ed that stem-pitting symptoms can be reproduced by budding or grafting tissues from diseased trees onto healthy Mahaleb (figure 6) and Stockton Morello cherry rootstocks and peach seedlings. Present studies suggest that the disease is caused by strains of the tomato ringspot virus, known to be carried in the soil and spread by the dagger nematode (*Xiphinema americanum*), but the possible implication of some causal agent other than tomato ringspot virus is also being investigated.

Long-term control measures consist in careful selection and use of propagation material from healthy trees, which should be planted only in non-infested soil. Because Prunus stem pitting is caused by a soil-borne virus and spreads slowly from diseased to adjacent healthy trees, roguing of diseased orchard trees is advisable. Before replanting in stem pitting-affected orchards, it is desirable to fallow the soil after tree removal, seed the area with a cereal crop for at least one year, and then fumigate for residual nematode control. The causal agent of Prunus stem pitting has a wide host range but it does not include cereals such as oats, barley, wheat, *etc.*

Stem pitting cannot be avoided by use of Nemaguard rootstock. Nemaguard is resistant to the important root-knot nematodes (*Meloidogyne* spp.), but not to the suspected vector of stem pitting, *Xiphinema americanum.*

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Mites in almonds and stone fruits

Richard E. Rice ■ Richard A. Jones

It has been observed that almonds suffer more severe infestations of pest mites than do other deciduous fruit trees. Until recently, the reasons for this were not known, but were usually thought to be due to differences in cultural techniques or other undefined management practices.

In 1972 a study was initiated to examine the relationships of pest and predaceous mites on peaches, nectarines, and plums. The objective of this work was to help develop integrated pest management programs for mites on these crops. During this study, samples were also taken from almonds for comparison with the other types of trees. The results of those comparisons are reported here.

Sampling procedures

Six cultivars in the genus *Prunus* were selected for continuous sampling throughout the study. These were Santa Rosa plum, *P. domestica* Lindl., Fay Elberta and Halford peaches, *P. persica* Batsch, Independence nectarine, *P. persica* var. *nectarina* Maxim., and Merced and Mission almonds, *P. amygdalus* Batsch. Four trees of each of these cultivars were randomly planted in a 1.0-acre experimental block of mixed stone fruits at the San Joaquin Valley Agricultural Research and Extension Center, Parlier. Trees were 3 years old when mite sampling started in March, 1972, and were not treated with insecticides or miticides before or during the study. The orchard was furrow irrigated and weeds were controlled by cultivation.

Mites were sampled at about 2-week intervals during the 1972 and 1973 growing seasons: 25 mature leaves were picked at random from each selected tree and processed through a standard mite-brushing machine. All leaf samples were brushed within 24 hours of picking and mite counts were made within one-half hour of brushing to insure optimum recovery and identification of mites. All mites were identified by species. Summaries of the data from each year are shown in tables 1 and 2. Mites were grouped as *Tetranychus* spp., which included the twospotted and Pacific mites, *Tetranychus urticae* Koch and *T. pacificus* McGregor, the European red mite *Panonychus ulmi* (Koch), two species of rust mites in the family Eriophyidae, four species of predaceous mites in the family Phytoseiidae, and another predaceous mite, *Zetzellia mali* (Ewing). The eriophyids collected were predominantly the big-beaked plum mite *Diptacus gigantorhynchus* (Nalepa), and peach silver mite *Aculus cornutus* (Banks). The phytoseiids collected were *Neoseiulus caudiglans* (Schuster), *Typhloseiopsis citri* (Garman and McGregor), *Typhlodromus occidentalis* Nesbitt, and *Amblyseius hibisci* (Chant). Leaf samples occasionally included specimens of Tydeidae and Tarsonemidae, but these were relatively infrequent and were not included in the tabulations of species.

Some notable differences in mite populations were found between the four soft-fruit and the two almond cultivars. Almonds appear to support much lower populations of eriophyids and phytoseiids than do peaches, plums, or nectarines, whereas populations of the three tetranychid species did not vary among cultivars. *Zetzellia mali* was never collected from almonds, although it was common on plum trees adjacent to almonds and was also collected at various times from the peach and nectarine varieties. The low numbers of twospotted, Pacific, and European red mites collected from all of the host trees are believed to be a result of the general predator activity found on mites in the experimental orchard. In addition to predaceous phytoseiid mites, other predators of mites present in the orchard included the sixspotted thrips *Scolothrips sexmaculatus*, *Stethorus* beetles, and green lacewings.

Predator distributions

Distribution of the four species of phytoseiids on the various cultivars is shown for 1973 in table 3. *Neoseiulus caudiglans* and *T. citri* were the dominant species on plums and peaches, while *T. citri* and *A. hibisci* predominated on nectarine. *Typhloseiopsis citri* was also collected most frequently from almonds, but in low numbers. These data show that of the four species of predaceous mites that usually occur on deciduous fruit trees in the San Joaquin Valley, none was present in consistently high numbers on almonds in the experimental orchard.

