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Abstract approved

The present study describes the habits and control of the Willamette mite, Eotetranychus willamettei (McGregor). This is the most common mite infesting deciduous fruit trees of the Hood River Valley. For purposes of comparison the related species are reviewed.

The codling moth is no longer a major pest and has been replaced, as a spraying problem, by this and related species of orchard mites. These different species of mites have a characteristic habit of feeding and subsequent injury to the host plant. These are listed and compared.

The Willamette mite, Eotetranychus willamettei (McGregor), European red mite, Metatetranychus ulmi (Koch), brown or clover mite, Bryobia praetiosa Koch, and the two-spotted mite, Tetranychus bimaculatus Harvey are described as they occur in the orchard. The synonymy of the Willamette mite is explained and reasons given for accepting this scientific name. The synonymy of the European red mite is also given. Characteristics that can be used in differentiating between the different species are described. A description of the adult mites, eggs, and young or larval stage is given for each species. The host preference of each is listed.

A review of the literature pertaining to mite control evaluation methods is presented to show the many different methods of counting mites and evaluating a mite spray. A new, reliable, and much faster method of measuring mite control is presented. Statistics and other data are presented to give credence to the value of this system.

The visual rating of infested trees is shown to be inadequate for these small pests. A complete count of eggs, young, and adult mites present on the leaves is explained and the shortcomings of this system are mentioned. A new system of obtaining information as to the effectiveness of an acaricide was developed from the need for a faster and yet reliable method of recording data of mite control experiments.
Mite control tests, as carried on at the Hood River Branch Experiment Station, for the years 1947-51, are discussed and analyzed. These studies show the relative effectiveness of many different acaricides as well as the proper time for their application. The specificity of some of these materials, as they affect the different species of mites, is demonstrated by experimentation and the results graphically shown.

The following acaricides were tested: Malathon, Parathion, Dimite, TEMT, EPN 300, Karathane, Sulphenone, IN 4200, and DN 111. All of these are evaluated as to mite control. The chemical composition and manufacturer's name are indicated for each material. Other materials not usually classed as mite sprays are listed and their value in reducing mite populations is shown.
HABITS AND CONTROL OF THE WILLAMETTE MITE
EOTETRANYCHUS WILLAMETTEI (MCGREGOR)
AND RELATED SPECIES IN HOOD RIVER VALLEY

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HABITS AND CONTROL OF THE WILLAMETTE MITE

Eotetranychus willamettei (McGregor)

AND RELATED SPECIES IN HOOD RIVER VALLEY

Hood River is the leading apple-producing county in Oregon with almost half the commercial acreage and about four-fifths of the commercial production. Yellow Newtown is the leading variety, followed by Delicious. These two varieties account for more than two-thirds of the commercial production of the State.

Jackson County has the largest pear acreage, and with Hood River County, accounts for 85 percent of the commercial acreage and about 90 percent of the commercial production of Oregon.

HISTORY OF MITE ACTIVITY IN THE ORCHARD

Although several species of mites have given Oregon fruit growers concern at various times for many years, the problem of control did not become important in most apple and pear growing districts until after the use of DDT for the control of the codling moth, Carpocapsa pomonella Linn. Much better control of this moth can be obtained with two covers of DDT than five to seven covers of lead arsenate. At the present time mite control is the major spraying problem in the Hood River Valley.

Temporary mite population reduction does occur following sprays of DDT. This appears to be a mechanical reduction due to the washing of the mites from leaf surfaces. Population reductions of this character are very limited in duration and reinfestations occur.
a short time after spraying. Breakey and Batchelor (12) found serious Willamette mite infestation occurring after the use of DDT on raspberries. Steiner, et al (110), Hough (56), DeBach (32) and others found DDT in apple orchards creates acute problems in controlling summer orchard mites. Landis and Davis (67) observed that all potato fields found infested with two-spotted mites had been treated with one or more applications of DDT dust prior to the occurrence of mite damage.

The only tangible explanation for mite increase is the destruction of their natural enemies by DDT. Orchard mites, as well as insect pests, have their natural enemies in the form of other insects and mites which attack them. The larvae and adults of a very small, black ladybird beetle, Stethorus picipes Casey, destroys large numbers of eggs and other stages of the mites. In an undisturbed habitat there also occurs a species of thrips, Scolothrips sexmaculatus (Pergande), and a predacious mite, Sejus pomi Parrott, which feed upon all forms of orchard mites. The anthocorid, Triphleps insidiosus Say, more commonly called minute pirate bug, does considerable good as a predator on eggs, young, and adult mites. The larvae as well as the adults suck out the life juices of the mites with their long proboscises. Where DDT is employed, these beneficial organisms largely disappear. Without question their elimination disrupts the natural balance, which, in turn, makes more favorable conditions for orchard mite increase. There may be other unknown causes that bring about
an orchard mite increase which are not yet known. Wingo and Thomas (118) in summarizing the mite situation in orchards sprayed with DDT attribute the increase of mites to the reduction of natural predators. Most entomologists agree with this idea.

Because of the extensive mite increase that has occurred and the resulting mite damage, an intensive study of the problem has been underway at the Hood River Experiment Station during the last five years. The first two years were spent getting acquainted with the different species of mites present and working out a satisfactory method of measuring mite control.

**MITE INJURY TO HOST PLANTS**

All active stages of the different spider mites feed upon the leaves, stems and fruits of the host plants. The feeding operation is accomplished by thrusting the sharp, slender, lance-like mouth parts through the epidermis and well into the leaf, usually on the underside. The chlorophyll and plant juices are used as food by the mites. The feeding pattern, as produced by the different species, forms a different type of injury and will be discussed under each species. However, the final injury following severe attack is much the same for all species. The trees become seriously devitalized, the leaves become yellow or straw-colored, and feel dry or crisp to the touch. Premature foliage drop occurs in varying degrees. On many pear varieties a blackening and dropping of leaves occurs in mid-summer, even under conditions of relatively mild attacks. The
injury is more pronounced on Anjou pears. Where mite injury is allowed to progress unretarded throughout the summer, the trees fail to size their fruits and normal coloring of red varieties of apples is often completely lacking. Excessive mite attack, which results in severe foliage injury and defoliation, often devitalizes the trees to the extent that the fruit set and tree performance are not normal during the following year.

MITES PREVALENT IN HOOD RIVER ORCHARDS

There are four species of mites prevalent in the Hood River Valley that are more or less generally distributed in Oregon. They are responsible for most of the trouble caused by this group of pests on deciduous fruit trees. These species are the Willamette mite, *Eotetranychus willamettei* (McGregor); European red mite, *Metatetranychus ulmi* (Koch); the brown or clover mite, *Bryobia pratiosa* Koch; and the two-spotted mite, *Tetranychus bimaculatus* Harvey. All four of these species of mites can often be found on the same tree. Another species, *Tetranychus pacificus* McGregor, is prominent in other areas but it has not been reported in the Hood River Valley.

