
New York Agricultural Experiment Station.

GENEVA, N. Y.

PLANT LICE INJURIOUS TO APPLE ORCHARDS. I.

STUDIES ON CONTROL OF NEWLY-HATCHED APHIDES.

P. J. PARROTT, H. E. HODGKISS, AND F. H. LATHROP.



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PLANT LICE INJURIOUS TO APPLE ORCHARDS. I.

STUDIES ON CONTROL OF NEWLY-HATCHED APHIDES.

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SUMMARY.

The studies reported in this text deal with certain habits of the rosy apple aphid (*Aphis sorbi* Kalt.), the oat aphid (*Aphis avenae* Fab.) and the green apple aphid (*Aphis pomi* DeGeer), and with experiments to determine their relative susceptibilities to spraying mixtures.

These aphides attack succulent tissues, as the stems of unopened blossoms and tender fruits and young leaves, and derive subsistence from such structures. During 1915 the dwarfing and deforming of apples were largely if not entirely the work of the rosy aphid. The effects of the oat aphid and the green apple aphid on the setting and development of fruit were not clearly indicated, but present evidence suggests that when numerous they may cause harm to blossom clusters and retard growth of young apples. The first external evidence of attack by the rosy aphid on the fruit was a retardation of increase in transverse diameter of the apples. Continued infestation resulted in a considerable reduction of both the transverse and axillary diameters. The extent of injury largely varied with the degree of infestation, while the rate of development of the apples was in inverse ratio to the numbers of the insects. The average of the calibrations of infested apples was 1.51 ins. for axillary diameter and 1.71 ins. for the transverse diameter. The checks measured 2.37 and 2.87 ins. respectively. In addition to inhibition of growth, attacks on the fruit by the insects produced various distortions of the apples.

Against the rosy aphid, spraying when buds were opening in an apple orchard (variety Rome) gave the following results: Average per sprayed tree, 2.55 centers of infestation, 1.83 injured fruits and 9.55 curled leaves; average per unsprayed tree, 45.71 centers of

infestation, 39.85 injured fruits and 189 curled leaves. Other experiments gave somewhat similar data. This treatment completely destroyed the oat aphid and afforded the trees temporary relief from the green apple aphid. These results in the main point to the spraying of apple trees as buds are breaking as the important initial step in the prevention of injuries.

Nicotine solution and soap, nicotine solution and lime-sulphur, and crude carbolic acid emulsion proved to be efficient insecticides, usually killing a large percentage of the insects wetted by them. In one comparative experiment against the rosy aphid there were indications of somewhat greater efficiency for nicotine solution and soap and nicotine solution and lime-sulphur. Of the foregoing preparations nicotine solution and soap proved uninjurious to foliage, while nicotine solution and lime-sulphur, and crude carbolic acid emulsion caused slight but unimportant injuries to apple leaves. Sodium sulphide and soap in combination, while an efficient aphidicide, caused serious injuries to opening buds and tender leaves.

The continued multiplication of the green apple aphid and constant production of winged forms necessitated repeated applications to obtain entire immunity of apple trees from this species. Experiments with soap and nicotine solution showed that while these are efficient sprays as contact insecticides, they afford only temporary protection. The value of nicotine solution was enhanced by the addition of large amounts of lime. In tests with this and other species of plant lice that are monophagous and breed for a long period on the same host, the need of spraying mixtures with more lasting toxic or repellent properties was strongly indicated.

INTRODUCTION.

Notwithstanding the admitted belief that the insects are susceptible to various remedial measures, there is no extensive body of positive and proven evidence which shows what can actually be accomplished in a practical way towards the prevention of losses by the various species of aphides that are injurious to foliage and fruit in bearing apple orchards. It therefore seems worth while to direct attention to certain studies on the activities of the creatures and to experimental results which bear on the susceptibility of these aphides to spraying mixtures. The matter is an important one because of the increasing shrinkages in apple yields in conse-

quence of the injurious work of these pests and the extreme difficulty of controlling the aphides by the measures usually advocated, some of which are strikingly at variance with experience and practice.

In order to secure data applicable to New York conditions this Station has been and is conducting a series of spraying experiments against the insects in apple orchards in the western portion of the State. The work so far points to the destruction of the aphides on the expanding buds as the most important step to avoid injuries by these pests. From a practical, as well as a scientific standpoint, this method of control requires additional study and experimental effort to develop greater efficiency in spraying practices. For this reason it has seemed important to those who have had the planning of these experiments that they continue over a series of years in order to eliminate as far as possible inaccuracies due to unknown and uncontrollable conditions and thus secure accuracy of results from which conclusions may be drawn. The chief purpose of this bulletin, which is our second report in this study, is to contribute further data on the habits of the insects, the susceptibility of the newly-hatched aphides to various insecticides and the effects of spraying when buds are breaking in reducing injuries to the apple crop. The data are presented under the following headings:

1. Seasonal behavior of the aphides injurious to apple foliage and fruit.
2. Influence of aphides on growth of apples.
3. Test with lime-sulphur and nicotine solution on Rome apples.
4. Test of various insecticides on mixed varieties of apples.
5. Test on young apple trees against the green apple aphid.
6. Auxiliary experiments.

OBSERVATIONS AND EXPERIMENTS.

SEASONAL BEHAVIOR OF THE APHIDES INJURIOUS TO APPLE FOLIAGE AND FRUIT.

Injuries to the foliage and fruit of bearing apple orchards in western New York were not as much in evidence during the summer of 1915 as in the preceding year. The important fruit-growing counties of Niagara and Orleans suffered very little from the insects, especially the rosy aphid. In occasional orchards about Spencerport, Wolcott, Geneva and other localities there was considerable evidence

of the destructive work of these pests, and quite similar conditions prevailed generally in such counties as Monroe, Wayne, Ontario and Oswego.

The more important facts in the seasonal development of the different species are briefly indicated as follows:

Rosy apple aphid.—Hatching of this species (*Aphis sorbi* Kalt.) occurred during the period of the swelling and breaking of the buds, and, as indicated by certain experiments, all of the nymphs had probably emerged from the eggs by April 24, at which time the tips of the leaves were beginning to project from the ends of buds in the most advanced stages of growth. On May 3, at which time most varieties of apples showed pink in the blossoms, many of the stem-mothers were giving birth to young. The creatures occupied exposed positions on stems of the blossoms, which were as yet unopened, or on the under surfaces of the leaves. The foliage at this date was little affected and only an occasional leaf showed evidence of being curled or rolled by the insects. As will later be observed, the oat aphid was much more numerous during this period because of the early maturing of the stem-mothers and the rapid rate of reproduction, which was now at its height. Frequently single specimens of *sorbi* could be found intermixed with large numbers of *avenæ* about blossom stems or in curled leaves. For a period about May 7 there was an actual reduction in the numbers of the stem-mothers of the rosy aphid. The diminution was attributed to the attacks of its parasitic and predaceous enemies which were abundant and undoubtedly destroyed many of the plant lice. On May 12 when trees were coming into full blossom there was a noticeable increase of the rosy aphid, coincidental with the maturing of the first individuals of the second generation, which were about to produce offspring. As late as May 23, however, solitary stem-mothers or stem-mothers with from eight to fifty-two offspring about them were observed at Geneva. Six days later similar conditions prevailed at Wolcott, where single stem-mothers were detected surrounded with from ten to thirty-five young. At this latter date, as the calyx cups of young apples were closing (Plate I), there began a period of activity by the insects which was characterized by a greatly accelerated rate of reproduction. For the succeeding two weeks the insects spread from the few isolated leaves, which constituted the initial centers of infestation, to the remaining leaves

of the affected clusters, and from them to the unfolding leaves of adjacent new growth. During a period of a few days of high temperatures and great humidity about June 15, while apples were about the size of marbles, the rosy aphid multiplied with still greater rapidity. In the suddenness of the attack and the overwhelming invasion of the new terminal growth, watersprouts, and fruit and leaf clusters, as evidenced by the curling and discoloration of the affected leaves, the effect was strikingly similar to that of a virulent attack by a blighting disease. An interesting fact to be noted in this production and spread of the rosy aphid was the complete infestation of the new growth of leaf-clusters, tips of young shoots and water-sprouts on trees or portions of trees where heretofore there had been little or no indication of the presence of the pest. On June 18, at which time the young apples ranged in size from marbles to small walnuts, the stunting and deforming effects of the attacks upon the fruit were plainly evident on trees in the Station orchards. At Wolcott the stunting of young apples was first detected on June 8.

