Collapse of 'Murcott' Tangerine Trees

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Abstract. 'Murcott' tangerine (Citrus hybrid) trees often decline suddenly during fall and winter, if they are heavily loaded with fruit. First symptoms are wilt, yellowing of leaves, defoliation, and shriveling of fruit. The rapid loss of leaves and fruit, followed by dying back of branches, gives the appearance of death. However, such trees generally recover. The remaining leaves are deficient in one or more minerals such as N, P, K, or Mn. However, extra fertilizer does not prevent tree collapse. Seasonal studies showed that starch depletion and death of feeder roots accompany the decline. Root starvation, as a result of crop strain, appears to be the primary cause of rapid tree collapse.

The 'Murcott' tangerine is a mandarin hybrid of unknown origin. It is thought (2) to be an early USDA cross between a tangerine and an orange [Citrus reticulata Blanco × C. sinensis (L.) Osbeck]. If that were so, it would be a tanger. However, it is commonly known as a tangerine in Florida, the main area in which it is grown.

'Murcott' is an extremely fruitful cultivar. Typically, the trees set so much fruit one year that they are unable to set a return crop the next. Under a heavy load of fruit, the trees decline in the fall months. Decline severity ranges from mild to drastic. In the latter case, both the leaves and fruit are shed, and the tree may appear to be dead. Such trees, however, are generally capable of recovering. The outer wood dies but new sprouts arise from the larger branches. In 1 or 2 years the tree returns to a vigorous condition and then repeats the cycle. Because of the rapidity of the decline, the condition is referred to as "collapse."

'Murcott' collapse has been attributed to a deficiency of minerals, especially N and K (6). This tentative conclusion was reached after a comparison was made of the mineral composition of various parts of healthy and collapsed trees and after some preliminary fertilizer trials. The recommended rates of N and K for 'Murcotts' were increased sharply in 1972 (4). Rates up to 450 kg/ha (400 lb./acre) for each element were suggested.

In 1968, I started several field tests to determine appropriate rates of fertilization for trees of various ages. In each experiment, supplemental amounts of N and K were added to the amounts applied by the cooperating growers.

From 1968 through 1973, collapse ranged from mild to severe in all test blocks. Rates of N and K, either separately or in combination, had little or no effect on the amount of tree collapse. Consequently, the study was broadened to include some of the physiologic and chemical changes that occur in the tree during the year in relation to collapse. Finally, I examined how thinning the crop of fruit affected the rate of collapse.

This report summarizes the results of these studies.

Materials and Methods

Fertilization. Five commercial 'Murcott' orchards in the ridge section of central Florida were given extra applications of NH₄NO₃ and KCl in 1968 and 1969. One of these, continued for 6 years, is used to illustrate the relation of fertilization to collapse. This was a young grove set in 1965. The trees were from nucellar budwood propagated on 'Carizo' citrange [C. sinensis × Poncirus trifoliata (L.) Raf].

The trees were set 350/ha and fertilized with the recommended rate of 8–2–8–3.0–0.25–0.1 through 1970 (4). In 1971 and thereafter, a 16–4–20 mixture was applied twice a year to all trees as a basic level. This supplied about 185 kg/ha each of N and K. Test plots received 2 appropriate supplemental applications of NH₄NO₃ and KCl by hand to make 3 levels of N and K (Table 1). Test plots, separated by buffers, consisted of 4 trees each in a 32 factorial plan for N and K. The 9 treatments were replicated 4 times, totaling 144 trees.

About 5-month-old leaves from nonfruiting twigs were collected each August for mineral analysis. The number of trees showing strong symptoms of collapse was counted each December to January.

Vegetative samples for starch trends and feeder root density. During 1972 and 1973, samples of leaves, twigs, scaffold root wood, and fibrous roots were collected almost monthly from 6 commercial 'Murcott' and 2 'Valencia' orchards. For twig and leaf samples, we cut a branch from each of 6 trees at each location. From these, samples of wood 1 cm diam (bark included) were composited into one sample. Thirty-six mature leaves of all ages were composited into a leaf sample.