These mites are known under the popular names red spiders, spinning mites, and spiders. Some members of this group spin webbing while others spin slight to none at all. They are included in the family *Tetranychidae*, Order *Acarina*, Class *Arachnida*.

Although the four species of mites are of the same family, they can be readily distinguished by their coloration, feeding
activity, and life history. The following summary of characters will help to separate these minute spiders.

**WILLAMETTE MITE, Eotetranychus willamettei** (McGregor)

Considerable disagreement exists as to the scientific and common name for this species of mite. McGregor (76) described the species *Tetranychus willamettei* in 1917. In his revision of the family Tetranychidae in 1950 McGregor (80, p. 286) suspected that his species might be identical with *Tetranychus flavus* Ewing. He also states (80, p. 306) that *borealis* may be the same as *flavus*. Ewing (37, p. 458) described *Tetranychus flavus* and listed Hood River, Oregon, as the type locality. On the page previous to this he described *Tetranychus borealis* as a mite on *Spirea douglasii* west of Corvallis, Oregon. On the basis of page priority *borealis* would supersede *flavus*. Pritchard and Baker (96, p. 263) consider *willamettei* as a distinct species but classify it in the genus *Eotetranychus*.

This mite will be referred to as the Willamette mite in this paper.

The Willamette mite is the most difficult to control in the Hood River area. It is closely related to the two-spotted mite and is often, particularly during mid-summer, mixed in great numbers with the latter species. Their characters are so nearly alike in the case of many individuals that it is difficult to separate them. In general, the adult female Willamette mite is somewhat more slender.
and smaller than its two-spotted relative. The Willamette mite overwinters as a lemon-colored, adult female, and can be found under the bark scales of infested trees.

On March 21, 1948, the adults were first observed moving out onto the tree branches in the Hood River area. This emergence may vary from year to year, being a few days earlier or later, depending upon weather conditions. Cagle (15) in his work with the two-spotted mite found only fertilized eggs could produce females. Unfertilized eggs produced males. This is also true with the Willamette mite. To add a little confusion to the picture, the author has observed a male European red mite mating with a female Willamette mite. On another occasion a male Willamette mite was observed copulating with a female European red mite. In the act of mating the male crawls beneath the female from the rear, clasps its legs about the female, and curves the tip of its abdomen upward and forward until it meets the tip of the abdomen of the female. The mating usually occurs while the female is in a quiescent state. This characteristic pose may be assumed even before the male gets close enough to clasp the female. On one occasion three males were observed, each with the tip of their abdomens curled over their backs, all in a line behind one female.

The first deposition of eggs occurred April 27 and young six-legged mites hatched May 21, 1948. Young mites have only six legs until the first molt. Repeatedly the Willamette female was observed to lay a "clutch" of 8 eggs, or multiple thereof, 16 or 24,
in one small restricted area near the midrib on the underside of the leaf. This egg pattern is clearly different from that of the two-spotted mite which lays its eggs singularly. The first brood of the Willamette mite started laying eggs June 5, 1948. Thereafter infested trees had considerable numbers of eggs, young, and adult mites throughout the summer. The mite population on unsprayed trees reached a peak of activity the latter part of July. If partial control can be obtained during the early part of the season, the population peak is postponed and occurs the latter part of August or even later. (See Figure 1.) It is usually the early, prolonged infestation that causes commercial damage to the fruit and trees.

The different species of pear and apple are affected quite differently by an infestation of this species of mite. The Anjou pear is apparently quite susceptible to attack by this mite. An observation made August 7, 1951, revealed the following information: When 97 percent of a random sample of Anjou pear leaves were found infested with European red mite and 1 percent of the same sample contained Willamette mites, there was some "stippled" injury to the leaves, but no leaves were turning black nor was there any leaf drop. In another plot with 31 percent of the sample infested with Willamette mites, some of the leaves were partially black and some leaves had already fallen. When 62 percent of the leaves, of another plot, contained one or more Willamette mites, the leaves were heavily blackened and severe leaf drop had already occurred. In contrast to these Anjou pear trees, Bartlett and Bosc pear trees in the same
plots were only slightly infested and showed very little of the characteristic black leaves.

The Yellow Newtown apple variety is more susceptible to attack by all mites because of its thin and less pubescent leaf. This variety was used in the mite control studies carried on at the Hood River Experiment Station.

The Willamette mite differs from the two-spotted mite in that the over-wintering form starts to take on the fall coloration approximately one month later in the season. This usually occurs about the middle of October. Willamette mites have been observed still feeding on the last leaves to fall in November. Adult females of both species may be found occupying the same hibernation niche.

**EUROPEAN RED MITE, *Metatetranychus ulmi* (Koch)

This species has been referred to in the literature as *Paratetranychus pilosus* (Canestrini and Fanzago). Pritchard and Baker (96, p. 260) give the following reason for changing the scientific name of this species: "*Metatetranychus* has been recognized by most acarologists in Canada, Europe, and Australia, and in our opinion it is a valid genus. *Metatetranychus ulmi* (Koch) is the type of the genus. There seems to be no justification for not accepting in the United States a name that is in current use throughout most of the world. *Metatetranychus ulmi* is, therefore, used instead of *Paratetranychus pilosus."

The European red mite is a deep cardinal red species
possessing long pronounced curved spines on the back with conspicuous white dots at the bases. There are 26 dorsal bristles. The male is much smaller than the female with the tip of the abdomen being much more pointed and the color usually more brown than red.

The egg is .15 mm. to .16 mm. in diameter, spherical, usually somewhat flattened, distinctly striated from top to bottom with numerous delicate lines, and usually with a stalk about the length of the diameter of the eggs. The egg is pale pink when laid and soon turns a bright red. The summer eggs are lighter, being a distinct pink or light red, and never attain the deep bright red of the winter eggs. The winter is passed in the egg stage on various species of deciduous fruit trees. The eggs are often deposited in such numbers as to give the appearance of red blotches on the smaller branches and at the base of the fruit spurs. They are more abundant on the underside or protected part of the twig. Hatching of the overwintering eggs occurs usually in April, about the time the first pink begins to show on apple buds. Summer eggs are deposited on both upper and lower leaf surfaces and can be found throughout the growing season where the pest is abundant.

In the Hood River area the first brood reaches maturity and starts laying eggs the latter part of May. Seven or eight generations a year occur in the Pacific Northwest.

Fruit trees, namely apple, pear, peach, plum, prune, and cherry are common hosts. Berries, as well as the ornamental shrubs cotoneaster and pyracantha, often serve as hosts. Elm, walnut,
almond, mountain ash, and black locust are also subject to attack.