As to the winged forms, occasional specimens were first observed at Geneva on June 8 and at Wolcott on June 12, and during the following week the creatures were detected on the narrow-leaf plantain (*P. lanceolata* L.). By June 22 large numbers were developing wings, and whole leaf and fruit clusters once infested by them were now free of the insects. On the other hand, larger or smaller numbers of wingless aphides were observed, and in some instances fruits the size of walnuts were much infested on one side by them.

Oat aphid.—At Geneva the oat aphid (*Aphis avenæ* Fab.) began to hatch on April 16. At this time many buds showed very little separation of the bud scales, and only an occasional bud, usually at the end of the terminal growth, exhibited any evidence of green tissues. As shown by a number of spraying experiments, hatching of this species, as well as of the rosy aphid, was completed as the buds showed green tissues (Plate VI). Antedating the rosy aphid by about seven days, specimens of *avenæ* were mature by April 26 and were then giving birth to young. On May 3 when apple blossoms were showing pink and hardly ready to open, blossom clusters generally were infested with the insects, which ranged as high as thirty to forty individuals to a bud. On an average there were three or four stem-mothers to thirty or forty of their offspring. From the

leaves, sepals and stems of the unopened blossoms sap was oozing in globules from the feeding punctures of the insects, and in some instances it appeared that the insects were causing the surfaces of the stems to be roughened or pimply. Not infrequently as many as eighteen to thirty-four aphides were also observed on a single petal and where the insects were numerous the leaves at this date were beginning to curl. In comparison with this species, *sorbi* at this date was quite scarce and was represented entirely by solitary stem-mothers or stem-mothers surrounded by a few of their offspring. On May 12 winged forms of the oat aphid were detected, and by May 20, when the petals were dropping, many of the creatures were in the winged state. Four days later the numbers of the species were greatly reduced by the migration of the winged forms to their summer host plants. On May 29, when the petals had dropped, apple trees about Geneva were practically free from this species.

Green apple aphid.— At Geneva this species (*Aphis pomi* DeGeer) hatched during the period of April 16 to 24. Stem-mothers began to mature about May 4, when pink of the apple blossoms was showing, and on this date a few specimens were observed with small numbers of offspring about them. On May 15, or about eleven days after birth, winged forms of this generation appeared. At Wolcott on May 23 great numbers of wingless and winged forms of this species were observed in the blossom and leaf clusters in a commercial plantation of Gilliflower apples, causing destruction of blossoms and severe injury to foliage. About Geneva this species was present in great numbers on the terminal growth of nursery stock and of young apple trees that were from two to five years old from planting. On the whole this species caused little foliage injury during the earlier part of the summer as there seemed to be a tendency for the creatures to ascend the growing shoots and attack the tender leaves as they unfolded. In abandoning the lower leaves for the newer ones the insects appeared not to be established a sufficient time on any of the foliage to cause much damage, aside from a slight incurving of the margins of the leaves. Towards the latter part of the summer the terminal portions of the new growth seemed less able to withstand the attacks of the pests, and during early August there were marked evidences of damage. The foliage of badly-infested trees at this time was frequently much curled and often blackened with the sooty fungus (Plate IV). In extreme cases leaves become discolored and

dropped and in not a few instances a goodly portion of the shoots, commencing from the tips, were killed.

An interesting fact in connection with this species is that on June 22 and for several succeeding days there was a distinct flight of winged individuals. These came from some unknown source and swarmed over small and large apple trees alike in the region of Geneva, establishing themselves on the undersides of the upper leaves of the new growth.

From our observations of the insects on bearing trees it is apparent that the three species prefer succulent tissues, as the stems of unopened blossoms, stems of tender fruits and young leaves; and they derive subsistence from all such structures. Dwarfing and deforming of apples were mainly, if not entirely, the work of *sorbi*, and became apparent soon after blossoms dropped from the trees. The effects of *avenæ* and *pomi* on the setting of the crop and the development of the fruit were not so clearly indicated. When numerous each species is apparently capable of causing harm to blossom clusters, even before the opening of blossoms, and probably inflicts some damage on young apples. Present evidence points to the conclusion that injuries by the different species are cumulative, increasing day by day and week by week, and that damages by one species may be intensified by the succeeding species as conditions favor their development to destructive numbers.

INFLUENCE OF APHIDES ON GROWTH OF APPLES.

In order to measure the influence of the rosy aphis on the growth of apples, twenty infested fruit clusters and an equal number of uninfested clusters were selected on a Rome apple tree. The infested clusters contained sixty-one apples, giving an average of 3.05 fruits to a cluster, while the uninfested ones bore fifty-four apples, making an average of 2.7 fruits to a cluster. The selections were made from all sides of the tree, the infested and free clusters being so interspersed that, so far as could be observed, they were, with the exception of one factor—infestation by the rosy aphis—affected by similar conditions.

The infested clusters were divided into three lots according to the numbers of aphides on them as follows: Series I, four clusters severely infested with aphides; Series II, eleven clusters moderately infested; and Series III, five clusters slightly infested. The checks, Series IV, comprised twenty fruit clusters, the apples of which were normal in all respects and not different from the general run of the sound fruit on the tree. During the summer all the apples were

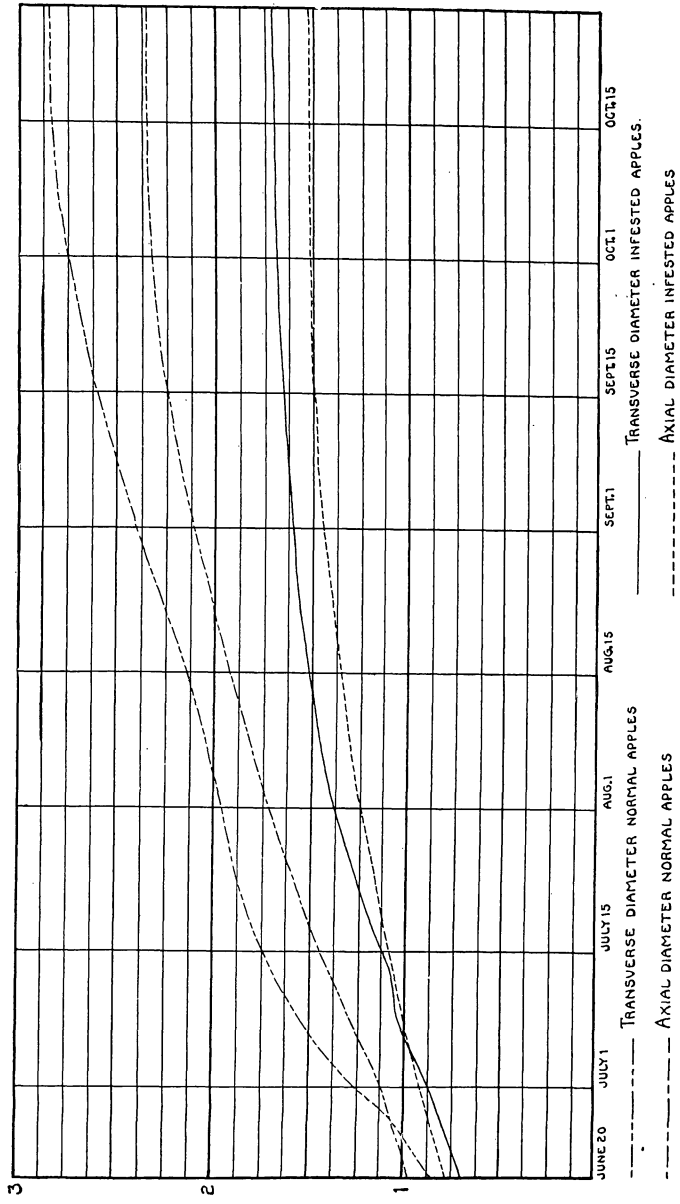


FIG. 1.— DIAGRAM SHOWING GROWTH OF APPLES INFESTED WITH ROSY APHIDS IN COMPARISON WITH NORMAL FRUIT.

calibrated at rather frequent intervals, the measurements being taken on June 20, 24 and 28; July 6, 10, 16, 23 and 30; August 11 and 18; September 8 and 25; and October 1, 8 and 18. The crop was harvested at the last-mentioned date.

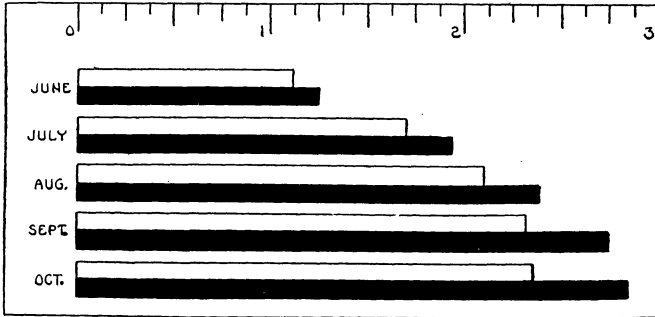


FIG. 2.—DIAGRAM SHOWING AVERAGES OF MEASUREMENTS OF NORMAL APPLES DURING SUMMER OF 1915.

