Fruit Varieties Journal 44(1):45-47 1990

Influence of Levels of Leaf Expression of Apple Mosaic on Net Photosynthesis and Transpiration of Leaves of Four Apple Cultivars

DAVID C. FERREE[1] AND KEVIN CLAYTON-GREENE[2]

Abstract

Net photosynthesis and transpiration of leaves of 4 apple cultivars displaying progressive levels of chlorosis due to apple mosaic (*Marmor mali*) were measured in the field. There was a linear depression of both net photosynthesis (Pn) and transpiration (Tr) with increasing chlorosis on the leaves of all 4 cultivars. 'Jonathan,' which exhibited the most severe symptoms in the field, had very low Pn rates at each level of symptom expression.

Introduction

Apple mosaic is one of the oldest known virus diseases of plants with transmission in apples first reported in France in 1825 (1). Its transmission by grafting has been reported in most countries where apples are grown and natural transmission by root grafts demonstrated (4). Infected trees often bear leaves with cream-colored chlorotic areas, which sometimes coalesce to produce large areas of non-green tissue (5). All leaves on a tree do not show the characteristic chlorotic symptoms and different degrees of mosaic leaf patterns may be interspersed between normal leaves on the same shoot. Leaves that develop severe symptoms early in the season may later develop large necrotic areas and prematurely drop from the tree. Environmental conditions appear to influence the degree of symptom expression as chlorosis varies from year to year.

Several studies show that severe strains of the virus reduce apple tree growth (1, 6), yield (1, 6, 7, 9) and fruit size (6). Cultivars vary in susceptibility (1, 6, 7) with cultivars 'Jonathan,' 'Cox's Orange Pippin,' 'Allington Pippin' and rootstocks, M.25, M.9, MM.104, and MM.105 identified as very sensitive. During the 1987-88 growing season in Victoria, Australia symptoms of apple mosaic were widespread and more severe than usual and net photosynthesis (Pn) and transpiration (Tr) were measured on leaves displaying varying degrees of chlorosis.

Materials and Methods

Exposed shoot leaves of 'Jonathan,' 'Golden Delicious,' 'Granny Smith' and 'Starking Delicious' were classed into four classes: those that exhibited no chlorosis symptoms of mosaic and those with chlorotic areas of the leaf covering <33%, 34-66% and 67-100% of the leaf surface (Fig. 1). Leaves in all classes were selected from the same tree to minimize between tree variation. Pn and Tr were measured using an Analytical Development Co. Model LCA-2 portable infrared gas analyzer with a 6.25 cm^2 chamber at an air flow rate of 300 ml/min. Measurements were made at light levels above saturation (800μ $Em^{-2}s^{-1}$). Since cultivars were not replicated and in different orchards at the Horticultural Research Institute, Victoria, Australia, a separate statistical analysis for each cultivar

Salaries and research support provided in part by State and Federal funds appropriated to the Ohio Agricultural Research and Development Center, The Ohio State University. Journal Article No. 264-89. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper, therefore, must be marked *advertisement* solely to indicate this fact.

[1]Professor, Department of Horticulture, The Ohio State University/OARDC, Wooster, OH.
[2]Horticultural Research Institute, Fern Tree Gully, Victoria 3156 Australia.

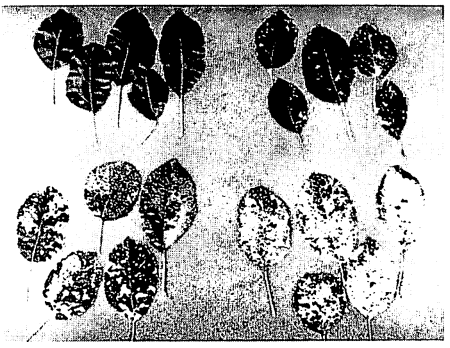

Figure 1. Apple leaves with the following percentages of their surface with apple mosaic symptons: None (upper left); 0-33% (upper right); 34-66% (lower left); 67-100% (lower right).

was performed on readings from 10 replicate sets of leaves.

Results and Discussion

There was a linear depression of both Pn and Tr as the degree of chlorotic symptoms increased on the leaves of all 4 cultivars (Figs. 1 & 2). For all cultivars, Pn was reduced 61% and Tr 24%, when more than 67% of the leaf was chlorotic. 'Jonathan,' which has previously (1) been identified as very susceptible to apple mosaic had very low Pn rates at each level of mosaic expression compared to other cultivars. In previous work (3), comparing Pn rates of 8 apple cultivars without apple mosaic 'Jonathan' had higher rates of Pn than either 'Golden Delicious' or 'Delicious' ('Granny Smith' was not included in the trial). Although direct comparisons between cultivars in this trial cannot be made because they were in different areas of the same orchard and not randomized, it is apparent that 'Jonathan' leaves even without symptoms had very low photosynthetic rates.

