

# Occurrence of Maize Dwarf Mosaic in Wisconsin and Reaction of Sweet Corn Plant Introduction Accessions and Commercial Hybrids

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## ABSTRACT

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Maize dwarf mosaic virus (MDMV) was isolated from late-planted sweet and field corn in Wisconsin in 1977 and 1978. Isolates were identified by infection of corn and Johnson grass but not wheat and by electron microscopic detection of long filamentous particles in leaf dips. Sweet corn Plant Introduction accessions, commercial hybrids, and experimental entries were tested for reaction to the isolates in the field, using mechanical inoculation and natural spread. Considerable differences were observed in the percentage of plants showing symptoms and in ear development. Bellringer, Cherokee, Golden Gleam, and Quicksilver were the most tolerant cultivars. In some entries, common rust was more severe on MDMV-inoculated plants than on noninoculated plants.

Maize dwarf mosaic virus (MDMV) affects *Zea mays* in several northern corn-growing areas of the United States. Strains A and B have been reported from the Hudson Valley in New York (2), northern Ohio (6), Minnesota (7,9), and central Iowa (4), and strain A was found in North Dakota in 1977 (11). As Johnson grass (*Sorghum halepense*), assumed to be the primary overwintering host of MDMV-A, does not occur in these areas, it has been suggested that aphids borne by airstreams brought in the virus (8,9).

In 1977 and 1978, MDMV was isolated from late-planted sweet and field corn in Wisconsin. Because of the importance of sweet corn for processing in Wisconsin, possible control measures were explored. There are only a few reports of the reactions of sweet corn hybrids or cultivars to MDMV. Dale and McFerran (3) recommended Bonanza, Gold Crown, Jubilee, Silver Queen, and Valley Market for further trial; they found that symptom severity and yield were not correlated. Studenroth and Boothroyd (10) reported that borders of the tolerant hybrid Spring Gold were effective in reducing the amount of infection in plots of the susceptible hybrid Seneca Scout. Knoke and Gordon (8) reported that all cultivars in their 1977 inoculation tests were susceptible, but among the best producing hybrids were Apache, Capitan, Cherokee,

Harmony, Jubilee, Merit, Salute, and Sundance, along with several numbered entries.

This report concerns the first detection of MDMV in Wisconsin and the reactions of available sweet corn Plant Introduction (P.I.) accessions, a sampling of commercial sweet corn hybrids, and some experimental lines to the isolates of MDMV found in Wisconsin.

## MATERIALS AND METHODS

Plants with possible maize dwarf mosaic virus symptoms were collected from three locations in 1977: sweet corn from Racine County, green foxtail (*Setaria viridis*) from Dane County, and late-planted field corn from Columbia County. Mechanical inoculations from these collections were made to sweet corn plants (cultivar Seneca Chief) grown in a greenhouse or growth chamber. Indicator hosts inoculated with virus from these plants were corn inbred SD P<sub>2</sub>, Michigan Amber wheat (*Triticum aestivum*), and Johnson grass. Inocula were prepared by grinding leaves from infected plants in 0.01 M phosphate buffer, pH 7.0. Indicator plants were dusted with 22 μm (600-mesh) Carborundum, rubbed with the inoculum, and rinsed with distilled water. Leaf-dip preparations made from plants with mosaic symptoms were observed with an electron microscope.

A test for resistance was made with 92 sweet corn accessions from the P.I. Station, Ames, IA, and with a limited number of commercial hybrids and experimental lines obtained from R. H. Andrew, Agronomy Department, University of Wisconsin, Madison, and H. S.

Humaydan, Harris Seeds, Rochester, NY. Four field corn hybrids and one inbred that have been considered resistant were included. Planting was late (12 June 1978) to favor natural spread of the virus and development of the disease. Two adjacent rows of each entry were planted 90 cm apart, with seven hills of two plants each per row. The limited amount of seed available prevented replication planting. One row of each pair was inoculated mechanically on 12 July with a mixture of the 1977 Wisconsin isolates. Inoculum was prepared from infected tissue and buffer (1:9, w/v) and kept on ice for transport to the field. Carborundum was added to the inoculum. Plants, which were in the five-to-seven leaf stage, were inoculated by rubbing an inoculum-saturated cheesecloth pad on the two uppermost leaves.