**BROWN OR CLOVER MITE, Bryobia prastiosa Koch**

The brown or clover mite is the largest of this group of pests which attack the fruit trees. The color is variable with reddish, rusty brown, and olive green forms predominating. The legs are more pale in color. The body is inclined to be flat, possessing fringe-like scales on the margin. There is a longitudinal depression on each side which extends the entire length of the abdomen. The front legs of this mite are much longer than those of other orchard mites and, along with its larger size and shield-shaped body, readily set it apart from the other tetranychids. Infestations of the brown mite are often overlooked or considered of minor importance because the pest does a greater proportion of its feeding by night, moving back from the leaves to the smaller twigs during the day. Their color blends with the color of the bark and, as a result, the mites are not easily detected. The overwintering adults may be found under the bark scales or other protected areas. This species may overwinter both in the egg stage and as adult mites.

The eggs are slightly larger, circular, and somewhat darker red than the European red mite eggs. Overwintering eggs hatch as early as the latter part of February, with the greater percentage hatching during March. Summer eggs are deposited on both sides of the leaves.

The newly hatched larvae are scarlet. A tree at the Hood
River Experiment Station was allowed to become heavily infested with this species of mite. In the Spring of 1951 several limbs were found to be bright red from the masses of eggs present. A count by Leroy Childs revealed a total of 31,766 mite eggs per square inch.

The brown mite, as contrasted with the European red mite, has a rather wide range of host plants including many cover crop plants that grow in and about the orchards.

**TWO-SPOTTED MITE, Tetranychus bimaculatus Harvey**

The two-spotted mite, because of the wide variation in color and host plants, is difficult to describe. Essig (35, p. 27) describes the species as follows: "The two-spotted mite, as the common and specific names imply, is a pale species with two large indefinite black spots occupying a great part of both sides of the body." These spots first appear as scattered brownish or greenish spherical bodies that look like oil drops. These increase in number with age and are sometimes arranged in three groups. Finally they emerge into a single mass. In older specimens dark patches are found in the anterior and posterior portion of the body, or in fully fed specimens the body is entirely dark colored. The shade seems to vary with the color of the food. The individuals vary in color from whitish to yellow, reddish or pale green. The greenish, two-spotted form is the one commonly found in Oregon. This species is the most widespread of this group of mites and infests a great many plants including fruit and native trees, shrubs, ornamentals, forage crops, and truck crops. In the
Hood River area this species feeds upon practically all types of plants growing in and about the orchard. In a survey, conducted by Leroy Childs, carried on in a single orchard during the summer of 1949, 31 different species of plants were found infested. All stages were present on these plants. Mites were not found on poison oak, cottonwood, cattail, or Oregon grape, all of which were growing in close association with infested plants.

The eggs are almost perfect spheres. When first deposited they are about as clear as water, but as incubation progresses they become opaque, turning a dark, straw-color just before hatching. The eggs are deposited singly on the underside of the host leaf in large numbers.

As a rule the two-spotted mite remains on the cover crop in and about the orchard until that source of feed becomes depleted. This usually occurs during the latter part of July. As the cover crop dies, the mites migrate to the trees and thus a reinfestation occurs. At this time there may be both two-spotted and Willamette mites feeding on the same leaf, living side by side. As the two are difficult to separate except by microscopical study, they have been combined in the counts conducted in the control of mites on orchard trees as reported in this paper. The feeding injury is similar to that of the Willamette mite. From the first of September on, this species begins to assume the bright orange color of the winter phase.

On September 17, 1949, several Anjou pear trees were observed
which were heavily infested with this species of mite. The leaves were practically all on the ground and the trunks of the trees were heavily "cellophaned". The descending mites had produced considerable amounts of webbing on the tree trunks. The fruit of these trees was not harvested because of its small size. The bright orange mites were clustered in the calyx ends of the fruit and descended in bunches by means of webs.

**METHODS OF EVALUATING MITE CONTROL**

A review of the literature shows that there is no accepted method of tabulating results of mite control. Each worker has his own system. Some merely estimate the mite population present while others remove the mites from the leaves and then laboriously count all of the mites present.

Newcomer and Dean (87), in their early studies, used a system of rating trees in the fall as to number of mites migrating down the trees and converting this rating to numbers 3, 2, 1, and 0 with 3 representing heavy infestation and 0 as no mites present. Jeppson (63) also rated his plots according to a degree of field infestation; trace, light, light-medium, and medium. Graham, et al (47) counted the actual number of red mites and red mite eggs from a sample of 10 leaves from each plot on five different dates, while Holloway, et al (54) based their population estimates on the number of red mites on 15 leaf samples taken at random from each tree. Lathrop, et al (69) counted the mites on 5 leaves picked at random from each of 20 trees.
from each treatment. Jeppson (64) evaluated mite infestations by counting adult mites on 32 leaves on each of 8 trees in each plot. The leaves were not removed from the trees. Sherman, et al, (106) selected 100 leaves from each of three trees in each test group and examined them with a binocular microscope. Leaves that showed mite damage were selected for the counts. Baten, et al, (8) used a folded piece of cardboard with one inch openings so that counts of all mites on one square inch of the upper surface of the leaf and one square inch of the lower surface could be tabulated. Reading lenses were used as binoculars were too cumbersome to keep in focus.

Jones, et al (65, p. 334) in discussing different methods of measuring the density of mite populations has the following to say:

"Methods based on estimation of populations were found to be unsatisfactory, since estimates of the numbers of mites and eggs on individual leaves, terminals or fruits were found to vary greatly from the numbers actually present. Counts of the populations present on unit areas of a given number of leaves or fruits proved equally unreliable for this species; such trials included the examination of halves of leaves, and counts made upon units of 1 and 2 square inches of plant surface. A prohibitively large amount of time would have been required to count all of the mites and eggs on a number of leaves and fruits sufficiently large to represent an adequate sample of a tree."

They finally took samples of 50 leaves from a tree, placed them in a two-quart, wide-mouthed Mason jar containing 5 percent formalin solution. Later these leaves were removed in the laboratory, placed in a beaker containing 800 c.c. of a .0125 percent solution of heated potassium hydroxide. This mass was agitated and each leaf removed
separately. With an elaborate device, the remaining solution was well stirred and 1/8 of the whole drawn off by a pipette and passed through a lined filter paper. All mites and eggs in this sample were counted.

Newell (92) removed mites and eggs by shaking the leaves in a soap solution. The residue was screened and all mites and eggs were counted. Fayette, et al, (39) working on the control of two-spotted mites on rose bushes divided the rose bush into top, middle, and bottom parts. Three, five, and seven leaves, respectively, were picked at random from these areas. All live and dead mites were counted with the aid of a binocular microscope. Hofmaster, et al, (53) selected infested leaves and extracted a 0.3 square inch leaf plug from a heavily infested area and counted all living and dead mites by means of a binocular microscope. They used 30 leaf samples in 1947, 1948, 1949, and 50 leaf samples in 1950.

