A. JARDENY, S. P. MONSELISE,
and MATHILDE CHORIN

# *Some Morphological and Physiological Features of Clementine Mandarin Trees Affected by Cachexia*

MANY CLEMENTINE MANDARIN (*Citrus reticulata* Blanco) trees on Palestine sweet lime (*C. limettioides* Tanaka) rootstock in Israel are affected by a decline, which has been considered by Reichert and Bental (9) to result from a viral complex. The disease occurs in trees of different ages and seems to be spread by budding. Affected trees produce poor growth with yellowish small leaves. Pegs, impregnated with gum, develop in the bark and are concentrated immediately above the bud-union. No gum impregnations are found below the bud-union.

The present report provides information about some morphological and physiological features of diseased trees.

Five hundred 7-year-old Clementine mandarin trees growing on sweet lime stock in sandy loam at Yavneh-Dar in the coastal citrus belt of Israel were classified into the following categories:

A. Trees healthy and well developed
  - 0—No bark symptoms.
  - 1—Bark of scion showing pegs but no gum impregnation.
  - 2—Bark of scion showing both pegs and gum impregnation.

B. Trees medium in size.
  - 3—Pegs, gum impregnation, and general phloem discoloration in the bark of the scion.

C. Trees dwarfed.
  - 4—Pegs, gum impregnation, and general phloem discoloration in the bark of the scion sometimes darker than in group 3.
  - 5—Pegs almost absent but gum impregnation and general phloem discoloration very extensive. Sometimes honeycomb pits are found (9) in scion bark (Fig. 1).

FIGURE 1. *Bark of diseased Clementine mandarin trees, group 5. Note impregnation concentrated above bud-union and honeycombing in scion.*

Ten replicate trees of each group (20 in group B) were chosen for further study. The 20 trees in group B were divided according to topographical proximity into two sets of ten each. These two sets were considered as separate treatments in the statistical analyses, although no significant differences were found between them.

The experimental trees were examined at different dates, when different measurements and evaluations were performed. Total chlorophyll in leaves was determined in the autumn, according to Mackinney (6); peroxidase activity of bark was determined, using guaiacol as an H-donor by a modified method (7) after Mahly & Chance, and expressed as average increase in optical density at 470 m$\mu$ over periods of 15 seconds per mg fresh weight of bark; total phenols of bark were tested by a colorimetric method using diazo reagent (4).

## *Results and Discussion*

Figure 2 shows some of the data, calculated in percentages, of healthy controls (group O). All trends in the figure are significant.

A trend of progressing divergence from the controls is evident in most of the examined factors. Peroxidase activity of bark and total phenol content increased with increasing severity of symptoms (Fig. 2). This is of interest, since peroxidase activity has been shown to be correlated with stunting of growth, whether induced by genetic or exogenic factors (3, 5, 7); decrease in phenols has been shown recently in psorosis-affected orange leaves (8). The chlorophyll content of leaves, the area of an average leaf, and the density of flowering steadily decreased with increasing decline. Conversely, there was a very sharp increase in leaf drop and in the stunting of growth of new branches (decrease in average length and increase in number of nodes per unit length).

The progressive decline described above seems to be due to progressive stages of the cachexia disease. This conclusion is based on the progressively stronger symptoms found in the bark of the cachexia susceptible Clementine scion. Trees of group 5, however, also showed

