Response of Annual and Perennial Teosintes (*Zea*) to Six Maize Viruses

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ABSTRACT

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Teosinte (*Zea*) species and subspecies were tested for susceptibility to maize dwarf mosaic virus strains A and B, maize chlorotic dwarf virus, maize chlorotic mottle virus, maize stripe virus, and maize streak virus. The annual teosintes, *Z. mexicana* subspecies *mexicana* and *parviglumis* and *Z. luxurians*, were susceptible to all viruses. The diploid perennial teosinte, *Z. diploperennis*, was immune to maize chlorotic dwarf, maize chlorotic mottle, and maize streak viruses, slightly susceptible to maize dwarf mosaic virus strain B and maize stripe virus, and susceptible to maize dwarf mosaic virus strain A. The tetraploid perennial teosinte *Z. perennis* was susceptible only to maize stripe virus. Because *Z. diploperennis* is interfertile with *Z. mays*, it offers potential for contributing to maize genes for immunity or tolerance to virus diseases.

The recent discovery of a new, perennial teosinte (*Zea diploperennis* Iltis, Doebley and Guzman) has led to speculation that the species may provide potentially valuable germ plasm; for example, the development of perennial maize is now possible (6). Other useful traits for incorporation into maize (*Z. mays* L.) include genes for resistance or tolerance to insect pests and diseases. *Z. diploperennis* is the most primitive species of the genus *Zea* (2). Hence, with its long history as a species, it may have acquired resistance or tolerance to insect pests and diseases in its mountain habitat in Mexico. More important, however, unlike annual species of teosinte that survive only by seed, the perennial species, in part, survives in situ. It can therefore be expected to be highly resistant or tolerant to insect pests and diseases in general.

Little is now known about the susceptibility of *Z. diploperennis* to insects and diseases. Reifschneider and Arny (13) have reported that it is susceptible to maize eyespot fungus, *Kabatiella zeae* Narita & Hiratsuka, which is not known to occur in Mexico. Nault (7) and Nault et al (9) reported that *Z. diploperennis* is susceptible to the corn stunt spiroplasma, tolerant to the maize rayado fino virus, and immune to the maize bushy stunt mycoplasma. These three leafhopper-transmitted pathogens are endemic to Mexico and may have played a role in the evolution of maize and its ancestors, including *Z. diploperennis* (8).

We report on the susceptibility of *Z. diploperennis* and other annual and perennial teosinte species to six maize viruses and speculate on the use of these plants to provide germ plasm for maize that is resistant to virus disease.

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MATERIALS AND METHODS

Z. diploperennis, as well as other *Zea* spp. (5)—*Z. perennis* (Hitchc.) Reeves & Mangelsdorf, *Z. luxurians* (Durieu & Ascherson) Bird, *Z. mays* subsp. *mexicana* (Schrader) Iltis (the races Chalco and Central Plateau), and *Z. mays* subsp. *parviglumis* Iltis and Doebley (varieties *parviglumis* and *huehuetenangensis*)—were tested for susceptibility to maize dwarf mosaic virus (MDMV) strains A and B, maize chlorotic dwarf virus (MCDV), maize chlorotic mottle virus (MCMV), maize streak virus (MSV), and maize stripe virus (MStpV).

Ohio isolates of strains A (14) and B (4) of MDMV and a Kansas isolate of MCMV (12) were mechanically inoculated to test species. Approximately 5 g of infected maize (Aristogold Bantam Evergreen) leaves were ground with 5 ml of buffer (0.01 M potassium phosphate, pH 7.0) in a mortar with pestle. Silicone sand was added to assist grinding. Expressed sap was filtered through two layers of cheesecloth. Plants in the two- to three-leaf stage were dusted with 600-mesh Carborundum before leaves were rubbed with virus inoculum.

