Increased Leaf Exudation Enhances Curvularia Leaf Spot Severity in Virus-Infected Gladiolus

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ABSTRACT

Increased susceptibility of virus-infected *Gladiolus hortulansus* to Curvularia leaf spot disease was correlated with an increased foliar exudation of electrolytic substances and carbohydrates. Extractable epicuticular lipids and wax were less on virus-mottled than on symptomless leaves. Although leachates from both healthy and virus-infected leaves enhanced inoculum potential, greater stimulation resulted with virus-infected leaf washings.

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Additional key words: predisposition, disease complex, cucumber mosaic virus, tobacco ringspot virus.

Recently, cucumber mosaic virus (CMV) and tobacco ringspot virus (TobRSV) infection of *Gladiolus hortulansus* L. were reported to adversely affect survival and yield (1). These adverse effects were correlated with increased prevalence and/or severity of root rot disease, storage rot of corms, and Curvularia (*Curvularia trifolii* f. *gladioli*) leaf spot disease. Although a significant increase in severity of this leaf spot was observed on extremely susceptible cultivars, increased severity was most pronounced on the more-resistant cultivars which equalled the level of severity observed on virus-free susceptible cultivars.

Nutritional status of leaf washings from virus-infected or healthy leaves.—Healthy and CMV- or TobRSV-infected leaves of cultivars 'Traveler' and 'Friendship' were excised from field-grown plants and paired on the basis of similar shape and width (11). Each leaf was submerged, tip first, 20 cm into 100 ml of glass-distilled H_2O for 10 min. Leaves were rinsed for 1 min under running tap H_2O (28 C) prior to tests. Diffusion of electrolytes from intact leaf surfaces was also tested by placing a 2-ml "drop" of distilled H_2O on the surface of prewashed or nontreated healthy and virus-infected leaves. Conductivity of solutions was determined with a conductivity bridge, carbohydrates by the anthrone method (9), and amino acids or related compounds with ninhydrin(8).

Conductivity of solutions retrieved by the "drop" method averaged 2.1 and 4.0 μmhos, respectively, for healthy and virus-infected leaves in two tests using 10 paired leaves. Conductivity averaged 19.8 and 33.2 μmhos, respectively, from leaf washing of healthy and virus-infected leaves in three tests using 10 paired leaves. Similar increases in electrolyte release occurred when virus-infected and healthy leaves of cultivars Traveler or Friendship were submerged in distilled H_2O.

Total detected amino compounds did not differ in healthy and virus-infected leaf washings in three tests. Average content of amino compounds in leaf washings was 1.1 and 1.3 μg (glycine equivalent) per leaf, respectively, for healthy and virus-infected leaves. Anthrone-positive compounds collected in washings were 2- to 4-fold greater from virus-infected leaves compared to healthy leaves. Washings from healthy and virus-infected leaves contained an average of 4.3 and 9.2 μg (glucose equivalent) per leaf of anthrone-positive compounds.

Enhancement of Curvularia leaf spot by washings from virus-infected leaves.—Standardized numbers of conidia (10^5/ml) suspended in washings from virus-infected leaves produced more lesions on healthy and virus-infected leaves than those suspended in washings from healthy leaves or H_2O (Fig. 1). Although conidia in washings from healthy leaves produced as many lesions on healthy leaves as that observed on virus-infected leaves inoculated with conidia in distilled H_2O, the addition of healthy leaf washings did not increase lesion numbers on virus-infected leaves. In other tests, lesions that developed from conidia suspended in washings from virus-infected leaves were 80% larger in diam after 5 days than those produced by conidia in distilled H_2O and 40% larger in diam than those produced by conidia suspended in healthy washings (Fig. 2). Tests were repeated once with similar results.

Reduction of extractable epicuticular lipids or waxes on virus-infected leaves.—Water droplets adhered to and spread more on virus-infected than on healthy gladiolus leaf surfaces. It was also noted that excised virus-infected leaves when not placed in a moist chamber desiccated more rapidly than healthy leaves. In one test where 20 virus-infected and healthy leaves were excised to 25-cm length, weighed, and placed on an exposed surface for 12 hr at 22-24 C, loss of weight was 23.3 and 51.9%, respectively, for healthy and virus-infected leaves. Moreover, when excised leaves were submerged in chloroform-methanol (3:1) for 10 min followed by evaporation of solutions to dryness, a greater amount of substances was extracted from healthy than from virus-infected leaves in 85% of matched leaves tested. The total substances extracted from healthy leaves weighed 9.1 and 22.3% more than that from virus-infected leaves in two tests. Average weight of extractable compounds was 19.2 and 17.5 μg per leaf, respectively, for healthy and virus-infected leaves.

DISCUSSION.—Nutrient diffusates from leaves, petals, or fruit increased conidial germination and in some situations appear to be necessary for infection of *Botrytis* spp. (6, 10) and other fungi (2, 7). The effect of leaf exudates on incidence and severity of foliar fungus disease of virus-infected plants has not been determined, however. The wax coating over the plant surface may protect against infection by causing "infection drops" to run off instead of spreading over the epidermis and by restricting host exudation (4) which enhances fungus germination and infection (2, 3, 5).

