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THE WILLAMETTE MITE ON GRAPES

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INTRODUCTION

FOR THE past three years the authors have observed extensive damage to grapevines by the Willamette mite, *Tetranychus willamettei* McGregor⁴ throughout the grape-producing areas of Fresno and Tulare counties. Prior to these observations, many growers in these two districts were familiar with the injury, although not aware of its cause. During the past eight years the authors have seen occasional vineyards damaged by this mite also in Sacramento, Santa Clara, Stanislaus, San Joaquin, Yolo, and Sonoma counties. In the spring of 1938 and of 1939 the mite was unusually abundant in Stanislaus and San Joaquin counties, and in 1945 was abundant in Sonoma County.

The species was named and described by McGregor (1917), who collected the type material on leaves of white oak, *Quercus lobata*, at Oregon City, Oregon, August 22, 1915. He stated, "The presence of this species on oaks is revealed from a distance through the rusty appearance." It has also been reported on elm (Garman, 1940), and on pears and apples (Gentner, 1937; Newcomer, 1941; Overholser, Overley, and Allmendinger, 1944). Lamiman (1935) reported the presence of the Willamette mite on grapes, often in association with *Tetranychus pacificus* McGregor. He states that the Willamette mite "confines its attacks to spring and early summer, disappearing during hot weather."

SYMPTOMS OF INJURY

Affected vines in the summer and fall are a characteristic rusty yellowish green, especially the older, basal leaves. On weakened vines with short growth, all leaves may present such an appearance. The mites characteristically feed and produce colonies on the under surface of the leaf. This localized feeding produces injured areas which turn straw colored and then become scarious. This effect is visible in the upper leaf surface as chlorotic-green, straw, or straw-bronze discolorations. The initial feeding is confined to areas enclosed by the larger net veins, and a narrow strip of leaf tissue close to the larger veins remains green. The smaller net veins and often sections of the larger net veins, and the areas they enclose, lose their chlorophyll. During early stages of injury the chlorotic areas may be small and confined within fine net veins. They may consist of a very few spots scattered or grouped, or many spots evenly covering the entire leaf, in appearance sharply differentiated from the strip of normal green tissue banding the veins. This condition results in a faint chlorotic-green mottled appearance on the upper surface, somewhat similar to and easily confused with the mottle of Pierce's disease of grapevines, especially in late spring. Leaves that are nearly mature when first infested

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⁴ The authors are indebted to E. A. McGregor for making the determination of the species.

show less intense mottling; the veins show no banding or only a slight suggestion of diffuse banding, which may be more clearly defined on shaded leaves.

When damage from Willamette mite occurs on newly opened buds and leaves, just as they unfold from the growing tip of the shoot, the injured areas—probably as a result of the rapid growth of these leaves after injury—are sharply defined. In other words, the junction of the injured, yellow tissue and the green, uninjured tissue forms a fairly sharp line. This delimiting of feeding areas can be used to distinguish the work of the Willamette mite from the damage caused by the Pacific mite, *Tetranychus pacificus*. This latter species does not produce injury in the early spring; instead, the damage it does appears on mature leaves in midsummer. As a colony increases in numbers and in size, the yellow spot on the leaf gradually expands so that the yellow center shades imperceptibly into the green, uninjured tissue.

The severity of injury is dependent upon mite population and growth factors of the vine. Injury may start with the first growth to appear in the spring and may keep pace with all subsequent growth during the remainder of the season. Or, it may affect only a few basal leaves of some canes, with injury apparently ceasing by midsummer; in the latter case, new succulent shoots that may grow in the fall are often attacked, especially those that are partially shaded. The effects on tender developing shoots may consist of dwarfing and deformation of leaves, angularity at nodes, shortened internodes, and spindling stems. The tips of the slow-growing axial shoots during summer or fall may be killed.

Vines showing the greatest degree of leaf injury are characteristically stunted and show a decided lack of vigor. There is a tendency for leaf incisions to be shallower and margins to be rolled downward. Canes are shorter, fruitfulness is impaired; clusters are fewer with less berries, and the berries are smaller, lack uniformity, are of poor quality, and appear to be somewhat delayed in maturity. Symptoms have been observed on the vinifera varieties Emperor, Ohanez, Muscat, Molinera, Tokay, Thompson Seedless, Carignane, Zinfandel, and White Malaga. They are basically similar, although some variations in expression occur on the several varieties.

The annual cycle has been completely studied only in the southern San Joaquin Valley. In the northern San Joaquin Valley, from about Modesto north, the hibernants could not be found.

SEASONAL CYCLE IN THE SOUTHERN SAN JOAQUIN VALLEY

The winter is passed in the adult stage by females. No males have been found to overwinter. The hibernating females are amber to lemon yellow—in contrast to the very much paler yellowish white or ivory color of the adults on the foliage; they can be found under the bark of three-year or older arms, mainly on the underside, singly or in small groups. Few have been found on the main trunk of the vines. They have been observed under outer layers of dead bark as well as in to the live bark. It is probable that feeding does not occur during the winter, although the mites are readily active when disturbed.

As the buds swell in the spring there is a tendency for the females to move slowly to the outer layers of bark, but not to the surface, along the arms and

toward the spurs, remaining however on two-year or older wood and under loose bark. Shortly after the breaking of the buds and the beginning of expansion of the first leaves, the entire population moves out to the basal 2 or 3 leaves of the new shoots. In 1944, the first few Emperor buds opened on March 24; the migration of mites to the foliage took place between 3 and 7 days later. No observations could be made on the third to seventh day. On the eighth day, as no mites could be found remaining under the bark, it was assumed all had moved to the new shoots. In the same vineyard in 1945, the first buds broke on April 2; the migration of the mites took place during the eighth to fifteenth day thereafter. During the first 8 days the weather was cool, with 2 days of rain.