We obtained root samples by taking 12 cores of soil from each orchard and screening out the roots. These cores were taken at the drip line of 12 trees and from all directions of exposure. The cores were 7.5 cm diam and 15.0 cm deep (3 and 6 in.). Pieces of scaffold roots between 0.5 and 1.0 cm diam

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1 Received for publication February 18, 1975.


3 This is a report on the current status of research involving use of certain chemicals that require registration under the Federal Environmental Pesticide Control Act (FEPCHA). This report does not contain recommendations for the use of such chemicals, nor does it imply that the use discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.
were composited as one sample. Feeder roots (1 mm or less diam) were quantitatively measured. They were washed on a sieve with a vigorous jet of tap water before being dried and weighed.

After being dried at 65°C all 4 tree fractions were ground to a fine powder and analyzed for starch (1).

Crop thinning. Pilot thinning tests were made on young trees. In 1972, 12 heavily overloaded trees were selected, and about half of the fruit was picked off by hand in June from 6 of these. This picking reduced the crop on 4-year-old trees from about 1,200 to about 600 fruit. In 1973, pre- and postbloom thinning sprays and June hand-thinning were tried. Gibberelic acid was applied about 4 weeks before bloom. Cycloheximide (B(2-(3,5-dimethyl-2-oxocyclohexyl)-2-hydroxyethyl) glutarimide), carbaryl (1-naphthyl N-methylcarbamate), and ethephon (2-chloroethyl phosphonic acid) were applied about 2 weeks after petal fall. Each treatment was applied in 10 replications to 1-tree plots. We determined the degree of thinning by counting the fruit at harvest in March 1974. Symptoms of tree collapse were evaluated just prior to harvest.

| Table 1. Relation of N and K fertilization to 'Murcott' tree collapse and leaf composition. |
|-----------------------------------------------|---------------|-----------------|---------------|---------------|---------------|---------------|
| 185 | 46 | 1.5 | 67 | 2.85 | 2.69 | 2.84 |
| 275 | 42 | 1.0 | 59 | 3.04 | 2.86 | 2.92 |
| 360 | 48 | 1.0 | 60 | 3.21 | 3.00 | 3.02 |
| Stat. sig. | ns | ns | ns | ** | ** | ** |
| 185 | 42 | 1.0 | 59 | 0.72 | 0.78 | 1.08 |
| 275 | 46 | 1.0 | 58 | 0.84 | 1.04 | 1.26 |
| 360 | 48 | 1.0 | 66 | 0.88 | 1.07 | 1.34 |
| Stat. sig. | ns | ns | ns | ** | ** | ** |

4Data are main effect means from a 32 factorial experiment; 1970 and 1972 were heavy-crop years; 1971 was a light-crop year. Tree collapse was not related (ns) to mineral supply but leaf composition was at 1% probability (**).

Results and Discussion

Fertilization. All of the fertilizer trials showed that mineral starvation is not a prerequisite for the collapse of 'Murcott' trees. Likewise, lavish fertilization did not prevent collapse. The N and K in 5-month-old leaves in August were well above deficiency levels (Table 1). The same was true for other mineral elements that were determined, but not presented here. Visible symptoms of collapse generally appear a few weeks later than this, but in some years they may be seen as early as July. Only heavily loaded trees collapsed. In 1970, a heavy-crop year, nearly one-half of the trees collapsed (Table 1). In 1971, a light-crop year, only about 1% of the trees were overloaded to the extent of causing collapse. In 1972, about 60% of the trees collapsed under a very heavy crop of fruit. Many of these were the same trees that had collapsed in 1970 and recuperated during 1971.

Collapsing trees first show symptoms of wilt, then start to defoliate. Finally, the few remaining leaves may gradually develop symptoms of some mineral deficiency. Analysis of such leaves shows a low mineral status (6). Thus, it is possible for a lush, green tree to become thinly foliated and impoverished in a few weeks.

A comparison of growth and leaf composition in relation to mineral nutrition of young, nonfruiting trees in aerated solution cultures showed no major difference between 'Murcott' and 'Valencia' (5).

