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 extensive 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

Washing Citrus Leaves for Leaf Analysis

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sprayed in July 1962 was sampled in October 1962. Composite samples consisted of 200 fully expanded terminal leaves per plot. Three subsamples of 60 leaves each were used to study the effectiveness of the washing techniques commonly used for preparation of samples for chemical leaf-tissue analysis.

Procedures

Washing procedures were: (a) control —leaves not washed; (b) leaves hand-washed in aqueous solution of 0.1% v/v detergent (JOY) by passing the fingers and thumb over the total surface of the leaf, then rinsing it in deionized water; (c) leaves washed in detergent (JOY) and rinsed as in (b), then dipped in 3% v/v of acidulated hydrochloric acid solution for exactly two minutes, and again rinsed in deionized water. Detergent solutions were prepared with tap water. Each sample was rinsed in running distilled water and in several separate deionized water baths. The processes of drying, grinding in a Christy and Norris chromium-plated laboratory mill, storage, and analysis for macro- and micronutrients were the same as have been used previously.

Nutrient leaching

Concentrations of nitrogen, phosphorus, potassium, calcium, and boron in the leaves were not significantly affected by the two washing treatments (see table), and no leaching of these nutrient elements occurred. Concentrations of magnesium, sodium, chloride, zinc, manganese, copper, and iron in or on the leaves were affected. Magnesium concentrations in the detergent-washed leaves were slightly lower than in the control sample but not in those which were detergent-washed and then dipped in acidulated hydrochloric acid solution. Sodium in unwashed leaves was slightly lower than in detergent- or detergent-acid-washed leaves, probably a result of slight contamination with sodium in the detergent. Leaves washed in detergent and then dipped in hydrochloric acid solution contained significantly higher chloride than the unwashed or detergent-washed. Thus, leaves dipped in acidulated hydrochloric acid solutions cannot be used for chloride determinations. No leaching of chloride was observed due to detergent washing.

Unwashed leaves

Unwashed leaves from trees sprayed with zinc and manganese in July, and sampled the following October, contained about double the zinc and manganese of analogous leaves which were detergent- or detergent-acid-washed. Detergent-acid washing was no more effective in removing surface contamination than detergent alone. Leaching of zinc and manganese from the leaves by washing seems improbable.

The unwashed leaves contained significantly higher concentrations of copper than the leaves washed with detergent or detergent-acid. These leaves had not been sprayed with copper compounds, but it was considered possible that some of the pesticides used contained small amounts of copper. Dipping leaves in acidulated hydrochloric acid solution after washing in detergent did not further reduce the copper concentration.

Iron concentration in the unwashed leaves was significantly higher than in the detergent- or detergent-acid washed, with no differences between the latter two. No leaching of iron was indicated. Soil dust particles on the surface of the leaves are assumed to be a major source of iron contamination. Iron concentration in the leaves generally indicates whether the sample was properly prepared for analysis. Since samples dipped in hydrochloric acid solution after washing in detergent contained the same amount of iron as those washed in detergent only, it appears that detergent-washing alone is sufficient to remove surface contamination.

Data summary

Data obtained in the present experiment indicate that dipping of detergent-washed leaves in acidulated hydrochloric solution is not necessary if the leaves are properly washed in the detergent solution. In this experiment there was no leaching of nitrogen, phosphorus, potassium, calcium, chloride, zinc, manganese, boron, and iron and probably none of magnesium from orange leaves resulting from the washing procedures used.

EFFECTS OF DIFFERENTIAL WASHING TECHNIQUES ON THE CONCENTRATION OF MACRO- AND MICRONUTRIENTS IN VALENCIA ORANGE LEAVES

Washing techniques	Nutrient concentrations in oven-dried leaves*											
	N	P	K	Ca	Ma	Na	Cl	Zn	Mn	Cu	B	Fe
	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	pmm
Unwashed	2.53	.147	1.07	3.97	.422y	.061x	.022x	.123y	182y	5.6y	367	186y
Detergent washed	2.56	.146	1.08	3.97	.407x	.066y	.028x	68x	94x	5.1x	368	61x
Detergent acid washed	2.55	.147	1.07	3.96	.416xy	.065y	.064y	65x	92x	5.0x	369	61x
Significance	NS	NS	NS	NS	**	**	**	**	**	**	NS	**
C.V.	2	4	3	3	5	8	32	10	14	9	3	12

* Each value is a mean of 64 individual determinations. Mean values within a column are statistically significant at the 1% level or more only if they do not have a subscript letter in common.

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