In addition to the mite sampling conducted at Parlier, collections have been made at various times from a number of commercial almond and stonefruit orchards in the Fresno-Tulare County area. In general, these samples confirmed the data collected from the untreated experimental orchard. For example, at least one, and normally two or three, of these phytoseiid species were usually collected from peach, plum, or nectarine orchards. These orchards may or may not have been treated with pesticides, nor did they always have high populations of tetranychid mites to serve as prey for the phytoseiids. However, the stonefruit orchards usually had one or both species of eriophyids present in varying numbers. Where high populations of twospotted or Pacific mites were present, *T. occidentalis* was usually the most numerous predaceous mite, followed by *T. citri.* In treated orchards, *T. citri* sometimes occurred in greater numbers than *T. occidentalis*, especially in plums.

In almonds, phytoseiids were usually found in much lower numbers, and only one species was normally collected in the samples. As pest mite populations increased, *T. occidentalis* and sometimes *T. citri* also increased but often not until extensive leaf injury had occurred. In one almond orchard with no ground cover or weeds but with frequent sprinkler irrigation, *T. citri* was collected in high numbers from mummy almonds that also contained many tarsonemids, and from leaves also infested with European red mite. *Amblyseieus hibisci* has been collected from three almond orchards in an area northeast of Sanger, Fresno County. Two of these orchards were non-tilled with permanent groundcover; the other orchard was tilled but had some weed growth and uncultivated fencerows nearby, along with alfalfa, grapes, and an uncultivated slough adjacent to the orchard. In these studies, *A. hibisci* has not been collected from orchards with clean cultivation or total weed control. *Neoseiulus caudiglans* has not been collected during these studies in commercial almond orchards.

In the development of successful mite management programs in other crops, such as apples and pears, it has been shown conclusively that alternate prey is a key factor in maintaining populations of predaceous phytoseiid mites. Data from almonds indicate that the relatively low numbers of alternate prey, in this case eriophyid mites, may be responsible for the correspondingly low numbers of predaceous mites collected throughout this study from almonds. In the absence of adequate numbers of primary prey—such as twospotted or Pacific mites—alternate prey on leaves would be important to the survival of phytoseiids. This would be particularly true during early spring when the *Tetranychus* spp. are not normally present on the trees. Because of the general absence of tetranychid mites, the eriophyid mites probably served as the primary prey for phytoseiids on the trees sampled at Parlier during 1972 and 1973.

These studies have shown the complexity of mite populations and species on deciduous fruit and nut trees in the San Joaquin Valley. Further studies will be needed before all of the interrelationships are fully understood.

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TABLE 1. Relative Mite Densities on Almonds and Stone Fruits, Parlier, Calif., 1972

	No. mites collected*				
Cultivar	Phytoseiidae	Eriophyidae	*Tetranychus* spp.	*Panonychus ulmi*	*Zetzellia mali*
Santa Rosa plum	566	101,233	4	202	33
Fay Elberta peach	360	25,884	4	81	0
Halford peach	381	37,768	20	271	8
Independence nectarine	191	41,488	20	61	0
Merced almond	100	912	0	49	0
Mission almond	57	1,748	4	88	0

*Total mites collected from 17 sample dates at 2-wk. intervals, March 13 to October 23, 1972. Four replicates of 25 leaves per cultivar per date.

TABLE 2. Relative Mite Densities on Almonds and Stone Fruits, Parlier, Calif., 1973.

	No. mites collected*				
Cultivar	Phytoseiidae	Eriophyidae	*Tetranychus* spp.	*Panonychus ulmi*	*Zetzellia mali*
Santa Rosa plum	93	69,035	91	221	364
Fay Elberta peach	152	10,553	74	198	6
Halford peach	233	20,526	155	294	32
Independence nectarine	209	8,191	113	203	21
Merced almond	9	85	45	214	0
Mission almond	11	876	17	167	0

*Total mites collected from 14 sample dates at 2-wk. intervals, Apr. 10 to Sept. 26, 1973. Four replicates of 25 leaves per cultivar per date.

TABLE 3. Distribution of 4 Species of Phytoseiid Mites Collected from 6 Cultivars of Almonds and Stone Fruits, Parlier, Calif., 1973*.

		Cultivar					
Mite species	Sex	Santa Rosa	Fay Elberta	Halford	Independence	Merced	Mission
Neoseiulus caudiglans	F	22	39	71	24	1	2
	M	4	12	23	8	0	0
	nymphs	8	19	30	18	0	1
	Total	**34**	**70**	**124**	**50**	**1**	**3**
Amblyseius hisbisci	F	19	6	15	48	0	0
	M	5	5	5	16	0	1
	nymphs	5	5	6	21	1	0
	Total	**29**	**16**	**26**	**85**	**1**	**1**
Thyphloseiopsis citri	F	11	36	51	41	4	1
	M	7	10	14	16	1	1
	nymphs	9	18	13	16	2	2
	Total	**27**	**64**	**78**	**73**	**7**	**4**
Typhlodromus occidentalis	F	2	1	4	1	0	1
	M	0	1	0	0	0	0
	nymphs	1	0	1	0	0	2
	Total	**3**	**2**	**5**	**1**	**0**	**3**

*Total mites collected from 13 sample dates at 2-wk. intervals, April 10 to September 26, 1973. Four replicates of 25 leaves each per cultivar per date.