one was not made, it is obvious that under the conditions of the experiment, the treatments of Sequestrene 138 were economically sound. Untreated trees did not bear a crop at all this season, whereas trees treated with Sequestrene 138 produced a normal crop.

### Summary and Conclusions

1. Sequestrene 138, Hampol and ferrous sulfate were compared as sources of iron to correct iron chlorosis in four varieties of avocados.
2. Sesquestrene 138 was best in correcting the chlorosis and putting the trees back in normal production. Hampol was partly effective and ferrous sulfate was wholly ineffectual.
3. Leaf iron content was found to be unreliable as a quantitative measure for correction of iron chlorosis.
4. Considering its cost and present avocado prices, the use of 1.0 lb/tree of Sequestrene 138 to correct iron chlorosis in avocado trees could be fully justified as a sound economic investment under the conditions of this experiment.

### Resumen

Se investigó, por medio de aplicaciones al suelo, la eficiencia de "Sequestrene 138" (FeNa EDDHA), "Hampol" (Fe Na EEDT) y sulfato de hierro, como fuentes de hierro para corregir las clorosis en cuatro variedades de aguacate en los suelos calcareos de Homestead, Florida. Los 170 árboles usados tenian 25 años y mostraban una aguda clorosis que era uniforme para las variedades 'Pollock,' 'Booth 8' y 'Waldin,' y más marcada para la variedad 'Lula.'

Se encontró que los árboles tratados con "Sequestrene 138" reaccionaron más rapidamente produciendo clorofila en las hojas después de dos semanas del tratamiento. Se concluyó que de los tratamientos usados la dosis de 1.0 lb/árbol de "Sequestrene 138" era el tratamiento más efectivo y el más económico, considerando la cantidad de frutos producidos seis meses después.

Análisis quimico foliar en árboles de la variedad 'Lula' con dos dosis de "Sequestrene 138," mostraron muy poca diferencia en el contenido de hierro en comparación con los árboles no tratados usados como control.

### Literature Cited

1. De Kock, P. C., and A. Wallace. 1965. Excess phosphorus and iron chlorosis. Calif. Agrictulture 19(12): 3-4.
2. Harkness, R. W., and J. L. Malcolm. 1957. Iron chlorosis in avocadoes. Proc. Fla. State Hort. Soc. 70: 297-300.
3. Malo, S. E. 1965. Promising methods for correcting iron chlorosis in avocados—A preliminary report. Proc. Fla. State Hort. Soc. 78: 358-364.
4. Samish, R. M., and Hoffman, M. 1964. The control of Micronutrient deficiencies in tree crops. Plant Analysis and fertilizer problems, edited by C. Bound, P. Prevot, and J. R. Magness, published by Amer. Soc. for Hort. Sci. vol. IV, pp. 414-421.
5. Wallace, A., and North, C. P. 1957. Iron chelates for chlorotic avocado trees. Calif. Avocado Soc. Yearbook 41: 136-140.
6. Wallace, T., and E. J. Hewitt. 1946. Studies in iron deficiency of crops. Journ. Pom. and Hort. Sci. 22: 153-161.
7. Walliham, E. F., and T. W. Embleton. 1961. Iron chlorosis. Calif. Citrograph 46: 67, 87, 89.

# COMPARATIVE GROWTH AND YIELD OF TEN GRAPE VARIETIES SPRAYED INTENSIVELY FOR INSECT AND DISEASE CONTROL

J. A. Mortensen[1]

### Introduction

The failure of grape growing as a thriving industry in Florida has been due primarily to a lack of adapted varieties that are resistant to Pierce's disease (9). Pierce's disease, a virus infection transmitted by insect vectors, is a principal factor limiting grape production in the state (2, 5, 6). Although DDT was reported as an insecticide for controlling the insect vectors of Pierce's disease, evidence was lacking whether control of the vectors would reduce the incidence of Pierce's disease (4).

An experiment was initiated in 1961 to determine whether grape varieties susceptible to Pierce's disease might be grown successfully if sprayed intensively with an insecticide-fungicide

[1]Assistant Geneticist, Watermelon and Grape Investigations Laboratory, Leesburg.
Florida Agricultural Experiment Stations Journal Series, No. 2545.

mixture. The purpose was to hinder or prevent the development of Pierce's disease in susceptible grape plants by controlling the insect vectors, and also to control the fungus diseases that are often severe on unadapted varieties.

