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The Relation of PEAR PSYLLA TO PEAR DECLINE . . . *Greenhouse Tests*

Extensive research by U.C. entomologists, in both greenhouse and field test plots, on the relation of insects to the cause or spread of pear decline disease indicates that the pear psylla, Psylla pyricola Foerster, is the key to the problem.

DURING THE 1961 SEASON, 895 pear trees were exposed to feeding by insects being tested as possible carriers of a pear decline virus—or as being potentially capable of introducing a phytotoxic secretion into the pear trees. In nearly all cases, the insects were caged on pear decline foliage for an acquisition feeding prior to caging on the test trees. Insects receiving the greatest emphasis were the pear psylla, various species of aphids and leafhoppers.

The trees exposed to feeding by aphids or leafhoppers during 1961 have not developed symptoms of pear decline. However, 39 of 102 Winter Nelis trees on *Pyrus serotina* rootstock, exposed to feeding by pear psylla during 1961, have died, as shown in Table 1. During the same period, only 6 trees died among 752 trees exposed to feeding by insects other than pear psylla or kept free of insects. Of the psylla-infested trees, 10 were dead by the end of 1961, and the others died during the spring and summer of 1962.

With the death of several of the pear psylla test trees in the fall of 1961, and the report from Washington that psylla caused pear decline by injecting a phytotoxin into the trees, the 1962 research in Northern California was restricted almost exclusively to tests with this insect.

During 1962, pear psylla fed on 298 pear trees in the greenhouse at Berkeley, on 133 young field trees in a plot on the Davis campus (see accompanying article), on 30 large 40-year-old orchard trees in Lake County and on 10 young pear trees set out in the field in El Dorado County. An equal number of control trees, of comparable size and growing condition, were kept free of psylla. Results are not yet available from the Lake County and El Dorado County experiments.

Greenhouse tests

Most of the greenhouse test trees were Winter Nelis on *Pyrus serotina* roots, in their second year of growth. Other combinations included: Bartlett on *P. serotina*, *P. ussuriensis*, *P. calleryana* or French rootstocks; Old Home grown from rooted cuttings; and seedlings of *Pyrus serotina* or Winter Nelis.

The pear psylla were reared in the greenhouse or collected from field trees, many of which had pear decline disease. Since such field-collected psylla developed from egg to adult on diseased trees, they had ample opportunity to acquire virus—if pear psylla is transmitting a virus in addition to causing a toxic effect in pear trees.

In most of the greenhouse experiments, 25 to 200 adult psylla were confined to a single branch of the test tree by using white organdy cloth sleeve cages. They were allowed to lay eggs and the hatching nymphs fed on the test tree until the adult stage was reached. The number of nymphs feeding on a single tree varied from a few to several thousand. The psylla infestation was usually confined to only one branch of a tree having two or more branches. This allowed better discrimination between tree effects that result from mere defoliation or other local injury and symptoms that are caused by a translocated systemic factor such as a toxin or a virus. If all branches of the tree are partially or entirely defoliated by infestation of all foliage, the tree is weakened and, in extreme cases, may even die in the absence of "pear decline" as we know it. In most cases such defoliated trees will subsequently put out new growth, if on French rootstock. However, if psylla, feeding on only one branch of a tree growing on susceptible Oriental rootstock, cause symptoms in or death of the entire tree it is almost certain that the causal factor was translocated from the site of feeding to the uninfested portion of the tree. A more profound effect results than would be expected from the mere loss of plant food that the infested branch failed to provide.

Forty-nine of the 205 Winter Nelis pear trees on *Pyrus serotina* roots that were exposed to feeding by pear psylla during 1962 have already died. All but one of the dead trees was exposed to psylla infestation prior to July. It is prob-

Top photo, to right—greenhouse tree in complete collapse following psylla feeding on only one branch by confinement with organdy sleeve as shown on healthy tree in lower photo. Both were Winter Nelis pear trees on Pyrus serotina rootstock.

