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The Blackberry Mite in Oregon

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SUMMARY

The blackberry mite (Figure 1) is relatively a new pest in the Northwest. It became destructive in 1930.

Infestation by the mite has spread until now, broadly speaking, it can be said to extend in the coastal area from Mexico to Bellingham, Washington.

The mite spends the entire year on the blackberry vines, overwintering in the buds and other protected parts of the plant, and infesting the fruit after it has set in the summer.

The host list of this pest has grown from the Himalaya blackberry to a large number of plants, but the most economic are Evergreen and Himalaya blackberries.

Mention is made of the predacious mite which attacks and destroys many of the blackberry mites. While this mite is no doubt a help in control, the application of sprays is essential to secure a normal harvest of fruit.

The blackberry mite, through its activity in the berries, causes all or part of the drupelets to remain red instead of ripening normally. (See illustration on cover.)

Experimental tests from 1930 to 1934 are reported.

The following programs are suggested for control:

PROGRAM I

Fall Spray. Summer oil (viscosity 55 to 70 seconds Saybolt and 90 per cent unsulfonated residue) at the rate of 3 gallons and 97 gallons of water, emulsified according to method suggested in Bulletin 336, Oregon Agricultural Experiment Station. Applied in fall after old canes are removed (Figures 2 and 3). A commercial summer emulsion of like specifications may be substituted. Applied in the fall after the old canes are removed. This is followed by a *Delayed Dormant Spray.*

Delayed Dormant Spray. Lime sulfur (30° Baumé) at the rate of 8 gallons and 92 gallons of water, applied in spring when shoots are 2 to 6 inches long. (Figure 7.)

PROGRAM II

Fall Spray. Lime sulfur (30° Baumé) at the rate of 8 gallons and 92 gallons of water. Applied in fall after old canes are removed. (Figures 2 and 3.)

This is followed by a *Delayed Dormant Spray.*

Delayed Dormant Spray. Same as above. (Figure 7.)

SUMMARY—*Continued*

PROGRAM III

Dormant Spray. Lime sulfur (30° Baumé) at the rate of 8 gallons and 92 gallons of water, applied in the spring after buds start to grow. (Figures 4 and 6). This is followed by a *Delayed Dormant Spray.*

Delayed Dormant Spray. Same as above. (Figure 7.)

PROGRAM IV

Delayed Dormant Spray. Same as above. (Figure 7.)

Caution. This single spray is not recommended unless the mites have been satisfactorily controlled in previous seasons, and only if applications are made with efficient spray equipment.

PROGRAM V

Fruit Spray. Summer oil (viscosity 55 to 70 seconds Saybolt and 90 per cent unsulfonated residue) at the rate of 3 gallons and 97 gallons of water, emulsified in accordance with Bulletin 336, Oregon Agricultural Experiment Station. A commercial summer emulsion of like specifications may be substituted. Applied after 90 per cent of the fruit is set. (Figure 8.) *Caution.* This single spray is recommended only as an emergency measure to be used when no sprays have been applied previously.

The preblossom spray of either wettable sulfur or of dilute lime sulfur has caused burning or yellowing during the past three seasons in the Willamette Valley (Figure 11) and hence cannot be recommended. Experimental data also show a reduction in yield on plots sprayed with this material. This wettable sulfur spray should *not* be used in the Willamette Valley at this time.

Only efficient spray equipment is recommended and emphasis is placed upon thorough coverage as the surface of the blackberry vines is such that it is very difficult to secure contact with the mites.

The Blackberry Mite in Oregon

(*Eriophyes essigi* Hassan)

W. D. EDWARDS, K. W. GRAY, J. WILCOX*, and DON C. MOTE†

INTRODUCTION

THE Blackberry Mite, *Eriophyes essigi* Hassan‡, appeared in startling and injurious numbers in Oregon in the 1930 season, and without apparent warning ruined the entire crop in several patches and materially reduced the yield in others by producing the so-called "Redberry Disease" on both the Himalaya and Evergreen varieties of blackberries. The situation was so alarming that Messrs. Ray Glatt, Secretary, and Blain McCord, Legal Adviser, of the Woodburn Fruit Growers Association, arranged to meet Dr. Mote in Berkeley, and together they investigated the control measures as recommended and used in California. Lack of experience with this mite, however, made control experiments necessary in Oregon. A few tests were made late in the 1930 season, and a formal Purnell project was approved for experiments in the growing season of 1931.§

HISTORY

The "Redberry Disease" of the Himalaya blackberry was first reported in California by Essig and Smith (5)‖ in 1922. In 1925 a more complete report was published by Essig (6), results of control tests were reported, and control measures recommended. Further recommendations for the control of this pest in California were made by Horne, Essig, and Herms (13, 14, 15, 16) in 1923, 1925, 1927, and 1930, and Essig (7) in 1926. Control in Washington was reported by Hanson (11) in 1933.

The mite was first brought to the attention of the Oregon Agricultural Experiment Station in the 1930 season by S. B. Hall, Agricultural Agent of Multnomah County, when by telephone on August 16 he reported a "redberry" condition of Himalaya blackberries. An examination of two patches suggested by Mr. Hall showed that about 50 per cent of the Himalayas were infested with mites. The most surprising discovery, however, was that the adjacent Evergreens in one field were also heavily infested. This discovery was surprising as Essig (6) reported the mite as being injurious only to the Himalaya blackberry, even when associated with or interlacing with other varieties such as Mammoth, Oregon Evergreen, Lawton dewberries, loganberries, and raspberries. An examination of

*Resigned August 1931.

†The writers express their gratitude to the Woodburn Fruit Growers Association; to Mr. Dennis Norton and to Mr. H. F. Butterfield, for their cooperation throughout the continuance of the project; and to Mr. W. W. Stover for assistance in the work on his blackberry patch in the 1934 season. The writers are also indebted to J. O. G. Wieting, Joe Schuh, and James Roaf, who have assisted in making applications and checking control tests.

‡Mites from Woodburn, Oregon, were determined as this species by H. E. Ewing of the Bureau of Entomology and Plant Quarantine for Mr. S. E. Crumb.

§Purnell Project No. 41, Oregon Agricultural Experiment Station.

‖Numbers in parentheses refer to literature cited, page 33.

Evergreen blackberries in the Woodburn district showed the berries in two patches to be very heavily infested with mites.

Subsequent information in Oregon supplied by growers indicates that the mite was present in small numbers in the 1929 season, and that possibly a few patches showed some symptoms of mite damage during the 1928 season. Information received after the discovery in the Willamette Valley in 1930 disclosed that the mite had been present in the Ashland district on small plantings of Himalayas since 1927, and that growers had been applying control measures, following California recommendations, since 1928.

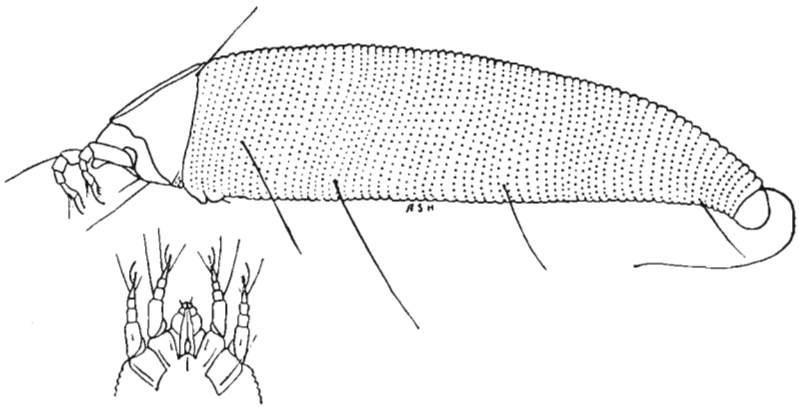

Figure 1. Drawing of *Eriophyes essigi* Hassan. This mite is responsible for the "redberry disease" of Evergreen and Himalaya blackberries. Drawing from Hassan (12).

DISTRIBUTION

Originally reported by Essig (6) to be coextensive with the Himalaya districts of California, the mite was found in Oregon to be rather generally distributed in the Willamette Valley and in Jackson, Josephine, Douglas, Coos, and Lincoln counties, on either Evergreen or Himalaya blackberries. The wild Dewberry *(Rubus macropetalus* Dougl.) is heavily infested, especially east of the Willamette River in the Willamette Valley. As an example of local increase, Lincoln county in 1930 was found to have only light infestations, but during the 1933 season wild patches, which the year before had exhibited little or no "redberry", were found to be heavily infested.

Hanson (11) reports the distribution of the mite in the United States as extending along the west coast from Mexico north to Bellingham, Wash.

Massee (17) reports that the mite occurs in England in the Canterbury district, East Malling, Maidstone, Kirdford, and W. Sussex.

It appears that the mite may be of European origin, remaining undescribed until it became a pest in the United States. Weight is given this supposition by the fact that Darrow (4) states that Himalaya and Evergreen blackberries are horticultural varieties of European vines.

DESCRIPTION

When first observed in California, the blackberry mite was thought to be *Eriophyes gracilis* Nalepa, which is reported by Massee (17) to be associated with abnormalities of the Himalaya berry and the raspberry. In 1928, however, Hassan (12) described the mite as a new species, *Eriophyes essigi* Hassan. The difference between the two species is borne out by the character of the injury. *E. gracilis*, according to Massee (17), is present on plants that are growing abnormally and causes abnormal foliage and shoots, and according to Hassan (12) is responsible for pale spots on the under sides of the leaves, which become curled. *E. essigi* causes the "redberry" symptom so well known to growers on the west coast.

The Mite (Figure 1) is small and is invisible to the naked eye. While there is some variation, the adult mites are about 0.15 mm. (1/167 of an inch) long and about 1/5 as wide, the male being somewhat smaller than the female. In color they are generally a transluscent white; during the winter, however, some forms are yellowish or rarely reddish. The body is made up of two parts: the cephalothorax and the abdomen. The abdomen is about six times as long as the cephalothorax, tapers posteriorly, and has 75 or 80 striae or concentric tuberculated rings. Mobility is provided by two pairs of short legs on the thorax, with which the mite drags its body over even surfaces, and by a sucker located on the posterior end of the abdomen which, when attached to the plant tissue, enables the mite to raise the forward part of its body over uneven surfaces. A pair of palpi, grooved maxillae, and a pair of organs called chelicerae, used for piercing the plant tissue, make up the mouthparts.

SEASONAL HISTORY

The blackberry mite overwinters on the host plants, using the protection afforded by the buds or the space between the buds and the canes. While no definite migration from the fruit to the buds in the fall has been observed by the writers, or by Hanson (11), it appears that only the mites which hibernate in the bud scales, or some protected place on the plant, survive. The effect of low temperatures on the mites is not known, but following a severe freeze in December, 1932, the experimental plots were heavily infested during the season of 1933. If the freeze resulted in the destruction of any considerable number of mites, the reproductive rate of the surviving mites was sufficiently high to product a heavy infestation.

During the winter the mites are somewhat inactive though some eggs were found during mid-winter, indicating possible winter reproduction or an overwintering form. With the arrival of warmer spring weather and the resumption of growth by the host plants, the reproductive rate of the mites is accelerated, but does not reach its peak until late summer after the Evergreen blackberries are beginning to ripen. In the counts made during the season of 1931, large numbers of mites were not found in the berries until about two weeks before harvest, and toward the end of the season the counts from unsprayed plots ran as high as 1,400 mites per berry. Following the picking season, the mites may be found in the berries until the late fall. Hanson (11) reports finding them in the fruit on January 13.

The rapid increase in mite population during the summer may be assisted by asexual reproduction. Hassan (12) quotes authors on this point who maintain that this form of reproduction occurs in some of the Eriophyids.

The number of generations of *E. essigi* has not been determined, as there is considerable overlapping of the stages.

NATURAL ENEMY

A large predacious mite, *Seius pomi* Parrot, is of considerable value in the control of the blackberry mite. This mite belongs to the family Parasitidae (Gamasidae), which includes several species of common predacious mites. It preys on several other mites besides the blackberry mite. Ewing (8) lists it as feeding on the citrus, the yellow, and the red spider mites. The predacious mite attacks the blackberry mite by inserting its chelicerae in the body and sucking out the juices, leaving the body shrunken or collapsed.