## Experimental Methods

Work was conducted at the Laboratory Farm of the Watermelon and Grape Investigations Laboratory at Leesburg. Ten varieties were included in the experiment: three *Vitis vinifera* L. varieties (Cardinal, Perlette, and Emperor), four *V. labrusca* L. varieties (Buffalo, Golden Muscat, Concord, and Niagara), and three varieties derived from native Florida species (Tamiami (1), Blue Lake (8), and Lake Emerald (7)). Each variety was replicated eight times in a randomized complete block design (single vine plots).

Plants were set 8 feet apart in rows 10 feet apart in March 1961. All varieties were grown on their own roots except Buffalo, which was grafted on rootstock No. 3309 (*V. riparia* Michx. X *V. rupestris* Scheele) one year before planting.

Spray applications of DDT 50WP and Dithane Z78 each at 2 pounds per 100 gallons, with 4 ounces of Triton B-1956 (spreader), were made beginning on March 17, 1961. Weekly applications were continued until May 26, 1966, except during each dormant season from mid-December to mid-March. Beginning in March 1964, Dithane M22 and Z78 (one pound each per 100 gallons) were substituted for zineb in the weekly applications. Dithane M45 at 1½ pounds per 100 gallons was used in 1965 and 1966 as the fungicide.

Records on individual vine vigor and disease development were made each month from May 1961 through July 1966. Individual vine records on weight of dormant prunings, date of first bud growth, date of bloom, date of ripening and yield of fruit were made annually.

## Results and Discussion

### *Insect and Disease Development*

Insects such as common grape leafhopper (*Erythroneura comes* (Say)), grape flea beetle (*Altica chalybea* Illiger), and grapevine aphid (*Aphis illinoisensis* Shimer) were seen occasionally in the plots, but they did not cause serious damage. By contrast, unsprayed vineyards nearby were sometimes severely damaged by common grape leafhopper, leaf folder (*Desmia*

Table 1. Vine vigor and Pierce's disease development in grape varieties under intensive spray program.

| Variety | No. of diseased vines 1962 | 1963 | 1964 | 1965 | 1966 | No. of vigorous vines 1962 | 1963 | 1964 | 1965 | 1966 |
|---|---|---|---|---|---|---|---|---|---|---|
| Blue Lake | 0 | 0 | 0 | 0 | 0 | 8 | 8 | 8 | 8 | 8 |
| Lake Emerald | 0 | 0 | 2 | 2 | 2 | 8 | 8 | 8 | 8 | 8 |
| Tamiami | 0 | 1 | 4 | 7 | 7 | 8 | 8 | 8 | 7 | 5 |
| Buffalo | 0 | 1 | 4 | 5 | 5 | 8 | 8 | 8 | 6 | 4 |
| Golden Muscat | 0 | 1 | 6 | 7 | 7 | 8 | 8 | 6 | 5 | 1 |
| Concord | 0 | 0 | 2 | 4 | 4 | 2 | 4 | 4 | 1 | 1 |
| Niagara | 0 | 0 | 0 | 5 | 5 | 1 | 3 | 4 | 2 | 1 |
| Cardinal | 0 | 3 | 7 | 8 | 8 | 2 | 5 | 4 | 1 | 0 |
| Perlette | 1 | 1 | 7 | 7 | 7 | 0 | 0 | 0 | 0 | 0 |
| Emperor | 3 | 3 | 6 | 7 | 7 | 0 | 0 | 0 | 0 | 0 |

*funeralis* (Hubner), and leaf skeletonizer (*Harrisana americana* (Guer.-Men.)). Intensive spraying with DDT was thus an effective control of the latter three insects on grape.

Leafhopper vectors of Pierce's disease (principally *Homalodisca coagulata* Say and *Oncometopia undata* F.) were observed singly on the vines at various times during the summer and winter. Pierce's disease symptoms (3, 4) began to appear in 1962. Additional plants became infected each year thereafter, followed by decline in vigor and yield and, in many instances, death (Table 1). Intensive spraying was not effective in controlling Pierce's disease on susceptible varieties because at least some leafhopper vectors transmitted the virus to the vines. The use of resistant varieties such as Blue Lake and Lake Emerald was the only satisfactory control of Pierce's disease observed. Although Lake Emerald had symptoms in two of eight plants, all plants of Lake Emerald and Blue Lake grew vigorously throughout the period (Table 1). The other eight varieties were susceptible to Pierce's disease, beginning a decline in vigor after three to four years. The hypothesis that varieties not resistant to Pierce's disease could be grown successfully if intensively sprayed to control insects and diseases was contrary to the experimental results, which support earlier work already reviewed by Stover (9).