Starch trends and feeder root density. Starch was chosen as an index of the energy reserve, because it is rather easy to determine. Exploratory field tests with iodine showed that scaffold roots on newly collapsed trees were free of starch, in contrast to a strong starch reaction in healthy trees. This finding led to a 2-year survey to follow the starch patterns in various parts of the trees. Each spring, healthy 'Murcott' trees were selected for periodic sampling of leaves, twigs, and roots. As excessive fruit set became evident, during the summer and fall, separate samples of twigs and roots were collected from overloaded trees. Leaf samples were not taken from overloaded trees because they were in the process of being shed.

In addition, twig and root samples were collected from nonfruiting (empty) 'Murcott' trees. These were trees that were recovering from previous collapse and bore little or no fruit. Their leaves were healthy but they were not sampled, because they were younger than the mature leaves used from other trees. 'Valencia' orange was used as a comparison because it is not prone to collapse.

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Fig. 1. Seasonal trends in starch content of 'Murcott' and 'Valencia' trees, 1970 and 1971 averages combined. Deviations in twig and root starch associated with 'Murcott' crop load are indicated by broken lines. Starch disappeared from twigs and roots during the period of tree collapse.


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Crop thinning. Studies on thinning were undertaken only to see if collapse is related to excessive fruit load. No attempt was made to establish a method of thinning commercial crops of fruit. Some studies on thinning tangerine crops in Florida have been made (7) and more are desirable.

Of the 12 heavily loaded trees selected in June 1972, the 6 hand-thinned trees remained healthy but the unthinned trees all collapsed and nearly died.

Ethephon was the only material that thinned the crop in the 1973 test (Table 2). Fortuitously, it did an excellent job of thinning in this trial. Conditions apparently were not favorable for the other chemicals, all of which are known to induce drop of young fruit (3).

Table 2. Results of 1973 fruit thinning test on 4-year-old 'Murcott' trees.2

<table>
<thead>
<tr>
<th>Thinning treatment</th>
<th>Conc (ppm)</th>
<th>Appl. date</th>
<th>Fruit/tree at harvest</th>
<th>Tree collapse (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>-</td>
<td>-</td>
<td>400 1185 653b</td>
<td>40</td>
</tr>
<tr>
<td>Gibberellin acid</td>
<td>50</td>
<td>2-13</td>
<td>485 960 587b</td>
<td>30</td>
</tr>
<tr>
<td>Cycloheximide</td>
<td>15</td>
<td>4-20</td>
<td>390 1041 623b</td>
<td>40</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>2000</td>
<td>4-20</td>
<td>510 1125 690b</td>
<td>50</td>
</tr>
<tr>
<td>Ethephon</td>
<td>150</td>
<td>4-20</td>
<td>225 5555 387a</td>
<td>0</td>
</tr>
<tr>
<td>Hand thin</td>
<td>-</td>
<td>6-15</td>
<td>310 525 435a</td>
<td>0</td>
</tr>
</tbody>
</table>

2Gibberellin was applied prebloom; other chemicals were applied near end of petal fall. Fruit was harvested in March 1974. Means for ethephon and hand-thinning differ from those of others at the 5% level of probability by Duncan's multiple range test.

There were no symptoms of collapse in trees that had 30 to 40% of their fruit removed either chemically or manually. In check trees and those of other treatments that did no thinning, 30 to 50% of the trees showed symptoms of collapse.

The overall results of this study seem to show 3 things: a) mineral deficiencies are not the cause of tree collapse, but the result of it; b) lack of sufficient carbohydrate energy to nurture a large crop of fruit and sustain the tree itself appears to be the main cause of collapse; with starvation of roots the underlying cause of wilt, defoliation, mineral starvation, and dieback of limbs; c) reducing the load of fruit prevents this type of tree decline.

During the course of this study, the same type of tree collapse was found in several other mandarin-type cultivars of citrus. Quick starch tests showed the absence of starch in the roots, just as in 'Murcott' trees. The problem in Florida, however, is less intense on other cultivars.

Literature Cited