The life history of the predacious mite correlates with that of the blackberry mite. The winter is spent in hibernation in the adult stage, and egg laying starts in the spring. Hanson (11) observed eggs March 16. The eggs are usually deposited singly, but in some cases two or three are deposited together on the buds and the berries, and sometimes on the leaves. The eggs hatch into larvae, which are similar to the adults except that they have only three pairs of legs. The larvae change to nymphs, which are similar to the adults in all ways except for size and for the genital armature. The blackberry mite is subject to the attack of these predacious mites throughout the year, and no doubt large numbers are destroyed, but the control thus effected is not sufficient to hold the mite in check.

HOST PLANTS

The Himalaya blackberry was the only host of the mite reported until 1928. Hassan (12) then reported that it occurred on blackberry, loganberry, and raspberry. Mote and Wilcox (20) found mites in Himalaya and Evergreen blackberries in the Willamette Valley. Crumb (3) reports finding the mites in Evergreen, Himalaya, Lawton, Eldorado, Snyder, and Kittatinny blackberries, and similar mites in two varieties of raspberry and in loganberry during his 1930 survey of Oregon and Washington. Horne, Essig, and Herms (16) in 1930 report Himalaya, Mammoth, and other blackberries and loganberries throughout California affected by the mites. Baker (2) reports finding the mite *E. gracilis* Nalepa in thimbleberry buds, (*Rubus parviflorus* Nutt). Baker (1) reports *E. essigi* Hassan in the fruit of the wild black raspberry (*Rubus leucodermis* Dougl.). Wilcox and Baker (21) report bush blackberries of the varieties Snyder, Lawton, Texas, Kittatinny, and Ward infested in Washington. The writers in Oregon found Himalaya, Evergreen, and the wild dewberry (*Rubus macropetalus* Dougl.) infested. Numerous mites were also found in loganberry and red raspberry, and also in grape buds at Woodburn. The mites found in raspberry, loganberry, and thimbleberry are likely the raspberry mite (*Eriophyes gracilis* Nalepa); those found in grape are likely the grape erinose mite (*E. vitis* Landois).

INJURY

The presence of *E. essigi* in the berries of the Evergreen and Himalaya varieties causes all or part of the drupelets to turn to a brilliant red, in either case resulting in an unmarketable berry (see illustration on cover). The affected berries usually attain normal size, but the drupelets are more filled out and of a brighter red color than unaffected unripened berries. It is not known how many mites must be present to cause typical "redberry" symptoms as there appears to be some variation. Infested fruit was found which appeared normal, and typical redberry fruit was observed with only a small number of mites.

Black raspberries in the Willamette Valley exhibit a characteristic "redberry" condition, part of the drupelets remaining red and the others turning black, but no mites have been found in the berries. On wild dewberries, "redberry" symptoms prevail, but this condition seems to be quite general whether the mites are present or not. Some symptoms of delayed ripening and of hardening of part of the drupelets were observed in red raspberries and loganberries, but so far this condition has not proved serious. Wilcox and Baker (21) report that bush blackberries in Washington are quite heavily infested, but exhibit no typical redberry symptoms. Thus far in Oregon only the Evergreen and Himalaya varieties have been seriously affected either in cultivated plantings or in wild entanglements.

1930 EXPERIMENTS*

The seriousness of the mite infestation was not apparent until the start of the picking season in 1930, and there was insufficient time remaining to allow large-scale control tests. Oil sprays were applied, however, to two heavily infested patches of Evergreens at Woodburn, as indicated in Tables 1, 2, and 3. The specifications of the oils are as follows: Oil No. 4, viscosity 50 to 55 seconds Saybolt and 90 per cent unsulfonated residue; Oil No. 5, viscosity 100 to 110 seconds Saybolt and 65 per cent unsulfonated residue; Oil No. 6, viscosity 72 to 75 seconds Saybolt and 90 per cent unsulfonated residue. The oils were used at the strength indicated in the tables—i.e., 1 per cent equals 1 gallon of oil in 99 gallons of water, thoroughly emulsified with casein spreader, according to the method described in Bulletin 336, Oregon Agricultural Experiment Station. A power sprayer and agitator is used to effect the emulsion.

Table 1. SUMMARY OF SPRAY TESTS, 1930—Series 1.
Sprays applied to H. F. Butterfield patch August 22, 1930.

Plot number and sprays used	Total—2 pickings	
	Yield per 4 hills	Estimated yield per acre
	Pounds	*Pounds*
1—Oil No. 6, 1 per cent	18.0	1,559.5
2—Oil No. 6, 1 per cent; nicotine sulfate 40 per cent, 1-800	22.0	1,905.5
3—Oil No. 6, 2 per cent	89.0	7,698.5
4—Oil No. 6, 2 per cent; nicotine sulfate 40 per cent, 1-800	83.0	7,180.0
5—Oil No. 4, 2 per cent	108.0	9,242.0
6—Oil No. 4, 2 per cent; nicotine sulfate 40 per cent, 1-800	77.0	6,660.5
——Check (average of 4 checks)	10.4	886.7

*Spray data for 1930 and 1930-31 seasons have been published in part by Mote, D. C., Wilcox, J., 1931. Proc. 27th Ann. Meeting Wash. State Hort. Asso., pp. 203-207. They are reprinted in this paper because the volume of proceedings is relatively unavailable.

Sprays were applied to the patch of H. F. Butterfield, Woodburn, Oregon, August 22, 1930, as shown in Table 1. A power sprayer was used maintaining 300 pounds pressure at the rate of about 1,000 gallons per acre. One picking was made previously to the application of the oil sprays, the yield at the first picking being about 318 pounds per acre.

Sprays applied to the Dennis Norton patch August 22, 1930, with resultant yields, are shown in Table 2.

Table 2. SUMMARY OF SPRAY TESTS, 1930—Series 1.
Sprays applied to Dennis Norton patch August 22, 1930.

Plot number and sprays used	Total—2 pickings	
	Yield per 4 hills	Estimated yield per acre
	Pounds	*Pounds*
1—Oil No. 4, 1 per cent	8.00	692.0
2—Oil No. 4, 1 per cent; nicotine sulfate 40 per cent, 1-800	11.00	951.0
5—Oil No. 6, 1 per cent	5.00	431.4
6—Oil No. 6, 1 per cent; nicotine sulfate 40 per cent, 1-800	5.50	475.7
3—Oil No. 4, 2 per cent	18.50	1,600.2
4—Oil No. 4, 2 per cent; nicotine sulfate 40 per cent, 1-800	22.00	1,930.0
9—Oil No. 4, 3 per cent	20.00	1,730.0
10—Oil No. 4, 4 per cent	24.50	2,119.2
7—Oil No. 6, 3 per cent	26.50	2,291.5
8—Oil No. 6, 3 per cent; nicotine sulfate 40 per cent, 1-800	43.00	3,719.5
——Check—No spray	1.25	113.4

In the case of both the Butterfield and Norton patches (Tables 1 and 2), sprayed August 22, results were not apparent until September 11, when the first picking was made.

An additional series of plots was sprayed at Mr. Butterfield's on September 12 to determine whether sprays at this time would control mites and allow the berries to turn black. The results of this test are shown in Table 3.

Table 3. SUMMARY OF SPRAY TESTS, 1930—Series 2.
Sprays applied to H. F. Butterfield patch September 12, 1930.

Plot number and sprays used	Yield per 4 hills	Estimated yield per acre
	Pounds	*Pounds*
9—Oil No. 6, 2 per cent	22.0	1,903.0
10—Oil No. 6, 3 per cent	48.0	4,152.0
11—Oil No. 5, 2 per cent; nicotine sulfate 40 per cent, 1-800	54.0	4,681.0
12—Wettable sulfur, 5 pounds to 100 gallons	8.0	692.0
13—Wettable sulfur, 10 pounds to 100 gallons	10.0	865.0
14—Wettable sulfur, 5 pounds to 100 gallons; lime sulfur, 3-100	13.0	1,124.5
15—Lime sulfur, 4-100	13.5	1,167.75
——Check—No Spray	6.5	562.25

The berries picked from these test plots were actually of poor quality owing to lack of sugar content. It was not assumed that sprays at this late stage of the season could be used as a commercial control of the mite, but they gave a lead as to what sprays might be used in mite control at other times of the year.

1930-31 EXPERIMENTS

Through the cooperation of the Woodburn Fruit Growers Association, the Evergreen blackberry patch of Mr. Dennis Norton was made available for experimental work. This patch was 100 per cent infested in the 1930 season. No berries were harvested commercially, excepting those from the spray plots recorded in Table 2. The patch of approximately one acre was divided into 110 plots, each plot consisting of the vines between three posts—usually 4 hills (Figure 10).

The various spray applications were made with a power sprayer, 100-gallon capacity, equipped with two hose leads and capable of developing 300 to 350 pounds pressure at the pump. Numerous spray materials, combinations, and dilutions were tested, including nicotine sulfate, pyrethrum extract, liquid lime sulfur, dry lime sultur, wettable sulfur, and oils of various specifications. Thousands of berries from the patch were examined, mite counts taken, and the percentage of "redberry" was checked every two weeks during the season.

The time of making the spray applications in the various experiments conducted in the years 1931-1934 was in general as follows:

1st. Fall Spray. Application in the fall to the new canes after the old canes have been cut out and removed from the field; the new canes remaining on the ground; usually applied in October. (See Figures 2 and 3.)

2d. Dormant Spray. Application in the early spring to the new canes after they have been trained on the wires; the buds dormant; usually applied in February. (Figures 4, 5, and 6.)

3d. Delayed Dormant Spray. Application to the vines when the buds which are to form the fruit spurs have grown so that they are from three to five inches long; usually applied in April. (Figure 7.)

4th. Preblossom Spray. Application to the vines just before blossoming, none of the blossom buds being open; usually applied in May or June.

5th. Fruit Spray. Application to the vines when about 90 per cent of the fruit has set and when some berries are turning black, usually about two weeks before the start of harvest; usually applied in July. (Figure 8.)

The actual dates of application of course varied considerably owing to differences in the seasons and in the weather conditions. The actual dates of making the spray applications are shown under the various tables. The applications are usually referred to by number, *1st* indicating the Fall Spray, *2nd* indicating the Dormant Spray, etc.

The amount of spray materials used is indicated numerically. For example, 4-100 means 4 gallons of the spray material and 96 gallons of water. As in most cases the different dilutions showed no outstanding differences, these were combined in tables to obtain the average yield. For example, lime sulfur, 4, 6, 8, 10-100, means that 4 gallons of lime sulfur and 96 gallons of water was used on one of the plots, 6 gallons of lime sulfur and 94 gallons of water was used on another plot, and so on. In the case of wettable sulfur, 5 pounds to 100 gallons of water was used in most of the tests.

Table 4 lists the sprays applied, the percentage of redberry, the average number of mites present in the berries, and the yield computed to pounds per acre. The number of mites infesting the berries was determined* at intervals of about two weeks, starting before the picking season and continuing until October.

*The counts were made by picking ten berries from each plot, cutting each berry transversely with a knife, and then breaking off the cut drupelets, after which the number of mites on each half surface was counted. The number of mites found was considered to equal ¼ of the mite population per berry as the average berry has five rows of drupelets with four interspaces in which the mites are found.

Table 4. BLACKBERRY MITE EXPERIMENTAL RECORD 1930-31.
Sprays applied to Dennis Norton patch.