Chapman and Lienk (17), Dean (29), English (34), Newcomer and Dean (90), and Hough (56) made counts of mites on the leaves by the use of a brushing machine whereby the mites were brushed off onto a glass plate covered with shellac. A measured portion of these was counted.

On the other hand, Newtown, et al, (93) measured the brown mite population by counting the overwintering eggs in the calyx basins of fruits at harvest.

The writer has devised the following simple and reliable
method of evaluating control of mites.

Four fruit trees, of uniform growth, in each plot, are selected for leaf counts throughout the season. These trees need to be in the center of the plot with no chance of contamination of sprays from adjoining plots. With speed sprayer applications of acaricides at least 16 trees and preferably more are required, with only the center trees sampled. The other trees act as buffers.

Twenty-five leaves are picked at random from each of these four trees. These leaves should be of uniform growth and age as old and new leaves do not represent the true mite picture.

Each group of 25 leaves is inspected with a hand lens immediately after collecting. Each leaf is scored as being clean or infested with a species of mite. Metal counters arranged on the worker's belt can be used to record the number of leaves infested with each species of mites. If a leaf has only one mite present it is infested with that species. Each leaf that is infested will, in time, become seriously injured if the mites are left unchecked.

Each plot may be checked in 20 to 30 minutes regardless of the number of mites present.

The trade name, chemical composition, and manufacturer's name of all spray materials used in the following experiments are listed on pages 44 and 45.
MITE CONTROL EXPERIMENTS

CONTROL TESTS DURING 1947

Leaf counts of mites were made with the aid of a hand lens to fully understand the mite situation, the species present, and how they responded to a few different sprays. A rating of the trees as to apparent mite damage was soon discarded as not satisfactory. Thereafter, twenty-five leaves were selected at random from four different Yellow Newtown apple trees of each plot and a record made of the total number of eggs, young and adult Willamette mites present. Sampling involved the counting of eggs and mites on the lower leaf surface in an area 3/4 of an inch wide along the midrib. This is the field of a 9X hand lens used in making the examination. This portion of the leaf area is most severely attacked by the Willamette mite. This did not always hold true with the Anjou pear. Where the Anjou leaf curls down and under, mites can be found feeding on the upper surface of the tip area of the leaf.

Figure 1 presents a graphic picture of the number of mites present per leaf on Yellow Newtown apple leaves throughout the season. In the check plot, which received a DDT spray May 26, 1947, the mites were unaffected and reached a peak on July 29. In an adjoining plot wherein the population was reduced by a fumigant type of spray, a good kill of all active mites occurred. The eggs hatched, however, and a delayed peak of activity occurred approximately one month later.
CONTROL TESTS DURING 1948

Since these plots were not replicated, their results can only be regarded as a trend with no chance of applying statistics to the counts. After the second cover all plots showed an increase of mites per leaf as well as percentage of leaves infested with a peak of activity occurring in September or October. Due to this late infestation and cooler weather, these trees were not critically injured. A tree may sustain a high population of mites during cool weather, without showing distress, but with temperatures of 90°F. and over the mite damage, if present, becomes evident. It is the early, prolonged infestation of mites that gives commercial injury.

CHECK PLOT:— Table 1 shows that the overwintering Willamette mites were averaging one per leaf on April 24, but thereafter a decrease occurred until May 27. The first brood started hatching at this time. The first cover of DDT apparently washed a number of mites off the leaves but shortly thereafter they increased rapidly. The second cover failed to stop the increase. By September 15 there were approximately 50 mites per leaf. Thereafter the number per leaf decreased.

Referring to the same table where the percent of leaves infested with one or more Willamette mite is listed, it can be seen that the percentage increased and fell along with the number of mites per leaf. However, after August 11 all leaves continued to be infested. This long period of time, wherein all leaves were infested,
gave commercial injury to the leaves, fruit, and trees.

**PARATHION PLOT:** - Oil-lime-sulfur, as a delayed dormant spray (see Tables 1 and 2), does an excellent job of reducing the Willamette mites and they remain at a low ebb until after the middle of June. Although Parathion held the Willamette mites down for a time after both the first and second covers, a fair population developed in October. This late infestation did not give commercial tree injury.

**DN-1ll PLOT:** - Here, too, the early infestation was reduced by the delayed dormant of oil-lime-sulfur. DDT alone in the first cover, as shown on Table 1, had no effect on the Willamette mite. A second cover of DN-1ll failed to kill all the mites and the population flourished. Increased burn and sunburning of the fruit occurred when the temperature reached 93°F. at the time of spraying or when high temperatures occurred for a few days following spraying.

**IN-4200 PLOT:** - A pink spray (see Table 2) of this material gave a good kill of mites present. Three sprays of IN-4200 gave commercial control but the population increased to 15 mites per leaf by October 8 with every sampled leaf infested.

**KARATHANE PLOT:** - This plot started out as a check (see Table 2). It received no delayed dormant and no pink spray. The first and second cover sprays were DDT alone. The Willamette mite was flourishing until a third cover spray of Karathane was applied August 9.
A good kill was obtained and the mite population remained low the rest of the season.

DIMITE PLOT:— Oil-lime-sulfur kept the mites down early in the season (see Table 2). Two covers of Dimite failed to prevent an increase. Possibly a third cover would have given a different and better picture.

MITTE CONTROL TESTS DURING 1949

In order to get statistical evidence of control of the Willamette mite, a series of ten plots, consisting of single trees replicated six times, were set up and sprayed by hand gun. Two of the plots received Karathane and the check received no spray in the delayed dormant, pink and calyx sprays. All other plots received 3 gallons of oil combined with lime-sulfur 4 gallons to 100 gallons of water in the delayed dormant. This was followed by 3 gallons and 2½ gallons of lime-sulfur per 100 gallons in the pink and calyx sprays, respectively. This latter program is used to control the mildew fungus on Yellow Newtown apples. Karathane has been found to give fair control of mildew as well as mites.

