMV tend to support this view. Of 15 such growers interviewed in 1971, none reported using pedigreed seed to grow this variety (Chiko, unpublished).

In 1972, two farms in Manitoba, where BSM was detected in 'Herta' barley the previous year, were revisited. In place of 'Herta', both growers had planted 'Fergus' in 1972. One field of 'Fergus' on each farm was thoroughly inspected and several plants affected with BSM were detected in each field. Therefore, even if growers in Manitoba switch completely from 'Herta' to 'Fergus', it seems evident that this action will not completely eradicate the virus from fields of 2-row barley in this province.

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