White bars, axillary diameter; black bars, transverse diameter.

As previously noted, the calyx cups of apples about Geneva began to close on May 29, and during the following weeks the rosy aphid multiplied very rapidly. This increase in the numbers of the insects was attended by injuries to young apples, which were externally

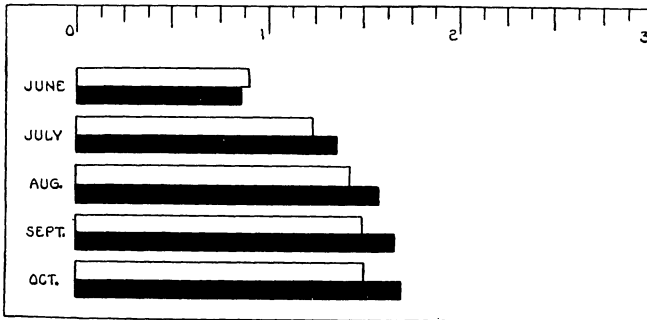


FIG. 3.—DIAGRAM SHOWING AVERAGES OF MEASUREMENTS OF APPLES INFESTED WITH ROSY APHIS.

White bars, axillary diameter; black bars, transverse diameter.

apparent during the first and second weeks in June. The effect of the attack was to cause a dwarfing of the young fruit, which was first indicated by a marked retardation of increase in transverse diameter. Affected apples therefore at this period appear to be

proportionately longer than the normal fruit. The average measurements, at intervals as stated, of the axillary and transverse diameters are given in Fig. 1. A study of the curves shows that while with apples in the early stages of development the axillary diameters of all series exceed the transverse diameters, the transverse diameters of the normal fruit increased much more rapidly than those of the affected fruit. The transverse diameters of the sound series equaled the axillary diameters on June 28, and rapidly exceeded them thereafter. The transverse diameters of infested apples, however, did not equal the axillary diameters until July 4, and the measurements subsequently until July 15 closely approximated each other. The inhibition of growth by the aphides is graphically shown in Figs. 2 and 3. The white bars represent the average of the measurements of the axillary diameters of the apples, while the black bars represent similarly the transverse diameters. Fig. 2 gives the average measurements of all of the fruit of the sound clusters, while Fig. 3 shows the average measurements of all of the fruits of the infested clusters. The average rate of growth of the apples in the two lots is shown in Table I.

TABLE I.—AVERAGE GROWTH OF SOUND APPLES AND APPLES INFESTED WITH ROSY APHIS.

SOUND APPLES.			INFESTED APPLES.		
	Axillary diameter.	Transverse diameter.		Axillary diameter.	Transverse diameter.
	<i>Ins.</i>	<i>Ins.</i>		<i>Ins.</i>	<i>Ins.</i>
June.....	1.125	1.265	June.....	0.906	0.875
July.....	.593	.688	July.....	.344	.500
August.....	.407	.453	August.....	.187	.218
September....	.218	.359	September....	.063	.094
October.....	.032	.110	October.....	.015	.031
Totals.....	2.375	2.875		1.515	1.718

It will be observed that the greatest development of the fruit occurred in June, the growth being less rapid as the season advanced. As previously indicated, the apples of the infested series sustained a great check to their development during early June, although the destructive work of the pest apparently continued in some cases until the middle of July. In this connection mention should be

made of the fact that June 14 marked the beginning of the period when fruit and leaf clusters were being entirely abandoned by the rosy aphid, and all those considered in the foregoing series were

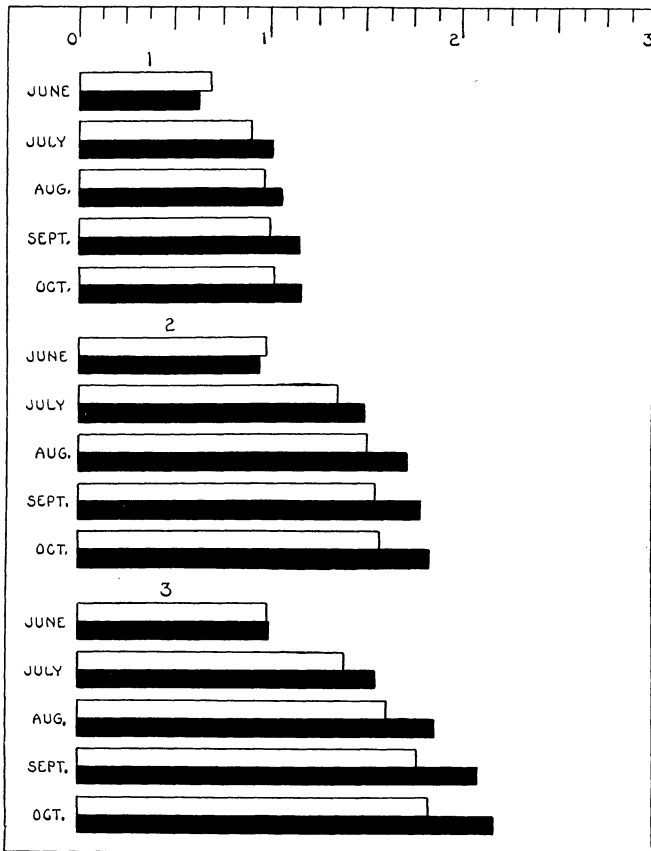


FIG. 4.—DIAGRAM SHOWING VARIATIONS IN SIZES OF APPLES ACCORDING TO DEGREE OF INFESTATION.

White bars, axillary diameter; black bars, transverse diameter. (1), Apple cluster severely infested; (2), apple cluster moderately infested; (3), apple cluster slightly infested.

free of the insects by July 6. Efforts to establish the aphides on apples met with failures after June 23, while some fruit clusters near those that were calibrated continued to be infested until July 15.

The inhibition of the growth of the young apples varied largely according to the extent of infestation. In general the rate of development was in inverse proportion to the degree of infestation—the larger the number of aphides—the smaller the size of the affected fruit. The extent of this variation according to the degree of infestation is represented graphically in Fig. 4, which is based on the measurements of three typical clusters. At the time of harvesting, October 18, there were forty-nine apples of the infested series I, II, and III, and thirty-one apples of the checks or series IV. When picked the fruit was classified according to size as follows:

LOT I. INFESTED APPLES.

- 5 apples less than 1 inch in diameter.
- 8 apples between 1 and 1 1/2 inches in diameter.
- 9 apples between 1 1/2 and 1 3/4 inches in diameter.
- 14 apples between 1 3/4 and 2 inches in diameter.
- 8 apples between 2 and 2 1/4 inches in diameter.
- 5 apples between 2 1/4 and 2 1/2 inches in diameter.

LOT II. CHECK OR SOUND APPLES.

- 7 apples between 2 1/4 and 2 1/2 inches in diameter.
- 10 apples between 2 1/2 and 2 3/4 inches in diameter.
- 6 apples between 2 3/4 and 3 inches in diameter.
- 7 apples between 3 and 3 1/4 inches in diameter.
- 1 apple 3 3/8 inches in diameter.

Because of irregular shape, only two of the infested apples of marketable size in Lot I. were of commercial value, and with these exceptions all of the fruits in this class were practically worthless. Aside from indicating the variation in extent of injury, these figures show more clearly, perhaps, than any other statistical data that have been given, the destructive power of the rosy aphis and the character of the shrinkages in fruit yields following a severe attack.

Reduction in the size of the fruits is not the sole injury sustained by young apples by attacks of aphides. There is in addition a distortion of their shape, which consists in the flattening of the calyx area or of the protrusion of the calyx or the checking of the growth of the fruit on one side (Plate III). These disfigurements are of varying intensity; sometimes so slight as to be scarcely noticeable, and in extreme cases so severe that the apples are knotty and gnarly and

generally misshapen. In the series under observation the apples were always distorted when both leaves and fruit of a cluster were affected, but such malformations were little in evidence when the infestation by insects was entirely restricted to the foliage of a fruit cluster. In the latter case the leaves were generally curled, and while the fruit, as will be later shown, was more or less reduced in size, there was no visible distortion of the apples aside from a slight flattening of the calyx area in some instances.

