A New Mosaic Disease of Corn

C. W. BOOTHROYD, Professor, and H. W. ISRAEL, Senior Research Associate, Department of Plant Pathology, Cornell University, Ithaca, NY 14853

ABSTRACT

BOOTHROYD, C. W., and H. W. ISRAEL. 1980. A new mosaic disease of corn. Plant Disease 64:218-219.

Severe stunting and mosaic of field-grown dent and sweet corn (*Zea mays*) were found in nine counties in New York in June and July 1979. Chlorotic white lines (1–2 mm × 1–2 cm) in and along veinal tissue occurred in the mosaic pattern of most of the leaves, suggesting the name white line mosaic. Isometric viruslike particles about 35 nm in diameter were recovered from diseased leaves, roots, and silks. Provisionally, this mosaic is believed to be dissimilar from any known virus disease of corn in the United States.

A few corn plants with severe stunting and a strong mosaic pattern of the leaves (Fig. 1A) were found in a field planted to sweet corn (*Zea mays*) at Ithaca, Tompkins County, New York, on 25 June 1979 (1). The mosaic was accentuated by short chlorotic lines (1–2 mm × 1–2 cm) in and along veinal tissue (Fig. 1B). Except for the white line characteristic, the mosaic resembled maize dwarf mosaic (MDM). Mechanical inoculations of corn and sorghum seedlings with extracts from diseased leaves, however, gave negative reactions.

MATERIALS AND METHODS

Distribution. In the 3-wk period following the discovery of the mosaic in Ithaca, many samples of leaves from plants with similar symptoms were collected and examined. Some diseased leaves were found in a limited survey of counties north and east of Ithaca; others were collected on farm visits requested by county agents or were submitted for diagnosis by county agents and seed corn industry representatives.

Laboratory and greenhouse tests. Samples of leaf material collected in June were used by us and by W. F. Rochow, Cornell University, in aphid transmission studies. Similar material was prepared for an enzyme-linked immunosorbent assay (ELISA) for maize dwarf mosaic virus (MDMV) and tested against antisera for MDMV-A and MDMV-B (3). Most of the diseased leaf samples, along with healthy controls in a single-blind test, were examined under the electron microscope (EM) for viruslike particles; initially, H. C. Hoch, New York Agricultural Experiment Station, Geneva, examined dent corn and later we examined dent and sweet corn. Most samples were prepared by a modified leaf-dip method (7). Briefly, each leaf was cut parallel to its long axis with a new razor, dipped into distilled water, "frayed" with 10 1-cm closely spaced parallel cuts made perpendicular to the original cut, dipped again into distilled water, blotted against absorbent paper while 1–2 mm of the frayed end was removed with a fresh cut made parallel to the original, and then subjected to negative staining. This was done by dipping the frayed end into a 4-μl drop of a 3:1 (v/v) mixture of 2% potassium phosphotungstate (pH 6.9) and 1% vanadatomolybdate (pH 3.0) placed on a Formvar carbon-coated 300-mesh copper EM grid and moving the leaf edge back and forth in the drop for 2 min. The leaf was then removed and the preparation was dried with absorbent paper. Other plant parts were prepared by placing a 4-μl drop of a crude extract of the organ, made up in the negative stain, on a grid for 5 sec and then drying it.

Several samples of leaves of healthy and diseased dent and sweet corn were sent to the Ohio Agricultural Research and Development Center (OARDC) for confirmation of what appeared to be a disease of corn new to the United States. O. E. Bradfute examined material by electron microscopy, R. E. Gingery conducted biochemical and physical tests, D. T. Gordon tested extracts serologically against antisera of agents of diseases resembling the new mosaic in morphology or etiology, and L. R. Nault tested several aphid and leafhopper species for possible vector transmission.

Yield losses. The incidence and severity of the new mosaic were checked in several locations. Fresh weight and number of marketable and unmarketable sweet corn ears were recorded in a simple correlation of healthy and diseased plants and for all healthy and diseased plants in a given length of row. Fresh weight of stalks, ears, and leaves and height of plants were recorded for equal numbers of healthy and diseased dent corn plants for silage. At a later date, additional ears of dent corn were harvested from healthy and diseased plants, fresh weights were taken, and sample ears were dried for computation of grain loss from the mosaic.

