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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).
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 mμ 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.](image-url)
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.

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