Another characteristic result of infestation by the rosy aphis was the failure of many of the apples to drop, with the result that the dwarfed, deformed fruit hung in clusters. In the different series under observation the average number of apples on the infested

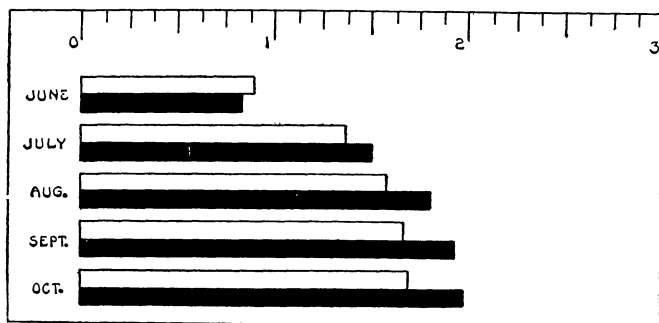


FIG. 5.— DIAGRAM SHOWING INFLUENCE OF LEAF INFESTATION ON GROWTH OF APPLES.

White bars, axillary diameter; black bars, transverse diameter.

clusters was greater than that of the normal clusters. At the time when the first measurements were made the largest number of apples on an affected cluster was seven, while the largest number of apples on a sound cluster was five. At the end of the season the largest numbers per cluster were respectively six and five apples. The average number of apples per cluster at the beginning of the period, as stated previously, was 3.05 fruits for the affected clusters and 2.7 fruits for the sound clusters. The average number of apples per cluster at the conclusion of the period of observation was respectively 2.63 fruits for the infested clusters and 1.83 fruits for the sound clusters.

Besides the injuries that result from the direct attack of the rosy aphis upon the apples, there are also damages to the crop in consequence of infestation of adjoining leaves. As a rule infestation of the

fruit is accompanied by the presence of more or less of the insects on the foliage, and generally the first intimation of an attack is the curling of one or more of the adjacent leaves. The question arises as to the extent of influence of the insects on the size of the apples when the infestation is confined solely to the foliage. To obtain data on this point calibrations were made of thirteen apples, distributed among five clusters, the leaves only of which were infested with the rosy aphid. The average measurements of these apples are shown in Fig. 5. It will be observed that these are intermediate in size between those obtained from normal fruit and those from apples directly attacked by the insects, as shown in Figs. 2 and 3. These apples, while undersized and unfit for the market, lacked the distortions so characteristic of fruits that had been infested by goodly numbers of aphides.

TEST WITH LIME-SULPHUR AND NICOTINE SOLUTION ON ROME APPLES.

This experiment was undertaken to get more detailed data than heretofore obtained in our work as to the effects upon the different species of aphides of spraying when buds are breaking, and the extent of protection to foliage and blossom and fruit clusters afforded by the treatment. The orchard chosen for the test consists of sixty trees of the variety Rome for the permanent planting. This variety was top-worked on Ben Davis, the Rome buds all having come from one tree and the stock having been carefully selected. This precaution was taken to exclude individual variations. The trees were set, forty feet apart, in 1896 and are therefore about nineteen years old (Plate V). Provision for ample pollination is provided by intervening rows of apple trees, embracing approximately one hundred seventeen other varieties. The whole orchard has been given careful attention with respect to cultivation, pruning, spraying, etc. During 1909, 1910 and 1914 the trees of the variety Rome sustained severe injuries by plant lice, especially the rosy aphid.

DETAILS OF EXPERIMENTAL OPERATIONS.

In this test the entire orchard was sprayed with lime-sulphur and nicotine solution. Lime sulphur testing 32° B. was used in the proportions of one gallon to eight gallons of water in order to combat the San José scale, and to every one hundred gallons of the dilute mixture there was added three-fourths of a pint of nicotine solution

(40 per ct.) to destroy the plant lice. The trees were divided into three plats, which were sprayed on April 24, 26 and 27, respectively, in order to catch the insects as the buds were in different stages of development. The applications were made with a power-sprayer under rather high pressures, using "mistry" nozzles with coarse

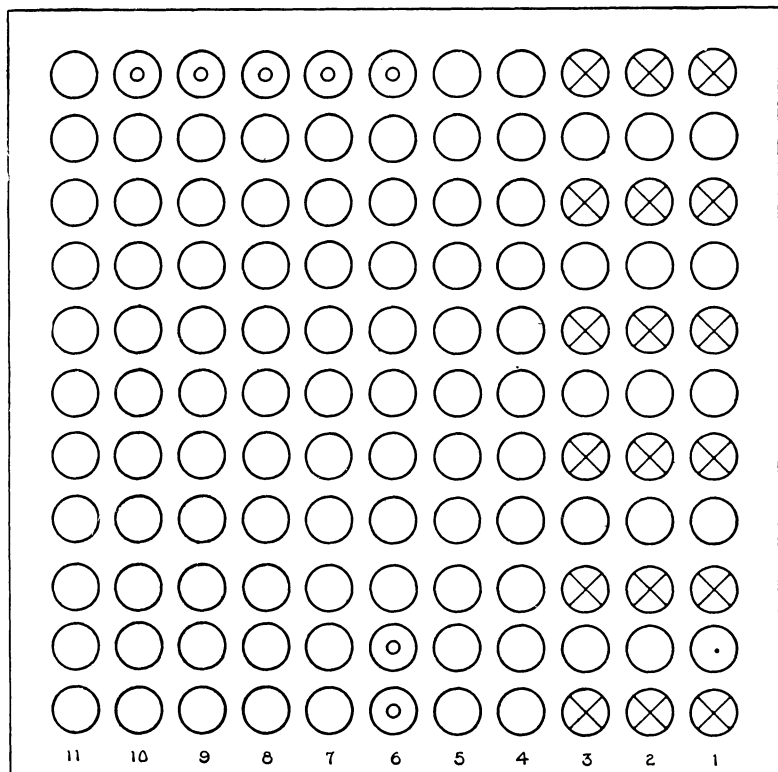


FIG. 6.— DIAGRAM OF ROME BEAUTY ORCHARD SHOWING SPRAYED PLAT AND CHECK TREES.

X, Sprayed trees; O, Checks.

apertures. The men operating them were cautioned to spray carefully in order to thoroughly wet the ends of all the buds, and to this end to apply the spraying mixture in liberal amounts. This experiment deals with three rows of the Rome apple, with the interplantings, sprayed on April 24 when the buds were green at the ends, and in some instances the tips of young leaves were projecting from the

buds (Plate VI). The plan of the orchard showing the location of the sprayed trees and the checks is given in Fig. 6. For the checks there were seven Rome trees. The number of trees sprayed in this plat were eighteen Rome and thirty-two trees of the same age of other varieties. For the treatment of these trees five hundred gallons of spraying mixture were applied, making an average of ten gallons per tree.

RESULTS OF SPRAYING ON APHIDES AND TREES.

At the time of treatment the oat aphid was abundant on all of the trees, scarcely a bud being free from the insects. The effect of the spraying was most marked. Following the application there was an almost complete disappearance of the creatures, and it was difficult to find a single specimen for the remainder of the period when one would normally find the species on apple trees. With the checks, quite different conditions prevailed. At first there was a gradual increase in the numbers of the aphides when, during the period of May 3 to May 12, the blossom clusters particularly were generally overrun with them. Many insects were clustered about the basal portions of the stems, from which there exuded tiny globules as a result of the feeding punctures of the insects. At this time stems of blossoms were observed that presented a roughened or "pimply" appearance. In addition more or less of the lice were assembled on the petals of the unopened blossoms and on the leaves, which were slightly curled or presented a wrinkled appearance.

The rosy aphid was not present in great numbers on the trees during the season. Until June 15 not an individual of this species was observed on any of the sprayed trees, then one small colony was observed on Tree 9, Row 1. A little later slight infestations were noted on a few more trees. While the checks were not abundantly infested, it was not difficult during early May to find stem-mothers. The trees gradually presented less satisfactory conditions as the season advanced, and by June 8 the aphides became numerous enough to cause appreciable damage to both fruit and leaf clusters. On June 27 when the principal injury had been done by the insects and they had practically disappeared from the orchard, each Rome tree and some of other varieties in the sprayed and unsprayed plats were carefully examined to note conditions with respect to injury by the rosy aphid. The data are collected in Table II.