RESULTS

Field surveys. The new mosaic was found to be most severe in the Ithaca area and within 25 miles northward in Cayuga County. Diseased plants were observed in 14 fields, for a total of eight dent corn hybrids, 12 sweet corn cultivars, and one ornamental corn cultivar. Dent and sweet corn were adjacent in only three locations. Additional material was of dent or sweet corn collected in surveys or submitted for diagnosis from Allegany, Clinton, Greene, Jefferson, Onondaga, and Ontario counties. A report of the mosaic in sweet corn in Wayne County was received from H. Humaydan, Harris Seed Co., and a specimen of diseased material of dent corn from a cultivar trial in Middlebury, Vermont, was submitted by R. D. Morse of Agway, Inc. No new mosaic was seen in a random survey of 15 additional counties east and northeast of Ithaca.

Symptoms. The mosaic pattern of leaves and severe stunting of plants resembled symptoms of severe MDM. The chlorotic white lines, primarily within veinal tissue, varied in number within and among cultivars of both dent and sweet corn. The characteristic and striking nature of this symptom, however, suggests that white line mosaic (WLM) is an appropriate and convenient name for the disease. Mosaic was mostly interveinal and varied in intensity from a mild mottle to severe necrosis. Many plants showed a crozierlike hooking of the terminal portions and were barren or produced small ears with reduced kernel number.

Laboratory and greenhouse tests. Results of mechanical transmission to corn and sorghum, aphid transmission to corn, and leaf-dip ELISA tests against strains A and B of MDMV were all negative. Examination of leaf dip preparations of both dent and sweet corn by EM revealed many isometric particles about 35 nm in diameter. Extracts of virgin silks and roots showed similar particles (Fig. 1C), but no particles were found in a few extracts of stamen, pollen, embryo, endosperm, and pericarp tissue from ears of diseased plants. A single greenhouse seedling from seed of a field-

Portions of this work dealing with electron microscopy were supported in part by USDA/SEA-CRGO Grant 7900096 and NSF Grant PCM 7903263 awarded to J. R. Aist and H. W. Israel.

Accepted for publication 13 November 1979.

00191-2917/80/000048$03.00/0

grown plant with WLM showed severe mosaic symptoms, and many isometric particles were seen in leaf dip and crude macerate preparations, suggesting seed transmission.

Tests conducted by scientists at the OARDC on New York specimens confirmed our belief that this mosaic was unlike any other described in the United States: The viruslike particles were about 35 nm in diameter, the particles could not be transmitted to corn by several aphid and leafhopper species, and serological assays against antisera for maize rayado fino (2), maize chlorotic mottle (6), maize chlorotic dwarf (4), and maize dwarf mosaic were negative.

Incidence, spread, and severity. Although the new mosaic was distributed widely in New York, actual yield losses in both dent and sweet corn were minimal. Most of the plants with severe WLM were found in the borders of fields. Evidence for spread into fields and across different cultivars was accumulated, suggesting some vector transmission relationship. Incidence of WLM within most fields was no greater than 5%, even along borders. In a few fields of both dent and sweet corn, the incidence of WLM was up to 40% along the edges but less than 5% in the field. In 225 ft of row of 4 acres of harvested sweet corn (Sweet Sue) in Ithaca, the incidence of WLM was 29%. About 15% of the ears from diseased plants were marketable, reducing potential loss from WLM to 14% in this area. Comparable loss in the rest of the field was about 10%. Actual numbers of diseased plants did not exceed 5% in four other plantings of sweet corn (Golden Beauty, Sprite, Spring Gold, and Sundance). Percentage of marketable ears of these plants with WLM was 70, 66, 35, and 0, respectively, reducing loss from the disease considerably.

Comparable data were obtained at harvest for corn for silage and corn for grain at Lake Ridge, Cayuga County. In a border area of 10 rows along one side of a 4-acre field of dent corn, 28–34% of the plants showed symptoms of WLM. Height of plants was significantly reduced and loss of corn for silage was about 5 tons per acre. Loss in yield of corn for grain was about 60 bushels per acre. Total incidence of WLM in this field, however, was less than 2%, and a reasonably good harvest was predicted.