Table 3 lists the spray program as followed for each of the ten replicated plots. Table 4 gives the average Willamette mites per leaf as found throughout the season. As the season progressed and the number of mites increased, it became evident that a
larger sample would be needed in order to get significant data. This procedure was prohibitive because of the large number of mites and the time involved in counting them. As the number of mites per leaf increased the number of leaves infested appeared to increase at the same rate. Table 5 gives the percentage of leaves infested throughout the season. Statistics were run on data for June 27 and July 29. The mites were at such low numbers during the first six counts that analysis was not needed. No correlation between mites per leaf and percentage of leaves infested could be made after September 25 as all plots were 100 percent infested; that is, every leaf sampled had Willamette mites present. With \( X \) as the mean Willamette mites per leaf and \( Y \) the transformed percent of leaves infested, the following data is presented:

<table>
<thead>
<tr>
<th>Plot No.</th>
<th>Material</th>
<th>June 27, 1949</th>
<th>X-Mean</th>
<th>Y-Mean</th>
<th>July 29, 1949</th>
<th>X-Mean</th>
<th>Y-Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-1</td>
<td>Parathion ( \frac{1}{2} ) lb.</td>
<td>3.2</td>
<td>14.03</td>
<td></td>
<td>5.2</td>
<td>8.87</td>
<td></td>
</tr>
<tr>
<td>R-2</td>
<td>Parathion 1 lb.</td>
<td>2.3</td>
<td>14.73</td>
<td></td>
<td>2.8</td>
<td>12.90</td>
<td></td>
</tr>
<tr>
<td>R-3</td>
<td>Dimite 1 pt.</td>
<td>4.2</td>
<td>20.53</td>
<td></td>
<td>0.2</td>
<td>4.43</td>
<td></td>
</tr>
<tr>
<td>R-4</td>
<td>Bladex ( \frac{1}{2} ) pt.</td>
<td>2.2</td>
<td>14.73</td>
<td></td>
<td>0.7</td>
<td>8.87</td>
<td></td>
</tr>
<tr>
<td>R-5</td>
<td>DN 111 3/4 lb.</td>
<td>0.7</td>
<td>7.50</td>
<td></td>
<td>3.7</td>
<td>13.07</td>
<td></td>
</tr>
<tr>
<td>R-6</td>
<td>Karathane ( \frac{1}{2} ) lb.</td>
<td>9.2</td>
<td>22.63</td>
<td></td>
<td>4.2</td>
<td>23.47</td>
<td></td>
</tr>
<tr>
<td>R-7</td>
<td>Karathane 1 lb.</td>
<td>10.7</td>
<td>25.93</td>
<td></td>
<td>0.3</td>
<td>8.87</td>
<td></td>
</tr>
<tr>
<td>R-8</td>
<td>None</td>
<td>4.3</td>
<td>22.63</td>
<td></td>
<td>54.0</td>
<td>51.53</td>
<td></td>
</tr>
<tr>
<td>R-9</td>
<td>None</td>
<td>178.3</td>
<td>69.88</td>
<td></td>
<td>57.7</td>
<td>65.73</td>
<td></td>
</tr>
<tr>
<td>R-10</td>
<td>Karathane</td>
<td>0.3</td>
<td>6.13</td>
<td></td>
<td>4.8</td>
<td>23.87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L.S.D., 5% level</td>
<td>77.0</td>
<td>15.55</td>
<td></td>
<td>34.4</td>
<td>23.57</td>
<td></td>
</tr>
</tbody>
</table>

**STATISTICAL ANALYSIS**

Prior to the second cover, when different acaricides were...
applied to the plots, all of them were significantly different from the check (R-9). Both lime-sulfur and Karathane gave a significant control of the Willamette mite. Ten days after the second cover was applied the following conclusions were drawn: (1) Parathion at $\frac{1}{2}$ pound was not significantly different from 1 pound; (2) Karathane at $\frac{1}{2}$ pound was not significantly different from 1 pound of the same material at the 5 percent level; (3) All plots were significantly different from the check except plot R-8 which received DDT alone in the second cover.

Furthermore, the conclusions, based on X, the number of mites per replicated plot, or Y, the transformed percent of leaves infested, are the same. In other words, there is a correlation between X and Y. The percentage of leaves infested, however, gives a better record of what a given spray has accomplished. In the author's opinion this is actually the easiest and best method of evaluating the effect of a given acaricide. If mites per leaf are counted, only a limited number of plots may be handled by one person. The reason for this is that as the season progresses and the mites become more numerous, more time is required to count the number of mites present. On the other hand, the percentage of leaves infested with one or more mites of a given species can be tabulated in the same amount of time whether it be early in the season or when the leaves are heavily infested. This is particularly true in the check or unsprayed plots.

In any given sample of leaves all the mites may occur on one
leaf. This would have a much different effect upon the tree than if the same number were found on a large percentage of leaves. A tree in the check plot, on July 28, had one leaf with 506 active mites, while another leaf of the same tree harbored only 18 Willamette mites. The time needed to count 100 leaves, such as these, is prohibitive. The same relative information may be obtained by the number of randomly selected leaves that are infested with one or more of a given species. Actually an acaricide is given a very critical test with this method. It is not important to know the number of mites living nor how many mites have been killed. 99 percent may be killed, yet with a heavy population this would mean very poor control. What is wanted is as many as possible of the leaves of each tree remaining free of mite attack throughout the season. This is especially true during the months of July and August when hot weather intensifies any mite damage present.

All counts for a given series of tests, in order to be compared, need to be made on the same day. When populations are high a simplified and quick method of tabulation is imperative.

**MITE CONTROL STUDIES FOR 1950**

A series of tests was set up to determine if, and to what extent, certain of the newer acaricides affect the different species of mites present in the orchards of Hood River Valley. Past experimental tests had shown that a dormant or delayed dormant of oil-lime-
sulfur had a deleterious effect on both European red and brown mite eggs. This series of plots received no delayed dormant, pink, or calyx spray. DDT was incorporated with the different acaricides applied to each plot. All plots were sprayed twice. The first spray was applied June 9, and the second on July 17, 1950. The sprays were applied with a Hardie (400 gallon) speed sprayer which traveled 1.2 miles per hour applying approximately 650 gallons of spray per acre. Each plot was \( \frac{1}{3} \) acre in size.

**METHOD OF SAMPLING**

Approximately every ten days, 25 leaves were picked at random from each of four trees of uniform growth and habit located in the center of each plot, making a total of 100 leaves. These leaves were rated according to whether they were infested or free from the three species of mites - European red, Willamette, and brown mite. Since the two-spotted mites are difficult to separate from the Willamette mites, they were grouped together in these counts. These leaf counts were made following the procedure as presented on pages 15 and 16.

Webster (115) seldom found the Pacific mite on the same leaf or even the same tree as the European red mite. In the Hood River area it is not uncommon to find European red, brown, Willamette and two-spotted mites all feeding and reproducing on the same leaf. Usually, however, one species will predominate. For example, the
check plot (G-0 of 1951) on September 4, of a sample of 100 leaves there were 49 infested with European red mites, 97 with Willamette mites, and 18 with brown mites. If the tree is in good vigor and the weather is not too warm an apple tree can sustain a larger population of mites than an Anjou pear tree.