TABLE II.—RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Total centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
Rome.....	Row	No.					No.	No.	No.
Rome.....	"	1, tree	0	4	0	0	4	0	7
Rome.....	"	1, " 3	0	0	0	0	0	0	0
Rome.....	"	1, " 5	0	3	0	0	3	0	23
Rome.....	"	1, " 7	0	0	0	0	0	0	0
Rome.....	"	1, " 9	10	10	3	0	23	26	70
Rome.....	"	1, " 11	0	0	0	0	0	0	0
Husband.....	"	1, " 2	0	0	0	0	0	0	0
Axident.....	"	1, " 4	0	0	0	0	0	0	0
Hanlon.....	"	1, " 6	0	1	7	0	8	0	29
Rome.....	"	2, " 1	0	0	0	0	0	0	0
Rome.....	"	2, " 3	0	0	0	0	0	0	0
Rome.....	"	2, " 5	0	1	0	0	1	0	6
Rome.....	"	2, " 7	0	5	0	2	7	0	34
Rome.....	"	2, " 9	0	0	0	0	0	0	0
Rome.....	"	2, " 11	0	0	0	0	0	0	0
Hyslop.....	"	2, " 2	0	0	0	0	0	0	0
Florence.....	"	2, " 4	0	0	0	0	0	0	0
Wagener.....	"	2, " 8	0	0	0	0	0	0	0
Kinnard.....	"	2, " 10	0	0	0	0	0	0	0
Rome.....	"	3, " 1	0	0	0	0	0	0	0
Rome.....	"	3, " 3	0	0	0	0	0	0	0
Rome.....	"	3, " 5	1	0	0	0	1	4	5
Rome.....	"	3, " 7	0	3	0	0	3	0	11
Rome.....	"	3, " 9	0	0	0	0	0	0	0

TABLE II.—RESULTS OF SPRAYING AGAINST ROSY APHIS (*concluded*).

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Total centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
Rome.....	No. 3, tree 11	Lime-sulphur and nicotine	1	3	0	0	No. 4	No. 3	No. 16
Kinnard.....	" 3, " 2	" " "	0	0	0	0	0	0	0
Hubbardston.....	" 3, " 6	" " "	0	0	0	0	0	0	0
Wagener.....	" 3, " 8	" " "	0	0	0	0	0	0	0
Rome.....	" 6, " 1	Check.....	29	42	21	0	92	73	413
Rome.....	" 6, " 2	"	9	9	4	0	22	11	51
Rome.....	" 7, " 11	"	18	51	25	0	94	72	469
Rome.....	" 8, " 11	"	15	19	4	0	38	21	112
Rome.....	" 9, " 11	"	11	15	0	0	26	23	104
Rome.....	" 10, " 11	"	9	3	1	1	14	26	46
Rome.....	" 11, " 11	"	20	8	3	2	33	53	128
Collins.....	" 12, " 11	"	3	0	9	7	19	11	62

TABLE III.—SUMMARY OF EXPERIMENT AGAINST ROSY APHIS.

NUMBER AND VARIETY OF TREES.	Treatment.	Centers of infestation.	Fruits injured.	Leaves curled.
		No.	No.	No.
18 Rome	Sprayed.....	46	33	172
10 Mixed varieties.....	Sprayed.....	8	0	29
7 Rome.....	Not sprayed....	319	279	1,323
Average per sprayed tree, Rome.....		2.55	1.83	9.55
Average for all sprayed trees.....		1.93	1.17	7.17
Average per unsprayed tree, Rome.....		45.57	39.85	189

DISCUSSION OF RESULTS.

There are two facts which the data in this experiment bring out clearly. The one of greatest interest and importance is that the oat aphid and rosy aphid had largely, if not entirely, hatched when the buds were still compact and the tips of the leaves were barely showing. The other fact, which is strongly indicated, is that the destruction of the newly-hatched aphides by the treatment afforded a large degree of protection to both fruit and foliage.

TEST OF VARIOUS INSECTICIDES ON MIXED VARIETIES OF APPLES.

The purpose of this experiment was to determine the merits of various insecticides for the control of the aphides as well as to ascertain the effects of bud treatment upon these insects in an orchard of mixed varieties of apples. The spraying mixtures tested were lime-sulphur with nicotine solution, soap with nicotine solution, sodium sulphide with soap, and crude carbolic-acid emulsion. The formulas for the different spraying mixtures are as follows:

- (1) Lime-sulphur and nicotine solution:

Lime-sulphur solution (32° B.).....	11 gals.
Nicotine solution (40 per ct.).....	$\frac{3}{4}$ pint.
Water.....	89 gals.
- (2) Soap and nicotine solution:

Soap.....	5 lbs.
Nicotine solution (40 per ct.).....	$\frac{3}{4}$ pint.
Water.....	100 gals.
- (3) Sodium sulphide and soap:

Sodium sulphide (56 per ct. sul.).....	15 lbs.
Soap.....	5 lbs.
Water.....	50 gals.
- (4) Crude carbolic-acid emulsion:

Soap.....	15 lbs.
Crude carbolic acid.....	1 pint.
Water.....	100 gals.

DETAILS OF EXPERIMENTAL OPERATIONS.

The orchard in which the test was made consists of a large variety of apple trees which are from 30 to 35 years of age. There were eighty-three trees in the experiment, of which sixty-nine were sprayed with the different preparations and fourteen reserved as checks. The applications were made on April 18, 19 and 20, when the buds of most varieties were quite green at the tips and still compact, although with some sorts the tips of young leaves were projecting (Plate VII). The trees were thoroughly sprayed, using a power-sprayer with "mistry" nozzles. The average amount of mixture used for each tree was about seventeen and one-half gallons.

EFFECTS OF SPRAYING ON APPLE TREES.

Of the mixtures applied, the soap and nicotine solution was the only combination that did not actually cause some harm to the foliage. There was slight burning of the tips of the most advanced leaves by the lime-sulphur and nicotine, but the injuries were not important and were soon obscured by the new growth. Similar conditions attended the application of the crude carbolic-acid emulsion. In marked contrast with the foregoing sprays very serious damage was caused by sodium sulphide and soap. The destructive properties of this combination were indicated on April 26, six days after the treatment, by the browning of the buds, which, when cut, appeared lifeless and much discolored. At the time of blossoming the buds on these trees generally showed great retardation in their growth, while many of them were evidently dead. Only a few blossoms opened at the normal period, and others that were only partially injured made their appearance one week later. The effects of the treatment were most apparent on the lower branches, while in the upper portions of the trees, especially on the tips of the tallest branches, the conditions of foliage and blossoms were normal. On the other hand, fruit spurs within reach of the operators were oftentimes practically devoid of any signs of life (Plate VIII). On May 18 the dead blossom clusters began to drop and adventitious growth was making its appearance near the base of the buds that were destroyed. Blossom clusters only partially injured showed a few blossoms with stems that were short and of uneven lengths, while the new leaves

were small and few in number. The condition of the trees improved as the summer advanced, by the development of the new growth; but during the entire summer and at the time of harvesting many of the dead blossom buds could be found with little difficulty. The yields of fruit, as was to be expected, were very small on the trees receiving this treatment.

RESULTS OF SPRAYING ON APHIDES.

The conditions of the trees with respect to the oat aphid and rosy aphid were quite similar to those in the preceding experiment, except perhaps that the latter species was slightly more numerous and therefore somewhat more destructive. The spraying with any of the mixtures effected an almost complete destruction of the oat aphid, and with respect to this insect all of the sprayed plats presented great contrast with the unsprayed plats. During the latter part of April and early May the rosy aphid could hardly be said to be abundant, and yet, especially with most of the checks, little difficulty was experienced in finding specimens of the stem-mothers. During June the insect developed rapidly in numbers, and from the relatively few leaf and blossom clusters which constituted the initial centers of infestation, it quickly spread to adjoining leaf and fruit clusters and, as will be observed later, caused considerable damage to some trees. One feature of the activities of the species in this orchard during the season that is deserving of note, was its rapid multiplication on trees where there were only slight evidences of its presence earlier in the season. This largely occurred on the checks, and it is believed that the infestation developed from stem-mothers which had escaped detection during previous observations, as there was no evidence of colonization by migrants of the second generation.

Twenty trees in the sprayed plats and fourteen trees in the check plat were closely examined during July with respect to injuries by the rosy aphid. The data are presented in Table IV.

