



Bartlett tree to left, on quince root, is in a state of slow decline. Adjacent healthy Bartlett tree is on domestic French root.

DECLINE

of quince in Santa

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HISTORICAL RECORDS show that the common quince rootstock has been used in Santa Clara County pear orchards since 1852, and Angers quince since the 1880's. These rootstocks were planted in a wide variety of soils—and frequently on slowly drained soils with perched ground water.

Quince has been used as a rootstock for Bartlett, Hardy, Bosc, Winter Nelis, Anjou, and Comice pears. In Santa Clara County, Hardy and Comice have been successfully budded directly on quince, while other varieties were double worked using the Hardy as an interstock. Comice on quince root forms a fairly standard size tree, whereas Bartlett and Hardy are dwarfed unless planted deep enough to become scion rooted. Solid plantings of Bartlett or Hardy on quince root are close planted, usually on 16 × 16-ft squares. Quince rootstock has worked well in Santa Clara County soils since orchardists learned the cultural practices necessary to make the fruit size properly.

For the first five years (1958–1962) that pear decline was a problem in the county, quince-rooted pear trees remained vigorous and produced normally. Most oriental (*Pyrus serotina*) rooted trees were eliminated by pear decline

during this period and many trees on imported French rootstock went into slow decline. During 1963 an occasional quince-rooted tree failed to make normal shoot growth, but none of them showed quick decline (sudden collapse usually followed by death).

In 1964, one orchard consisting of Hardy trees with quince rootstocks made sparse growth. A sampling of the adult psylla population in this orchard showed 40 psylla per 100 beats, which was much higher than normally found in the post-harvest season. It was initially assumed that the high psylla population and the excess water from the previous winter's rains had caused the retarded growth in these Hardy trees. During the 1965 season the grower put on a complete psylla-control program from prebloom through postharvest seasons. Periodic surveys for adult psylla made in the 1965 season revealed only an occasional psylla. The quince-rooted trees that had shown retarded growth in 1964 continued weak and many worsened in 1965.

In the spring of 1965 many quince-rooted pear trees in several Santa Clara orchards failed to make normal growth and as the summer progressed the condition of these trees worsened. Character-

istically, the shoot growth was seriously retarded (one to three inches long), and leaves were pale in color, small, and few in number.

County survey

Because of the severity and magnitude of the deterioration of trees on quince root, a survey was made in 1965 of 15 orchards comprising 600 acres of Bartlett, Hardy, and Comice pears with quince

Two declining Bartlett trees on quince root on either side



TABLE 1. AVERAGE NUTRIENT LEVEL OF LEAVES ON HEALTHY AND DECLINE TREES

Sampling time	Number of orchards	Decline trees on quince root		Healthy trees only on quince root		Healthy trees with Hardy scion roots	
		% N	% K	% N	% K	% N	% K
September 1965	6	1.6	0.61	1.8	0.79	2.1	0.90
August 1966	8	1.8	0.52	1.9	0.74	2.2	0.82

-rooted pear trees

Clara County



Bartlett on the left is on Angers quince. It is in a state of severe slow decline. The tree on the right is a Bartlett originally on Angers quince, but has become scion rooted (planted more deeply, the tree produced roots above the graft union) and having domestic French-type roots the tree grew larger and proved to be more immune to pear decline.

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rootstock to determine possible causes of the trouble. All probable factors concerning cultural operations and environment were investigated.

The survey showed that trees with quince root were affected with poor growth and general decline under a wide variety of situations. Age of affected trees ranged from 9 to 70 years. Affected orchards were located on a wide range of soils, including deep, well-drained Camp-

bell loam, slowly drained Mocho clay loam, and shallow, poorly drained Pescadero adobe. Some orchards were periodically flooded in the winter and had a high groundwater level while others were well drained and never flooded. All affected orchards showed decayed feeder roots with more decayed roots on poor growing trees than on normal, healthy appearing trees. Examinations of hundreds of pulled trees on quince root in the fall of 1965 showed extensive root deterioration. Irrigation water application ranged from 12 to 48 inches per acre, averaging 27 inches. All growers applied at least two effective psylla sprays per year. Half the growers applied three sprays for psylla, and 20% applied a total of four sprays.