Several lines of evidence presented herein suggest the role of increased leaf exudation as a primary mechanism

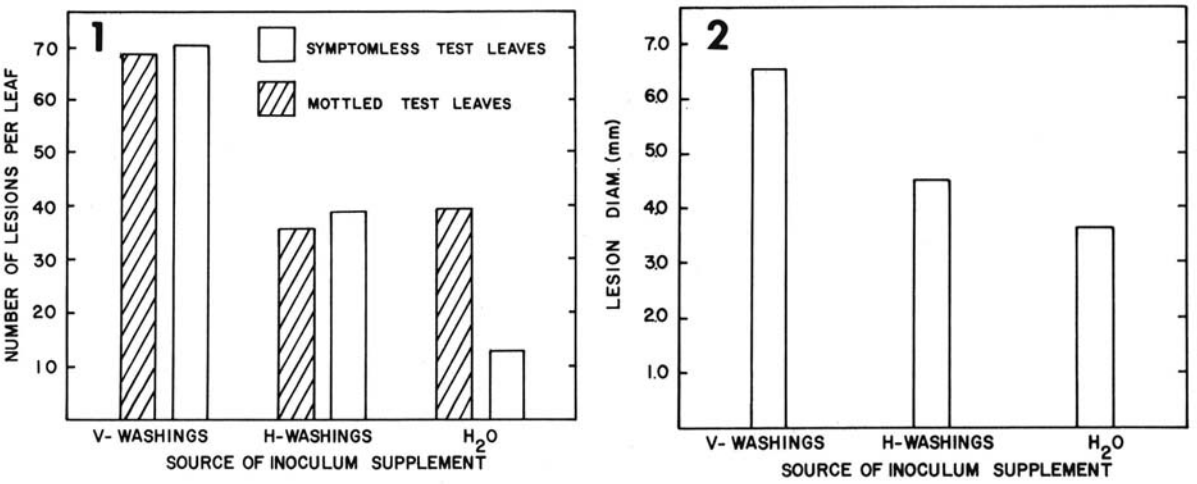

Fig. 1-2. Effect of supplementing conidial suspensions with leaf washings from virus-infected (V) leaves, healthy (H) leaves, or distilled water (H_2O) on: **1)** infectivity of conidia on healthy (symptomless) or virus-infected (mottled) test leaves, and **2)** lesion development on healthy test leaves.

in increasing nutritional aspects of the inoculum potential of *C. trifolii* and subsequent leaf spot severity. Virus-infected leaves of gladiolus may be more readily infected by *Curvularia* because of an increased concentration of stimulatory substances occurring in "infection droplets" adhering to leaf surfaces. Moreover, a reduction in total extractable epicuticular lipids and waxes was correlated with increased exudation of electrolytic and carbohydrate compounds. Direct microscopic observation of intact leaf surfaces or sectioned and stained leaf tissues did not reveal any variation in cuticle thickness or continuity. It is possible, however, that nonuniformity of cuticle as well as total quantity of epicuticular lipids and waxes may be involved in increased diffusion from virus-infected leaves. The decreased surface tension phenomenon with virus-infected leaves is considered, however, to be a reflection of the decreased extractable epicuticular substances.

LITERATURE CITED

1. BEUTE, M. K. 1970. Effect of virus infection on susceptibility to certain fungus diseases and yield of gladiolus. Phytopathology 60:1809-1813.
2. BLAKEMAN, J. P. 1968. Studies on the influence of leaf washings on infection by Mycosphaerella ligulicola. Ann. Appl. Biol. 61:77-88.
3. FLENTJE, N. T., R. L. DODMAN, & A. KERR. 1963. The mechanism of host penetration by Thanatephorus cucumeris. Australian J. Biol. Sci. 16:784-799.
4. GARRETT, S. D. 1970. Pathogenic root-infecting fungi. Cambridge University Press, London. 294 p.
5. KERR, A., & N. T. FLENTJE. 1957. Host infection in Pellicularia filamentosa controlled by chemical stimulus. Nature 179:204-205.
6. MARTIN, J. T., & B. E. JUNIPER. 1970. The cuticle of plants. St. Martins Press, Inc., New York. 347 p.
7. MILHOLLAND, R. D. 1970. The effect of leaf exudates on blueberry leaf spot caused by Gloeosporium minus. Phytopathology 60:635-640.
8. MOORE, S., & W. H. STEIN. 1954. A modified ninhydrin reagent for the photometric determination of amino acids and related compounds. J. Biol. Chem. 211:907-913.
9. MORRIS, D. L. 1948. Quantitative determination of carbohydrates with Dreywood's anthrone reagent. Science 107:254-255.
10. ORELLANA, R. G., & C. A. THOMAS. 1962. Nature of predisposition of castor beans to Botrytis. I. Relation of leachable sugars and certain other biochemical constituents of the capsule to varietal susceptibility. Phytopathology 52:533-538.
11. SIEGEL, S. 1956. Nonparametric statistics for the behavioral sciences. McGraw-Hill Book Co., Inc., New York. 312 p.