Fungus diseases appearing in the plots were anthracnose (*Elsinoe ampelina* (d By.) Shear), downy mildew (*Plasmopara viticola* (B. and C.) Berl. and de T.), powdery mildew (*Uncinula necator* (S.) Burr.), black rot (*Guignardia bidwellii* (Ell.) Viala and Ravaz), and unidentified leaf spots. The only fungus diseases severe enough to reduce vine growth were anthracnose in 1961 on Tamiami and Buffalo varieties, and downy mildew on Perlette, Emperor, Cardinal, and Lake Emerald.

*Growth and Yield Comparisons*

A comparison of mean vigor ratings (1 = poor to 5 = excellent) for the ten varieties is shown in Figure 1. Three varieties derived from native Florida species were exceptionally vigorous (Lake Emerald, Blue Lake, and Tamiami). However, Tamiami declined in vigor after 1964 because of Pierce's disease. Among the four *V. labrusca* varieties, Buffalo and Golden Muscat were more vigorous than Niagara and Concord, but all declined in vigor during 1964 and 1965 to a nonproductive level in 1966. Three *V. vinifera* varieties (Cardinal, Perlette, and Emperor) were non-vigorous throughout the test. Species background thus largely determined the vigor of a given variety from 1961 through 1963, while resistance to Pierce's disease was the major factor affecting vigor thereafter (Figure 1).

The amount of plant growth as measured by weight of prunings (Table 2) was closely related to the fruit yields (Table 3). The relative ranking of varieties was similar from 1964 to 1966, except that Tamiami dropped from first to third place in pruning weights (Table 2).

Though susceptible to Pierce's disease, Tamiami significantly outyielded resistant varieties Lake Emerald and Blue Lake. However, due to the uneven maturity of berries on the cluster, most of the Tamiami fruit was unmarketable. Lake Emerald and Blue Lake significantly outyielded all other varieties and the fruit was of marketable appearance (Table 3). Golden Muscat had mostly unmarketable fruit because of cracking, dropping, decay, and an uneven development of soluble solids in berries on the cluster. Buffalo and Niagara had mostly marketable fruit, but yields declined between 1964 and 1966. Concord berries ripened unevenly on the clusters, and Cardinal berries were cracked and also unmarketable. Only Blue Lake and Lake Emerald were satisfactory for both yield and marketable appearance of fruit.

*Earliness Comparisons*

Dates of first bud growth, first bloom, and harvest indicate that (among the bearing varieties) Buffalo and Cardinal were the earliest to start bud growth in the spring, Buffalo and Niagara were the earliest to bloom, and Buffalo and Cardinal were the earliest to reach harvest stage (Table 4). Buffalo was the only variety that was early in all three categories.

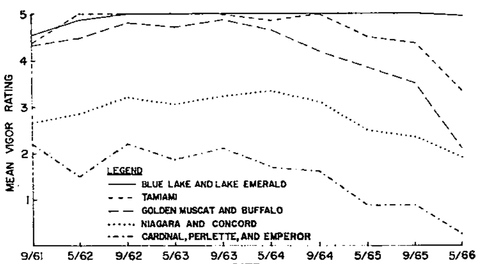


FIGURE 1. COMPARATIVE MEAN VIGOR RATINGS FOR TEN GRAPE VARIETIES AT REGULAR INTERVALS DURING THE EXPERIMENT.

Table 2. Varietal comparisons of pruning wood weights.

| Variety | Mean weights of prunings* 1964 | 1965 | 1966 | Mean |
|---|---|---|---|---|
| Lake Emerald | 17.0 b | 22.8 a | 22.7 a | 20.8 a |
| Tamiami | 23.1 a | 20.1 a | 14.9 b | 19.4 a |
| Blue Lake | 12.2 c | 18.9 a | 20.6 ab | 17.2 b |
| Buffalo | 4.4 d | 4.3 b | 1.7 c | 3.5 c |
| G. Muscat | 1.4 de | 1.4 b | 1.0 c | 1.3 d |
| Niagara | 0.8 e | 0.7 b | 0.7 c | 0.7 d |
| Concord | 0.4 e | 0.3 b | 0.5 c | 0.4 d |
| Cardinal | 0.3 e | 0.2 b | 0.3 c | 0.3 d |
| Perlette | 0.1 | 0.05 | 0.1 | 0.1 |
| Emperor | 0.05 | 0.02 | 0.03 | 0.03 |

* In pounds per vine. Means not followed by a letter in common are singificantly different at the .05 level (Duncan's Multiple Range Test).

