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Maize Dwarf Mosaic: NEW CORN VIRUS DISEASE IN OHIO

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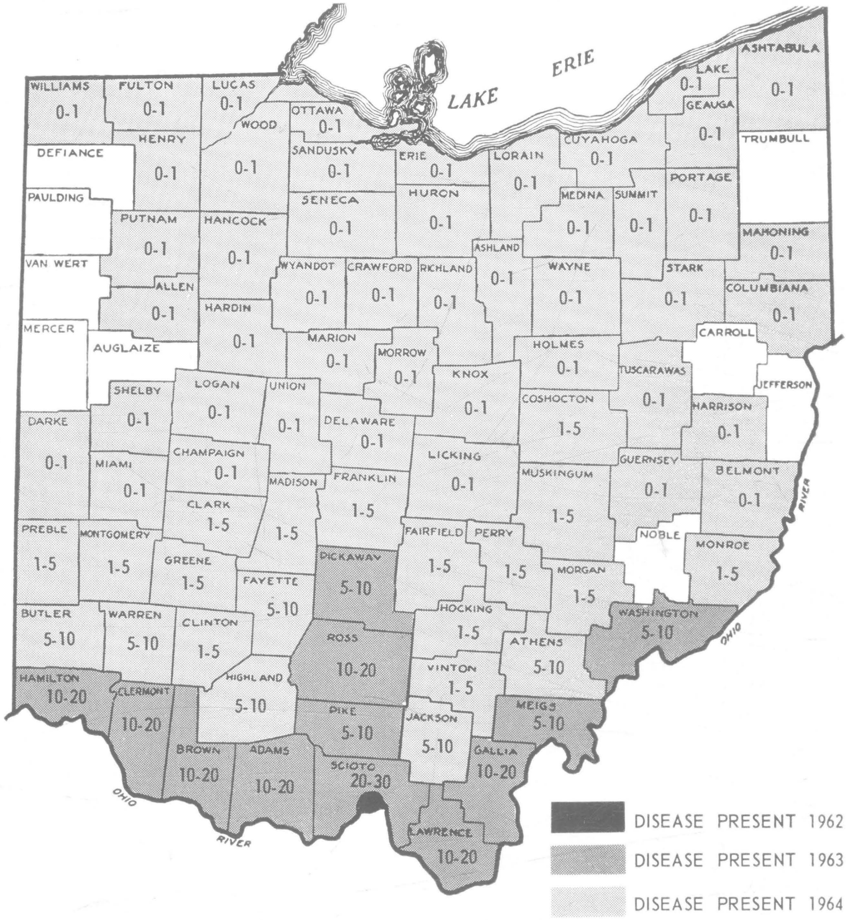

Fig. 1.—Spread of maize dwarf mosaic disease in Ohio, 1962-64, and corn yield loss in 1964. Black area in Scioto County is where disease was first observed in 1962; shaded areas show spread of disease in 1963 and 1964; figures indicate estimated percentage of corn yield loss by counties in 1964.

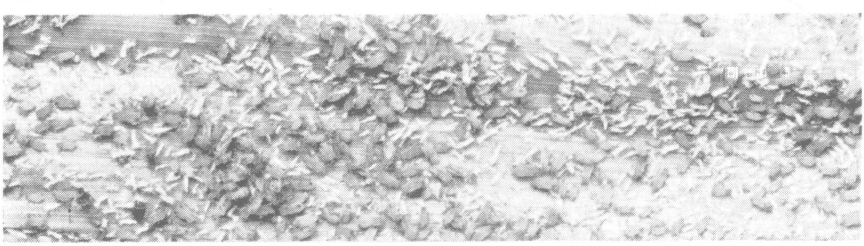

Fig. 2.—Corn leaf aphids, carriers of the virus which causes maize dwarf mosaic, feeding on a corn leaf.

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Maize Dwarf Mosaic:
NEW CORN VIRUS DISEASE IN OHIO

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Corn is the key crop in Ohio's farm economy. Ohio farmers annually produce an average of more than 210 million bushels of corn valued at $220 million. Much of this corn is fed on the farm and marketed at a much higher value in livestock and livestock products.

A new virus disease now threatens to seriously limit production of this important crop. First reported in Scioto County in southern Ohio in 1962, the disease has since been observed in practically all major corn-producing counties of the state (Fig. 1). It is the first serious corn virus disease reported in the Corn Belt.