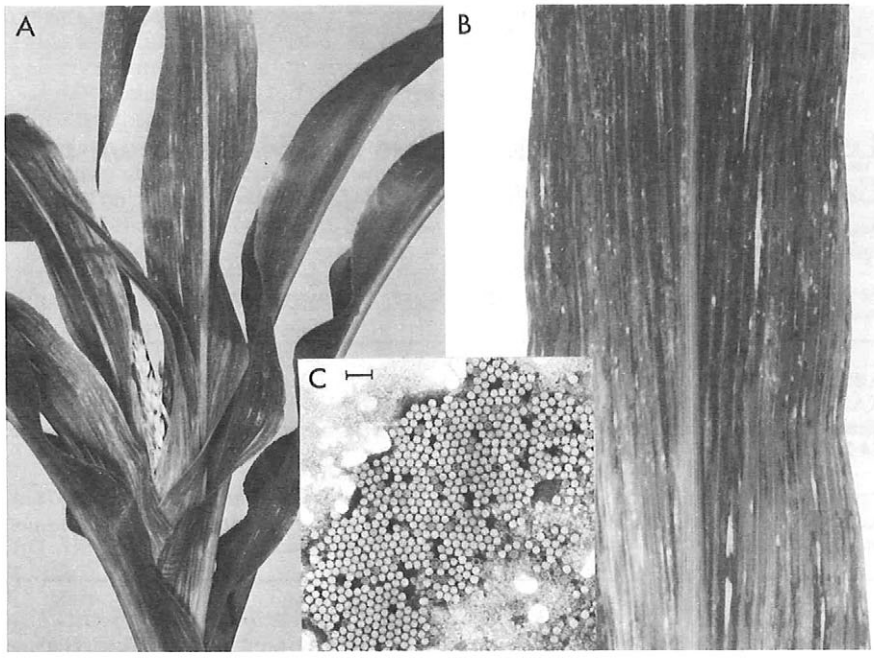

Fig. 1. White line mosaic in sweet corn (Seneca Scout): **(A)** Stunted plant with mosaic. **(B)** Leaf with mosaic and chlorotic white lines along veins. **(C)** Individual isometric viruslike particles (about 35 nm) from silk tissue; magnification scale = 100 nm.

DISCUSSION

An apparently new mosaic disease (white line mosaic) of dent and sweet corn has appeared in the northern United States. It was first seen in central New York in late June 1979 and was reported later in Vermont (A. R. Gotlieb, *personal communication*) (5), Ohio (D. T. Gordon, *personal communication*), and Wisconsin (D. C. Arny, *personal communication*). It differs from other mosaic diseases of corn in symptomatology and etiology. Isometric viruslike particles about 35 nm in diameter suggest a virus as the causal agent. Transmission by several aphid and leafhopper species has been negative, but the pattern of spread in the field suggests a vector relationship. Possible vectors or overseasoning hosts have not been identified. There is evidence of possible seed transmission, and roots and virgin silk of diseased plants contain numerous viruslike particles. The disease caused minimal losses in sweet corn in 1979 and was not of importance in corn for grain or for silage except in northern Vermont (A. R. Gotlieb, *personal communication*). The sudden appearance of a similar disease over a broad geographic region, the potential for 100% reduction in yield of infected plants, and the lack of information about survival and transmission of the viruslike particles warrant serious consideration of this new disease of corn.

ACKNOWLEDGMENTS

We thank W. F. Rochow and H. C. Hoch for corroborative studies and L. W. Hsu and S. J. Bucci for technical assistance.

LITERATURE CITED

1. BOOTHROYD, C. W., and H. W. ISRAEL. 1980. A new mosaic of corn. (Abstr.) Phytopathology. In press.
2. BRADFUTE, O. E., L. R. NAULT, D. T. GORDON, D. C. ROBERTSON, R. W. TOLER, and C. W. BOOTHROYD. 1980. Identification of maize rayado fino virus in the United States. Plant Dis. 64:50-53.
3. CLARK, M. F., and A. N. ADAMS. 1977. Characteristics of the microplate method of enzyme-linked immunosorbent assay for the detection of plant viruses. J. Gen. Virol. 34:475-483.
4. GORDON, D. T., and L. R. NAULT. 1977. Involvement of maize chlorotic dwarf virus and other agents in stunting diseases of *Zea mays* in the United States. Phytopathology 67:27-36.
5. GOTLIEB, A. R., and A. L. LIESE. 1980. White line mosaic and stunt of field and sweet corn in Vermont associated with polyhedral virus infection. (Abstr.) Phytopathology. In press.
6. NIBLETT, C. L., and L. E. CLAFLIN. 1978. Corn lethal necrosis—a new virus disease of corn in Kansas. Plant Dis. Rep. 62:15-19.
7. STUDENROTH, J. C. 1979. Some aspects of the epidemiology of maize dwarf mosaic in New York. Ph.D. thesis, Cornell University, Ithaca, NY. 232 pp.