Maize Dwarf Mosaic Virus Replication in Pigment-Deficient Mutants of Corn

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ABSTRACT

Maize dwarf mosaic virus (MDMV) replication was demonstrated in several pigment-deficient mutants of corn. Infected plants were symptomless, and presence of the virus was determined by recovery assays on susceptible sweet corn. Of nine mutants tested, six supported replication of the A strain of MDMV, and eight supported replication of the B strain. Etiolated mutants seemed more susceptible to MDMV than those grown in light.

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A few albino corn seedlings were present in selected lots of seed in a routine test of many inbred lines at the Iowa State University Agricultural Experiment Station. These mutants were routinely mechanically inoculated, along with the normal seedlings, with the A-strain of maize dwarf mosaic virus (MDMV-A). Although the normal seedlings were susceptible to MDMV, the inoculated albino seedlings did not express any symptoms compared with the noninoculated albinos. No evidence of virus replication was detected from inoculated leaves during routine recovery assays from all symptomless seedlings. Because a graded series of pigment-deficient mutants was available and already being studied (1), we wanted to determine what stage of plastid development would allow MDMV replication.

Plant virus replication has been demonstrated in plants with variegated leaf areas due to mutations that cause deficiencies in chlorophyll and other pigments. Tobacco mosaic virus has been shown to increase in variegated pepper leaves (2) and to form local lesions in albino leaf areas of variegated tobacco (5). Cucumber mosaic virus has been shown to form local, necrotic lesions in the albino areas of variegated *Vicia faba* leaves (6). Although MDMV has been recovered from an inoculated albino mutant of corn

TABLE 1. Ability of pigment-deficient mutants of corn to support replication of maize dwarf mosaic virus

Genotype	Phenotype	No. infected/inoculated MDMV-A	MDMV-B
lw_1	albino	0/6	1/96 X[a]
w_1	albino	1/2	8/22 Y
w_1	normal sib	2/5	2/4
w_{8657}	albino	0/6	0/6
w_{8657}	normal sib	0/1	0/1
l_{10}	yellow	3/5	3/5
w_{8896}	yellow	1/6	18/137 Z
lBrawn no. 1	yellow-green	3/6	3/4
pas_{8686}/w_3	pale green	2/4	2/4
pas_{8686}	pale green	2/4	21/104 Z
l_7	pale green	0/0	1/1
l_7	normal sib	4/7	2/6

[a] Results having letters in common are not significantly different from each other at the 1% level.

(4), the present work is the first study of plant virus replication in a series of pigment-deficient mutants of corn.

Mutant corn plants (*Zea mays* L.) were grown in autoclaved peat: sand: loam soil (1:1:2, v/v) in a growth chamber at 25 C under 12 hr of illumination 21,520 lx (2,000 ft-c). After emergence and partial expansion of the first two leaves, plants were dusted with Carborundum (600-mesh), and rubbed with cheesecloth saturated with plant sap prepared by grinding MDMV-infected sweet corn tissue in equal volumes (1 ml/g tissue) of 0.01 M KPO_4 buffer (pH 7.2) with a mortar and pestle. Both the A-strain (Ia-74) and the B-strain (ATCC PV-53) of MDMV were used in this study.

After 5-10 days, individual mutant plants, which were symptomless, were assayed for the presence of MDMV by grinding the plants in equal volumes (1 ml/g tissue) of 0.01 M KPO_4 buffer (pH 7.2), and inoculating susceptible sweet corn by the procedure just described. Systemic mosaic symptoms on the assay plants appeared in 7-10 days, if virus was present in the mutant tissue.

Three mutants (lw_1, w_{8896}, pas_{8686}) were selected in order to study the effect of etiolation on susceptibility to virus infection. The plants were grown in the same soil mixture described but were maintained under greenhouse conditions. Half the plants were kept in a light-tight box in which temperature and humidity conditions were maintained identical to those of plants grown in full illumination. The plants were inoculated with the B-strain of MDMV and assayed as described previously. Replications of experiments were limited because of limited seed supplies and the poor germination percentage of many of the mutants.

TABLE 2. Effect of etiolation of the ability of pigment-deficient mutants of corn to support replication of maize dwarf mosaic virus

Genotype	Phenotype	No. infected/inoculated Etiolated	Full light
lw_1	albino	2/30	0/30
w_{8896}	yellow	4/21	2/29
pas_{8686}	pale green	2/30	0/30

Of the nine mutants tested for susceptibility to MDMV infection, six supported replication of the A-strain of MDMV, and eight supported replication of the B-strain. Of the four mutants for which there was a good seed supply, the w_1 albino seemed the most efficient in supporting MDMV replication; pas_{8686} and w_{8896} were intermediate, and the lw_1 albino was relatively resistant (Table 1, combined data). Results from experiments with etiolated mutants, suggest that they may be better able to support viral replication than those grown in full illumination (Table 2).

Because maize dwarf mosaic virus can replicate in plants that severely lack normal amounts of photosynthetic pigments, MDMV replication may be independent of photosynthesis. Additional evidence of this is the apparent lack of correlation between relative infectivity and the amount of pigmentation of the mutants. The w_1 albino, with little pigmentation, supports MDMV infection, while the pale green mutant pas_{8686} is less efficient, and the lw_1 albino is almost totally resistant to infection. Because all normal sibs were not available for assay, the presence or absence of innate resistance or susceptibility to MDMV infection cannot be ruled out as a possible explanation of the differences in susceptibility observed among the mutants. The important question raised by these data is, what role do the chloroplasts play in virus replication, especially in the light of the work of Mayhew et al. (3), which implicates the chloroplast in MDMV replication and demonstrates the presence of ribonuclease-resistant RNA, possibly viral RNA, in the degenerate plastids of the w_1 albino mutant. The results of the etiolation studies might seem to substantiate the theory that virus replication is independent of photosynthesis. The work of Bachmann et al. (1), which shows that some mutants grown in very dim light produce relatively normal plastids would lend weight to the hypothesis that the etiolation results indicate a dependence of MDMV replication on chloroplasts.

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