In three of the orchards surveyed, numerous trees had multiple interstocks (additional graft unions). Originally, the quince-rooted trees with the Hardy tops had been grafted to Winter Nelis. Later, the Winter Nelis was cut back and grafted to Bartlett. Since many of these trees were growing poorly, it was considered possible that the additional interstocks were the cause of this poor growth. To measure the effect of interstocks, a total of 60 trees in two orchards were cut back severely. One-third were cut to the Hardy interstock, one-third to the Winter Nelis and the final third to Bartlett. Shoot measurements in these plots one year later failed to show any appreciable difference in growth between trees with one, two, or three graft unions. It was then concluded

that the additional interstocks were not the primary cause of poor growth of the original trees.

Nutrient differences

Nutritional levels were checked in half of the declining orchards to determine which, if any, deficiencies might be the cause of poor growth. Leaf samples were taken from: 1) quince-rooted trees showing symptoms of poor growth and general tree decline, 2) adjacent quince-rooted trees showing normal growth, and 3) nearby healthy trees with Hardy scion roots.

Quince-rooted trees showing decline in vigor were generally lower in leaf nitrogen and potassium than healthy, normally growing trees on quince root (table 1), and trees with Hardy scion roots had appreciably more nitrogen and potassium

TABLE 2. PEAR DECLINE DETERMINATIONS OF HARDY-QUINCE BUD UNION

Orchard	Number of trees sampled	Positive & Probable	Normal	Indeterminate	Damaged tree samples
1	15	7	4	4	
2	9	2	3	4	
3	11	4	3	4	
4	8	6	0	2	
5	7	2	2	3	
6	8	3	1	4	
7	2	2	0	0	
8	9	4	3	1	1
9	18	8	5	3	2
10	15	8	0	6	1
11	18	9	2	7	
12	5	4	1	0	
Total 1965	125	59	24	38	4
% 1965	100	47.2	19.2	30.4	3.2
Total 1966	20	9	4	7	-
% 1966	100	45	20	35	-

than either declining or healthy trees exclusively on quince rootstock. No consistent differences were found in phosphorus, calcium, magnesium or chloride between any groups of trees. In a few orchards, however, the sodium content was considerably higher in declining trees than in healthy ones.

Normally pear leaves with 2.0% nitrogen and 0.70% potassium in September are considered adequately supplied with these nutrients. Thus the nutrient levels shown in table 1 indicate that declining trees with quince root are low in nitrogen and potassium but correction has not been obtained after two years of relatively heavy applications of nitrogen (up to 180 lbs of actual nitrogen per acre) and 1,000 lbs of actual potassium per acre each year. Healthy trees with French scion roots appeared to have picked up more nitrogen and potassium than healthy trees with only quince roots. Leaf levels for trees with French scion roots or other trees exclusively on French rootstock in the same orchards showed adequate nitrogen and potassium, indicating that growers had used adequate fertilizer practices.

Bud union decline

Poor tree growth of many trees randomly distributed in quince-rooted orchards and good growth of trees with French scion roots suggested that pear decline could be a possible cause of the deterioration of pear trees on quince rootstock. No quick decline of trees on quince root was found in 1965 or 1966 in Santa Clara County and no brown lines at bud union were found in 1964 or 1965.