Plot number and material used	Sprays applied (See page 11)	Average percentage of redberry August 3 to October 6	Average number of mites July 21 to October 9	Estimated yield per acre
		Per cent		*Pounds*
1—Lime sulfur 4-100	3d	24.4	95.1	6,215
2—Wettable sulfur 5 pounds to 100 gallons	4th	20.2	62.5	5,192
3—Wettable sulfur 10 pounds to 100 gallons	4th	15.6	60.3	4,895
4—Oil No. 6, 2-100	4th	29.8	233.9	3,630
5—Oil No. 6, 4-100	4th	31.0	92.3	1,540
6—Oil No. 4, 2-100	5th	16.8	38.6	6,490
7—Oil No. 4, 4-100	5th	6.8	171.3	4,070
8—Oil No. 4, 4-100	4th	40.8	171.7	1,210
9—Oil No. 4, 2-100	4th	51.0	105.1	2,860
10—Nicotine sulfate 40 per cent 1-800	4th	54.8	140.1	1,155
11—Pyrethrum extract 1-800	4th	56.2	107.5	1,045
12—Lime sulfur 6-100	3d	32.0	143.0	3,685
13—Check—No spray	—	51.2	503.7	770
14—Check—No spray	—	52.0	430.5	880
15—Associated Oil Lemon Neutral 2-100	2d and 4th	38.2	182.3	1,925
16—Associated Oil Lemon Neutral 2-100	2d	51.2	186.3	2,497
17—Associated Oil Lemon Neutral 4-100	2d and 4th	47.4	231.8	1,017
18—Associated Oil Lemon Neutral 4-100	2d	59.8	128.5	1,100
19—Nicotine sulfate 40 per cent 1-800	2d and 4th	49.8	154.1	1,595
20—Nicotine sulfate 40 per cent 1-800	2d	61.2	205.0	880
21—Pyrethrum extract 1-800	2d and 4th	59.2	226.1	577
22—Pyrethrum extract 1-800	2d	59.0	164.3	605
23—Lime sulfur 8-100	3d	24.6	150.2	2,680
24—Oil No. 4, 2-100	2d and 4th	38.8	178.9	1,815
25—Oil No. 4, 2-100	2d	36.8	164.8	1,177
26—Oil No. 4, 4-100	2d and 4th	18.6	93.1	2,007
27—Oil No. 4, 4-100	2d	41.8	145.5	2,827
28—Oil No. 6, 2-100	2d and 4th	37.6	123.6	3,740
29—Oil No. 6, 2-100	2d	45.0	275.6	1,405
30—Oil No. 6, 4-100	2d and 4th	17.0	92.3	1,357
31—Oil No. 6, 4-100	2d	38.6	133.6	1,815
32—Oil No. 6, 2-100	5th	3.8	99.3	5,500
33—Oil No. 6, 4-100	5th	2.6	99.0	3,575
34—Lime sulfur 2-100	3d	32.6	154.8	2,695
35—Dry lime sulfur 10 pounds to 100 gallons	2d	33.6	325.1	1,952
36—Dry lime sulfur 15 pounds to 100 gallons	2d	38.4	178.7	1,980
37—Dry lime sulfur 20 pounds to 100 gallons, wettable sulfur 5 pounds to 100 gallons	2d and 4th	16.8	81.3	5,390
38—Dry lime sulfur 20 pounds to 100 gallons	2d	38.8	174.6	2,612
39—Check—No spray	—	47.0	343.0	1,540
40—Check—No spray	—	34.8	370.6	907
41—Dry lime sulfur 25 pounds to 100 gallons, wettable sulfur 5 pounds to 100 gallons	2d and 4th	10.0	152.4	4,840
42—Dry lime sulfur 25 pounds to 100 gallons	2d	40.0	322.1	2,585
43—Dry lime sulfur 30 pounds to 100 gallons	2d	40.6	219.5	1,870
44—Dry lime sulfur 35 pounds to 100 gallons	2d	38.4	193.9	2,970
45—Lime sulfur 4-100	3d	21.2	116.5	1,815
46—Wettable sulfur 5 pounds to 100 gallons	5th	8.6	60.5	2,640
47—Wettable sulfur 10 pounds to 100 gallons	5th	7.2	50.5	4,235
48—Lime sulfur 2-100	2d	20.8	109.9	3,410
49—Lime sulfur 4-100	2d	24.8	209.2	2,475
50—Lime sulfur 6-100, wettable sulfur 5 pounds to 100 gallons	2d and 4th	23.4	152.3	4,565
51—Lime sulfur 6-100	2d	36.8	248.5	4,510

Table 4. BLACKBERRY MITE EXPERIMENTAL RECORD 1930-31—*Continued*
Sprays applied to Dennis Norton patch.

Plot number and material used	Sprays applied (See page 11)	Average percentage of redberry August 3 to October 6	Average number of mites July 21 to October 9	Estimated yield per acre
		Per cent		*Pounds*
52—Lime sulfur 8-100, wettable sulfur 5 pounds to 100 gallons	2d and 4th	9.6	64.0	4,290
53—Lime sulfur 8-100	2d	26.2	152.1	2,035
54—Lime sulfur 10-100	2d	31.2	210.1	1,045
55—Lime sulfur 15-100	2d	35.8	167.1	1,625
56—Lime sulfur 6-100	3d	27.6	139.1	3,135
57—Extermol 5-100, Oil No. 6, 4-100	1st, 2d, and 4th	23.2	86.0	1,430
58—Extermol 5-100	1st and 2d	30.8	75.5	3,052
59—Extermol 5-100, Oil No. 6, 4-100	1st and 4th	21.2	93.7	1,842
60—Extermol 5-100	1st	35.8	118.7	1,980
61—Extermol 2½-100, Oil No. 6, 2-100	1st, 2d, and 4th	33.8	129.4	2,915
62—Extermol 2½-100	1st and 2d	52.8	165.2	880
63—Extermol 2½-100, Oil No. 6, 2-100	1st and 4th	18.0	104.7	2,860
64—Extermol 2½-100	1st	37.4	119.4	1,375
65—Kerosene 4-100	2d and 4th	35.4	139.4	1,265
66—Kerosene 4-100	2d	41.6	130.9	687
67—Lime sulfur 2-100	3d	16.2	63.7	3,135
68—Oil No. 6, 4-100	1st, 2d, and 4th	11.2	110.1	761
69—Oil No. 6, 4-100	1st and 2d	17.2	111.6	2,025
70—Oil No. 6, 4-100	1st and 4th	10.8	67.1	935
71—Oil No. 6, 4-100	1st	26.2	197.3	1,677
72—Check—No spray	—	47.6	289.5	1,127
73—Check—No spray	—	50.0	176.0	1,375
74—Oil No. 6, 2-100	1st, 2d, and 4th	18.6	66.3	3,162
75—Oil No. 6, 2-100	1st and 2d	36.8	104.2	1,320
76—Oil No. 6, 2-100	1st and 4th	40.6	127.5	2,805
77—Oil No. 6, 2-100	1st	46.2	151.7	1,045
78—Oil No. 6, 3-100, nicotine sulfate 40 per cent 1-800	5th	44.0	93.7	1,815
79—Nicotine sulfate 40 per cent 2 pt.-100	5th	15.0	131.0	3,245
80—Nicotine sulfate 40 per cent 1 pt.-100	5th	17.0	144.7	4,152
81—Oil No. 4, 4-100	1st, 2d, and 4th	13.2	73.8	2,227
82—Oil No. 4, 4-100	1st and 2d	30.4	87.8	2,557
83—Oil No. 4, 4-100, kerosene 2-100	1st, 2d, and 4th	38.4	156.8	2,585
84—Oil No. 4, 4-100, kerosene 2-100	1st and 2d	36.8	148.0	1,715
85—Oil No. 4, 2-100	1st, 2d, and 4th	18.4	58.8	3,355
86—Oil No. 4, 2-100	1st and 2d	40.6	66.6	2,255
87—Oil No. 4, 2-100	1st and 4th	38.4	105.1	1,045
88—Oil No. 4, 2-100	1st	55.8	129.7	577
89—Lime sulfur 4-100	4th	9.0	60.3	3,850
90—Lime sulfur 10-100, wettable sulfur 5 pounds to 100 gallons	1st, 2d, and 4th	6.2	31.4	3,877
91—Lime sulfur 10-100	1st and 2d	13.8	102.4	5,995
92—Lime sulfur 10-100, wettable sulfur 5 pounds to 100 gallons	1st and 4th	10.4	58.0	6,435
93—Lime sulfur 10-100	1st	24.2	116.7	2,860
94—Lime sulfur 8-100, wettable sulfur 5 pounds to 100 gallons	1st, 2d, and 4th	12.0	67.1	6,160
95—Lime sulfur 8-100	1st and 2d	19.8	106.8	4,125
96—Lime sulfur 8-100, wettable sulfur 5 pounds to 100 gallons	1st and 4th	9.2	69.2	6,545
97—Lime sulfur 8-100	1st	28.8	110.0	2,035
98—Check—No spray	—	50.4	155.8	522
99—Check—No spray	—	65.6	163.9	220
100—Lime sulfur 6-100	4th	11.2	39.1	3,382
101—Lime sulfur 4-100, wettable sulfur 5 pounds to 100 gallons	1st, 2d, and 4th	9.2	29.6	4,785
102—Lime sulfur 4-100	1st and 2d	12.8	52.5	5,417
103—Lime sulfur 4-100, wettable sulfur 5 pounds to 100 gallons	1st and 4th	12.4	107.5	6,105
104—Lime sulfur 4-100	1st	25.4	111.8	1,815
105—Lime sulfur 6-100, Oil No. 6, 2-100	2d and 4th	15.4	94.3	3,435
106—Lime sulfur 6-100	2d	25.8	56.4	6,875
107—Lime sulfur 6-100, wettable sulfur 5 pounds to 100 gallons	1st, 2d, and 4th	17.6	39.3	6,490
108—Lime sulfur 6-100	1st and 2d	31.0	80.2	3,465
109—Lime sulfur 6-100, wettable sulfur 5 pounds to 100 gallons	1st and 4th	22.4	35.0	2,612
110—Lime sulfur 6-100	1st	43.6	97.2	1,210

Effective sprays. From a study of the results in Table 4, it is apparent that there is a wide variation in the acreage yield of the plots. The single-spray applications and combinations of sprays which were followed by yields of more than 4,500 pounds per acre* are given in the following paragraphs:

Single-spray Program

2d Lime sulfur 6-100 (2 plots).....5,692 pounds per acre
3d Lime sulfur 4-100.....6,215 pounds per acre
4th Wettable sulfur 5-100.....5,192 pounds per acre
4th Wettable sulfur 10-100.....4,895 pounds per acre
5th Oil No. 4, 2-100.....6,490 pounds per acre
5th Oil No. 6, 2-100.....5,500 pounds per acre

Two-spray Program

1st Lime sulfur 8-100, plus *4th* Wettable sulfur 5-100.....6,545 pounds per acre

1st Lime sulfur 10-100, plus *4th* Wettable sulfur 5-100.....6,435 pounds per acre

1st Lime sulfur 4-100, plus *4th* Wettable sulfur 5-100.....6,105 pounds per acre

1st Lime sulfur 10-100, plus *2d* Lime sulfur 10-100.....5,995 pounds per acre

1st Lime sulfur 4-100, plus *2d* Lime sulfur 4-100.....5,417 pounds per acre

2d Dry lime sulfur 20-100, plus *4th* Wettable sulfur 5-100.....5,390 pounds per acre

2d Dry lime sulfur 25-100, plus *4th* Wettable sulfur 5-100.....4,840 pounds per acre

2d Lime sulfur 6-100, plus *4th* Wettable sulfur 5-100.....4,565 pounds per acre

Three-spray Program

1st Lime sulfur 6-100, plus *2d* lime sulfur 6-100, plus *4th* Wettable sulfur 5-100.....6,490 pounds per acre

1st Lime sulfur 8-100, plus *2d* lime sulfur 8-100, plus *4th* Wettable sulfur 5-100.....6,160 pounds per acre

1st Lime sulfur 4-100, plus *2d* lime sulfur 4-100, plus *4th* Wettable sulfur 5-100.....4,785 pounds per acre

In Table 5 the results of the experimental work are summarized by combining sprays similar in time of application but varying in the strength of the sprays.

*The yield on all plots was below normal because about 30 per cent of the fruit failed to set. This condition was thought to be due to lack of pollination caused by the heavy rains in June.

Table 5. SUMMARY OF SPRAY TESTS 1930-31, SHOWING FIFTEEN HIGHEST SPRAY COMBINATIONS.