At a November 1964 conference on corn viruses, representatives from 32 states and Canada named the disease maize dwarf mosaic. This name distinguishes the new disease from a similar virus disease, corn stunt, which has seriously damaged corn crops in southern and southwestern states.

Maize dwarf mosaic or a similar disease has been reported in several states since first discovered in Ohio. The same or a similar disease has also been observed in several countries in Europe and Asia.

Losses from maize dwarf mosaic in Ohio in 1964 were estimated at 5 million bushels of corn, worth $5.85 million. Losses varied by county from a trace to an estimated 30 percent of the corn harvest. In some fields, nearly 100 percent of corn plants were affected. Only traces of the disease were found in other fields.

Research is underway to control or prevent maize dwarf mosaic. Scientists at the Ohio Agricultural Experiment Station isolated the virus in 1963. They have identified several host grasses and one insect vector which transmits the virus. Ohio Experiment Station researchers are now testing disease resistance of several hundred corn strains. Studies are continuing on control of insect vectors, resistance of present hybrids, and breeding of new resistant hybrids.

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ON THE COVER

Mature corn plant with final stages of maize dwarf mosaic disease. Note the red color of leaves and dwarfing of plant.

Fig. 3.—Young corn plant with first symptoms of maize dwarf mosaic. Note the mosaic pattern of light and dark green areas.

Distribution in Ohio

Maize dwarf mosaic was first observed in a single field near Portsmouth, Scioto County, in 1962. The disease may have been present in other fields that year but was not observed or reported.

A limited survey in the fall of 1963 revealed an estimated 15,000 acres of diseased corn in 12 counties in the Ohio and Scioto river valleys. The total included 7,000 affected acres in Scioto County.

A 1964 survey by staff members of the Ohio Cooperative Extension Service, Ohio Agricultural Experiment Station, Ohio Dept. of Agriculture, and U. S. Dept. of Agriculture indicated that maize dwarf mosaic was present in 79 of Ohio's 88 counties. In the counties where the disease was not observed, the survey had been completed in August, too early to detect possible late infections.

The most severe losses occurred on bottomland soils in valleys of rivers and streams in the southern third of the state. In this area, where fields were surrounded by or infested with Johnson grass, the disease appeared in a high percentage of plants early in the season. In many of these fields, the disease was evident by the time corn plants were 12 inches high.

Thousands of acres of diseased corn were found throughout the state on upland soils free of Johnson grass. However, losses to date in these soils have not been great. In a few fields in northern Ohio, as many as 10 percent of the plants were diseased and yield loss was estimated at 5 percent. In general, disease incidence was higher in later planted fields.

Insect Carriers

Corn leaf aphids, *Rophalosiphum maidis* (Fitch), (see Fig. 2), have been identified as one carrier of the virus which causes maize dwarf mosaic. Aphids removed from diseased corn plants near Portsmouth, Ohio, transmitted the virus to young healthy corn seedlings in isolation tests in greenhouses at the Ohio Agricultural Experiment Station.

Fig. 4.—Corn plant with intermediate stages of maize dwarf mosaic. Mosaic pattern has merged into yellow streaks and started to redden. Note shortened internodes, resulting in bunching of leaves.

Populations of corn leaf aphids were observed in 32 western Ohio counties in a 1964 corn borer survey by state entomologists. The aphids also were observed in many eastern Ohio counties and probably were present throughout the state.

Several other aphid species are suspected carriers and research is underway to attempt transmission with them. There is no evidence at present that other types of insects can serve as vectors. All attempts at transmission with beetles, leafhoppers, and similar insects have failed. However, these failures do not rule out transmission by insects other than aphids.

Symptoms of the Disease

Symptoms of maize dwarf mosaic vary considerably, even in corn plants of the same hybrid in the same field. One plant may show symptoms early in the season and another not until after pollination.

Diseased plants usually appear in fields as spots or centers. Such spots frequently, but not always, appear first along one side or end of a field. As the season progresses, these diseased areas may enlarge until all corn plants in the field are infected.

Plants in affected areas usually have marked variation in height by the end of the season. It is not unusual to find a plant 12 to 18 inches tall adjacent to other plants of normal or near normal height. Heights of surrounding plants may vary anywhere within this range.