*Longevity Comparisons*

Longevity of the ten varieties can be determined from Table 4 by comparing the number of living vines with the number of vigorous vines at the conclusion of the experiment. Although no single variety was dead in all replicates, the *V. vinifera* verieties were near that point. Their lack of adaptability to Florida environment was evident throughout the experiment. Buffalo had four vigorous surviving plants, while other *V. labrusca* varieties had only one each. The fact that only Buffalo was grafted on a vigorous rootstock may account for its superiority. Tamiami maintained vigor longer than other susceptible varieties, but once infected with Pierce's disease the vines developed severe symptoms. The comparative longevity of grape varieties in this test agreed with earlier reports, but the average lifespan was somewhat longer with intensive spraying (6, 9). Only the resistant varieties (Blue Lake and Lake Emerald) survived in all replicates as vigorous plants, which stresses the importance of Pierce's disease resistance for extended longevity and adaptability to Florida environment.

*Ratio of Fruit to Vine*

The ratios of fruit to vine (pounds of fruit per pound of dormant pruning wood) for eight bearing varieties are given in Table 4. Blue Lake and Lake Emerald had low ratios of fruit to vine, a trait inherited from the tree-climbing species native to Florida woodlands (7, 8). Tamiami also inherited this tendency for strong vine growth from vigorous native species (1), but the ratio of fruit to vine was higher than that of Blue Lake and Lake Emerald. This comparison suggests that conscious selection for a higher ratio of fruit to vine in a breeding program involving native parentage should produce new grape varieties of higher fruit yield in proportion to vine growth.

## Conclusions

1. DDT was an effective control of common grape leafhopper, leaf folder, and leaf skeletonizer.

Table 3. Varietal comparisons of fruit yields.

| Variety | Mean fruit yields* 1964 | 1965 | 1966 | Mean |
|---|---|---|---|---|
| Tamiami | 55.1 a | 52.7 a | 30.8 a | 46.2 a |
| Lake Emerald | 29.3 b | 26.5 b | 26.0 a | 27.2 b |
| Blue Lake | 29.7 b | 26.1 b | 29.9 a | 28.6 b |
| Buffalo | 21.4 c | 10.4 c | 7.1 b | 11.5 c |
| G. Muscat | 12.2 d | 6.0 c | 1.9 b | 8.2 c |
| Niagara | 5.5 e | 3.6 c | 1.5 b | 3.5 d |
| Concord | 2.5 e | 1.7 c | 1.4 b | 1.9 d |
| Cardinal | 2.5 e | 0.4 c | 0.0 b | 1.0 d |
| Perlette | 0.0 | 0.0 | 0.0 | 0.0 |
| Emperor | 0.0 | 0.0 | 0.0 | 0.0 |

* In pounds per vine. Means not followed by a letter in common are significantly different at the .05 level (Duncan's Multiple Range Test).

2. Fungicides used were effective in retarding the development of fungus diseases, although each of the principal diseases was observed occasionally.

3. The attempt to control Pierce's disease on susceptible varieties by insecticidal control of the insect vectors was unsuccessful. If leafhopper vectors of Pierce's disease were effectively controlled by DDT sprays, they apparently were able to transmit the virus prior to their death.

4. Although there was a slight increase in lifespan of susceptible varieties by intensive spraying, none of the susceptible varieties could be grown satisfactorily even for five years.

5. Vigor was dependent on species background. Maintenance of vigor after the third year was largely dependent on resistance to Pierce's disease.

6. Only the resistant varieties (Blue Lake and Lake Emerald) were satisfactory for vigor, yield, and marketable appearance of fruit. Resistance to Pierce's desease as derived from native Florida species was essential for extended longevity under Florida environment.

7. Implications in breeding for fruitfulness in material derived from native species were discussed briefly.

## LITERATURE CITED

1. Brooks, R. M., and H. P. Olmo. 1957. Register of new fruit and nut varieties, List 12. Proc. Am. Soc. Hort. Sci. 70: 557-584.