TABLE IV.—RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
Newtown.....	No. 3, tree 2	Lime-sulphur and nicotine	0	0	0	0	No. 0	No. 0	0
Pease.....	" 3, " 4	" " " "	0	0	0	0	0	0	0
Winter Banana.....	" 3, " 6	" " " "	0	0	0	0	0	0	0
Winter Banana.....	" 3, " 7	" " " "	0	0	0	0	0	0	0
Pumpkin Sweet.....	" 3, " 12	" " " "	48	36	86	23	193	110	620
Mother.....	" 3, " 14	" " " "	0	0	0	5	5	0	27
Green Newton Pippin.....	" 3, " 15	" " " "	6	0	0	8	14	13	60
Northern Spy.....	" 3, " 16	" " " "	10	23	12	6	41	28	145
Pecks Pleasant.....	" 3, " 17	" " " "	9	0	13	2	24	14	64
Pewaukee.....	" 3, " 18	" " " "	0	0	0	0	0	0	0
Pomme Grise.....	" 3, " 19	" " " "	4	0	9	6	19	6	48
Boikin.....	" 4, " 3	" " " "	0	0	0	0	0	0	0
Roxbury.....	" 4, " 4	" " " "	35	39	49	17	140	71	565
Wabash Red.....	" 4, " 5	" " " "	2	0	0	0	2	2	4
Windsor.....	" 4, " 6	" " " "	3	5	8	0	16	5	50
Stearns.....	" 4, " 7	" " " "	0	0	0	0	0	0	0
Esopus.....	" 4, " 12	" " " "	0	0	0	7	7	0	44
Rhode Island Green- ing.....	" 4, " 17	" " " "	13	25	17	15	70	27	305
Currant.....	" 4, " 18	" " " "	0	0	0	0	0	0	0
Ralls.....	" 4, " 20	" " " "	11	9	3	15	38	23	149
Kalkidon.....	" 4, " 22	" " " "	0	0	0	0	0	0	0
Seedling.....	" 5, " 1	Soap and nicotine.....	0	0	0	0	0	0	0
Alexander.....	" 5, " 3	" " " "	0	0	0	0	0	0	0



PLATE I.—LEAF AND FRUIT CLUSTERS OF APPLE INJURED BY PLANT LICE.
(1), Curling of leaves during blossoming period; (2), dwarfing
of fruit by rosy aphid, with closing of calyces.

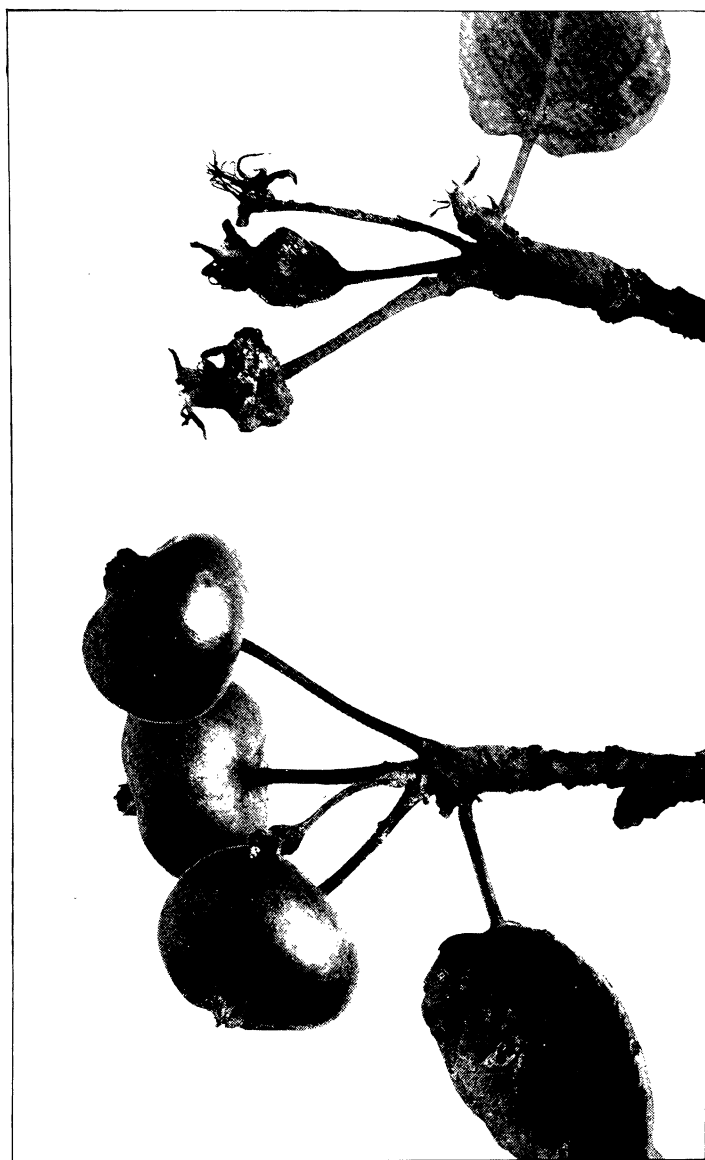


PLATE II.—FRUIT AND LEAF CLUSTERS INJURED BY ROSY APHIS.

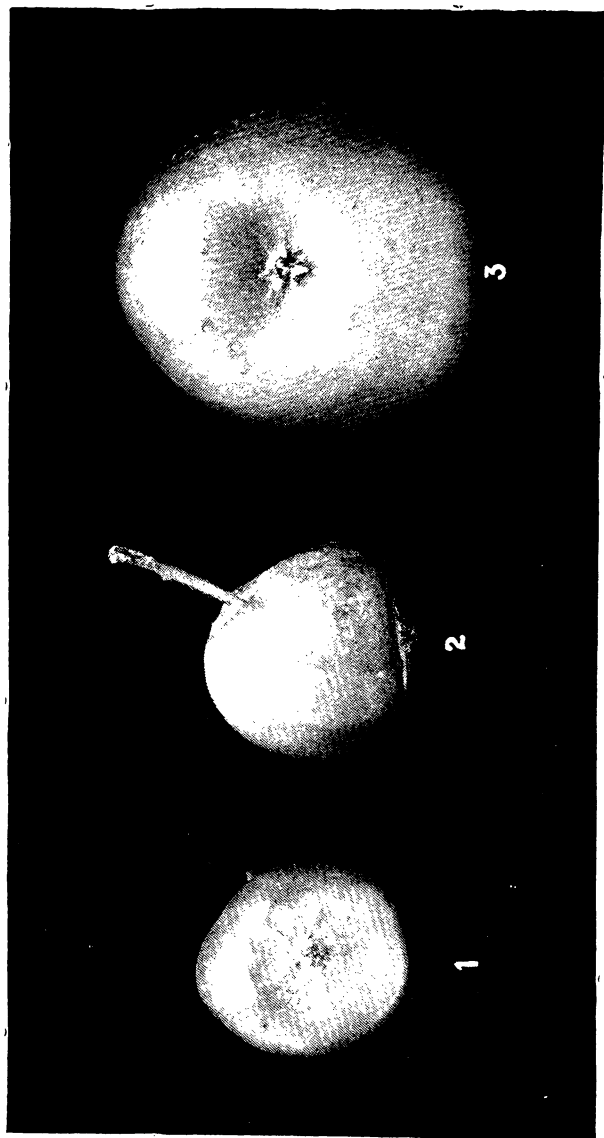


PLATE III.—EFFECTS OF ROSY ARMS ON CONTOUR AND SIZE OF APPLES.



PLATE IV.—CURLING OF LEAVES AND DEFOLIATION BY GREEN APPLE APHIS.



PLATE V.—TYPE OF ROME APPLE TREES IN EXPERIMENTAL PLAT.



PLATE VI.—STAGE OF DEVELOPMENT OF BUDS IN EXPERIMENT AT TIME OF SPRAY-
ING OF ROME APPLES.
(Slightly enlarged.)



PLATE VII.—STAGES OF DEVELOPMENT OF BUDS OF MIXED VARIETIES OF APPLES.



PLATE VIII.—INJURIES TO FRUIT BUDS AND WOOD BY SODIUM SULPHIDE AND SOAP.
Left, Apple; right, peach, sodium sulphide alone.

TABLE IV.—RESULTS OF SPRAYING AGAINST ROSY APHIS (*concluded*).