These ten plots, although giving a good indication of what a given acaricide will do to a certain species of mite, were not randomized or replicated. Consequently, no statistical data can be obtained.

The first count, taken May 29, prior to the first cover, revealed some variation in the number of leaves infested by the Willamette mite from plot to plot. The European red mite infestation was, according to this count, quite unevenly distributed. The brown mite failed to make an appearance until July 11, 1950. Only the Willamette mites were recorded on the counts made just prior to the first cover spray.

Following is an evaluation of each plot as recorded on September 24, 1950:

CHECK PLOT:— Although 96 percent of the leaves were still infested with Willamette mites, predators were quite active and the number per infested leaf had dropped to about 5 mites. The leaves were considerably injured during the season but not as severely as was expected. Some trees showed some distress at harvest time. See Figure 2.
DIMITE PLOT:— Dimite (see Figure 3) controlled the Willamette and brown mite very satisfactorily, but the European red mites were not controlled. It can be noted that there occurred a build-up of this species after each spray, and, on September 15, 100 percent of the leaves were infested. At this time there were approximately 100 European red mites per leaf. Even with this population, damage appeared to be of little commercial importance at harvest time. As was noted for the Anjou pear, the European red mite did not cause the extensive damage that occurred when the Willamette mite became abundant.

PARATHION PLOT:— Parathion, as shown in Figure 4, clearly illustrates the lack of control of the Willamette mite, even at 1 1/2 pounds of the 25 percent material. This verifies previous experimental results with this material against the Willamette mite. On September 24, the Willamette mites were increasing, averaging about 65 per leaf. The trees, however, failed to show injury as would undoubtedly have been the case had this population occurred earlier in the summer. The European red and brown mites were satisfactorily controlled.

ARAMITE PLOT:— The trees of this plot showed severe damage from the brown mite infestation which was not controlled by Aramite (see Figure 5). This injury, which became evident about August 25, took the form of a general bronzing of the leaves. On September 25 there were approximately 30 to 35 brown mites per leaf. The Willamette and European red mites failed to cause appreciable damage.
MALATHON EMULSION PLOT:— This material gave excellent control of all three species of mites (see Figure 6). The leaves were in excellent condition, large, and of good color at harvest time. At no time were there more than 6 mites per infested leaf. It might be added that the woolly apple aphid, *Eriosoma lanigerum* (Hausmann) was also controlled by this material.

MALATHON WETTABLE PLOT:— The wettable powder, used at a strength of 1.5 pounds of the 25 percent material gave commercial control of all mites (see Figure 7). There occurred a slight infestation prior to harvest. This occurred so late in the season that no commercial injury resulted. The woolly apple aphid was also controlled in this plot.

EPN 300 PLOT:— A visual evaluation on September 24 showed variable amounts of mite injury, none of which was of commercial significance. EPN, used at 0.5 pound in the first cover (see Figure 8), did not control the Willamette mite. However, 1 pound of this material, applied in the second cover, gave better control. Mite increase occurred so late in the season that no commercial damage resulted. Each infested leaf had approximately 8 Willamette mites and 2 to 3 brown mites at harvest.

SULPHENONE PLOT:— Sulfphenone, used at 1.5 pounds in two applications, gave a good kill immediately after each spray (see Figure 9). The residual control, however, was of short duration. All mites started
to increase a month after the second cover. On September 15, 99 percent of the leaves had an average of 13 to 15 Willamette mites per infested leaf. No commercial injury occurred from this late infestation.

KARATHANE PLOT:-- This material gave good control of all mites during the critical part of the growing season. The late infestation, as shown on Figure 10, although averaging 19 to 20 Willamette mites per infested leaf, did not result in commercial injury. This may be accounted for by the excellent condition of the foliage which was apparently stimulated by this dinitro product.

In the past all trees whether apple or pear receiving this material have produced larger and greener foliage. This condition of large green leaves can sustain a greater mite population without showing commercial injury.

TETRAETHYL PLOT:-- This plot should not be compared with the other plots of this series. Due to the lack of residual control, as noted in previous trials with this material, an additional spray was applied seven days prior to the first cover. This first application killed all active forms and the second application, to a good extent, killed the young mites that had hatched (see Figure 11).

This material has a place as an acaricide if used properly. In order to obtain any lasting effect, a repeat spray should be applied 7 to 10 days after the first spray. This, of course, depends upon
the season or time of the year. In the early part of the season when the weather is cool, a 10 to 14 day interval is sufficient. The eggs hatch in a shorter period of time in warm weather.

All of these plots, including the check, received a thorough ground cover when the trees were sprayed. The lower jets of the speed sprayer were directed toward the ground. This sprayed the cover crop thoroughly. The cover crop in the check plot, which received DDT alone, became very brown late in August as a result of heavy feeding of the two-spotted mite. This did not occur in the other plots.

MITE CONTROL TESTS DURING 1951

In the 1951 tests, acaricides followed oil-lime-sulfur as a delayed dormant and a pink spray of lime-sulfur in one series of plots (M-series, see Table 7). Another set (G-series, see Table 6) received oil and Copper A as a late dormant application. This was followed by a thinning spray of Elgetol at bloom period. In the Hood River district it is usually necessary to apply these sprays for the control of apple scab, mildew, or anthracnose. Elgetol is used to reduce fruit set of Yellow Newtown apples.

The oil sprays, as brought out in previous discussion, exert a very definite influence on European red and brown mite control. Although not proven by experimentation, Elgetol appears to kill all species of mites. This possibly accounts for the low mite
population in the G-series of plots. In this series Marlate was used to control the codling moth. DDT may cause trouble in the orchard soils, somewhat similar to the action of lead arsenate in the past. Also a resistant strain of these moths may develop by the continued use of DDT. Marlate may be used in place of DDT for codling moth control.

DDT was used in the first and second cover sprays for the control of codling moth in the M-series of mite plots.

DISCUSSION OF PLOTS

All plots were sprayed with a Hardie speed sprayer traveling at 1.2 m.p.h., applying approximately 650 gallons of spray per acre. Both high pressure and low pressure jets were used to give a thorough coverage.

The check plot, G-0 (see Table 6) which received DDT instead of Marlate and did not receive any dormant or thinning spray, very clearly demonstrates how all species of mites may infest an apple tree. Plot G-7, a semi-check, shows what the delayed dormant and thinning sprays can do in mite control. In this plot Marlate was used alone in the first and second covers. The leaves were severely injured, in plot G-0, by the heavy mite infestation but G-7 showed commercial control of mites. However, the woolly apple aphid, at the end of the season, were very abundant in G-7.
Plots G-1 and G-2 were sprayed as one plot until the second cover when one-half of the plot was resprayed with Malathon while the other half received only Marlate. This division was also carried out with plots G-3 and G-4, G-5 and G-6, G-8 and G-9, and G-10 and G-11. This procedure was used to determine just how long one spray of a given acaricide would give control.