Early season symptoms of maize dwarf mosaic are quite different from those found toward the end of the season.

Under greenhouse conditions, symptoms appear in plants only 4 to 6 inches tall. In the field, the first obvious symptoms occur when corn plants are about 12 inches high.

Early symptoms first appear at the bases of leaves and consist of a mosaic pattern of light and dark green areas within the leaves (Fig. 3). The mosaic may remain in a uniform pattern or the spots or flecks may merge into narrow continuous or broken streaks along the veins of the leaves.

Later, at about the time of last cultivation in the field, the younger leaves unfolding in the whorl are more uniformly yellow or chlorotic. The yellowing may be more pronounced at the sides and tips (Fig. 4). Yellow stripes are evident in leaves of some plants until maturity.

As the diseased plants approach maturity in late August or September, red or reddish purple spots and streaks develop in the leaves (see cover photo and Fig. 5). In many plants, the reddish color is quite vivid and appears throughout much of the leaf. This red pigment which forms late in the season is more conspicuous in the upper leaves than in those below the ear. Lower leaves of plants infected late in the season may not show any discoloration.

When corn is infected early, severe stunting accompanies the above symptoms. The degree of dwarfing appears to be due to the stage of plant development when the infection occurs. Many plants have shortened internodes throughout but in others only the internodes above the ear are shortened. Plants infected in later stages of growth may not be stunted noticeably.

Diseased plants have from none to several ear shoots. One ear may develop at each of several nodes or several at one node. In general, all ears remain poorly filled on plants infected early in the season (Fig. 6). Plants with "late season" symptoms usually produce a fairly good ear.

Host Plants

Many kinds of plants, both weed and crop plants, have been tested in the greenhouse to determine the host range of maize dwarf mosaic. In addition to corn, the following grasses were found susceptible to the virus: sorghum, sudangrass, Johnson grass, teosinte, green foxtail, yellow foxtail, foxtail millet, barnyard grass, crabgrass, Indian grass, love grass, little blue stem, panic grass, wild cane, and sugar cane.

With the exception of sorghum, sudangrass, teosinte, and sugar cane, the above are weed grasses, most of which are widely distributed in Ohio. Johnson grass is a perennial weed found in most sections of Ohio. It is widely distributed in southern areas of the state and is especially prevalent in valleys of rivers and streams.

In early May 1964, when corn was being planted in southern Ohio, maize dwarf mosaic was found to be present in much of the Johnson grass. It presumably had persisted over the winter in the underground rhizomes of this weed. Later in the season, the virus appeared to be present in a high percentage of foxtail grass and in lesser amounts of crabgrass.

Further research may show that other plants are susceptible to this virus.

Control and Prevention

Chances of controlling the disease with insecticides which kill the virus-carrying insects are not too good. Most commonly used insecticides will not kill the insects quickly enough to prevent initiation of feeding. However, entomologists are investigating the possibility of some degree of control.

There is general agreement that the ultimate answer lies in development of resistant hybrids. Limited experiments to date suggest that

Fig. 5.—Late symptoms of the disease. Because of heredity, some hybrids show differences in susceptibility among individual plants.

resistance is controlled by a few dominant genes. If this is true, it may be fairly simple to breed this factor into adapted corn hybrids.

Measuring Resistance of Hybrids

Information was obtained in 1964 on resistance in many commercially available corn hybrids to maize dwarf mosaic.

The test planting was made along the Ohio River near Portsmouth, Ohio. Maize dwarf mosaic occurred in this area during the two previous years. Entries were restricted largely to hybrids adapted to the area. However, many eligible ones were not included because of space and other limitations.

Drought and Johnson grass hampered normal plant development. At planting on May 13, there was a maximum of subsoil moisture from river overflow, but little rain fell until the latter part of July. Johnson grass was brought under control in early July. These stress factors complicated evaluation of the stunting effects of the disease.

Disease development depended on natural infection. Symptoms of maize dwarf mosaic were first noted in plants in the test plots in mid-June. By early July, the disease had spread to epidemic proportions.

Rating Method

Plants were rated for disease reaction as susceptible (S), intermediate (I), or resistant (R), depending on the degree of stunting and chlorosis.

Fig. 6.—Poorly filled ears typical of corn plants infected with maize dwarf mosaic.