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
	No						No.	No.	No.
Bell Laws Pippin....	Row 15, tree 12	Carbolic acid emulsion...	0	0	0	0	0	0	0
Early Joe.....	" 15, " 13	" " "	46	5	20	4	75	106	275
Station Seedling.....	" 15, " 15	" " "	0	0	0	0	0	0	0
Alexander.....	" 15, " 16	" " "	0	0	0	0	0	0	0
Jeffers.....	" 15, " 17	" " "	0	0	0	0	0	0	0
America.....	" 15, " 19	" " "	0	0	0	0	0	0	0
Orengo.....	" 15, " 20	" " "	0	0	0	0	0	0	0
Orengo.....	" 15, " 21	" " "	0	0	0	0	0	0	0
Seedling.....	" 1, " 1	Check.....	19	97	44	16	176	20	938
Elsar.....	" 1, " 3	" " "	27	4	15	0	46	37	119
Seedling.....	" 1, " 4	" " "	*0	95	11	5	111	*0	636
Oswego.....	" 1, " 7	" " "	*0	55	33	8	96	*0	608
Alexander.....	" 1, " 16	" " "	77	16	11	0	104	223	398
Constantine.....	" 1, " 20	" " "	2	47	78	8	135	3	620
Schoharie.....	" 2, " 1	" " "	45	62	6	14	127	95	757
Jersey Black.....	" 2, " 4	" " "	63	20	50	0	133	93	495
Maiden Blush.....	" 2, " 14	" " "	222	208	132	30	592	689	2,342
Jersey Sweet.....	" 2, " 15	" " "	418	141	200	69	828	1,218	3,580
Hurlburt.....	" 2, " 17	" " "	2	142	114	60	318	9	1,365
Gravenstein.....	" 2, " 19	" " "	92	91	132	8	323	237	1,183
Striped Fameuse.....	" 2, " 20	" " "	1	8	2	1	12	3	37
Green Newtown.....	" 2, " 22	" " "	38	34	7	1	80	156	242

* No fruit on trees.

TABLE V.—SUMMARY OF EXPERIMENTS AGAINST ROSY APHIS.

TREATMENT.	Number of trees.	Centers of infesta- tion.	Fruits injured.	Leaves curled.
		No.	No.	No.
Lime-sulphur and nicotine solution...	21	569	299	2,081
Nicotine solution and soap.....	17	19	11	41
Sodium sulphide and soap.....	5	295	70	1,118
Carbolic acid emulsion.....	23	976	710	3,736
Check, no treatment.....	14	3,081	2,783	13,320

AVERAGES PER TREE.

Lime-sulphur and nicotine solution.....	27	14	99
Nicotine solution and soap.....	1	1—	3
Sodium sulphide and soap.....	59	14	224
Carbolic acid emulsion.....	42	31	162
Check, unsprayed trees.....	220	199	951

DISCUSSION OF RESULTS.

Observations at frequent intervals during the early summer could hardly fail to leave in the mind of the observer the impression that all of the treatments had brought about greatly improved conditions in the sprayed plats. However, in the interpretation of the statistical data as regards the rosy aphid, the test has one defect that does not appear in Experiment I, — that the orchard consists of many varieties which are not equally distributed, if at all, among the different plats. With the small amount of knowledge that exists as to the susceptibility of different sorts of apples to aphides, the preliminary character of the experiments may be again emphasized. An important phase of our work has been to devise satisfactory methods of conducting experimental operations against these pests, and discrepancies and errors due to differences in varietal susceptibility will best be determined by repetition of the experiments under varying conditions. Most commercial orchards consist of several varieties, and none of our leading sorts of apples are immune to attack. In this particular planting, the rosy aphid has been very abundant during certain years, and the general behavior of different varieties to the pest may be fairly gauged by the conditions of the checks, among which there is not a variety which does not show more or less infestation. In the main the effects of spraying in this orchard were not dissimilar from those of other similar operations recorded in the bulletin. The results so summarized are regarded as indicating

considerable protection by the various treatments. Leaving out of consideration sodium sulphide and soap, on account of their destructive properties when used as a combination spray, it appears that the remaining preparations, when allowance is made for experimental errors and differences in conditions, do not differ materially in effectiveness, although somewhat superior results are indicated for nicotine solution and soap. For some reason not clearly apparent the carbolic-acid emulsion in this test was less effective than nicotine solution combined with either soap or lime-sulphur. In other tests the differences in efficiency were not so large.

TESTS ON YOUNG APPLE TREES AGAINST THE GREEN APPLE APHIS.

The chief objects of these experiments were to ascertain the effects on the green apple aphid of spraying when buds are opening, and the number of treatments required to keep this species under control. The orchard in which the operations were undertaken comprises twelve hundred trees, three years old from time of planting, which were seedlings of such parents as Canada Red, Delicious, Yellow Transparent and McIntosh. In the distribution of the trees into experimental plats, provision was also made for tests to determine the comparative merits of lime-sulphur and nicotine solution, nicotine solution and soap, and nicotine and lime as aphidicides. The nicotine solution and soap were used in the proportions recommended by this Station, see page 51. The plats comprising from sixty to one hundred twenty trees each were sprayed as follows:

Plat 1, check.

Plat 2, lime sulphur, 32° B. (1-8) and nicotine solution on April 19 as buds were breaking; nicotine solution and lime, June 22.

Plat 3, lime-sulphur and nicotine solution, April 20; nicotine solution and soap on June 22, July 10 and August 2.

Plat 4, lime-sulphur and nicotine solution, April 20; nicotine solution and lime on June 22, July 10 and August 2.

Plat 5, lime-sulphur and nicotine solution, April 20; nicotine solution and soap on June 22 and August 2; nicotine solution and lime on July 10.

Plat 6, lime-sulphur and nicotine solution, April 20; nicotine solution and soap on June 22; nicotine solution and lime on July 10 and August 2.

Plat 7, check.

RESULTS OF SPRAYING ON APHIS.

As previously noted, the green apple aphid began to hatch in this planting about April 16 and, as shown by the condition of the plats receiving the early spraying with lime-sulphur and nicotine solution, few if any insects emerged from eggs after April 20. On May 4 the first of the stem-mothers to mature began to give birth to offspring. Winged forms of this, the second generation, appeared on May 15, and thereafter alate forms were always present on the checks from which they spread to other plats in the planting. As will be observed the habit of this species in breeding on apples the entire season and the constant appearance of winged forms with the maturing of the second generation necessitated several applications of spraying mixtures in order to keep the trees practically free of the insects.

At the time of spraying on April 20 the buds generally were well infested, principally by the green apple aphid, with which were interspersed considerable numbers of the oat aphid. The trees receiving this treatment were quite free of the insects until June 22, which date concluded the period when protection was afforded to the trees by the "bud" spraying. It is also desirable to note that the colonies of rosy aphid that existed in this planting of young apples were confined solely to the checks. At this date, June 22, all of the plats except the checks received a second application. Notwithstanding the almost complete destruction of the creatures at the time of treatment, the continuous breeding of *pomi* and constant appearance of migrating winged forms eventually resulted in a considerable reinfestation of the sprayed plats. For this reason it was necessary to respray the trees on July 10 and again on August 2. As a result of spraying at the different intervals as indicated, the foliage, for the most part, of the trees in the treated plats other than Plat II, sustained no important damage by the insects. There was little evidence of discoloration or curling of the leaves so characteristic of a prolonged attack by the green apple aphid, and the growth of the trees as to extent and vigor seemed in every respect quite normal.

In comparison with the sprayed trees the checks were never during the entire growing season free from infestation by considerable numbers of the insects. However, until about July 10, the aphides, in spite of their numbers, caused very little injury. Up to this time the insects showed a marked preference for the tips

of the succulent shoots. The lower leaves were not subject to infestation for a lengthy period and therefore showed little evidence of permanent injury. Such as there was consisted apparently of little more than a slight incurving of the margins of the leaves. During the latter part of July and August when the production of new growth was less rapid the effects of accumulated injuries became increasingly apparent. The foliage of the badly-infested shoots showed curled and distorted leaves, which were discolored and smutty as a result of honey dew and the sooty fungus. Later, there was more or less browning of the leaves, followed by a slight defoliation. Occasionally there were examples of more extreme forms of injuries as dwarfing or killing of the tips of the new growth, which in some instances were extensive enough to destroy the symmetry as well as to cause stunting of the trees.

As to the comparative insecticidal properties of the various spraying mixtures there was very little difference in effectiveness. Nicotine and soap possess superior spreading and wetting properties and always showed an increased rate of toxicity over the other preparations. The destructive action of lime-sulphur and nicotine solution or lime and nicotine solution was appreciably slower but generally the final results on the pests were very satisfactory.

LIME AS AN APHIDICIDE.