Each noninoculated row had an inoculated row on either side, allowing observation of natural spread. At the time of inoculation, the very early maturing entries were more developed and may have escaped the full impact of the disease. No insecticides were used, and large populations of aphids and corn rootworm beetles developed. Aphids presumably were responsible for transmitting the virus to noninoculated rows. Rootworm beetles removed the silks of late-maturing entries, contributing to poor ear development.

Plants with mosaic symptoms and total plants were counted 25 days after inoculation in both inoculated and noninoculated rows. Ears were harvested on 13 September, 10 ears per row where possible. Ears were rated as to whether or not they were at least 75% filled. Because a comparable MDMV-free planting of the entries was not available and many noninoculated rows became infected, these comparisons obviously do not reflect the full potential for virus-induced damage.

An epidemic of rust (*Puccinia sorghi*) developed, and estimates of infection were made.

## RESULTS AND DISCUSSION

Each of the three 1977 MDMV collections produced mosaic symptoms on Seneca Chief, SD P<sub>2</sub> corn, and Johnson grass. No symptoms developed on the

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MDMV-inoculated Michigan Amber wheat, and inoculation back to SD P<sub>2</sub> was negative, indicating that wheat streak mosaic virus was not involved. Electron microscope examination of leaf dips from infected corn plants revealed flexuous rod-shaped particles characteristic of MDMV (1). Thus, the Johnson grass strain of MDMV was present in Wisconsin in 1977. Symptoms on late-planted sweet corn were found at several locations in 1978, and mechanical transmissions again indicated the presence of MDMV-A.

At one location on the Arlington (WI) Experimental Farm, a plot of late-planted field corn was heavily infected in 1977, and late sweet corn in the same plot in 1978 developed considerable infection, indicating possible establishment in local grass hosts.

The reactions of the P.I. accessions and commercial hybrids are given in Table 1. In most of the inoculated rows of the P.I. accessions, the number of plants with symptoms was high; among the few exceptions were 231740, 231742, and 231746. Among the hybrids, inoculated rows of Earliking and Seneca 60 had no plants with symptoms and several entries, eg, Golden Beauty, Seneca Star, and Sundance, had few diseased plants. Among the inoculated field corn entries, Pa 405 had no infected plants and Funk's G4171 and PAG SX346 had low numbers. In subsequent greenhouse tests, the virus could not be recovered from inoculated Pa 405 plants.

Noninoculated rows ranged from no plants with symptoms to all plants with symptoms. Symptoms in all of the inoculated and none of the noninoculated plants indicated some factors inhibiting aphid transmission. The field corn entries showed no or few infected plants in noninoculated rows.

Some virus tolerance is indicated where 10 ears developed and most or all were well filled. Several hybrids showed a relatively good performance in this respect, eg, Bellringer, Cherokee, Golden Beauty, and Quicksilver. Among the P.I. entries, 220866 and 228182 had the best ear development. In both sets of entries, the very late tropical lines were at an obvious disadvantage regarding ear development, and early lines may have escaped severe damage.

Most of the experimental lines tested (not shown in Table 1) appeared to be susceptible with mechanical inoculation, but ear development was good in a number of the lines. In noninoculated rows, several lines showed no or few infected plants.

Among the commercial sweet corn hybrids tested, Cherokee appeared to be tolerant, as suggested by Knoke and Gordon (8). Merit and Jubilee, also reported as tolerant, appeared to be

**Table 1.** Reaction of sweet corn Plant Introduction (P.I.) accessions and commercial hybrids to maize dwarf mosaic virus infection by mechanical inoculation and by natural spread (noninoculated) and to common rust in the field at Arlington, WI, in 1978