A South African biotype of *Cicadulina mbila* Naude was used as a vector of an African isolate of MSV (1), an Ohio biotype of *Graminella nigrifrons* (Forbes) was used as a vector of an Ohio isolate of MCDV (11), and a Florida biotype of *Peregrinus maidis* Ashmead was used as a vector of a Florida isolate of MStpV (3). Two or three MSV-inoculative *C. mbila* were caged on each test species in the one- to three- and the six- to eight-leaf stage for at least 24 hr. Ten MCDV-inoculative *G. nigrifrons*, prepared as previously reported (11), were caged on each test species for a 48-hr inoculation access period (IAP). MStpV-inoculative *P. maidis*, prepared as previously reported (3), were given a 72-hr IAP on test species.

Following inoculation with the six viruses, test species were placed in the greenhouse and observed weekly for symptom development for 4 wk, after which final results were recorded. In all tests, except for those with MSV, Aristogold Bantam Evergreen sweet corn was inoculated to test for the presence of virus in inocula. DeKalb XL45 field corn was used for MSV tests. Plants with and without symptoms of MDMV-A, MDMV-B, MCDV, and MCMV were tested by enzyme-linked immunosorbent assay, as described previously (10), to check for presence of virus in test species. Bioassays were performed on a limited number of test species to check for presence of MSV and MStpV. For MSV, plants with or without symptoms were selected at random from each test species and caged with five or more nonviruliferous *C. mbila* for 2 or more days. The *C. mbila* were transferred to one or two small XL45 corn seedlings for 3 days and then removed. Symptoms were recorded upon appearance. For MStpV, plants with symptoms were caged with 25 nymphs of *P. maidis* for a 4-day acquisition access period followed by a 17-day incubation period and then transferred to sweet corn at the rate of five per plant for a 4-day IAP. Test plants were placed in the greenhouse and observed for 3 wk for symptoms.

RESULTS AND DISCUSSION

All of the annual teosinte species were susceptible to the six viruses tested, although resistance to MSV was noted for several introductions of *Z. mays* subsp. *parviglumis* var. *huehuetenangensis* (Table 1). Immunity to viruses occurred only with the perennial teosinte species. *Z. diploperennis* was immune to MCDV, MDMV, and MSV. Only 1 of 24 plants was susceptible to MDMV-B. Although *Z. diploperennis* was susceptible

Table 1. Susceptibility of *Zea* species and subspecies to maize dwarf mosaic virus (MDMV) strains A and B, maize chlorotic dwarf virus (MCDV), maize chlorotic mottle virus (MCMV), maize stripe virus (MStpV), and maize streak virus (MSV)

Taxon	Virus					
	MDMV-A	MDMV-B	MCDV	MCMV	MStpV	MSV
Zea mays						
subsp. *mays* (Aristogold)	18/20[a]	17/19	18/18	8/8	15/15	13/13[b]
subsp. *mexicana*						
Central Plateau, race	10/10 (4/4)[c]	9/10 (4/4)	7/12 (8/12)	12/12 (4/4)	12/12 (2/2)	7/9 (2/2)
Chalco, race	5/5 (2/2)	5/5 (2/2)	NT[d]	9/9 (4/4)	NT	11/11 (2/2)
subsp. *parviglumis*						
var. *parviglumis*	10/10 (4/4)	9/10 (4/4)	4/12 (5/12)	12/12 (4/4)	8/12 (2/2)	19/20 (2/2)
var. *huehuetenangensis*	3/4 (3/4)	4/4 (4/4)	3/3 (3/3)	4/4 (4/4)	2/4 (2/2)	8/58 (5/5)
Z. luxurians	4/4 (4/4)	4/4 (4/4)	3/3 (3/3)	4/4 (4/4)	1/4 (1/1)	12/13 (2/2)
Z. perennis	0/10 (0/4)	0/10 (0/4)	NT[e]	0/10 (0/4)	4/7 (2/2)	0/14 (0/2)
Z. diploperennis	22/24 (4/4)	1/24 (1/24)	0/26 (0/26)	0/14 (0/4)	6/8 (2/2)	0/12 (0/2)

[a]Number of plants with symptoms/number of plants inoculated.
[b]DeKalb XL45 field corn.
[c]Within parentheses: Number of plants positive/number checked for virus. Plants were checked for MDMV-A, MDMV-B, and MCDV by enzyme-linked immunosorbent assay; for MCMV by microprecipitin assay; and for MSV and MStpV by bioassay.
[d]Not tested.
[e]*Zea perennis* was previously reported immune to MCDV (11).

to MStpV, symptoms were mild and observed only on one to three leaves above those inoculated; leaves developing later were free of symptoms. Only MDMV-A produced vivid symptoms that persisted on all leaves that developed after inoculation. *Z. perennis* was susceptible only to MStpV, with mild symptom expression similar to that seen for *Z. diploperennis*.