Plants rated susceptible showed pronounced stunting and, generally, considerable chlorosis. Yield of such plants was drastically reduced. Many plants were infected with stalk-rotting organisms and broke near the ground. Most of these plants were a complete loss.

Intermediate ratings were given to plants that showed virus symptoms but which were only moderately affected in development. Plants with indefinite but suspicious symptoms of virus infection also were rated as intermediate.

Resistant ratings were given to plants with no apparent maize dwarf mosaic symptoms.

When plants of a hybrid showed a range of symptoms, a double rating was given. For example, a rating of S-R indicates that both susceptible and resistant plants were observed. In most cases, intermediate type plants also occurred in the S-R range. Although numbers of plants rated were not recorded, each rating usually covered at least one-fifth of the plants in each variety.

Table 1 reports ratings of experiment station single-crosses. Ratings of open and closed formula commercial and experimental hybrids are listed in Table 2.

Early observations on disease reaction were made in mid-July. Final ratings were made in mid-September. The earlier a hybrid was infected, the greater the yield reduction. Indicated stand is the total number of plants observed.

Most hybrids tested were observed to contain enough susceptible plants to be economically impractical. A few, however, were found resistant. More resistant hybrids undoubtedly are available commercially than were included in the test.

Observations on the maize dwarf mosaic reaction of inbred lines and single crosses indicate that most currently available double-cross hybrids will have 25 percent or more susceptible plants. Hybrids that combine lines with lesser degrees of susceptibility should contain a higher percentage of resistant plants. Hybrids in which 75 percent of the plants show good resistance may have high enough yields to be useful until fully resistant hybrids can be developed.

Further testing of this type is needed to learn the degree of resistance in hybrids. Double-crosses containing no susceptible plants will be rare but may exist with certain combinations. Single-cross hybrids involving one resistant inbred should be uniformly resistant.

A single year's results should be treated with considerable caution. This is especially true of this test since disease development depending on natural infection increases the chance for escapes. Although maize dwarf mosaic symptoms were present over the entire test area, discrepancies were noted in disease scores of certain hybrids in the two test replications. Limited knowledge concerning maize dwarf mosaic and insect vectors also precludes positive statements about the validity of this test's results.

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TABLE 1.—Virus Reaction of Experiment Station Single-Crosses at Portsmouth, Ohio, 1964.

Single Crosses	Total Plants	July Rating*	September Rating*
Oh3C x Oh7N	52	I-R	S
Oh3C x Oh7P	47	I-R	S
Oh3F x Oh4C	16	S-R	S
Oh3F x Oh7G	41	S-R	R
OhO4 x CI.28A	29	S	S
Oh4C x Oh67A	2	S	S
OhO5 x Oh7K	43	R	R
OhO5 x Oh32	41	I-R	I-R
OhO5 x B8	21	I-R	S-R
OhO5 x K159	53	I-R	R
OhO5 x K237	36	S-R	S-R
OhO5 x Pa11	39	I-R	R
OhO5 x W23	35	S-R	R
Oh07 x C103	51	R	R
Oh07 x P8	30	R	R
Oh07 x L317	38	R	R
Oh7A x OhTh	42	I-R	I-R
Oh7A x Oh40B	16	I-R	S-R
Oh7B x Oh26B	25	S-R	R
Oh7B x H15	52	R	R
Oh7B x B33	40	R	R
Oh7N x Oh43B	31	S-R	S
Oh7N x CH9	54	I-R	S-I
Oh7N x H60	39	I-R	I-R
Oh7N x B37	37	S-R	S
Oh7N x HD2187	48	R	R
Oh7K x Oh42LH	46	S-R	S
Oh7R x Oh29	32	S-R	S
Oh26 x Oh51	47	S-R	S
Oh26 x Oh501	42	I-R	R
Oh26 x Hy	27	S-R	S-R
Oh26A x Oh51A	32	I-R	S-R
Oh26C x Oh28	14	S-I	S
Oh26F x Oh43	54	S-R	S
Oh26F x Oh501	31	I-R	S-R
Oh26F x Oh502	40	I-R	I-R
Oh26F x Oh503	45	S-R	S-R
Oh26F x A619	31	S-R	S-I
Oh28 x Oh41	48	S-R	S
Oh28 x M14	37	S-R	S
Oh28 x W22	43	S-R	S
Oh29 x Oh51A	38	S-R	S
Oh29 x W22	42	S-R	S
Oh33 x Oh40B	11	S-R	S
Oh43 x Oh45	26	S-I	S

*S = Susceptible; I = Intermediate; R = Resistant

TABLE 1. (Continued)—Virus Reaction of Experiment Station Single-Crosses at Portsmouth, Ohio, 1964.