P.I. no. or hybrid	No. plants <sup>a</sup> Infected/Total		Ears <sup>b</sup> Filled/Total		Notes <sup>c</sup>	Rust <sup>d</sup>
	Inoc.	Noninoc.	Inoc.	Noninoc.		
162571	14/14	4/14	1/5	3/7		5
162572	12/14	10/12	5/8	5/8		5
162573	12/12	14/15	4/5	3/7		5
174418	...	10/10	...	1/4		5
179132	8/8	11/11	2/4	1/9		3
181843	10/10	5/5	4/10	0/2		7
183752	8/8	8/8	0/5	1/8		5
198641	13/13	9/10	0/4	0/10		2
204823	11/13	12/13	0/7	1/11		7
213796	12/12	10/11	4/8	4/10	VE	9
218134	11/11	12/13	0/5	0/4	L	3
218174	13/13	12/14	0/5	0/9	E	9
219870	14/14	0/14	6/9	1/8	VE	7
219872	14/14	0/14	6/10	8/10	VE	7
219894	12/13	4/13	3/10	6/10		7
220866	8/13	0/14	9/10	5/10	E	5
228182	10/10	10/14	9/10	7/10		4
228183	10/12	5/14	5/8	9/11		4
231296	12/13	12/14	0/8	1/6		4
231297	14/14	12/13	0/3	2/5		4
231298	13/16	13/13	0/1	0/7		4
231299	14/14	14/14	1/5	2/8		2
231300	11/13	9/14	6/9	5/10		5
231301	14/14	6/14	6/10	8/10		5
231302	12/14	9/14	5/9	8/10		5
231739	12/13	3/12	2/10	7/10		7
231740	7/12	4/13	5/10	7/10		5
231741	9/14	4/14	0/10	7/10		5
231742	8/14	14/14	1/10	0/10		5
231743	12/12	11/13	3/6	3/10		8
231744	12/14	10/12	3/5	4/8		7
231745	13/13	6/15	3/10	8/10		7
231746	7/13	1/13	4/10	5/10		3
231748	9/12	4/12	5/6	3/7		6
231749	11/13	11/15	1/4	4/10		9
233312	14/14	14/14	1/5	4/7	Y	7
233313	13/13	10/12	0/8	2/8	Y	7
233315	13/13	6/12	0/4	1/10		5
233316	10/12	3/12	5/10	7/10		7
233317	13/14	13/14	1/10	5/10	Y	6
233318	11/14	8/14	1/10	3/10		5
233319	9/14	10/13	...	...		3
233320	14/14	14/14	0/0	0/3	E	7
233321	9/9	13/13	0/3	3/7		9
233322	14/14	8/12	0/3	4/10	E	9
233323	16/16	8/14	0/1	0/3		7
245130	12/12	6/13	3/7	5/9	VL	4
253730	10/12	1/9	0/0	0/0	VL	2
255193	9/13	2/12	2/10	9/10		4
255975	14/14	4/14	4/10	2/10		7
255976	14/14	4/14	5/10	6/10		4
255977	13/14	7/14	5/9	3/10		8
255981	11/13	6/13	5/10	6/10		7
255982	14/14	7/14	4/10	6/10		6
255983	14/14	7/14	1/8	4/7	E	7
269756	13/14	10/14	3/9	8/10		7
289766	14/14	7/12	2/7	5/10		7
289767	14/14	11/16	2/10	3/9	Y	2
289768	11/12	2/13	0/10	3/10		5
289769	13/14	10/14	5/10	5/10		6
289770	15/15	12/14	1/5	2/9		6
289771	9/9	12/14	1/6	3/9		9
289772	14/14	6/6	0/0	0/0	E,Y	9
289773	13/14	6/12	0/8	0/10		6
289774	14/14	11/13	0/7	0/10		7
289775	10/12	6/14	1/7	1/6	L	2
291391	13/14	9/16	1/6	2/7		7
318728	6/10	3/13	0/0	0/0	VL	2
345569	14/14	1/14	2/8	5/9		7
345570	14/14	2/14	3/10	5/9		5
345571	10/14	1/14	3/10	3/4		7
345572	14/14	5/14	0/1	2/7		7
358283	14/14	6/12	3/10	6/8		4

TABLE 1. (continued)