Dennis Norton Evergreen patch, Woodburn, Oregon

Plots and materials used	Sprays applied	Average percentage of redberry August 3 to October 6	Average number of mites per berry July 21 to October 9	Estimated yield per acre—4 pickings
		Per cent		*Pounds*
Average of 4 plots—Lime sulfur 4, 6, 8, 10-100; wettable sulfur 5-100	1st and 4th	13.6	67.4	5,424
Average of 4 plots—Lime sulfur 4, 6, 8, 10-100; wettable sulfur 5-100	1st, 2d, and 4th	11.2	41.8	5,328
Average of 2 plots—Oil No. 4, 2, 4-100	5th	11.8	104.9	5,280
Average of 2 plots—Dry lime sulfur 20, 25 pounds to 100 gallons; wettable sulfur 5-100	2d and 4th	13.4	116.8	5,115
Average of 2 plots—Wettable sulfur 5, 10 pounds to 100 gallons	4th	17.9	61.4	5,043
Average of 4 plots—Lime sulfur 4, 6, 8, 10-100	1st and 2d	77.4	85.4	4,750
Average of 2 plots—Oil No. 6, 2, 4-100.	5th	3.2	99.1	4,537
Average of 2 plots—Lime sulfur 6, 8-100; wettable sulfur 5 pounds to 100 gallons	2d and 4th	16.5	108.1	4,427
Average of 6 plots—Lime sulfur 2, 4, 6, 6, 8, 10-100	2d	27.6	164.3	4,070
Average of 4 plots—Lime sulfur 2, 4, 6, 8-100	3d	24.3	113.0	3,928
Average of 2 plots—Lime sulfur 4, 6-100	4th	10.1	49.7	3,616
One plot—Lime sulfur 6-100, Oil No. 6, 3-100	2d and 4th	15.4	94.3	3,435
Average of 2 plots—Oil No. 4, 2, 4-100	1st, 2d, and 4th	15.8	66.3	2,791
Average of 2 plots—Oil No. 6, 2, 4-100	4th	30.4	163.1	2,585
Average of 2 plots—Oil No. 6, 2, 4-100	2d and 4th	27.3	107.9	2,548
Average of 8 plots—Check—No spray.	.....	49.8	304.1	917

Injurious sprays. The following sprays were found to be injurious on the blackberry patch of Mr. Dennis Norton during the season of 1930-31:

Fall Sprays. Extermol 5-100, burned all the leaves off the plants; Extermol 2½-100, burned the leaves.

Preblossom Sprays. Lime sulfur 4-100 and 6-100, yellowing of the leaves and burning on the edges; Lemon neutral oil 4-100, severe burning to leaves and buds; Lemon neutral oil 2-100, burning to leaves and buds; Oil No. 6, 4-100 and Oil No. 4, 4-100 burning to leaves and buds.

Fruit Sprays. Wettable sulfur 5 pounds and 10 pounds-100. No apparent injury to the plants and good mite control but the heavy deposit of sulfur on the fruit would be objectionable both for canning and for fresh fruit trade.

Ineffective sprays. Nicotine sulfate 40 per cent, 1 pint to 100 gallons, and Evergreen 1 pint to 100 gallons were apparently not effective in controlling the mites as the plots sprayed with these materials exhibited nearly as much redberry as the unsprayed plots. These results were not surprising as these materials are not ordinarily recommended for the control of mites.

Growers' sprays on Evergreen blackberries. Good results were obtained and crops harvested by growers using the following spray programs in the 1930-31 season:

I. { Fall Spray. Summer oil emulsion 2½ per cent.
Dormant Spray. Lime sulfur 8-100.
Fruit Spray. Summer oil 3 per cent after first picking.

II. { Dormant Spray. Lime sulfur 8-100.
Preblossom Spray. Wettable sulfur 5 pounds to 100 gallons.

Good results in mite control and freedom from redberry were reported from the use of the following sprays but only a light crop was harvested:

III. { Dormant Spray. Lime sulfur 10-100.
Delayed Dormant Spray. Lime sulfur 7-100.

All of the foregoing patches had a heavy infestation of mites in the 1930 season, the estimated losses ranging from 50 to 90 per cent.

Loganberry sprays. A considerable number of mites were found in loganberry buds in the fall of 1930. Consequently, a series of spray tests was made on the H. F. Butterfield planting at Woodburn.

The spray data obtained from the loganberry applications are not included in this paper as no redberry symptoms developed on this fruit. The spray applications proved to be of considerable experimental value, however, as the loganberry was found to be more susceptible to spray injury than the Evergreen blackberry. Serious injury resulted to the flower buds from the preblossom application of summer oil at the rate of 4 gallons to 100 gallons of water. This was also true of the wettable sulfur applications at the rate of 10 pounds to 100 gallons of water. Some injury in the preblossom sprays also resulted when oils were used at 2 gallons to 100 gallons of water. Serious injury was apparent from fruit sprays of oil as they caused a bronzing of the fruit and resulted in an underdevelopment of part of the drupelets, making a very undesirable berry (Figure 9).

From the data collected, it appears that, if control applications do become necessary on loganberries, a dormant spray of liquid lime sulfur (32° Baumé) at the rate of 6 or 8 gallons to 100 gallons of water can be used to reduce the mite infestation.

1931-32 EXPERIMENTS

Through the continued cooperation of the Woodburn Fruit Growers Association, the Evergreen blackberry patch of Mr. Dennis Norton was again made available for experimental work in 1931-32.

Results obtained from the 1930-31 sprays indicated that satisfactory control of the blackberry mite could be obtained with the application of summer oils, lime sulfur, and wettable sulfur. As a result, emphasis was placed on the strength and time of application of the various sprays. The regular counting of the mite population per berry in the various plots was found to require more time than could be devoted advantageously to this work, and hence was dropped.

The sprays were applied at the various times indicated previously, using summer oils, lime sulfur, dry lime sulfur, and wettable sulfur.

Table 6 shows the applications on the plots in the Norton patch and the yield obtained from three pickings, compared with the yield of the nearest check plots.

Table 6. BLACKBERRY MITE EXPERIMENTS 1931-32—PLOT YIELDS COMPARED WITH NEAREST CHECKS.

Dennis Norton Evergreen patch, Woodburn, Oregon.

Plot number and materials applied	Sprays applied*	Estimated yield per acre	Average yield of nearest checks	Check plot numbers	Ratio of increase
		Pounds	*Pounds*		
1—Oil No. 4, 3-100	4th, 5th	7,480	2,227	13, 14	3.35
2—Wettable sulfur 5 pounds to 100 gallons	4th	7,095	2,227	13, 14	3.18
3—Oil No. 4, 3-100	2d, 5th	3,465	2,227	13, 14	1.55
4—Dry lime sulfur 8 pounds to 100 gallons	1st, 2d, 4th†	7,095	2,227	13, 14	3.18
5—Dry lime sulfur 8 pounds to 100 gallons	2d, 4th	5,995	2,227	13, 14	2.69
6—Dry lime sulfur 8 pounds to 100 gallons	2d, 4th	7,700	2,502	10, 11	3.08
7—Dry lime sulfur 8 pounds to 100 gallons	1st, 2d	4,565	2,502	10, 11	1.82
8—Oil No. 4, 3-100	1st, 2d, 4th, 5th	5,015	2,502	10, 11	2.00
9—Oil No. 4, 3-100	1st, 5th	5,170	2,502	10, 11	2.06
10—Check—No spray		3,740			
11—Check—No spray		1,265			
12—Oil No. 4, 3-100	5th	5,449	2,227	13, 14	2.44
13—Check—No spray		3,355			
14—Check—No spray		1,100			
15—Dry lime sulfur 32 pounds to 100 gallons	1st, 2d, 4th	4,785	2,731	13, 14, 26	1.75
16—Dry lime sulfur 32 pounds to 100 gallons	1st, 4th	5,830	2,731	13, 14, 26	2.13
17—Dry lime sulfur 32 pounds to 100 gallons	1st, 2d	6,820	2,731	13, 14, 26	2.49
18—Dry lime sulfur 32 pounds to 100 gallons	2d, 4th	8,415	2,878	10, 11, 33	3.02
19—Lime sulfur 8-100	1st, 2d, 4th	7,150	2,878	10, 11, 33	2.57
20—Lime sulfur 8-100	1st, 2d	6,490	2,878	10, 11, 33	2.25
21—Lime sulfur 8-100	1st, 4th	6,380	2,878	10, 11, 33	2.21
22—Lime sulfur 8-100	2d, 4th	5,720	2,878	10, 11, 33	1.98
23—Dry lime sulfur 8 pounds to 100 gallons	1st, 2d, 4th	5,500	2,731	13, 14, 26	2.01
24—Dry lime sulfur 8 pounds to 100 gallons	1st, 4th	4,675	2,731	13, 14, 26	1.71
25—Dry lime sulfur 8 pounds to 100 gallons	1st, 2d	3,990	2,731	13, 14, 26	1.46
26—Check—No spray		3,740			
27—Dry lime sulfur 8 pounds to 100 gallons	2d, 4th	6,655	2,731	13, 14, 26	2.43
28—Oil No. 6, 3-100	2d, 5th	10,285	3,153	26, 39, 40	3.26
29—Lime sulfur 4-100	1st, 2d, 4th	5,005	3,153	26, 39, 40	1.58
30—Lime sulfur 4-100	1st, 2d	4,125	3,116	33, 39, 40	1.32
31—Lime sulfur 4-100	1st, 4th	5,225	3,116	33, 39, 40	1.67
32—Lime sulfur 4-100	2d, 4th	3,553	3,116	33, 39, 40	1.71
33—Check—No spray		3,630			
34—Wettable sulfur 5 pounds to 100 gallons	4th	6,105	3,080	26, 47	1.98
35—Dry lime sulfur 16 pounds to 100 gallons	1st, 2d, 4th	5,060	3,080	26, 47	1.64
36—Dry lime sulfur 16 pounds to 100 gallons	1st, 4th	4,235	3,080	26, 47	1.37
37—Dry lime sulfur 16 pounds to 100 gallons	1st, 2d	4,180	2,768	26, 39, 47	1.51
38—Dry lime sulfur 16 pounds to 100 gallons	2d, 4th	4,730	2,860	39, 40	1.69
39—Check—No spray		2,145			
40—Check—No spray		3,575			
41—Dry lime sulfur 32 pounds to 100 gallons	1st, 3d, 4th	7,260	2,713	39, 40, 53	2.67
42—Dry lime sulfur 32 pounds to 100 gallons	1st, 4th	6,820	2,713	39, 40, 53	2.51
43—Dry lime sulfur 32 pounds to 100 gallons	1st, 3d	6,380	3,025	33, 53	2.10
44—Dry lime sulfur 32 pounds to 100 gallons	3d, 4th	6,645	3,025	33, 53	2.19
45—Oil No. 4, 2-100	4th, 5th	4,125	2,420	47	1.70
46—Oil No. 4, 2-100	1st, 2d, 4th, 5th	3,465	2,420	47	1.43
47—Check—No spray		2,420			
48—Oil No. 4, 3-100	1st, 5th	3,080	2,420	47	1.27

*See footnote on page 19.
†See footnote on page 19.

Table 6. BLACKBERRY MITE EXPERIMENTS 1931-32—PLOT YIELDS COMPARED WITH NEAREST CHECKS—*Continued.*

Dennis Norton Evergreen patch, Woodburn, Oregon.