Single Crosses	Total Plants	July Rating*	September Rating*
Oh43 x Oh45B	37	S-I	S
Oh43 x Oh56A	53	S-I	S
Oh43 x Oh57	28	S-R	S-R
Oh43 x R53	39	S-I	S
Oh43 x 38-11	23	I-R	S-I
Oh43 x Pa32	16	S-I	S-I
Oh43 x W64A	41	S-R	S-R
Oh43 x W153R	36	S-R	S
Oh45B x M14	41	S-R	S
Oh45B x H55	40	S-R	S-I
Oh45C x Mo5	26	S-R	S
Oh45C x Pa887P	33	S-R	S-R
Oh51 x B46	42	S-R	S-R
Oh51A x W182D	50	S-R	S-I
Oh65 x W23	67	R	R
H21 x 33-16	18	I-R	S-R
K41 x K44	19	I-R	I-R
K55 x K64	48	S-R	S
C103 x B14	46	I-R	S-R
C103 x K148	45	S-R	S
A x W23	31	I-R	I-R
M14 x Pa23	34	R	R
M14 x Cl.187-2	36	I-R	R
M14 x W22	42	S-R	S
R181 x B37	49	S-R	S-I
R181 x Pa32	47	S-R	I-R
WF9 x Hy	36	S-R	S-R
WF9 x H55	45	S-R	S-I
WF9 x Cl.21E	5	R	S-R
WF9 x 38-11	45	S-R	S
WF9 x B35	54	I-R	S-R
WF9 x B37	33	I-R	S-I
WF9 x Oh51A	45	I-R	S-R
WF9 x H73	45	S-R	S-I
WF9 x A158	44	S-R	S
WF9 x K150	43	R	S-R
WF9 x Oh4G	48	S-R	S
WF9 x Oh33	36	I-R	I-R
H5 x W22	2	S-R	S-I
H49 x H55	29	S-R	S
H49 x B14	33	I-R	S-R
H49 x B37	39	R	S-I
N6G x Mo4524	38	S-R	S-R

*S = Susceptible; I = Intermediate; R = Resistant

TABLE 2.—Virus Reaction of Open-Pedigree and Private-Formula Commercial and Experimental Corn Hybrids at Portsmouth, Ohio, 1964.

Hybrid Designation	Total Plants	July Rating*	September Rating*
	Open-Pedigree Hybrids		
Indiana 678	47	S-I	S-I
Indiana 682	41	S	S
Indiana 750A (White)	45	I-R	S-R
Indiana 837	47	S-R	S
Indiana 863	41	S-I	S-R
Indiana 909-4B (White)	37	S-R	S-R
Iowa 4297	47	S-R	S-R
Ohio 401	21	S-R	S
Ohio M15	46	S-R	S-R
Ohio M53	28	I-R	S-I
Ohio 524	41	S-I	S-I
Ohio K24	27	S-R	S-R
Ohio K62	27	I-R	S-R
Ohio W45	45	S-R	S
Ohio W49	31	S-R	S-R
Ohio W64	40	S-R	S
Ohio 708	38	S-R	S
Ohio 710	32	S-R	S
Ohio C38	32	S-R	S-I
Ohio C47	25	S-R	S
Ohio C54	78	S-R	S-I
Ohio 760	48	S-R	S-I
Ohio L41	40	S-I	S
Ohio 823	39	S	S
Ohio L94	47	R	S-I
Ohio 5701	53	S-R	S
AES 805	35	S-R	S
Pa. 555	38	S-R	S-R
Pa. 602A	29	S-R	S
U. S. 13	40	S-R	S
U. S. 523W (White)	40	S-R	S-R
Wisconsin 537	42	S-R	S-I
Wisconsin 545	33	S-R	S-R
Wisconsin 575	45	S-R	S-I
Wisconsin 577	46	S-I	S-R
Wisconsin 600	49	S-R	S-R
Wisconsin 630	37	S-R	S-R
Wisconsin 646	48	S-R	S-I
Wisconsin 647	33	S-R	S-R
Wisconsin 690	48	S-R	S-R
Wisconsin 1584	35	S-R	S-I
Wisconsin 1585	40	S-R	S-R
Wisconsin 1587	32	S-R	S-I
Wisconsin 1589	37	S-R	S-I
Wisconsin 1591	47	S-R	S-R
Wisconsin 1592	43	S-R	S-I
Wisconsin 1593	34	S-R	S-I
Wisconsin 1802	40	I-R	S-R
Wisconsin 1803	52	S-R	S-I
Wisconsin 1804	54	S-R	S-R
Wisconsin 1805	33	S-R	S-R