TABLE 1. EFFECT OF PEAR PSYLLA FEEDING ON WINTER NELIS TREES ON PYRUS SEROTINA ROOTSTOCK IN GREENHOUSE TESTS. 1961–1962

Tests initiated	Psylla test trees		Control trees	
	No. tested	No. dying	No. tested	No. dying
1961 (April-Nov.)	102	39	752*	6
1962				
April	26	11	26	0
May	75	28	75	0
June	46	9	46	0
July	51	1	51	0
August	7	0	7	0
Totals	307	88	957	6

* Includes over 500 pear trees fed on by experimental insects other than the pear psylla.

TABLE 2. THE EFFECT OF HEAT AND DROUGHT STRESS ON PEAR TREES WITH AND WITHOUT PRIOR PEAR PSYLLA FEEDING

Stress Factor*	1961 test trees		1962 test trees	
	Psylla trees	Controls	Psylla trees	Controls
Heat only	10/36**	0/124	2/14	0/16
Heat and drought	1/11	0/32	1/12	0/11

* Heat stress consisted of 42 days in greenhouse compartment in which temperature was 90°F. or above for at least 4 hours during each of 32 days. Drought stress consisted of withholding water until trees wilted each day (except weekends) over a 21-day period.

** Numerotor = number of trees dying; denominator = number of plants in test.

able that additional test trees will die during 1963.

Collapse of foliage

The common symptom preceding death of test trees in the greenhouse was the collapse of foliage—first, portions of individual leaves, followed by wilting and drying of all leaves on the infested branch. When these symptoms appeared on a branch caged with pear psylla, the uninfested branch of the same tree usually developed the same symptoms simultaneously or within a few days after the disorder was apparent in the foliage of the infested branch. These symptoms indicate a failure of the root system. The time elapsing between infestation of the test trees with adult psylla and the collapse of the foliage was approximately 60 days. Most of the trees that have died following psylla feeding did so while being held at normal greenhouse temperatures.

Effects of stress

Trees that had been exposed to pear psylla feeding (some in 1961 and some in 1962) but had not collapsed, together with control trees, were placed in a special greenhouse compartment for 42 days. During this period the temperature was allowed to rise every day to over 90°F, if the weather permitted. The maximum daily temperature in this compartment reached 90°F or above for at least a four-hour period during 30 of the 42 days. None of 140 control trees was brought into collapse by this treatment, but 12 of 50 psylla trees died after removal from the heat stress compartment, as shown in Table 2.

Some of the trees being subjected to high temperatures were also placed under drought stress. These trees were watered lightly in the evening only after wilting of the foliage had occurred during the day. This was done daily, except weekends, over a 21-day period. Terminal growth and many leaves were killed by this treatment, but with the resumption of normal watering, most trees put out new growth. Two of 23 psylla trees died but all 43 controls are still alive.

Toxin or virus

The causal factors in pear decline have not yet been adequately determined. Washington researchers reported last year that the disease results from a non-multiplying toxin that is introduced into the plant by the pear psylla. The toxin is considered responsible for phloem necrosis in susceptible Oriental rootstock at the graft union. Although considerable evidence has been obtained to support a phytotoxin explanation, and most attempts to transmit pear decline by grafting have been unsuccessful, the possible involvement of a virus as an important factor in pear decline has not yet been excluded.

Research work in both Washington and California implicates the pear psylla as the key to this disease. However, it is possible that this insect is serving as a vector of a virus that is necessary in the development of pear decline disease. Twenty-five of 72 test trees have died that were exposed only to adult psylla in greenhouse tests. Several of these trees received adult feeding for less than two weeks. The death of such trees suggests that a virus may be involved. However, experimental results do not yet adequately demonstrate or exclude either virus or toxin as the sole cause of pear decline. Experiments in progress should yield more definite information on this question during the 1963 season.

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