Plot number and materials applied	Sprays applied*	Estimated yield per acre	Average yield of nearest checks	Check plot numbers	Ratio of increase
		Pounds	*Pounds*		
49—Oil No. 4, 3-100	2d, 5th	3,905	2,218	39, 40, 60	1.76
50—Oil No. 4, 3-100	5th	4,180	2,218	39, 40, 60	1.88
51—Dry lime sulfur 8 pounds to 100 gallons	1st, 3d, 4th†	6,985	2,713	39, 40, 53	2.57
52—Dry lime sulfur 8 pounds to 100 gallons	1st, 4th	4,730	2,713	39, 40, 53	1.74
53—Check—No spray	.....	2,420	.....	.....	.....
54—Dry lime sulfur 8 pounds to 100 gallons	1st, 3d	2,640	1,925	53, 66	1.37
55—Dry lime sulfur 8 pounds to 100 gallons	3d, 4th	4,125	1,925	53, 66	2.14
56—Lime sulfur 8-100	1st, 3d, 4th	4,840	1,677	47, 60	2.88
57—Lime sulfur 8-100	1st, 3d	3,080	1,677	47, 60	1.83
58—Lime sulfur 8-100	1st, 4th	5,445	1,677	47, 60	3.24
59—Lime sulfur 8-100	3d, 4th	6,215	1,677	47, 60	3.70
60—Check—No spray	.....	935	.....	.....	.....
61—Oil No. 6, 3-100	5th	4,950	1,246	60, 72, 73	3.97
62—Dry lime sulfur 16 pounds to 100 gallons	1st, 3d, 4th	4,345	1,246	60, 72, 73	3.48
63—Dry lime sulfur 16 pounds to 100 gallons	1st, 4th	6,380	1,906	53, 66, 73	3.34
64—Dry lime sulfur 16 pounds to 100 gallons	1st, 3d	3,795	1,906	53, 66, 73	1.99
65—Dry lime sulfur 16 pounds to 100 gallons	3d, 4th	4,840	1,906	53, 66, 73	2.53
66—Check—No spray	.....	1,430	.....	.....	.....
67—Wettable sulfur 5 pounds to 100 gallons	4th	3,300	1,595	78, 79	2.06
68—Oil No. 6, 3-100	1st, 2d, 4th, 5th	2,310	1,595	78, 79	1.45
69—Oil No. 6, 3-100	1st, 5th	4,565	1,595	78, 79	2.86
70—Oil No. 6, 3-100	2d, 5th	4,565	1,246	60, 72, 73	3.66
71—Oil No. 6, 3-100	5th	1,815	1,246	60, 72, 73	1.45
72—Check—No spray	.....	935	.....	.....	.....
73—Check—No spray	.....	1,870	.....	.....	.....
74—Lime sulfur 4-100	1st, 3d, 4th	6,380	1,411	66, 72, 73	4.52
75—Lime sulfur 4-100	1st, 3d	3,300	1,411	66, 72, 73	2.33
76—Lime sulfur 4-100	1st, 4th	3,740	1,411	66, 72, 73	2.65
77—Lime sulfur 4-100	3d, 4th	3,035	1,411	66, 72, 73	2.15
78—Check—No spray	.....	1,375	.....	.....	.....
79—Check—No spray	.....	1,815	.....	.....	.....
80—Oil No. 6, 3-100	1st, 2d, 4th, 5th	3,465	1,595	78, 79	2.17
81—Oil No. 6, 3-100	1st, 5th	3,245	1,595	78, 79	2.03
82—Oil No. 6, 3-100	2d, 5th	2,860	1,402	72, 73	2.03
83—Oil No. 6, 3-100	5th	4,950	1,402	72, 73	3.53
84—Oil No. 4, 3-100	4th, 5th	5,320	1,402	72, 73	3.79
85—Oil No. 4, 3-100	1st, 2d, 4th, 5th	4,400	1,402	72, 73	3.13
86—Oil No. 4, 3-100	1st, 5th	4,070	948	72,73,98,99	4.29
87—Oil No. 4, 3-100	2d, 5th	2,970	948	72,73,98,99	3.13
88—Oil No. 4, 3-100	5th	2,090	948	72,73,98,99	2.20
89—Dry lime sulfur 32 pounds to 100 gallons	1st, 2d, 4th	3,300	2,071	78, 79, 100	1.59
90—Dry lime sulfur 32 pounds to 100 gallons	1st, 4th	3,025	2,071	78, 79, 100	1.46
91—Dry lime sulfur 32 pounds to 100 gallons	1st, 2d	5,225	2,071	78, 79, 100	2.52
92—Dry lime sulfur 32 pounds to 100 gallons	2d, 4th	6,985	2,071	78, 79, 100	3.37
93—Oil No. 6, 3-100	1st, 5th	2,420	1,246	72, 73, 105	1.94
94—Lime sulfur 8-100	1st, 2d, 4th	5,610	1,246	72, 73, 105	4.50
95—Lime sulfur 8-100	1st, 2d	4,455	1,246	72, 73, 105	3.57
96—Lime sulfur 8-100	1st, 4th	6,215	1,246	72, 73, 105	4.98
97—Lime sulfur 8-100	2d, 4th	4,785	948	72,73,98,99	5.04
98—Check—No spray	.....	440	.....	.....	.....
99—Check—No spray	.....	550	.....	.....	.....
100—Check—No spray	.....	3,025	.....	.....	.....
101—Lime sulfur 4-100	1st, 2d, 4th	3,960	2,071	78, 79, 100	1.92
102—Lime sulfur 4-100	1st, 2d	5,940	2,071	78, 79, 100	2.85
103—Lime sulfur 4-100	1st, 4th	5,775	2,071	78, 79, 100	2.78
104—Lime sulfur 4-100	2d, 4th	2,695	935	105	2.88
105—Check—No spray	.....	935	.....	.....	.....
106—Oil No. 6, 3-100	1st, 2d, 4th, 5th	3,685	935	105	3.94

*See footnote on page 19.
†See footnote on page 19.

Table 6. BLACKBERRY MITE EXPERIMENTS 1931-32—PLOT YIELDS COMPARED WITH NEAREST CHECKS—*Concluded.*
Dennis Norton Evergreen patch, Woodburn, Oregon.

Plot number and materials applied	Sprays applied*	Estimated yield per acre	Average yield of nearest checks	Check plot numbers	Ratio of increase
		Pounds	*Pounds*		
107—Dry lime sulfur 16 pounds to 100 gallons	1st, 2d, 4th	6,628	641	98, 99, 105	10.33
108—Dry lime sulfur 16 pounds to 100 gallons	1st, 4th	4,730	641	98, 99, 105	7.37
109—Dry lime sulfur 16 pounds to 100 gallons	1st, 2d	1,100	641	98, 99, 105	1.71
110—Dry lime sulfur 16 pounds to 100 gallons	2d, 4th	2,750	641	98, 99, 105	4.29

*Spray dates: 1st, October 13-14, 1931; 2d, February 20-23, 1932; 3d, April 12, 1932; 4th, June 6-7, 1932; 5th, August 1, 1932.
†All "4th" sprays on Sulfur plots were Wettable sulfur 5 pounds to 100 gallons.

A study of the data presented shows considerable variation in the yields of the plots. While this variation is to a considerable extent due to the spray applications, it is also thought that differences in the condition of the many individual hills is likewise responsible. An attempt was made to overcome this difference between hills by repeating the spray applications in other portions of the patch, but even with this treatment the fluctuations in data so common in field-plot experiments were obvious.

Effective sprays. The following sprays are those which gave a yield per acre of more than 6,000 pounds:

Two-spray Program

2d Dry lime sulfur 32 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons (2 plots).....7,700 pounds per acre

2d Dry lime sulfur 8 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons .....7,700 pounds per acre

1st Lime sulfur 8-100, plus *2d* Lime sulfur 8-100 .....7,490 pounds per acre

4th Oil No. 4, 3-100, plus *5th* Oil No. 4, 3-100....7,480 pounds per acre

1st Dry lime sulfur 32 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons.....6,820 pounds per acre

1st Dry lime sulfur 32 pounds to 100 gallons, plus *2d* Dry lime sulfur 32 pounds to 100 gallons .....6,820 pounds per acre

1st Dry lime sulfur 32 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons .....6,820 pounds per acre

1st Dry lime sulfur 8 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons .....6,655 pounds per acre

3d Dry lime sulfur 32 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons .....6,645 pounds per acre

1st Dry lime sulfur 16 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons ..... 6,380 pounds per acre

1st Dry lime sulfur 32 pounds to 100 gallons, plus *3d* Dry lime sulfur 32 pounds to 100 gallons ..... 6,380 pounds per acre

1st Lime sulfur 8-100, plus *4th* Wettable sulfur 5 pounds to 100 gallons (2 plots) ..... 6,297 pounds per acre

3d Lime sulfur 8-100, plus *4th* Wettable sulfur 5 pounds to 100 gallons ..... 6,215 pounds per acre

Three-spray Program

1st Dry lime sulfur 32 pounds to 100 gallons, plus *3d* Dry lime sulfur 32 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons ..... 7,260 pounds per acre

1st Lime sulfur 8-100, plus *2d* Lime sulfur 8-100, plus *4th* Wettable sulfur 5 pounds to 100 gallons ..... 7,150 pounds per acre

1st Dry lime sulfur 8 pounds to 100 gallons, plus *2d* Dry lime sulfur 8 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons ..... 7,095 pounds per acre

1st Dry lime sulfur 8 pounds to 100 gallons, plus *3d* Dry lime sulfur 8 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons ..... 6,865 pounds per acre

1st Dry lime sulfur 16 pounds to 100 gallons, plus *2d* Dry lime sulfur 16 pounds to 100 gallons, plus *4th* Wettable sulfur 5 pounds to 100 gallons ..... 6,628 pounds per acre

1st Lime sulfur 4-100, plus *3d* Lime sulfur 4-100, plus *4th* Wettable sulfur 5 pounds to 100 gallons ..... 6,380 pounds per acre

Check: No spray, average of 20 plots ..... 2,049 pounds per acre

Spray injury. The foregoing data, showing a predominance of the wettable sulfur preblossom spray and the fall application of lime sulfur, would naturally lead to a recommendation of these two sprays for the control of the blackberry mite. Unfortunately, following the application of the preblossom spray of wettable sulfur during the season of 1932 the weather turned unusually warm and spray injury resulted which became apparent in August 1932. The injury consisted of a decided yellowing of the foliage and was confined to plots sprayed with sulfur on June 6 and 7, 1932 (Figure 11). As this injury did not occur during the previous season it was at first thought to be due to poor spray materials, but subsequent investigation proved that the same difficulty was experienced in Puyallup, Wash.,* with a different brand of wettable sulfur. No actual damage to the fruit was noticeable, but some growers reported a loss in yield on patches sprayed with the preblossom application. The data from the Norton patch do not show an appreciable reduction in yield, but this may be due to the use of small plots so that the reduction is not noticeable.

*In experiments conducted by the Division of Truck Crop and Garden Insects, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

Cooperative project. A cooperative project on the control of the blackberry mite was carried on during the 1931-32 season with Mr. H. F. Butterfield, Woodburn, Oregon. The plots used in this patch were considerably larger and afforded an opportunity to check the results obtained from the small plots in the Norton patch.

No dormant sprays were applied because of weather conditions and the requirements of other farm work. The various sprays applied and the results obtained are shown in Table 7.

Table 7. BLACKBERRY MITE EXPERIMENTAL PLOTS 1931-32.
H. F. Butterfield Planting, Woodburn, Oregon.

Plot number, sprays used, and time of application	Total number of hills per plot	Total yield per plot, 2 pickings	Average yield per hill	Estimated yield per acre*
		Pounds	*Pounds*	*Pounds*
1—*1st* Lime sulfur 10-100, October 20, 1931.... *4th* Wettable sulfur 5 pounds to 100 gallons, June 6-7, 1932.....	176	2,353	13.3	4,588
2—*3d* Lime sulfur 8-100, April 2, 1932..... *4th* Wettable sulfur 5 pounds to 100 gallons, June 6-7, 1932.....	160	2,020	12.6	4,347
3—*1st* Oil No. 6, 3-100, October 20, 1931..... *3d* Lime sulfur 8-100, April 2, 1932..... *4th* Wettable sulfur 5 pounds to 100 gallons, June 6-7, 1932.....	96	1,075	11.1	3,829
4—*1st* Oil No. 6, 3-100, October 20, 1931 } ..... *3d* Lime sulfur 8-100, April 2, 1932.... }	64	1,491	23.2	8,014
5—*3d* Lime sulfur 8-100, April 2, 1932.....	160	2,900	18.1	6,244
6—Check—No spray.....	16	137	8.5	2,932

*Approximately 345 hills per acre.

A study of the data presented in Table 7 shows a marked superiority of the Fall Oil Spray followed by the Delayed Dormant Spray of lime sulfur over the other spray programs. It is interesting to note that the single Delayed Dormant Spray of lime sulfur ranks second in yield to the Fall-Delayed Dormant Spray. It is noticeable, however, that the remaining applications feature the preblossom spray of wettable sulfur and that these are considerably lower in yield. This fact bears out the contention of growers that the yellowing of the foliage resulting from the wettable sulfur sprays is associated with a reduction in yield. The yellowing in this patch was very noticeable. Observers were able to tell to a row where the preblossom applications were made (Figure 11).

The average estimated yield for all rows sprayed with wettable sulfur was 3,966 pounds per acre. For all rows not receiving this sulfur the average was 6,351 pounds per acre.

1932-33 EXPERIMENTS

During the fall of 1932 arrangements were made to continue the control experiments in the Butterfield and Norton plantings at Woodburn. The programs of various sprays were similar in the time of application and strengths to those of previous seasons except that the fruit spray of oils was abandoned because it was considered a dangerous practice to postpone application to such a late time and then rely on a single spray for control. The preblossom spray was omitted on the Butterfield patch because of the injury caused by the wettable sulfur during the previous season and

Figure 2. View of Evergreen blackberry patch showing condition at time of Fall Spray applications (1st).