*S = Susceptible; I = Intermediate; R = Resistant

TABLE 2. (Continued)—Virus Reaction of Open-Pedigree and Private Formula Commercial and Experimental Corn Hybrids at Portsmouth, Ohio, 1964.

Hybrid Designation	Total Plants	July Rating*	September Rating*
	Open-Pedigree Hybrids		
Wisconsin 1806	37	S-R	S-I
Wisconsin 1807	36	I-R	S-I
Wisconsin 1808	42	S-I	S-R
Wisconsin 1809	29	S-R	S
Wisconsin 1810	49	S-R	S-I
(Oh51A x B37) (Oh43 x H55)	44	S-R	S
(WF9 x B37) (Oh43 x H55)	41	S-R	S
(WF9 x H55) (B37 x C103)	45	S-R	S
	Private-Formula Hybrids		
Dekalb 441	43	S	S-R
Dekalb 624	47	S	S-R
Dekalb 805	36	S-R	S
Dekalb 822	36	I-R	S
Dekalb XL65	45	S-R	S
Dekalb XL361	47	S-R	S
Edw. J. Funk 6700	49	S-R	S
Edw. J. Funk HB S-7	51	S-R	S-R
Edw. J. Funk HB S-66	50	S-R	S
Edw. J. Funk HB 851	49	S-R	S
Edw. J. Funk HB 890	40	S-R	S-R
Edw. J. Funk HB 891	48	S-R	S
Edw. J. Funk HB 6300	44	S	S
Edw. J. Funk HB 6500	54	S-R	S
Edw. J. Funk HB 8300	42	I-R	S-R
Edw. J. Funk S-88	49	S-R	S-R
Funk G-81	43	S-R	S-R
Funk G-83	37	S-R	S
Funk G-96	37	S-R	S
Funk G-144	39	S-R	S-R
Funk G-4582	40	S	S
Funk G-4703	47	S-R	S-R
Funk 11917	46	R	S-R
Funk 14390	44	S-R	S
Funk 15350	48	S-I	S
Funk 15352	43	R	R
Hancock 1C4-X150	48	S-I	S
Hancock 1C6-X145	33	S-R	I-R
Hancock 1C7	41	S-R	S-R
Hancock 1500	34	S-R	S
Hancock 21C3-152A	34	S-I	S
Hancock 24C4-X1604	41	S-R	S
Hancock 24C6-160	28	S-R	S
Hancock 25C3	49	S-R	S
Hancock 25C4-152K	44	S-R	S-I
Hancock X158	46	S-R	S-R
Hiser H-406	51	S-R	S-R
Hiser H-702	52	S-R	S-R
Hiser H-720	37	S-R	S
Hiser H-725	52	S-R	S-I

*S = Susceptible; I = Intermediate; R = Resistant

TABLE 2. (Continued)—Virus Reaction of Open-Pedigree and Private Formula Commercial and Experimental Corn Hybrids at Portsmouth, Ohio, 1964.