**ARAMITE:** If the brown mite is controlled early in the season, this material is highly effective in controlling mites in the orchard due to its long residual action. Both the wettable powder and the emulsion gave good control. This material is strictly an acaricide. Commercial control was obtained in plots G-8, G-9, and M-6. It has no value in controlling the woolly and green apple aphids or pear psylla.

**DIMITE:** When the European red mite is held under control by oil in the dormant or delayed dormant spray, Dimite does a fair job of controlling mites. However, the residual effect is not very long. A third cover should be applied for best results.

**EPN 300:** EPN has given good control of all species of mites. Although it performs very well against the pear psylla, it has no effect on the woolly apple aphids.

**KARATHANE:** Although no longer in commercial production, this material gave commercial control of mites. A fall build-up occurred again this season.
MALATHION:- Both the wettable powder and emulsion has continued to give good control of all species of mites. In addition, this material gave good control of pear psylla and controlled the green and woolly apple aphid on apples.

MR 30:- Due to a limited amount of this material only one application was tried. Further testing is needed (see Table 6).

PARATHION:- Both the European red and brown mites were controlled by this material, but a few Willamette mites survived and produced a delayed population. Even at two pounds of 25 percent material to 100 gallons of water the Willamette mite (see Table 6, G-11) continued to survive.

SULPHENONE (R-242):- Although this material gives a good kill of the active mites the residual control is not long enough to prevent a reinestation when using a two-spray program. At the end of the season plot G-4 showed severe mite damage and plot G-3 had very severe mite injury. Woolly apple aphids are not affected by this material.

TETRAETHYL PYROPHOSPHATE:- Tetraethyl (TEPP) is a good killer of all active stages of mites. Eggs are not affected. If a repeat spray is applied 10 days after the first, reasonably good commercial control can be obtained. Some pears, badly infested with mites, were sprayed every other row on August 12 and a repeat spray on the alternate rows on August 24, 1951. No further mite damage occurred.
The high volatility of this material makes it possible to get a good kill of active mites by a drift of the material through a tree.

**SUMMARY**

Orchard mites have become a major problem following the widespread use of DDT to control the codling moth. Several species of insects that tend to hold the mite population in check are listed. These predators are reduced by DDT.

Injury produced on the host plant is described for each species of mites.

Synonomy of the Willamette mite, *Eotetranychus willamettei*, is explained. A complete description of all stages of this very important mite is given. The other mites, *Metatetranychus ulmi*, *Bryobia practiosa*, and *Tetranychus bimaculatus*, are described to show the differences that exist between these minute spiders in the egg as well as the adult stages.

A thorough review of the literature is presented to show the many different methods now being employed to evaluate mite control. A new, quick, and reliable method of obtaining mite control data is described. Statistical analyses and bar graphs are presented to show the value of this system of tabulation.

The species of mites present must be known before any recommendation can be given for their control. Some of the acaricides, such as Aramite, Parathion, and Dimite, are shown to be very selective in their control of the different species of mites.
A delayed dormant spray of oil-lime-sulfur will materially reduce the European red and brown mite eggs and also the Willamette and two-spotted adult females that are exposed.

Malathon has given the best results on all species of mites. Tetraethyl pyrophosphate is a good killer of all active mites but does not harm the eggs. A repeat spray of this latter material, applied 7 to 10 days later, will give good control of the mites. EPN has given commercial control of all mites. Karathane, Sulphenone, IN-4200 and DN 111 reduced the mite population but residual action was not long enough for a two-spray program.

Any one of these acaricides will give commercial control of the orchard mites if properly applied. Three applications spaced 30 to 35 days apart will allow the trees to produce marketable fruit.


51. Hoffman, Julius R. Hexamethyl tetraphosphate and tetraethyl pyrophosphate as aerosols against the two-spotted mite. Journal


100. Ripper, Dr. W. E. Biological control as a supplement to chemical control of insect pests. Nature 153: 448-452. 1944.


SPRAY MATERIALS USED


Aramite XP-29 - Emulsifiable conc., 2 lbs. Aramite per gal. Shell Oil Co.

Bladex - Tetraethyl pyrophosphate 20%, other related phosphates 10%. Shell Oil Co.

Copper A - 45% Copper. E. I. du Pont de Nemours.

Deenate 50% - Wettable Powder 50%. Dichloro diphenyl trichloroethane. E. I. du Pont de Nemours.

DDTOL 50%. - Dichloro diphenyl trichloroethane. Sherwin Williams Co.

Dimite - 25% Emulsifiable, 25% Di(P-chlorophenyl) methyl carbimol. Sherwin Williams Co.

DN-I11 - Dinotro-o-cyclohexephenol, dicyclohexylamine salt 20%. E. I. du Pont de Nemours.


Extermoil - 82% Dormant oil. Hood River Apple Growers Association.

Fermate Fungicide - 75%. Ferric dimethyl dithiocarbamate. E. I. du Pont de Nemours.

IN-4200 - Lorol-2-thiazoliny1 sulphide 75%. E. I. du Pont de Nemours.

Karathane - (CR-1639) Dinotre capry1 phenyl crotonate, 25% Wettable. Rohm & Haas.

Killex - Tetraethyl pyrophosphate 20%, other related phosphates 10%. Sherwin Williams Co.


Malathon (4049) - S-(1,2-dicarbethoxyethyl) 0,0-dimethyl dithiophosphate 25%, Wettable Powder. American Cyanamid Co.
Malathon (4049) - 50.3% emulsion. American Cyanamid Co.

Marlate - Methoxychlor Marlate, 50% active. E. I. du Pont de Nemours.

MR-30 - 50% bis(p-chlorophenyl)-ethynyl carbinol. Rohm & Haas.

Persisto - Wettable, 50% DDT. California Spray Co.

Sulphenone - 50% (R-248) p-chlorophenyl phenyl sulfone. Stauffer Chemical.

TEPP - 20% Tetraethyl pyrophosphate. E. I. du Pont de Nemours.


Table 1 - Mites per leaf found in experimental plots compared with percent of leaves infested - 1948.

