Black-end of Pear

problem is subject of extensive field and laboratory studies

L. D. Davis

Intensive investigations have been conducted in the field and in the laboratory since about 1930 regarding black-end or hard-end condition of pears and the relation of the rootstock to the incidence of the disease.

Investigations were extended to include many thousands of trees whose rootstocks were known. The greatest incidence of the disorder occurred on the Japanese stock—*P. pyrifolia*—although black-end was found on pear trees propagated on *P. ussuriensis*, *P. betulafolia* and *Kieffer* seedling roots.

Although the trouble has been found on trees that were said to be propagated on *P. calleryana* stock, it always has been small in amount. There have been a few cases where black-end has occurred on what has seemed to be French—*P. communis*—rootstock. The occurrence on French root however, has been so rare that the question might well be raised whether these particular trees might not be propagated on hybrid stock.

Records have been kept of the performance of individual trees over a period of years. The trouble does not spread throughout the orchard. All degrees of severity have been found; trees tend to hold their relative positions from year to year with respect to the amount of black-end produced.

The curve of incidence of the disease has been obtained by counting the number of black-end fruits on selected trees at weekly intervals.

Materials Tested

A number of materials have been applied to the soil and injected into black-end trees. Among those applied to the soil have been: A complete fertilizer, beet lime, sulfur, iron sulfate, a combination of manure and lime. Oxalic acid, tartaric acid, citric acid, iron sulfate, copper sulfate, boric acid, and a mixture of 12 different salts containing copper, boron, manganese, molybdenum, zinc, thorium, barium, strontium, tungsten, chromium, cadmium, and cobalt have been injected into the trees. None of the soil applications or tree injections has changed the black-end condition of the trees.

Grafts Studied

Reciprocal and intermediate grafts have been made in an effort to transmit the disease. In the intermediate grafts root pieces were used as the intermediates, some having soil filled boxes built around them. None of the grafting experiments has been successful in transmitting the disease.

Several thousand inarched trees have been observed. None of them has cured the disorder except when the original stock has been separated and the top caused to stand upon the inarches.

Young trees have been produced by propagating Bartlett on piece roots obtained from trees that produced black-end

Continued on page 15

IRRIGATION

Continued from page 6

The spud ditch finds favor in peat areas where the water table is already reasonably high. It simply saturates the surrounding peat mass with water by rapid percolation through the porous peat.

Cost of irrigation naturally varies with the type of system used. It costs about $3 to pump one acre-foot of water where the total lift is 100 feet.

If this total lift is in a well and a sprinkler system is operating requiring a pipe line pressure of about 40 pounds per square inch at the pump discharge, the pumping cost is increased by approximately $3 per acre-foot.

In contrast, some supplies for gravity systems cost as little as 50 cents or less per acre-foot.

The cost of gravity or ditch water depends upon the gross cost of the project and how rapidly it is being amortized.

C. N. Johnston is Associate Professor of Irrigation, and Associate Irrigation Engineer in the Experiment Station, Davis.

Rate of Water Supply and Length of Run for Various Types of Irrigation and Slopes of Land

Type of irrigation	Slope of land in ft./100′	Coarse sandy soils		Medium silt loam		Very heavy clay soils	
		Supply needed	Length of run	Supply needed	Length of run	Supply needed	Length of run
Basin	0– 2′	20 cubic feet per second/acre	....	5 cfs	.....	2 cfs	.....
	2– 5′	20 cfs/acre	....	5 cfs	.....	2 cfs	.....
	5– 8′	20 cfs/acre	....	5 cfs	.....	2 cfs	.....
	8–12′	20 cfs/acre	....	5 cfs	.....	2 cfs	.....
Border or Check	0– 2′	1.5 cfs/10′	220′	.5 cfs/10′	550–880′	.3 cfs/10′	to 1,000
	2– 5′	width	220′	width	550–880′	width	to 1,000
	5– 8′	.....	220′	.....	550–880′	.....	to 1,000
	8–12′	.....	220′	.....	550–880′	.....	to 1,000
Furrow	0– 2′	.02 cfs each	220′	.01 cfs ea.	440–660′	.005 cfs ea.	880′
	2– 5′	.02 cfs each	contour	.005 cfs ea.	220–440′	.003 cfs ea.	550′
	5– 8′	.02 cfs each	furrows 2%	.002 cfs ea.	110–220′	.002 cfs ea.	330′
	8–12′	.02 cfs each	slope				
Sprinkler	0– 2′	2″ per hour	.....	.5″ per hour	.....	.....	
	2– 5′	2″ per hour	.....	.5″ per hour	.....	.....	
	5– 8′	1.5″ per hour	.....	.4″ per hour	.....	.....	
	8–12′	1.0″ per hour	.....	.3″ per hour	.....	.....	