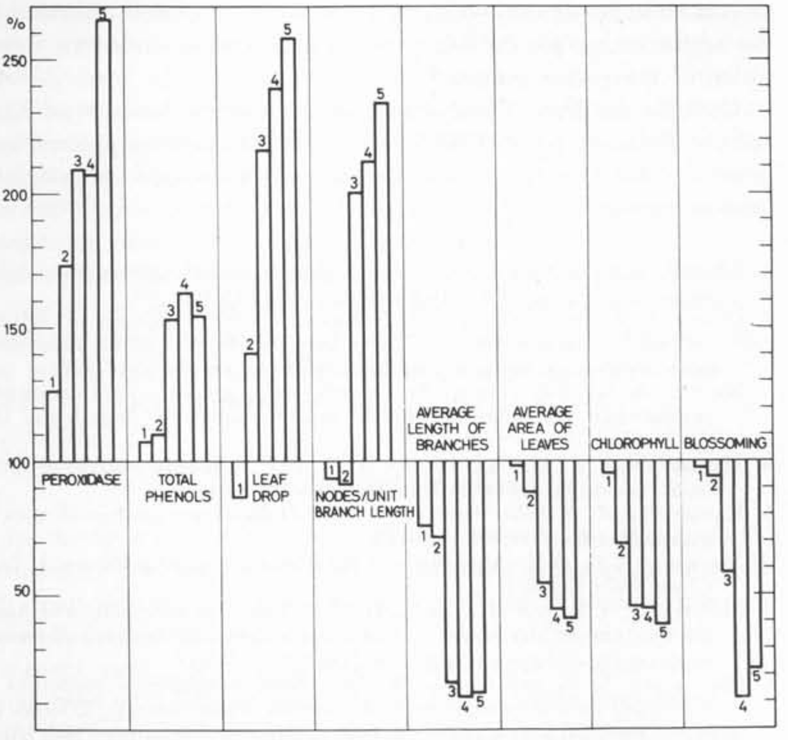


FIGURE 2. *Quantitative changes in some morphological and physiological features of Clementine mandarin trees progressively more heavily affected by cachexia (1 to 5) in percentage of apparently healthy controls.*

some honeycombing (Fig. 1) which has been considered by Reichert and Bental (9) to be a symptom of an additional viral complex. Gum impregnation seems to be responsible for thicker bark in groups 2 to 5.

The trees used in this investigation were chosen among those which did not show any xyloporosis symptoms (pegs) in the bark of the susceptible sweet lime stock. The mere fact that such trees were available seems to corroborate the view (9) that xyloporosis and cachexia may be the consequence of different viral complexes.

We have implied that progressive decline parallels progressive stages of the disease. It should, however, not be assumed that different trees have been inoculated at different ages and therefore evince different degrees of decline. Since no vector for cachexia has been found yet, it is most probable that all trees were inoculated at the same age, at budding time, through diseased propagating material.

ACKNOWLEDGMENTS.—This paper is based on a thesis presented by the senior author for the Master of Science Degree under the supervision of the junior authors.

Contribution from The National and University Institute of Agriculture, Rehovot, Israel, 1963 Series, No. 594-E, partly supported by a grant (4, A-5) of the Ford Foundation. Help provided is gratefully acknowledged.

### *Literature Cited*

1. CHILDS, J. F. L. 1956. Transmission experiments and xyloporosis-cachexia relations in Florida. Plant Disease Reptr. 40: 143-145.
2. GRANT, T. J., GRIMM, G. R., and NORMAN, P. 1959. Symptoms of cachexia in Orlando tangelo, none in sweet lime and false symptoms associated with purple scale infestations. Plant Disease Reptr. 43: 1277-1279.
3. HALEVY, A. H. 1962. Inverse effect of gibberellin and Amo-1618 on growth, catalase and peroxidase activity in cucumber seedlings. Experientia 18: 74-76.
4. HENDRICKSON, R., and KESTERSON, J. W. 1957. Chemical analysis of citrus bioflavanoids. Proc. Florida State Hort. Soc. 70: 196-203.
5. KAMERBEEK, G. A. 1956. Peroxidase content of dwarf types and giant types of plants. Acta Bot. Neerl. 5: 257-263.
6. MACKINNEY, G. 1941. Absorption of light by chlorophyll solutions. J. Biol. Chem. 140: 315-322.
7. MONSELISE, S. P., and HALEVY, A. H. 1962. Effects of gibberellin and Amo-1618 on growth, dry matter accumulation, chlorophyll content and peroxidase activity of citrus seedlings. Am. J. Bot. 49: 405-412.
8. MONSELISE, S. P., and GOREN, R. 1965. Some physiological properties of leaves and bark of psorosis-infected Valencia orange trees, p. 295-298. *In* W. C. Price [ed.], Proc. 3d Conf. Intern. Organization Citrus Virol. Univ. Florida Press, Gainesville.
9. REICHERT, I., and BENTAL, A. 1961. On the problem of xyloporosis and cachexia diseases of mandarins. Plant Disease Reptr. 45: 356-361.