The immunity of *Z. diploperennis* to three viruses and its interfertility with maize provide the possibility of incorporating this immunity into maize. We are encouraged by preliminary tests with first generation backcrosses (maize × *Z. diploperennis* with maize as the recurrent parent) that are resistant to MCDV (W. R. Findley, Nault, and Gordon, *unpublished*). The limited susceptibility of *Z. diploperennis* to MDMV-B suggests that useful germ plasm may be available for this virus. Our results also imply that the introductions of *Z. diploperennis* used in these studies (sources from two locations in Jalisco) are heterozygous for virus resistance and that further search for seed in Mexico may reveal genotypes immune to all six viruses. Although *Z. perennis* was immune to all viruses but MStpV, its resistant germ plasm will be difficult to transfer to maize because the latter is diploid and *Z. perennis* is tetraploid, and crosses between them produce sterile, triploid progeny.

LITERATURE CITED

1. Damsteegt, V. D. 1980. Investigations of the vulnerability of U.S. maize to maize streak virus. Prot. Ecol. 2:231-238.
2. Doebley, J. F., and Iltis, H. H. 1980. Taxonomy of *Zea* (Gramineae). A subgeneric classification with key to taxa. Am. J. Bot. 67:982-993.
3. Gingery, R. E., Nault, L. R., Tsai, J. H., and Lastra, R. J. 1979. Occurrence of maize stripe virus in the United States and Venezuela. Plant Dis. Rep. 63:341-343.
4. Gordon, D. T., and Williams, L. E. 1970. The relationship of a maize virus isolate from Ohio to sugarcane mosaic virus strains and the B strain of maize dwarf mosaic virus. (Abstr.) Phytopathology 60:1293.
5. Iltis, H. H., and Doebley, J. F. 1980. Taxonomy of *Zea* (Gramineae). II. Subspecific categories in the *Zea mays* complex and a generic synopsis. Am. J. Bot. 67:994-1004.
6. Iltis, H. H., Doebley, J. F., Guzman, M. R., and Pazy, B. 1979. *Zea diploperennis* (Gramineae): A new teosinte from Mexico. Science 203:186-188.
7. Nault, L. R. 1980. Maize bushy stunt and corn stunt: A comparison of disease symptoms, pathogen host ranges, and vectors. Phytopathology 70:659-662.
8. Nault, L. R., and DeLong, D. M. 1980. Evidence for co-evolution of leafhoppers in the genus *Dalbulus* (Cicadellidae: Homoptera) with maize and its ancestors. Ann. Entomol. Soc. Am. 73:349-353.
9. Nault, L. R., Gingery, R. E., and Gordon, D. T. 1980. Leafhopper transmission and host range of maize rayado fino virus. Phytopathology 70:709-712.
10. Nault, L. R., Gordon, D. T., Gingery, R. E., Bradfute, O. E., and Castillo Loayza, J. 1979. Identification of maize viruses and mollicutes and their potential insect vectors in Peru. Phytopathology 69:824-828.
11. Nault, L. R., Gordon, D. T., Robertson, D. C., and Bradfute, O. E. 1976. Host range of maize chlorotic dwarf virus. Plant Dis. Rep. 60:374-377.
12. Niblett, C. L., and Claflin, L. E. 1978. Corn lethal necrosis—A new virus disease of corn in Kansas. Plant Dis. Rep. 62:15-19.
13. Reifschneider, F. J. B., and Arny, D. C. 1980. Host range of *Kabatiella zeae*, causal agent of eyespot of maize. Phytopathology 70:485-487.
14. Williams, L. E., and Alexander, L. J. 1965. Maize dwarf mosaic, a new corn disease. Phytopathology 55:802-804.