POTASH

Continued from page 3

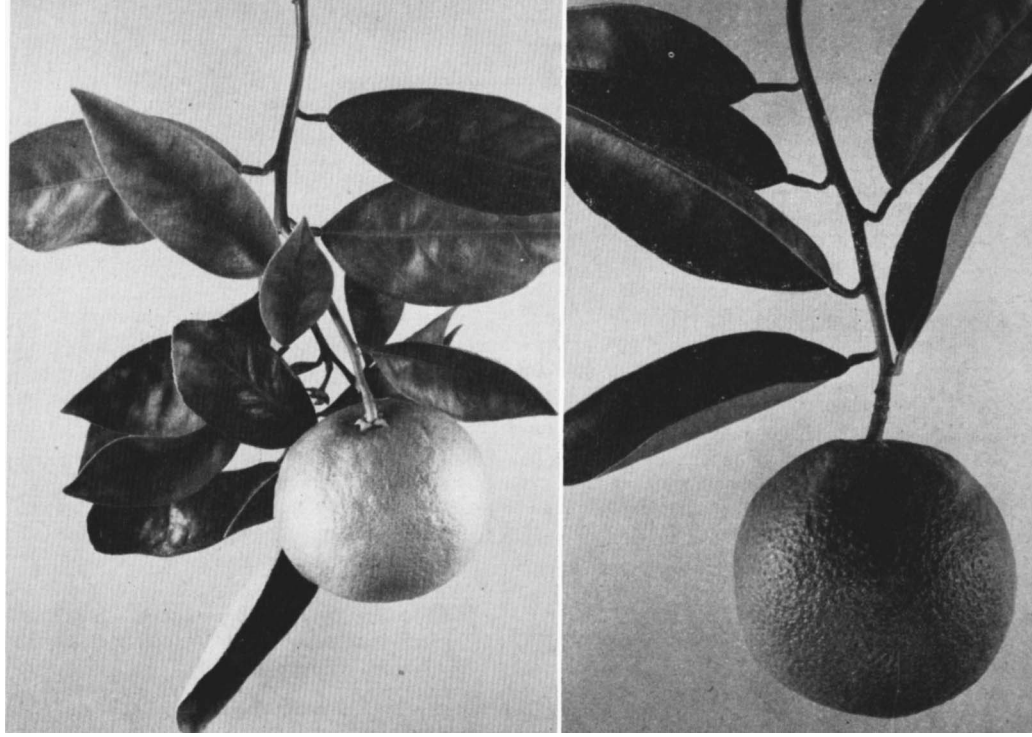
slightly deficient in potash showed from 0.26% to 0.35% potassium on a dry weight basis.

Leaves from trees markedly deficient in potassium and showing the type of puckering and malformations described previously had a potassium content ranging from 0.14% to 0.24%.

Leaves from trees showing injury from excessive potash showed potassium ranging from 2.15% to 3.63%. It would thus appear that values in between these extremes, that is from about 0.35% to 2% can be regarded as representing ample but not excessive supplies of this element.

Many hundreds of leaf samples have been analyzed from commercial orchards following this work and the great majority show potassium values ranging from 0.4% to 1.5%.

In no case have we obtained values greater than 2%, and in only a few instances have we found orchards where the level was below 0.4%.



Twig and fruit (left) from tree moderately deficient in potash contrasted with fruit (same age) from tree receiving ample potash. Note difference in both size, rind texture, and in characteristics of foliage.

Variable Supply

Each year the fruit from each tree was counted, weighed, graded as to rind texture and other external characteristics. Measurements were made on diameter, thickness of rind and percentage of juice characteristics.

Fruit from trees lacking in potash was small in size but otherwise of good quality.

The rinds tended to be smoother in general than fruit from trees receiving ample potash and the fruit from the trees injured from excessive potash had very coarse rinds.

The juice from the low-potash fruit was slightly lower in acid than the fruit from the amply supplied trees but was of good total solid content and acceptable flavor. The chief effect of lack of potash on fruit therefore was in the matter of size.

The decrease in average size of fruit was found to hold not only for the fruit from trees acutely deficient in potassium, but also for the fruit from the trees which were so slightly deficient in this element that no visible symptom of potash lack could be seen.

The results of leaf analysis and soil survey in these tests give no evidence of a potash lack in most California citrus soils. This suggests some other reason or reasons for small fruit sizes.

Some of the orchards sampled, where small sizes are an acute problem, have a much higher potash level in both leaves and soil than in other orchards where sizes are good.

In a number of orchards manures have been consistently used over a period of years. This practice has substantially increased the potash content of both the soil and citrus trees without apparently affecting fruit sizes.

It thus appears improbable that increasing the potash of a soil already sufficiently supplied will improve fruit sizes.

H. D. Chapman is Chairman of the Division of Soils and Plant Nutrition, Professor of Agricultural Chemistry, and Chemist in the Experiment Station, Riverside.

S. M. Brown is Associate Chemist in the Experiment Station, Riverside.

D. S. Rayner is Senior Laboratory Technician, Experiment Station, Riverside.

BLACK-END

Continued from page 10

fruits and from those that did not. These young trees are now growing in an experimental block at the University Farm at Davis. They have produced crops whose black-end performance is closely correlated with that of the original trees.

The disease has never been observed on Beurré Hardy even when this variety was on the same clonal stock as the Bartlett which had severe black-end.

Rootstock

All the foregoing point to the fact that the black-end condition is closely related to the rootstock of the individual tree.

A number of investigations have been conducted in the laboratory.

The distribution of lenticels from the stem to the calyx end has been studied. Certain morphological and histological features have been investigated. The pH and acidity of various sections of fruit with and without black-end have been determined as well as the seasonal pH changes of fruits on French and Japanese stocks. In the latter case the samples were divided into those from trees that did not produce black-end and those that did.

The buffer capacities of juice from black-end and normal fruit have been compared. The sugar content of mature pears from Japanese stocks with and without black-end and from French rooted trees has been determined. Certain ash constituents of leaves and fruit have been studied.

A block of selected Japanese clones on their own roots, whose black-end history is known, is now being grown at Davis for further basic study of this disorder.

It may be stated that this disorder, so far as the California pear industry is concerned, is now largely only of academic interest.

Pear Acreage Down

The severe losses suffered from fireblight in 1930, the prevalence of hard-end, and economic conditions during the early thirties resulted in the removal of most pear orchards propagated on oriental rootstocks.

As of 1946 there were 37% fewer bearing pear trees in California than in 1933, leaving a comparatively small acreage where hard-end is a problem.

L. D. Davis is Professor of Pomology and Pomologist in the Experiment Station, Davis.