Hybrid Designation	Total Plants	July Rating*	September Rating*
	Private-Formula Hybiids		
Hiser H-736	47	S-R	S-R
Hiser H-740	40	S-R	S
Kenworthy 48	48	S-I	S
Kenworthy 50	34	S-R	S
Kenworthy 455	51	I-R	S-I
Kenworthy 465	44	S-R	S-R
Mark M20W (White)	51	S-R	S
Mark M211	55	S-R	S-R
Mark M217	52	S-R	S-R
Mark M218	38	S-R	S
Mark M219	54	S-R	S
Mark M227	32	S-R	S
Mark M228	47	S-R	S
Mark M314	38	S-R	S-R
Mark M314A	49	S-R	S
Mark M397	55	S-R	S
Mitchell Farms C/F 55	48	S-R	S-I
Mitchell Farms C/F 63	29	I-R	S
Mitchell Farms C/F 66	50	S-I	S-R
Mitchell Farms C/F 70	46	S-R	S
Mitchell Farms C/F 75	41	R	S-I
Mitchell Farms C/F 78	41	S-I	S
Mitchell Farms C/F 116	37	R	S-R
Mitchell Farms C/F 123	38	S	S
Mitchell Farms C/F 131	48	S-R	S-I
Mitchell Farms C/F 134	45	S-R	S-R
Mitchell Farms C/F 183W (White)	50	S-R	S-R
Mitchell Farms C/F 708	44	S-I	S-R
Moews MCB90A	47	S-R	S-I
Moews M96A	45	S-R	S
Moews M527	46	S-I	S
Moews M560	46	S-R	S-I
Moews M700	51	S-I	S
Moews M814A	45	S-R	S-I
Moews Exp. #1 (White)	39	S-I	S-I
Moews Exp. #2	46	S-R	S-I
Moews Exp. #3	39	S-I	S
Moews Exp. #4	51	S-I	S
Northrup King KT612	52	S-R	S-R
Northrup King KT626	41	S-R	S-I
Northrup King KT632	30	S-I	S
Northrup King KT638	41	S-I	S
Northrup King KT652	45	S-R	S-R
Northrup King Px84	54	S-R	S
OYO Seed Assoc. OYO 315	36	S-R	S
OYO Seed Assoc. OYO 380	26	S-R	S-I
OYO Seed Assoc. OYO 410	30	S-R	S-R
OYO Seed Assoc. OYO 435	39	S-R	S-R
OYO Seed Assoc. OYO 470	44	S-R	S

*S = Susceptible; I = Intermediate; R = Resistant

TABLE 2. (Continued)—Virus Reaction of Open-Pedigree and Private Formula Commercial and Experimental Corn Hybrids at Portsmouth, Ohio, 1964.

Hybrid Designation	Total Plants	July Rating*	September Rating*
	Private-Formula Hybrids		
OYO Seed Assoc. OYO 490	36	S-I	S
OYO Seed Assoc. OYO 525	48	S-R	S-I
Pfister PAG 399	55	S-R	S
Pfister PAG 418	31	S-I	S
Pfister PAG 434	54	S-R	S-R
Pfister PAG 437	46	S-R	S-R
Pfister PAG 633 (White)	33	S-R	S
Pfister PAG SX19	48	R	R
Pfister PAG SX29	49	S-R	S-R
Pfister PAG SX59	39	I-R	S-R
Pfister PAG SX63	50	S-I	S
Pfister PAG Exp. 64GG	29	S-R	S
Pioneer 310	53	I-R	S-I
Pioneer 312A	48	S-R	S
Pioneer 318A	54	S-R	S
Pioneer 321	57	S-R	S
Pioneer 323	50	S-I	S
Pioneer 325A	56	S-R	S
Pioneer 3304	51	S-R	S
Pioneer 3306	40	R	S
Pioneer C114 Cr(64)	36	S-R	S
Pioneer X8310	48	S-R	S-R
Pioneer 22910 Exp.	52	I	S-I
Ruff R170	38	S-R	S-I
Ruff R188	24	S-R	S
Ruff R244	27	S-R	S-R
Ruff R285	41	S-R	S
Ruff R290	38	S-R	S-R
Ruff R304	50	S-R	S-I
Ruff R311	43	S-R	S-I
Ruff RE323	47	I-R	S-R
Ruff RW22 (White)	45	I-R	S-R
Ruff RW33	43	S-R	S-R
Stulls 85Y	47	S-I	S-R
Stulls 100YB	39	S	S
Stulls 101YA	40	S-R	S-R
Stulls 400W (White)	45	I-R	S-I
Stulls 500W (White)	48	I-R	S-R
Stulls 807Y	35	S-I	S
Stulls 807YA	43	S	S-R
Williams W40	31	S-R	S-R
Williams W50	46	S-I	S
Williams W60	44	S-R	S
Williams W66	40	S-R	S
Williams W70	49	S-R	S-R
Williams W76	35	S-I	S-I
Williams W77	40	S-R	S
Williams W99	38	S-R	S

*S = Susceptible; I = Intermediate; R = Resistant