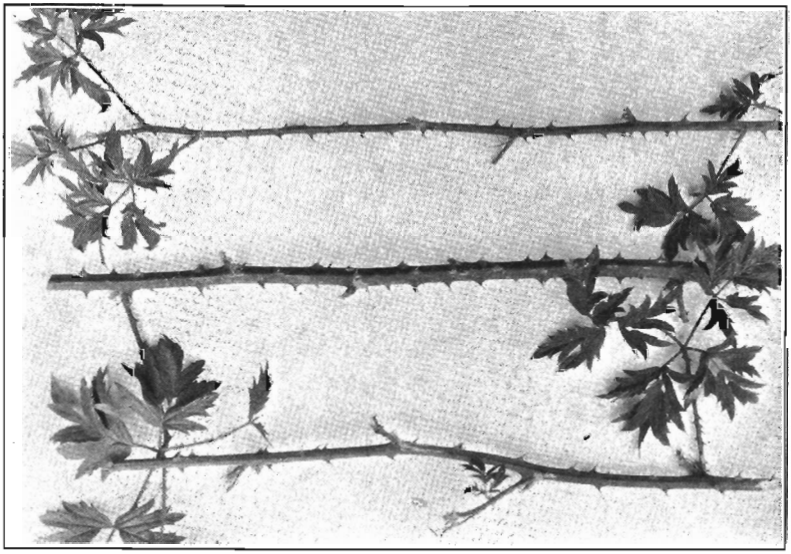

Figure 3. Evergreen canes showing condition at time of Fall Spray (1st).

the resultant loss in yield. It was fortunate that this spray was dropped as the injury recurred on the Norton patch in 1933.

Two important factors influenced the results of the Norton patch. Following the fall spray applications, a severe freeze accompanied by a strong north wind occurred in December, 1932. This freeze alone, while definitely injurious to some extent, would not have resulted in such a spotted condition of the patch had it not been for a heavy infestation of the clear wing borer, *Bembecia marginata* Harris. The work of this borer in the crowns and canes of the blackberries had apparently caused such damage to the vines that a serious loss in vitality resulted. This condition, when followed by the freeze, resulted in the destruction of many of the hills in some plots. With such a condition present, the data obtained from the control experiments varied to such a degree that it is not believed advisable to attach any particular significance to the results.

In the Butterfield patch, injury due to the winter freeze was noticeable in the buds during the early spring, but the hills seemed to overcome this handicap and produce a fairly normal yield. Only three pickings were made owing to a heavy rain which softened the berries. Had a fourth picking been made, it was estimated that about 100 to 150 pounds of berries would have been harvested per row. There was a noticeable spread of "redberry" on either side of the check plot during the third picking, and by the time the fourth picking should have been made this spread had extended for from two to three rows on each side of the check.

The data obtained from the Butterfield patch are presented in Table 8. Where wettable sulfur was applied as a preblossom spray in 1932 this fact is indicated as there is evidence that the reduction in yield resulting from spray damage may be apparent in the following year's crop.

Table 8. BLACKBERRY MITE EXPERIMENTAL PLOTS 1932-33.
H. F. Butterfield Planting, Woodburn, Oregon.

Plot number, sprays used, and time of application	Total number of hills per plot	Total yield per plot, 3 pickings	Average yield per hill	Estimated yield per acre*
		Pounds	*Pounds*	*Pounds*
1—*1st* Lime sulfur 8-100, November 18, 1932 } *3d* Lime sulfur 8-100, April 27, 1933 }	32	549.0	17.15	5,916
2—*3d* Lime sulfur 8-100, November 18, 1932	156	3,733.0	23.92	8,252
3—*1st* Oil No. 6, 3-100, November 18, 1932 } *3d* Lime sulfur 8-100, April 27, 1933 }	154	3,189.0	20.70	7,141
4—*4th* Wettable sulfur 5 pounds to 100 gallons, June 6-7, 1932 } *3d* Lime sulfur 8-100, April 27, 1933 }	64	994.0	15.53	5,357
5—*4th* Wettable sulfur 5 pounds to 100 gallons, June 6-7, 1932 } *1st* Oil No. 4, 3-100, November 18, 1932 } *3d* Lime sulfur 8-100, April 27, 1933 }	32	356.0	11.13	3,839
6—*1st* Oil No. 4, 3-100, November 18, 1932 } *3d* Lime sulfur 8-100, April 27, 1933 }	116	2,219.0	19.29	6,655
7—*1st* Oil No. 4, 3-100, November 18, 1932	12	69.0	5.75	1,983

*Approximately 345 hills per acre.

A study of the data presented in Table 8 shows two spray combinations that can be considered satisfactory: a single delayed dormant spray of lime sulfur and a fall oil spray followed by a delayed dormant spray of lime sulfur.

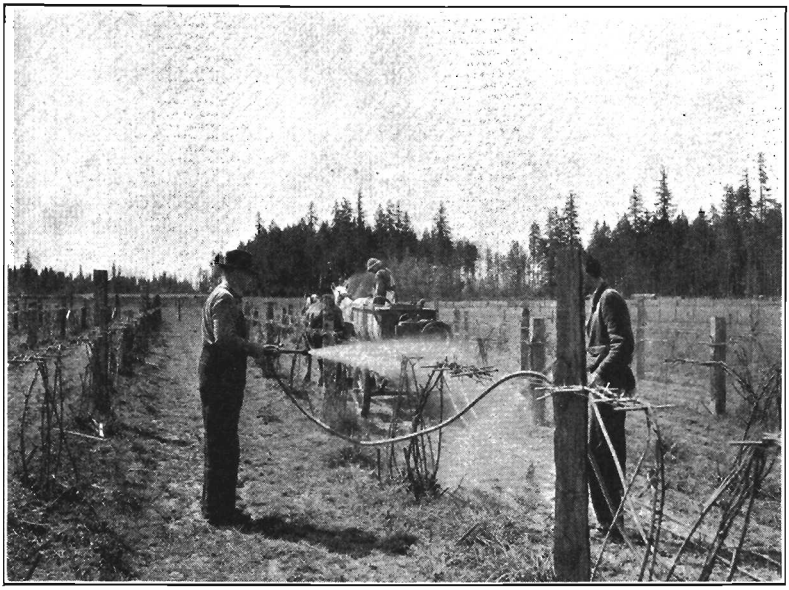

Figure 4. Application of Dormant Spray on Evergreen blackberry patch (2d).

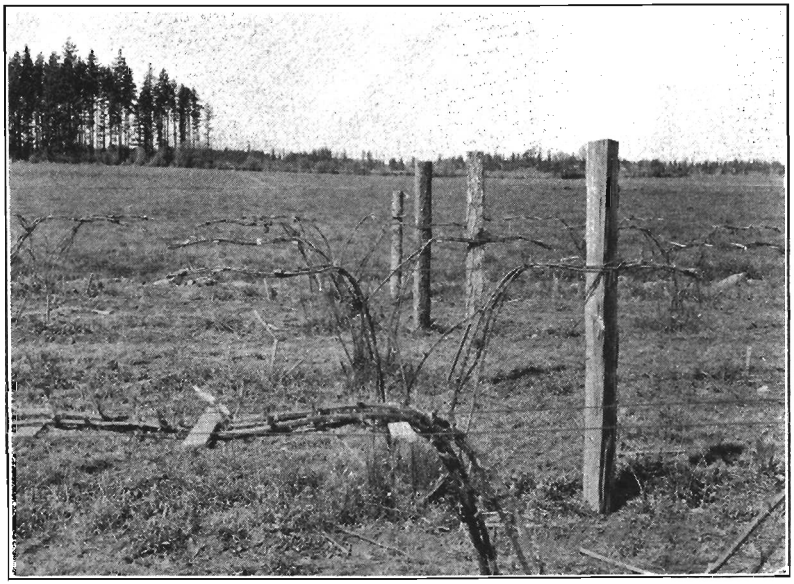

Figure 5. Vines trained up on wires ready for Dormant (2d)

Plots that were sprayed with wettable sulfur as a 4th spray in the spring of 1932 and then sprayed with fall or delayed dormant sprays in 1932-33, appear to be somewhat lower in yield. This is difficult to explain, but there is a possibility that the injurious effect of the preblossom application may remain and show up in the results of the next year. Since the application of this spray causes a marked reduction in yield, it does not appear that the spray can be used satisfactorily in the Willamette Valley. The fact that this spray should be avoided was strengthened by the recurrence of the injury from wettable sulfur spray in the Norton patch.

1933-34 EXPERIMENTS

During the season of 1933-34 experimental work on the blackberry mite was carried out on a somewhat smaller scale than in previous seasons. This curtailment was due to lack of funds as appropriations for the continuance of the work ceased.

In cooperation with Mr. H. F. Butterfield, Woodburn, Oregon, approximately two and one-half acres were sprayed in an effort further to substantiate experimental data on the correct timing of sprays for adequate control. Results from this work were very satisfactory as the prolonged picking season made it possible to obtain weights from six pickings and to establish the fact that "redberry" can be prevented throughout the entire harvest period.

The data presented in Table 9 show the spray applications and the yields obtained from the Butterfield patches.

Table 9. BLACKBERRY MITE EXPERIMENTAL PLOTS 1933 34.
H. F. Butterfield Planting, Woodburn, Oregon.

Plot number, sprays used, and time of application	Total number of hills per plot	Total yield per plot, 6 pickings	Average yield per hill	Estimated yield per acre*
		Pounds	*Pounds*	*Pounds*
Old yard—				
1—*1st* Lime sulfur 8-100, November 25, 1933 *3d* Lime sulfur 8-100, March 23-24, 1934	204	5,452	26.7	9,211
2—*1st* Oil No. 4, 3-100, November 25, 1933 *3d* Lime sulfur 8-100, March 23-24, 1934	170	4,700	27.6	9,522
3—*3d* Lime sulfur 8-100, March 23-24, 1934....	204	5,592	26.4	9,108
New yard—				
4—*1st* Lime sulfur 8-100, November 25, 1933 *3d* Lime sulfur 8-100, March 23-24, 1934	193	5,697	29.4	10,143
5—*1st* Oil No. 4, 3-100, November 25, 1933 *3d* Lime sulfur 8-100, March 23-24, 1934	165	4,747	28.7	9,901
6—*3d* Lime sulfur 8-100, March 23-24, 1934....	314	9,469	30.1	10,384

*Approximately 345 hills per acre.

No check plots were used. Mr. Butterfield objected to their use as the mites spread from the unsprayed plots to the sprayed plots late in the season.

Some variation in yield in the various spray plots was noticeable. In the old yard the two-spray program of fall oil and delayed dormant lime sulfur showed the best yield, while in the new yard the single delayed dormant spray of lime sulfur showed the highest yield. The differences in yields from the various plots were too small, however, to make a definite

selection. As these variations might be caused by insects or other factors rather than the spray combinations themselves, each of the sprays appears to be worthy of recommendation.

The outstanding result of the experiments in the two Butterfield yards in 1934, and also in 1933, is that satisfactory control can be obtained with a single Delayed Dormant Spray of lime sulfur. In these patches, satisfactory control of the blackberry mite has been obtained, beginning with the season of 1931, and as a result the mite population has been held to a minimum.

A demonstration of mite control was carried out on the Evergreen patch of Mr. W. W. Stover, Corvallis. In this patch, however, the rows were so close together that a spray machine could not be pulled through and only the ends of the rows (5 hills) could be reached with the spray nozzles. Data from this patch are not included as the spotted condition of the hills made results very irregular. Mention should be made, however, that the preblossom spray of wettable sulfur, 5 pounds to 100 gallons, and of lime sulfur at 2½ gallons in 100 gallons of spray, caused the same yellowing as had been seen during the two previous seasons. As this injury occurred for three successive seasons in the Willamette Valley and definitely reduced the yield of fruit, this spray cannot be recommended.

RECOMMENDED SPRAYS

Sprays which have been proved to be satisfactory in the Willamette Valley include three two-spray programs and a single-spray program.

TWO-SPRAY PROGRAMS

I. **Fall Spray.** Summer oil (viscosity 55 to 70 seconds Saybolt and 90 per cent unsulfonated residue) at the rate of 3 gallons and 97 gallons of water, emulsified according to the method suggested in Bulletin 336, Oregon Agricultural Experiment Station, or a commercial summer emulsion of like specifications. This spray is applied after the old canes are removed and with the new canes on the ground. (Figures 2 and 3). This spray is followed by a *Delayed Dormant Spray.*

Delayed Dormant Spray. Lime sulfur (30° Baumé) at the rate of 8 gallons and 92 gallons of water. This spray is applied in the spring after the canes are trained and when the new growth has reached from 2 to 6 inches in length. (Figure 7.)