Buds do not break simultaneously on all vines in a vineyard, nor in all vineyards in a district. Some vines or vineyards may be delayed a number of days. On such late-breaking vines the mites were found to leave hibernation simultaneously with those on early-breaking vines, moving out to the swelling buds and collecting on the green portions of folded leaves exposed by the loosened bud scales.

In 1944, on April 6, about 9 days after migration of the mites to the leaves, the shoots ranged from 2 to 7 inches in length and had from 4 to 7 leaves, all immature. Thirty shoots examined under a binocular microscope showed the following total number of mites: 31 on the first basal leaf, 12 on the second leaf, 1 on a third leaf, and none on any of the more apical leaves. The adults spin a sparse web. The overwintering females become much paler after migration to the leaves. The eggs are tiny, round, transparent, and shiny and are laid anywhere on the under surface of the leaf, glued to the epidermis, leaf hair, or vein. The first nymphs were observed on April 19, about 7 days after the first eggs were found, but this does not necessarily indicate the exact egg period. On April 29, about 32 days after migration, examination of leaves under a binocular microscope showed a total of 23 overwintering adults, 151 eggs, 77 nymphs, and 4 first-generation adults. These first-generation adults were the first to be observed and indicated a nymphal period of about 10 days.

On approximately the fifteenth day after migration to the leaves, some of the overwintered adults leave the basal 2 or 3 leaves and make their way upward toward the younger leaves. A count made on May 8, about 53 days after migration from hibernation, revealed the presence of adults and eggs as far apically as the eleventh, eighth, and sixth leaf of three 14-leaf shoots. No overwintered adults were observed on these shoots. Totals of 1,605 eggs, 180 nymphs, and 279 adults were counted.

During both 1943 and 1944, throughout the summer and fall until at least November 1, frequent search showed eggs, nymphs, and adults to be present on the grape foliage, although no attempt was made to follow the complete life history in detail during those seasons. On November 30, 1944, a very few adults were still present on leaves, a number were observed migrating downward on the canes toward and on the arms and some were moving along trellis wires. Most of the mites on this date were already under the bark of the arms, since higher numbers could be found there than on the leaves and canes.

SEASONAL CYCLE IN THE NORTHERN SAN JOAQUIN VALLEY

In this area, the mites (all females) appear on the vines in the early spring just as the buds open. In heavy infestation, as many as 15 to 20 overwintered females may be found on a single bud. These mites lay their eggs as described above, but during May all stages usually disappear from the vines. The adults disappear first, then eggs, then nymphs, as indicated in the following averaged data for individuals per leaf on May 11, 1938: adults, 0; nymphs and larvae, 56; and eggs, 0.3. By May 20, no specimens remained. In another district, on May 14, microscopic examination of 11 injured leaves showed 9 leaves free from mites in any stage, 1 leaf with 2 adults and 76 young mites. On May 27, no mites in any stage could be found in this vineyard.

Repeated search for females hibernating under grape bark has failed to yield any specimens in the northern San Joaquin area. The locus of the mites during the winter is probably under the grape bark, as described above, but the sparse populations in the northern area make discovery difficult. In an attempt to find alternate host plants, mites were transferred to potted raspberry and bean plants, grown indoors, with potted grape plants as checks. The mites failed to survive on raspberry, but developed a large colony on bean and grape; they were discarded on July 6. Whereas the adults are pale yellowish white or ivory color on grape, they are yellow with large, granular, dark-green lateral pigmented spots which extend the entire length of the body when living on bean.

CONTROL

It is evident that this species causes considerable losses, especially during years of high populations, and warrants the development of specific control measures. Control studies of the Pacific mite have indicated a possible control of the Willamette mite. On February 10, 1939, a block each of the varieties of Carignane and Thompson were banded with a sticky material at the bases of the spurs. On April 4, examination of 15 suckers growing below the bands in the Thompson block gave 2 Willamette mites, and 6 similar suckers in the Carignane block gave 120 Willamette mites. No mites could be found above the sticky bands. The suckers were removed from the vineyard and destroyed on April 18, thus destroying the Willamette mite, and no damage occurred to the vines in either of these blocks that year. This banding and suckering method has been recommended for the control of the Pacific mite, but it may be even more effective against the Willamette mite. Since the latter emerges in great numbers in the early spring, when bands are effective, and since it is a much more active species than the Pacific mite, it runs blunderingly into the sticky material and is killed. The Pacific mite, on the other hand, avoids the bands.

SUMMARY

The Willamette mite is an important pest on grapes. As a result of injury to foliage caused by its feeding, vines appear to be weakened, with resultant loss in quantity and quality of crop. In the southern San Joaquin Valley, the females pass the winter in hibernation under bark on the arms of the vines, migrating to immature foliage in the spring shortly after the buds have broken.

In the northern San Joaquin, as well as in the Sacramento and Sonoma valleys, the mite has not been found in hibernation. Approximate observed periods of life-history stages of the first spring generation are as follows: 15 days from migration to foliage until the beginning of egg deposition; 7 days, egg period; and 10 days, nymphal period. Overwintered adults were still present on leaves 32 days, but not 53 days after spring migration to leaves. Eggs, nymphs, and adults were present on foliage as late as November 1, while on November 30, migration from foliage to hibernating quarters under bark was in progress. Banding the bases of the spurs with a sticky material may be a means of control.

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