<table>
<thead>
<tr>
<th>Date</th>
<th>Check Plot Av. (1)</th>
<th>% (2)</th>
<th>Parathion Plot Av. (1)</th>
<th>% (2)</th>
<th>DN-111 Plot Av. (1)</th>
<th>% (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 12</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td>Oil 3 gals.</td>
<td></td>
</tr>
<tr>
<td>Delayed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lime-sulfur 4 gals.</td>
<td></td>
</tr>
<tr>
<td>Dormant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>April 24</td>
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<td>44</td>
<td>.03</td>
<td>3</td>
<td>.00</td>
<td>0</td>
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<td></td>
<td>.87</td>
<td>32</td>
<td>.00</td>
<td>0</td>
<td>.00</td>
<td>0</td>
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<td>May 3</td>
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<td>May 13</td>
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<td>.01</td>
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<td>.00</td>
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</tr>
<tr>
<td>May 20</td>
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<td>20</td>
<td>.00</td>
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<td>.00</td>
<td>0</td>
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<tr>
<td>May 27</td>
<td>6.37</td>
<td>36</td>
<td>.00</td>
<td>0</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>June 2</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>June 9</td>
<td>DDT 2 lbs.</td>
<td></td>
<td>Parathion</td>
<td></td>
<td>DDT 2 lbs.</td>
<td></td>
</tr>
<tr>
<td>First</td>
<td></td>
<td></td>
<td>1 lb.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cover</td>
<td></td>
<td></td>
<td>DDT 2 lbs.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June 16</td>
<td>.72</td>
<td>32</td>
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(1) Average Willamette mite per leaf.
(2) Percent of leaves infested with one or more Willamette mite.
Table 2 - Mites per leaf found in experimental plots compared with percent of leaves infested - 1948.

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(1) Average Willamette mite per leaf.
(2) Percent of leaves infested with one or more Willamette mite.
### Table 3 - Amount of spray materials applied to randomized plots throughout season of 1949

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### Table 4 - Average Willamette mite per Newtown apple leaf - 1949

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*Note: Values are averages of multiple plots.*
Table 5 - Percent of Newtown leaves infested with Willamette mites - 1949

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FIGURE 2. CHECK PLOT - 1950 (NEWTOWN APPLES)

- European Red Mite
- Willamette Mite
- Brown Mite

Percent leaves infested:

May 29, June 9, 20, 27, July 11, 24, 3, August 15, 25, September 5, 15, 30
FIGURE 3. DIMITE PLOT - 1950 (NEWTOWN APPLES)

- European Red Mite
- Willamette Mite
- Brown Mite

Percent leaves infested by mites over the months of May to September.
FIGURE 4. PARATHION PLOT - 1950 (NEWTOWN APPLES)

- EUROPEAN RED MITE
- WILLAMETTE MITE
- BROWN MITE

PERCENT LEAVES INFESTED

1 lb.
1 1/2 lbs.

May 29
June 9
June 20
June 27
July 11
July 24
August 3
August 15
August 25
September 5
September 15
September 30
FIGURE 5. ARAMITE PLOT - 1950 (NEWTOWN APPLES)

- European Red Mite
- Willamette Mite
- Brown Mite

PERCENT LEAVES INFESTED

May 29, June 9, 20, 27, July 11, 24, August 3, 15, 25, September 5, 15, 30

1 lb.
FIGURE 6. MALATHION EMULSION PLOT - 1950 (NEWTOWN APPLES)

- EUROPEAN RED MITE
- WILLAMETTE MITE
- BROWN MITE

May 29, June 9, 20, 27, July 11, 24, August 3, 15, 25, September 5, 15, 30

1 pt.
FIGURE 7. MALATHON (WETTABLE) PLOT - 1950 (NEWTOWN APPLES)

PERCENT LEAVES INFESTED

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<th>Month</th>
<th>Infestation</th>
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<td>July 24</td>
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<td>July 3</td>
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<td>August 15</td>
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<td>September 5</td>
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</tr>
<tr>
<td>September 15</td>
<td>20</td>
</tr>
<tr>
<td>September 30</td>
<td>10</td>
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</tbody>
</table>
FIGURE 8. EPN-300 PLOT - 1950 (NEWTOWN APPLES)

European Red Mite

Williamette Mite

Brown Mite

PERCENT LEAVES INFESTED

May 29, June 9, 20, 27, July 11, 24, August 3, 15, 25, September 5, 15, 30

1 lb.

1 lb.
FIGURE 9. SULPHENONE PLOT - 1950 (NEWTOWN APPLES)

- EUROPEAN RED MITE
- WILLAMETTE MITE
- BROWN MITE

PERCENT LEAVES INFESTED

May 29, June 9, 20, 27, 11, 24, 3, 15, 25, 5, 15, September 30, August 30
FIGURE 10. KARATHANE PLOT - 1950 (NEWTOWN APPLES)

- European Red Mite
- Willamette Mite
- Brown Mite

Percent leaves infested:

- May 29: 9
- June 20: 11
- July 11: 1 lb.
- July 24: 1 lb.
- August 15: 5
- September 15: 5
- September 30: 8
FIGURE 11. TETRAETHYL PLOT - 1950 (NEWTOWN APPLES)

- European Red Mite
- Willamette Mite
- Brown Mite

PERCENT LEAVES INFESTED

<table>
<thead>
<tr>
<th>Date</th>
<th>May 29</th>
<th>June 9</th>
<th>June 20</th>
<th>June 27</th>
<th>July 11</th>
<th>July 24</th>
<th>August 15</th>
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Table 6 - Percent of Newtown apple leaves infested with mites - 1951

G Series - All plots sprayed as follows: Late Dormant, 4 gals. oil plus 4 lbs. Copper A, 4/11; Thinning Spray, Elgetol 1 qt. (19%) 4/30; 2 lbs. Marlite 5/28 and 7/26 to which was added the acaricides as indicated. G-0 had 3 covers of DDT alone, 6/8, 7/26, and 8/3.

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<td>1 13 13</td>
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<td>R-242 2 lbs.</td>
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<td>Malathion 1 pt.</td>
<td>No Acaricide</td>
<td>No Acaricide</td>
<td>Aramite 1 pt.</td>
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<tr>
<td>July 26</td>
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<td>Parathion 2 lbs.</td>
<td>TEPP 1/3 pt.</td>
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</table>
Table 7 - Percent of Newtown apple leaves infested with mites - 1951

M Series - All plots sprayed as follows: Late Dormant, oil 3 gals. and lime-sulfur 3 gals., 4/9; Pink Spray, lime-sulfur 3 gals., 4/16; DDT 2 lbs., first and second covers, June 6-8 and July 20; DDT 1 lb. Aug. 31. Acaricides added to DDT in first and second covers as indicated.

<table>
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<tr>
<th>Date</th>
<th>M - 1 E.R.</th>
<th>M - 1 W.</th>
<th>M - 1 B.</th>
<th>M - 2 E.R.</th>
<th>M - 2 W.</th>
<th>M - 2 B.</th>
<th>M - 3 E.R.</th>
<th>M - 3 W.</th>
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<th>M - 4 E.R.</th>
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<tr>
<td>Aug. 31</td>
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<td>32</td>
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E.R. - European red mite  
W. - Willamette mite  
B. - Brown mite