II. **Fall Spray.** Lime sulfur (30° Baumé) at the rate of 8 gallons and 92 gallons of water. Applied after the old canes are removed and with the new canes on the ground. (Figures 2 and 3.) This spray is an alternative for the Fall Spray in Program I, and is followed by a *Delayed Dormant Spray.*

Delayed Dormant Spray. Same as above. (Figure 7.)

III. **Dormant Spray.** Lime sulfur (30° Baumé) at the rate of 8 gallons and 92 gallons of water. This spray is applied in the spring after the new canes are trained and shortly after the buds start to grow. (Figures 4 and 6). This spray is followed by a *Delayed Dormant Spray.*

Delayed Dormant Spray. Same as above. (Figure 7.)

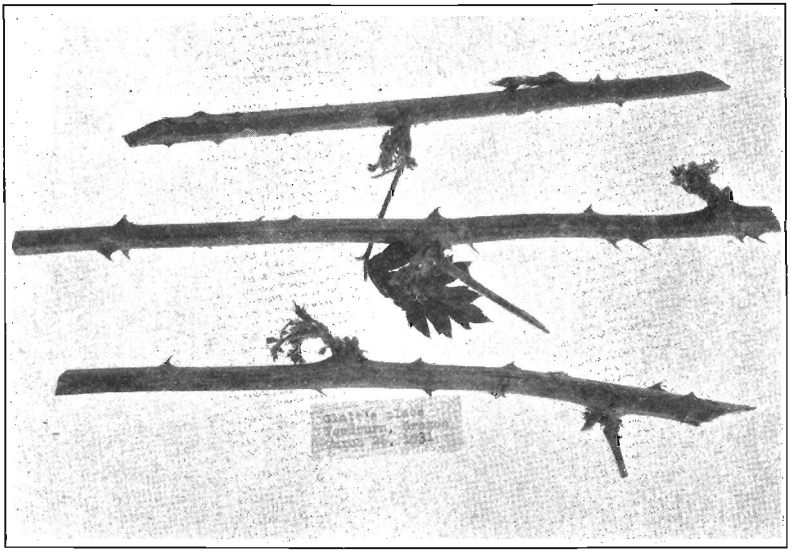

Figure 6. Development of buds at time of Dormant Spray (2d).

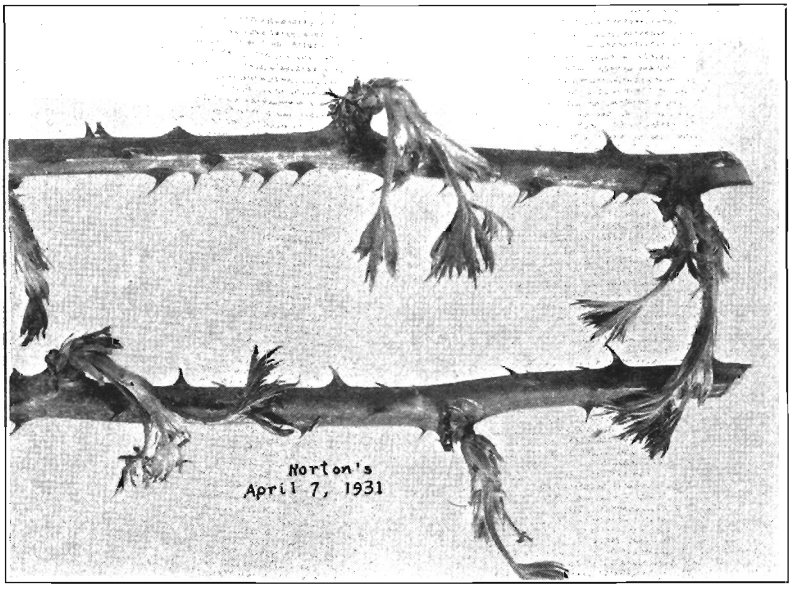

Figure 7. Development of buds at time of Delayed Dormant Spray (3d).

SINGLE-SPRAY PROGRAM

IV. **Delayed Dormant Spray.** Same as above. (Figure 7.)

Caution. This spray is not recommended unless the mites have been satisfactorily controlled in previous seasons, and only if applications are made with efficient spray equipment.

V. **Fruit Spray.** Summer oil (viscosity 55 to 70 seconds Saybolt and 90 per cent unsulfonated residue) at the rate of 3 gallons of oil and 97 gallons of water, emulsified in accordance with Bulletin 336, Oregon Agricultural Experiment Station, or a commercial summer emulsion of like specifications. This spray is applied after 90 per cent of the fruit is set and requires about 500 to 750 gallons per acre. (Figure 9.)

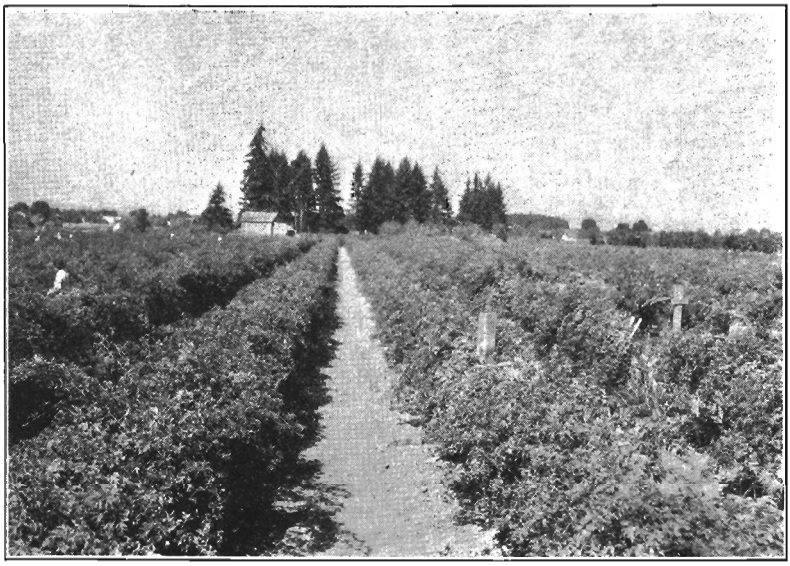

Figure 8. View of Evergreen blackberry patch showing effect of Wettable Sulfur Preblossom Spray (4th). Rows to right are "yellowed." Picture taken during picking season.

Caution. This spray is recommended only as an emergency measure to be used when no sprays have been applied previously. It is apparently unwise to expect control with a single spray this late in the growing season.

SPRAY AMOUNTS

The required amount of spray necessary for coverage for the sprays is approximately as follows:

Fall Spray and **Dormant Spray**, 175 to 250 gallons per acre.
Delayed Dormant Spray, 225 to 300 gallons per acre.
Fruit Spray, 500 to 750 gallons per acre.

SPRAY EQUIPMENT

Mention has been made before as to the necessity of good spray equipment for control. The nature of the Evergreen and Himalaya blackberry

Figure 9. Condition of Evergreen blackberry patch at time of Fruit Spray (5th). Note advanced condition of berries.

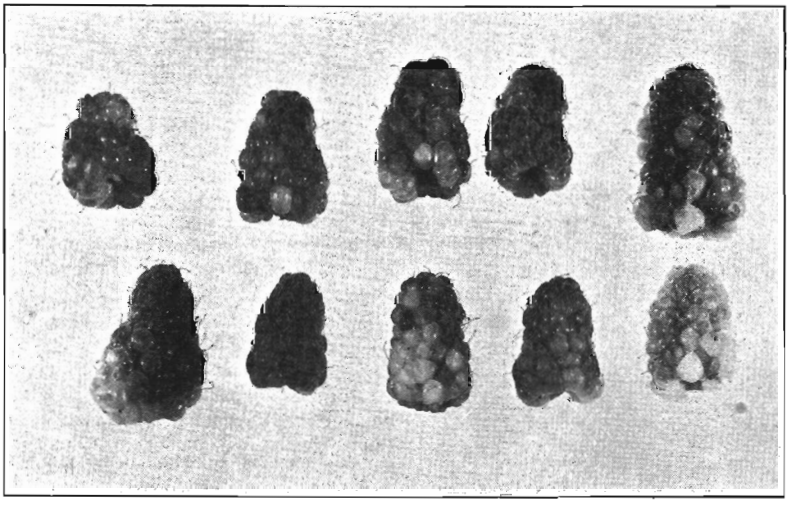

Figure 10. Injury to loganberries from Fruit Sprays.

foliage is such that wetting is difficult. The hairy surface of the leaves and buds presents a formidable obstacle in wetting the vines, and since the mites are very small the entire surface of the plant must be thoroughly covered with spray. Hand-operated spray machines have been observed to give unsatisfactory results and may be unreliable in the control of the blackberry mite. Growers who have been using efficient power sprayers have obtained very good control at the minimum cost.

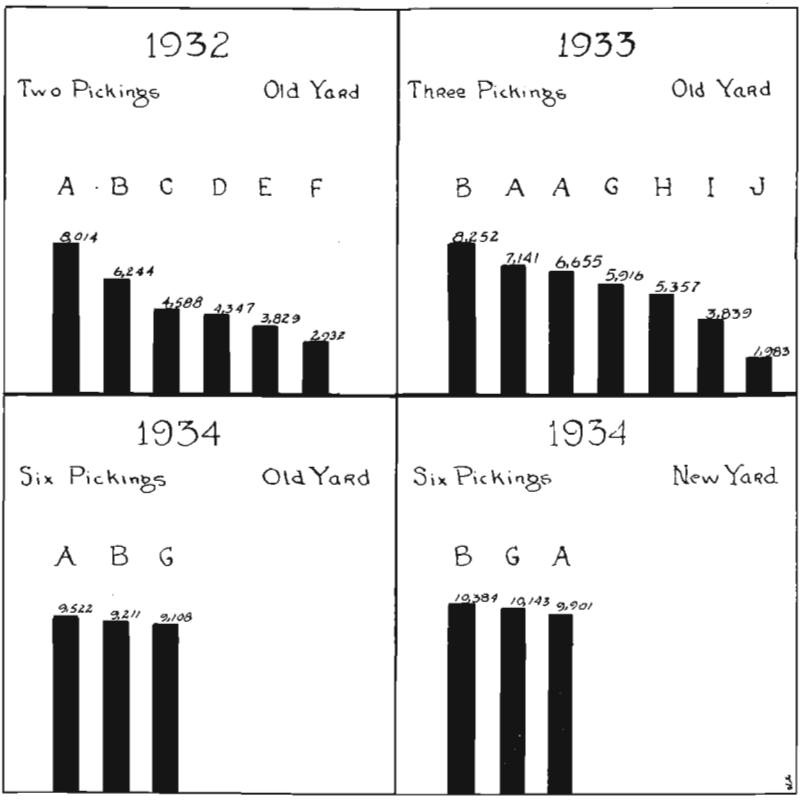

Figure 11. Yield in pounds from Spray Programs applied on Evergreen blackberries of H. F. Butterfield, Woodburn, Oregon.

The spray machines suggested are those in good condition and capable of developing at least 300 pounds pressure per square inch at the pump. If oil sprays are applied, the tank agitator must be capable of making a good emulsion. Two hose leads are desirable as a time saver and as an aid in effective spraying since by working two guns on a row from opposite sides simultaneously a good coverage may be secured. Spraying with two hoses is facilitated by the use of a boom fastened to the rear of the sprayer upon which one of the hoses can be carried and held over the row of berries, thus eliminating crawling back and forth under the vines when both sides of a row are to be sprayed at the same time. Either the berry type or the orchard type of spray gun may be used in making applications. Both

have been used satisfactorily. It is especially important that the spray machine be designed to turn a sharp corner as in many blackberry patches there is very little room for turning.

EXPLANATION OF SPRAYS IN FIGURE 11

A. 1—Summer Oil, 3 gallons and 97 gallons water as fall spray (1st).
2—Lime Sulfur, 8 gallons and 92 gallons water as delayed dormant spray (3d).

B. 1—Lime Sulfur, 8 gallons and 92 gallons water as delayed dormant spray (3d).

C. 1—Lime Sulfur, 10 gallons and 90 gallons water, as fall spray (1st).
2—Wettable Sulfur, 5 pounds to 100 gallons water, as preblossom spray (4th).