P.I. no. or hybrid	No. plants <sup>a</sup> Infected/Total		Ears <sup>b</sup> Filled/Total		Notes <sup>c</sup>	Rust <sup>d</sup>
	Inoc.	Noninoc.	Inoc.	Noninoc.		
358521	14/14	11/11	0/0	0/5	VY	4
358522	5/5	10/10	0/0	0/0		4
358523	14/14	14/14	0/3	0/10	VY	2
358524	14/14	13/14	0/0	0/0	Y,N	7
358525	13/13	12/12	0/0	0/3	Y,N	1
358526	13/13	14/14	1/3	0/8	Y	4
358527	14/14	13/13	3/8	9/10	Y	3
358528	10/10	4/7	0/2	2/3		1
358529	13/13	9/12	0/1	0/1		3
358530	8/8	10/11	0/6	0/10	VY	2
358531	14/14	9/10	0/10	0/10	Y	1
358532	8/8	9/13	0/0	0/0	Y,N	2
358533	15/15	10/10	4/9	5/7		4
358534	11/11	10/10	0/3	3/6		2
358535	13/14	10/14	2/10	2/10		4
358536	13/13	12/14	0/7	0/10		6
358537	12/14	10/10	1/6	0/8		5
358538	14/14	12/12	0/4	0/10		3
358539	14/14	12/14	0/5	5/8		5
Bellringer	14/14	0/14	10/10	10/10		2
Butter & Sugar	14/14	1/15	8/10	10/10		5
Cherokee	14/14	7/14	10/10	8/10		5
Commander	14/14	8/14	5/10	6/10		3
Earliking	0/14	0/14	7/9	...		7
Early Sunglow	14/14	0/16	6/10	9/10		7
Enterprise	12/14	3/14	6/7	8/10		4
FM Cross	14/14	3/13	1/2	5/9		6
Ga. Special	4/9	0/13	0/3	0/4	VL	1
GCB Elite	14/14	11/13	0/9	4/10		5
Gold Crown	14/14	4/14	7/10	9/10		5
Gold Cup	14/14	3/14	9/10	9/10		5
Gold Cup	14/14	7/15	6/10	10/10		4
Golden Beauty	1/14	0/14	2/8	10/10		4
Golden Gleam	14/14	7/14	10/10	10/10		3
Gold Rush	5/14	0/12	5/10	7/10		4
Hawaiian No. 8	11/14	6/12	0/6	0/7	VL	0
Hawaiian No. 9	6/11	0/11	0/6	0/5	VL	0
H68-1	14/14	8/14	0/4	0/7	VL	1
Intrepid	14/14	10/14	4/5	6/10		2
Jubilee	14/14	6/14	1/10	9/10		6
Merit	14/14	2/14	2/9	2/9		7
Midway	14/14	14/14	0/10	6/10		3
NK199	14/14	8/14	8/10	6/10		4
NK199	14/14	6/14	5/10	9/10		...
Quicksilver	6/12	0/14	10/10	10/10		6
Seneca Star	2/14	0/13	6/10	9/10		7
Seneca 60	0/12	0/13	8/8	9/12	VE	7
Southern Belle	13/13	14/17	7/10	9/10		3
Stylepak	14/14	13/14	0/1	4/9		5
Stylepak	14/14	14/14	0/3	0/11		7
Sugar Daddy	11/14	1/14	0/8	2/10		6
Sugar King	14/14	0/14	5/10	5/10		7
Sundance	1/14	1/14	6/10	10/10		7
Tendermost	11/11	0/15	1/9	3/10	Y	6
Tropic 3	14/14	2/14	0/5	0/10	VL	4
W900	10/14	7/17	7/10	10/10		5
PAG SX346 <sup>e</sup>	4/12	0/14	10/10	7/10		3
Funks G4085 <sup>e</sup>	10/14	0/14	7/10	10/10		3
Funks G4171 <sup>e</sup>	1/14	0/14	8/10	6/11		3
Funks G5190 <sup>e</sup>	4/14	2/14	10/10	10/10		3
Pa 405 <sup>f</sup>	0/14	0/14	9/10	10/10		7

<sup>a</sup>Two adjacent rows of each entry, one row inoculated manually. Plants with visible symptoms counted on 5-7 August in inoculated and noninoculated rows.

<sup>b</sup>Ears with at least 75% filling per total number of ears.

<sup>c</sup>VL = very late, L = late, VE = very early, E = early, Y = yellow inoculated plants, VY = very yellow inoculated plants, N = inoculated plants with considerable leaf necrosis.

<sup>d</sup>0 = no infection, 9 = very severe infection.

<sup>e</sup>Field corn hybrid.

<sup>f</sup>Field corn inbred.

relatively susceptible. Such differences in reaction may be due to differences in virus strains and in the stage of plant development at infection. Other commercial hybrids, ie, Bellringer, Golden Beauty, and Quicksilver, appeared to be as tolerant as Cherokee, but we have seen no other reports of their reactions.

Several entries had slight rust infections. In some of the more susceptible ones, MDMV-inoculated plants were more heavily infected with rust than noninoculated plants. A similar condition was noted by Genter et al (5) with *Cercospora zea-maydis* and MDMV.

Within the limits of the reservations indicated, we feel the several characteristics evaluated in our test give an indication of MDMV reaction. Some of the commercial sweet corn hybrids are less susceptible than others. These would be particularly important in late-season plantings, which are most likely to be infected. The P.I. accessions may include different, and perhaps better, sources of resistance than have been available.

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