Foliar diseases such as apple scab (8) or mildew (2) also cause reductions in Pn when visible symptoms are present. Neither disease reduced Pn in direct relation to the % of leaf surface infected (e.g., powdery mildew 45% infection and 26% reduction in Pn; scab 46% infection and 17% reduction in Pn). This indicates more than a direct depression due to reduction in photosynthetic area conversely expression of apple mosaic chlorosis produced a linear depression in both photosynthesis and transpiration. The effect of apple mosaic in depression of yield, growth and fruit size (1, 6, 7, 9) may be due to the reduction in photosynthetic area due to chlorosis. Although circumstantial evidence suggests that base rate of Pn on leaves not showing symptoms may be reduced ('Jonathan' example), this cannot be proven by this work, as it was pre-

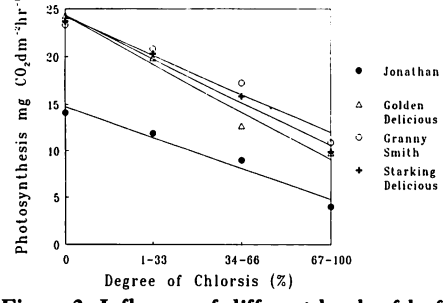

Figure 2. Influence of different levels of leaf expression of apple mosaic virus in photosynthesis (mg CO_2 $dm^{-2}hr^{-1}$) of leaves of 4 apple cultivars. Linear relationship significant for all cultivars at 1% level.

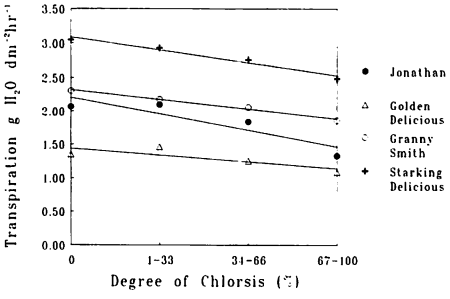

Figure 3. Influence of different levels of leaf expression of apple mosaic virus on transpiration (g H_2O $dm^{-2}hr^{-1}$) of leaves of 4 apple cultivars. Linear relationship significant for all cultivars at 1% level.

sumed that all trees were infected. This work certainly supports the efforts of commercial nurseries to propagate only trees free of apple mosaic.

Literature Cited

1. Chamberlain, E. E., T. D. Atkinson, J. A. Hunter and G. A. Wood. 1971. Effect of apple mosaic virus on growth and cropping of 'Freysberg' apple trees. N.Z. J. of Agr. Res. 14:963-43.
2. Ellis, M. A., D. C. Ferree, and D. E. Spring. 1981. Photosynthesis, transpiration, and carbohydrate content of apple leaves infected by *Podosphaera leucotricha*. Phytopathology 71:392-95.
3. Ferree, D. C., F. R. Hall and M. A. Ellis. 1986. Influence of mites and diseases on net photosynthesis of apple leaves. IN: The Regulation of Photosynthesis in Fruit Trees. ed. by A. N. Lakso and F. Lenz. Symp. Proc. Pub. NY St. Agr. Exp. Sta., Geneva, NY. pp. 56-62.
4. Hunter, J. A., E. E. Chamberlin, and T. D. Atkinson. 1957. Note on transmission of apple mosaic by natural root grafting. NZ J. Agr. Res. 1:80-82.
5. McCrum, R. C., J. G. Barrat, M. T. Hilborn, and A. E. Rick. 1960. An illustrated review of apple virus diseases. Bul 593. Maine Agr. Exp. Sta. pp. 63.
6. Posnette, A. F. and R. Cropley. 1956. Apple mosaic viruses. Host reactions and strain interference. J. Hort. Sci. 31:119-33.
7. Posnette, A. F. and R. Cropley. 1959. The reduction in yield caused by apple mosaic. Ann. Rpt. E., Malling Res. Sta. for 1958:89-90.
8. Spotts, R. A. and D. C. Ferree. 1979. Photosynthesis, transpiration and water potential of apple leaves infected by *Venturia inaequalis*. Phytopathology 69:717-19.
9. Wood, G. A., E. E. Chamberlin, J. D. Atkinson and J. A. Hunter. 1975. Field studies with apple mosaic virus. NZ J. Agr. Res. 18:399-0404.

CRFG and NAFEX Joint Meeting, June 1990

The organizations North American Fruit Explorers, Inc., and California Rare Fruit Growers, Inc., have announced plans for their next annual meetings, to be held jointly on the campus at the University of California at Davis in late June, 1990.

Topical emphasis of the joint meeting is on New Fruit Crops, Variety Development and Breeding. Three days of sessions on unusual fruits, their adaptation to commerce and domestic horticulture, breeding of totally novel forms of fruits, the issues arising in the new culture of high-quality fruits, and expansion of fruit culture beyond traditional commercial zones of production, will be complemented by four days of tours of orchards and nurseries of many fruit crops in California.

Sessions are designed to inform growers, researchers, extension agents, amateurs of fruits and food and horticulture writers of new developments in the field. Sponsors of the joint meeting are the State of California-Genetic Resources Conservation Program and University of California-Cooperative Extension, Small Farm Center. Hosts are Department of Pomology, University of California and Sacramento Valley Chapter, California Rare Fruit Growers, Inc.

Date of the meeting is 27 June-3 July 1990, inclusive of pre- and post-meeting events. For further information, contact: Ms. Shirley Humphrey, CRFG-NAFEX 1990 Meeting, Small Farm Center, University of California, Davis, CA 95616.