D. 1—Lime Sulfur, 8 gallons and 92 gallons water, as delayed dormant spray (3d).
2—Wettable Sulfur, 5 pounds to 100 gallons water, as preblossom spray (4th).

E. 1—Summer Oil, 3 gallons and 97 gallons water, as fall spray (1st).
2—Lime Sulfur 8 gallons and 92 gallons water as delayed dormant spray (3d).
3—Wettable Sulfur 5 pounds to 100 gallons water, as preblossom spray (4th).

F. Check Plot—No Spray.

G. 1—Lime Sulfur, 8 gallons to 100 gallons water, as fall spray (1st).
2—Lime Sulfur, 8 gallons to 100 gallons water, as delayed dormant spray (3d).

H. 1—Wettable Sulfur, 5 pounds to 100 gallons water, as preblossom spray of previous season (4th).
2—Lime Sulfur, 8 gallons and 92 gallons water, as delayed dormant spray (3d).

I. 1—Wettable Sulfur, 5 pounds to 100 gallons water, as preblossom spray of previous season (4th).
2—Summer Oil, 3 gallons and 97 gallons water, as fall spray (1st).
3—Lime Sulfur, 8 gallons and 92 gallons water, as delayed dormant spray (3d).

J. 1—Summer Oil, 3 gallons and 97 gallons water, as fall spray (1st).

Dennis Norton's Evergreen Blackberry Patch, Woodburn, Oregon

Each vertical line represents a row, and each cross mark the end of a plot of about four hills .

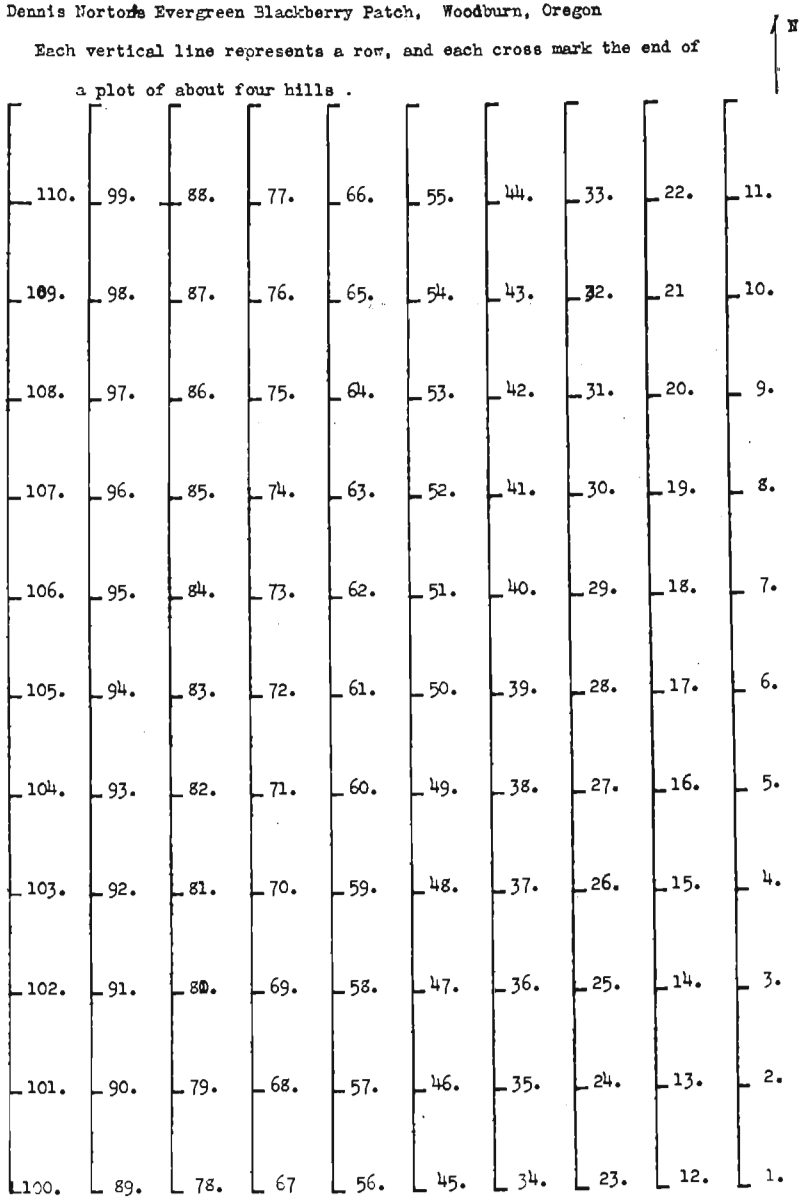

Figure 12. Arrangements of plots on Evergreen patch of Mr. Dennis Norton, Woodburn, Oregon.

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Animal Husbandry

O. M. Nelson, M.S. ..... Animal Husbandman
A. W. Oliver, M.S. ..... Assistant Animal Husbandman

Dairy Husbandry

Gustav Wilster, Ph.D. ..... Dairy Husbandman (Dairy Manufacturing)
I. R. Jones, Ph.D. ..... Associate Dairy Husbandman

Fish, Game, and Fur Animal Management

R. E. Dimick, M.S. ..... Assistant in Charge

Poultry Husbandry

A. G. Lunn, B.S. ..... Poultry Husbandman
F. L. Knowlton, M.S. ..... Poultry Husbandman
F. E. Fox, M.S. ..... Associate Poultry Husbandman

Veterinary Medicine

B. T. Simms, D.V.M. ..... Veterinarian
W. T. Johnson, B.S., D.V.M. ..... Poultry Pathologist
J. N. Shaw, D.V.M. ..... Associate Veterinarian
R. Jay, D.V.M. ..... Associate Veterinarian, Bureau of Animal Industry*
E. M. Dickinson, D.V.M. ..... Assistant Poultry Pathologist
F. M. Bolin, D.V.M. ..... Assistant Veterinarian*
O. H. Muth, D.V.M., M.S. ..... Assistant Veterinarian*
O. L. Searcy, B.S. ..... Technician

Division of Plant Industries

G. R. Hyslop, B.S. ..... Agronomist; In Charge, Division of Plant Industries

Farm Crops

H. A. Schoth, M.S. ..... Associate Agronomist; Division of Forage Crops and Diseases*
D. D. Hill, M.S. ..... Associate Agronomist
D. C. Smith, Ph.D. ..... Assistant Agronomist*
B. B. Robinson, Ph.D. ..... Assistant Plant Breeder, Fiber Plant Investigations*
Grace Cole Fleischman, A.B. ..... Assistant Botanist, Division of Seed Investigations*
A. E. Gross, M.S. ..... Research Fellow in Farm Crops

Horticulture

W. S. Brown, M.S., D.Sc. ..... Horticulturist
A. G. B. Bouquet, M.S. ..... Horticulturist (Vegetable Crops)
E. H. Wiegand, B.S.A. ..... Horticulturist (Horticultural Products)
H. Hartman, M.S. ..... Horticulturist (Pomology)
C. E. Schuster, M.S. ..... Horticulturist (Fruits and Vegetable Crops and Diseases)*
W. P. Duruz, Ph.D. ..... Horticulturist (Plant Propagation)
G. F. Waldo, M.S. ..... Assistant Pomologist (Fruits and Vegetable Crops and Diseases)*
T. Onsdorff, B.S. ..... Assistant Horticulturist (Horticultural Products)

STATION STAFF—*(Continued)*

Soil Science

W. L. Powers, Ph.D.—Soil Scientist
C. V. Ruzek, M.S.—Soil Scientist (Fertility)
M. R. Lewis, C.E.—Irrigation and Drainage Engineer, Bur. of Agric. Engineering*
R. E. Stephenson, Ph.D.—Associate Soil Scientist
E. F. Torgerson, B.S.—Assistant Soil Scientist (Soil Survey)

Other Departments

Agricultural Chemistry

J. S. Jones, M.S.A.—Chemist in Charge
R. H. Robinson, M.S.—Chemist (Insecticides and Fungicides)
J. R. Haag, Ph.D.—Chemist (Animal Nutrition)
D. E. Bullis, M.S.—Associate Chemist (Horticultural Products)
M. B. Hatch, M.S.—Assistant Chemist

Agricultural Engineering

F. E. Price, B.S.—Agricultural Engineer
C. Ivan Branton, B.S.—Assistant Agricultural Engineer

Bacteriology

G. V. Copson, M.S.—Bacteriologist in Charge
J. E. Simmons, M.S.—Associate Bacteriologist
W. B. Bollen, Ph.D.—Associate Bacteriologist

Entomology

D. C. Mote, Ph.D.—Entomologist in Charge
A. O. Larson, M.S.—Entomologist (Stored Products Insects)*
H. A. Scullen, Ph.D.—Associate Entomologist
B. G. Thompson, M.S.—Assistant Entomologist
S. C. Jones, M.S.—Assistant Entomologist
K. W. Gray, M.S.—Field Assistant (Entomology)
W. D. Edwards, B.S.—Field Assistant (Entomology)

Home Economics

Maud M. Wilson, A.M.—Home Economist

Plant Pathology

C. E. Owens, Ph.D.—Plant Pathologist
S. M. Zeller, Ph.D.—Plant Pathologist
B. F. Dana, M.S.—Plant Pathologist, Division Fruits and Vegetable Crops Diseases*
F. D. Bailey, M.S.—Associate Plant Pathologist (Insecticide Control Division)*
F. P. McWhorter, Ph.D.—Plant Pathologist*
P. W. Miller, Ph.D.—Assoc. Pathologist (Div. Fruits and Veg. Crops and Dis.)*
G. R. Hoerner, M.S.—Agent (Hop Disease Investigations)*
T. Dykstra, M.S.—Asst. Plant Pathologist (Div. Fruits and Veg. Crops and Dis.)*
Roderick Sprague, Jr., Ph.D.—Assistant Pathologist (Cereal Diseases)*
H. H. Millsap—Agent (Division of Fruits and Vegetable Crops and Diseases)*

Publications and News Service

C. D. Byrne, M.S.—Director of Information
E. T. Reed, B.S., A.B.—Editor of Publications
D. M. Goode, B.A.—Editor of Publications
J. C. Burtner, B.S.—Associate in News Service

Branch Stations

D. E. Stephens, B.S.—Supt., Sherman Br. Expt. Sta., Moro; Sr. Agronomist*
L. Childs, A.B.—Superintendent, Hood River Br. Expt. Station, Hood River
F. C. Reimer, M.S.—Superintendent, Southern Oregon Br. Expt. Station, Talent
D. E. Richards, B.S.—Supt. Eastern Oregon Livestock Br. Expt. Sta, Union
H. K. Dean, B.S.—Superintendent, Umatilla Br. Expt. Station, Hermiston*
O. Shattuck, M.S.—Superintendent, Harney Valley Br. Expt. Station, Burns
H. B. Howell, B.S.—Superintendent, John Jacob Astor Br. Expt. Sta., Astoria
G. A. Mitchell, B.S.—Act. Supt. Pendleton Br. Expt. Sta., Pendleton; Asst. Agron.*
G. G. Brown, A.B., B.S.—Horticulturist, Hood River Br. Expt. Station, Hood River
Arch Work, B.S.—Associate Irrigation Engineer, Medford*
W. W. Aldrich, Ph.D.—Assistant Horticulturist, Bureau of Plant Industry, Medford*
L. G. Gentner, M.S.—Associate Entomologist, Sou. Or. Br. Expt. Sta., Talent
J. F. Martin, M.S.—Junior Agronomist, Div. Cereal Crops and Diseases, Pendleton*
M. M. Oveson, M.S.—Assistant to Supt., Sherman Br. Experiment Station, Moro*
R. B. Webb, M.S.—Jr. Agronomist, Sherman Branch Experiment Station, Moro
R. E. Hutchison, B.S.—Asst. to Supt., Harney Branch Expt. Station, Burns

SPRAYS FOR BLACKBERRY MITE CONTROL

RECOMMENDED PROGRAM:

I. **Fall Spray.** Lime sulfur or summer oil emulsion
followed by
Delayed Dormant Spray. Lime sulfur.

ALTERNATE PROGRAM:

II. **Dormant Spray.** Lime sulfur followed by
Delayed Dormant Spray. Lime sulfur.

See Summary, page 3 for detailed information.

Illustration on front cover—

Typical "redberry disease" symptoms on branch of Himalaya blackberries. Half natural size. Color plate through the courtesy of College of Agriculture, University of California.