Since pear decline was considered a possible cause for pear tree failure on quince root, 203 bud union samples were taken from 130 trees showing decline symptoms in 12 different orchards. Of this total, 125 samples were taken at the Quince-Hardy union and 78 were taken from interstock unions (Hardy-Bartlett, Hardy-Winter Nelis and Winter Nelis-Bartlett). The bud union samples were subjected to the standard determination for virus pear decline and results are reported in table 2. Bud union samples were checked in both 1965 and 1966. These determinations showed that all 12 orchards had trees with positive (or probable) pear decline. In 1965 and 1966 twice as many trees were found positive for pear decline as were found normal. In 1966, brown lines (characteristic of pear decline) were obvious at the Hardy-Quince union in 11 of the 13 orchards checked. This is the first time that exten-

sive brown lines were found at the union between Quince and Hardy in Santa Clara County.

Of 78 bud union samples taken between interstocks of various French-type varieties, only three were reported as positive for pear decline—all others were reported as normal or indeterminate. This again confirms that decline was occurring at the Hardy-Quince graft union and not at the union between French varieties.

In 1965 and 1966 brown-line and positive bud union determinations were obtained from pear trees growing on quince rootstock in Contra Costa, Sacramento, and San Benito counties. Pear trees in these same orchards had been growing normally during the early stages of pear decline of 1958 to 1962. Records from the California Department of Agriculture also reveal that in 1965 some positive bud unions had been found on declining pear nursery trees budded to Angers quince rootstock. This was the first time this situation had been reported in nursery stock in California.

Summary

It was concluded from this survey that the general decline of pear trees on Angers quince root is due to virus-induced pear decline similar to that existing on oriental-rooted pear trees. Bartletts, Hardys, and Comice grown on Angers quince rootstocks show top, bud union, and root symptoms typical of pear decline. The random distribution of the trees in affected orchards is typical of the distribution of pear decline trees where they are grown on oriental or other susceptible rootstocks. Individual trees that have been marked and watched for three years have generally gone into more serious decline each succeeding year. No cases of quick decline, however, have been found with quince rootstock.

Changes in cultural management, fertilization, pest control, irrigation, and/or cultivation have not rejuvenated these declining pear trees on quince roots. Thus, pear trees on Angers quince rootstock appear susceptible to pear decline and should be replaced when they can no longer produce and size commercial crops. No new plantings of pears on Angers quince rootstock should be made because of its susceptibility to pear decline.

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The effects of leaf-washing techniques for removal of surface contaminants were evaluated with regard to possible mineral losses that might affect orange-leaf analysis. Techniques used were: (1) nonwashed, (2) rubbing in detergent and rinsing, (3) rubbing in detergent, then dipping in 3% HCl and rinsing. Concentrations of N, P, K, Ca, and B in the leaves were not significantly affected by the washing procedures. Concentrations of Mg, Na, Cl, Zn, Mn, Cu, and Fe in or on the leaves were affected. No significant leaching losses of nutrients from the leaves were found due to washing treatments.

AT LEAST 75% of the commercial citrus acreage in California is sprayed with compounds of zinc and manganese to furnish these essential nutrients which cannot be supplied effectively through the soil. These compounds, as well as urea, are applied in the spring after the leaves have largely expanded. Leaves from the sprayed trees usually are sampled in early fall to determine the nutritional status of the trees. Samples require some kind of washing treatment to remove dust particles and various spray deposits. If nutritional foliage sprays have been applied, all surface deposits must be removed.

There are two commonly used washing methods to remove surface contamination from sprayed citrus leaves. The usual method is to wash and rub the citrus leaves in a detergent solution; the less commonly used method is to then add a further treatment using acidulated hydrochloric acid solution. Both of these methods were evaluated for removal of surface contaminants from sprayed Valencia orange leaves.

In July, 1962, Valencia orange trees, showing leaf symptoms of zinc and manganese deficiencies, were sprayed with 1 lb of zinc from zinc sulfate per 100 gallons of water and 2 lbs of Mn from manganese sulfate per 100 gallons of water. Sodium carbonate was used as a precipitation agent for zinc sulfate and manganese sulfate in quantities equal to one-half the weight of zinc sulfate and manganese sulfate used. The same spring flush of leaves from nonfruiting terminals