2. Crall, J. M., and L. H. Stover. 1957. The significance of Pierce's disease in the decline of bunch grapes in Florida (Abs.). Phytopathology 47: 518.

3. Hewitt, W. B., N. W. Frazier, H. E. Jacob, and J. H. Frietag. 1942. Pierce's disease of grapevines. Calif. Agr. Exp. Sta. Circ. 353: 1-32.

4. Hewitt, W. B., N. W. Frazier, J. H. Frietag, and A. J. Winkler. 1949. Pierce's disease investigations. Hilgardia 19: 207-264.

5. Stoner, W. N. 1953. Leafhopper transmission of a degeneration of grape in Florida and its relation to Pierce's disease. Phytopathology 43: 611-615.

6. Stoner, W. N., L. H. Stover, and G. K. Parris. 1951. Field and laboratory investigations indicate grape degeneration in Florida due to Pierce's disease virus infection. Plant. Disease Reptr. 35(8): 341-344.

7. Stover, L. H. 1954. The Lake Emerald Grape. Fla. Agr. Exp. Station Circ. S-68: 1-12.

8. Stover, L. H. 1960. Blue Lake, a bunch grape for Florida home gardens. Fla. Agr. Exp. Sta. Circ. S-120: 1-10.

9. Stover, L. H. 1960. Progress in the development of grape varieties for Florida. Proc. Fla. State Hort. Soc. 73: 320-323.

Table 4. Varietal comparisons for earliness, longevity, and fruitfulness.

| Variety | Mean Dates: First bud growth | Mean Dates: First bloom | Mean Dates: Harvest | Plants living in 1966 | Plants vigorous in 1966 | Ratio of fruit to vine* |
|---|---|---|---|---|---|---|
| Tamiami | 3/10 | 4/18 | 8/1 | 7 | 5 | 2.4 |
| Lake Emerald | 3/6 | 4/11 | 7/28 | 8 | 8 | 1.3 |
| Blue Lake | 3/5 | 4/7 | 7/18 | 8 | 8 | 1.7 |
| Buffalo | 3/3 | 4/5 | 6/24 | 4 | 4 | 3.3 |
| G. Muscat | 3/7 | 4/8 | 7/12 | 7 | 1 | 6.4 |
| Niagara | 3/6 | 4/4 | 6/30 | 5 | 1 | 4.8 |
| Concord | 3/8 | 4/7 | 7/10 | 7 | 1 | 4.6 |
| Cardinal | 3/4 | 4/12 | 6/15 | 2 | 0 | 3.5 |
| Perlette | 2/25 | 4/4 | 0 | 1 | 0 | 0 |
| Emperor | 3/3 | 0 | 0 | 2 | 0 | 0 |

* Pounds of fruit per pound of dormant wood prunings removed.

# A REVIEW OF THE FLORIDA LYCHEE INDUSTRY

T. W. Young[1]

Ten years ago it appeared that the lychee, *Litchi chinensis* Sonn., would soon become one of the more important minor fruit crops in Florida. Fairly substantial commercial plantings had been made in Dade, Broward, Brevard, Seminole, Lake, Polk, Highlands, Hillsborough, Pinellas, Manatee, Sarasota and Lee Counties. Some citrus growers becoming concerned about the possible over-production of citrus, became interested in lychees as a non-competitive substitute tree crop for citrus. Interest of growers with citrus on deep sandy soils, where spreading decline, caused by the burrowing nematode, *Radopholus similis* (Cobb) Thorne, had become widespread, was heightened when it was found that the lychee was resistant to the burrowing nematode (2). Lychee trees grew well on burrowing nematode infested soil without benefit of nematocial treatment of the soil, whereas citrus would not.

Prior to World War II, practically all lychee trees, in Florida were dooryard or specimen trees, and mostly in relatively warm locations. During about the first decade following the war, commercial lychee plantings in the state increased rapidly. By 1957 there were approximately 15,000 trees in commerical plantings on about 300 to 350 acres, plus a substantial number of dooryard plantings. This was a period of relatively warm winters. Most of these plantings became well established without serious cold damage. But severe freezes in the winter of 1957-58 damaged lychees in all areas, *with* extensive damage in the colder locations (6).

Florida Agricultural Experiment Stations Journal Series No. 2522.

[1]Horticulturist, University of Florida, Sub-Tropical Experiment Station, Homestead.