One result of the comparative tests of the foregoing insecticides that deserves more specific mention is the value of lime or white-wash in protecting foliage from plant lice and leaf-hoppers. Such contact insecticides as soap, oil emulsions or nicotine solutions, excellent as they are as aphidicides, are in one respect very deficient against such a pest as the green apple aphid—their toxicity ceases as soon as the spraying mixture dries on the foliage. Failure to destroy all of the insects or invasion of the planting by winged forms frequently results in a reinfestation, when repetition of the treatment becomes necessary. The extreme need of more lasting properties led to experiments with lime in combination with nicotine solution. With this mixture immediate results were obtained as usual by the nicotine, while, in addition, the lime, through the heavy coating of the foliage, was found to be very repellent to the insects. In the plats as described, the trees receiving this treatment showed throughout the entire summer a degree of freedom from

aphides and a vigor of growth that was hardly equalled by any treated with other insecticides. The leaves that had their under-surfaces thoroughly coated with the whitewash were not only largely exempt from attack by plant lice but they were also quite immune from such species of leaf-hoppers as the apple leaf-hopper (*Empoasca mali*) or the rose leaf-hopper (*Typhlocyba rosæ*). In pear orchards similar results were obtained against the pear psylla. Directions for using lime as an aphicide are withheld, pending experiments to determine its ranges of usefulness for this purpose, and the conditions under which it may be satisfactorily employed.

AUXILIARY EXPERIMENTS DURING 1915.

Through the courtesy of Commissioner Charles S. Wilson the auxiliary experiments for this year were conducted largely under the personal direction of Mr. L. F. Strickland, Inspector of the State Bureau of Horticulture for Niagara County, and Mr. A. B. Buchholz, Horticultural Inspector for Orleans County. The principal details of these tests are briefly summarized as follows:

EXPERIMENTS IN NIAGARA COUNTY.

Test 1. Orchard of E. S. Gifford, Gasport.—In this planting twenty-two trees of the variety Greening, about sixty years old, were reserved for the test. On April 22, as the buds were green at the tips and in some instances the ends of the young leaves were breaking out, the trees were sprayed with lime-sulphur in combination with nicotine solution (Black Leaf 40) in the usual proportions. All three species of the aphides were present on the trees, and the buds showing green tissues in the more advanced stages of growth harbored in some instances as high as twenty-five to eighty of the newly-hatched nymphs. The greater part of the infestation was in the upper branches, but a small percentage of the creatures was on the lower fruit spurs. The oat aphid and green aphid were the most abundant species, and only occasionally was a specimen of the rosy aphid observed. In order to insure thorough treatment the trees were drenched with three hundred thirty gallons of the spraying mixture, which makes an average of fifteen gallons of the liquid to the tree.

An examination of the plat on May 12 showed only scattering numbers of the three species of plant lice on the sprayed trees, while

neighboring unsprayed trees were badly infested with the oat aphid, which had developed to considerable numbers since the time when the test was begun. Varying numbers of the green aphid and rosy aphid, though usually not large in extent, were detected on the checks. On June 5 there was an apparent improvement in the conditions of the unsprayed trees on account of the new growth and the migration of the oat aphid to its summer hosts. The rosy aphid was slightly more conspicuous than before and was curling some leaves on all of the trees, but at this date there were more affected leaves and larger numbers of the insects on the check trees. This insect increased in numbers during succeeding days, and on July 17 an examination of the sprayed plat showed one tree entirely free from infestation and twenty-one trees with varying numbers of affected fruit and leaf clusters, which in the main were few when considered on the basis of the great size of the trees in this orchard and the conditions of the checks with respect to injuries by the rosy aphid.

Test 2. Orchard of C. D. Tabor, Wilson.—In this planting forty-three trees of the variety Baldwin, about thirty-five years old, were sprayed on April 23 with lime-sulphur and nicotine solution (Black Leaf 40) in the proportions commonly recommended. To this plat two hundred eighty gallons of the spraying mixture were applied, making an average of six and one-half gallons of the liquid to each tree. At the time of treatment the young aphides, especially of *avenæ* were abundant on the green tips of the opening buds. Green aphid occurred in sparse numbers. The rosy aphid was not detected at this time notwithstanding the species caused serious damage during the preceding year. On May 21 the sprayed plat was entirely free of all three species of aphides, while the checks showed only occasional colonies of the oat aphid. On July 10 the conditions of sprayed plats remained unchanged, while a few colonies of the rosy aphid were detected on some of the checks. These trees, however, were generally free of the insects during the entire season and at the conclusion of the test no appreciable differences between treated and untreated trees could be detected.

Test 3. Orchard of B. S. Harwood, Appleton.—This experiment was conducted in a plat of thirty-six Greenings, which were fifty years of age and of unusual height, besides showing great horizontal growth of the lower limbs. The orchard is carefully sprayed each

year and has been well managed in all respects. It has the reputation of producing annually large yields of fruit. Owing to the height of the trees special towers have been constructed for the spraying machines so that the tops of the trees may receive thorough treatment. The applications of lime-sulphur and Black Leaf 40 were given on April 22 and 23, at which time the buds were green at the ends, and in the protected portions some of the young leaves had actually begun to separate. The buds were thickly covered with newly-hatched lice, principally the oat aphid, and scattering numbers of the rosy aphid. Apparently the green aphid was not present on the trees. In spraying, the trees were thoroughly wetted with the mixture, which was applied at the rate of fourteen gallons per tree. On May 15 a few specimens of the oat aphid and rosy aphid were observed in the treated plat, while on the checks the insects, especially the oat aphid, were abundant. On May 21 the differences between the two lots of trees were more marked. Scattering numbers of both species were on the treated trees. Occasional clusters of fruits showed evidences of injury, while the checks revealed greater numbers of the insects and considerably more clusters of deformed apples. On July 15 there was a greater contrast in the conditions of the trees owing to the fact that many of the affected leaves on the checks were turning yellow or were blackened by the sooty fungus, causing portions of the trees to present a sickly appearance. For the most part the sprayed trees showed relatively little curling of the leaves and the foliage had a vigorous, healthy appearance. In order that there might be more detailed knowledge regarding the effects of the spraying, counts were made of the affected leaf and fruit clusters of all the trees in the sprayed plat and two representative trees of the check plat. The data are presented in Table VI.

Test 4. Orchard of F. L. Backus, Olcott.—This test was conducted in a plat of thirty-two Greening trees, which are about twenty-six years old. The orchard of which the experimental plat is a part has been carefully managed and the trees, from their size, have the appearance of being considerably older than they really are. The spraying was made on April 21, using lime-sulphur and Black Leaf 40 at the rate of twelve gallons per tree. At this time the buds were well advanced, most of them being quite compact, although they showed green tissues at the tips. Occasional buds showed a

TABLE VI.—RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
Greening.....	Row 2, tree *1	Lime-sulphur and nicotine	0	0	18	4	No. 22	No. 0	No. 140
".....	" 2, " 3	" " " "	16	0	0	0	16	40	96
".....	" 2, " 5	" " " "	3	0	18	0	21	3	100
".....	" 2, " 7	" " " "	24	0	0	13	37	41	235
".....	" 2, " *9	" " " "	0	0	1	0	1	0	3
".....	" 2, " 11	" " " "	8	0	0	0	8	8	42
".....	" 2, " 15	" " " "	3	0	0	0	3	5	16
".....	" 2, " 17	" " " "	10	0	34	0	44	15	144
".....	" 2, " 19	Check.....	39	0	110	0	149	143	724
".....	" 3, " *2	Lime-sulphur and nicotine	0	0	0	3	3	0	20
".....	" 3, " 4	" " " "	23	0	0	0	23	42	108
".....	" 3, " 6	" " " "	10	0	0	0	10	16	55
".....	" 3, " 8	" " " "	17	0	0	12	29	28	157
".....	" 3, " 10	" " " "	7	0	0	26	33	9	302
".....	" 3, " 12	" " " "	11	0	0	0	38	38	251
".....	" 3, " *14	" " " "	0	0	0	1	1	0	7
".....	" 3, " 16	" " " "	7	0	0	0	28	7	147
".....	" 3, " *18	Check.....	0	0	125	0	125	0	734

* Tree produced no crop this season.

separation of the tips of the young leaves but none were sufficiently opened to afford protection to the insects. The infestation of buds in this orchard was greater than in any other of the experimental plats this season in this county. The insects were largely oat aphides, among which were scattering numbers of the rosy aphid. The green apple aphid was not detected.

As will be observed, some of the trees that were sprayed did not set fruit, while the two checks in both cases produced goodly numbers of apples. On May 21 the latter showed considerably greater infestation than any of the treated trees. On July 10 there was more or less curling of leaves on the sprayed trees, but the foliage was generally of good color and presented a healthy appearance. The checks at this date showed decidedly inferior conditions as the larger numbers of leaves that were infested were now either discolored by sooty fungus or becoming brownish, which caused the trees to appear sickly. Besides, there was more stunted fruit, and the clusters of small, deformed apples were visible in all portions of the trees. Because of the contrast in the conditions of the two lots of trees, close examination was made of each tree and all centers of infestation noted. The data as tabulated are given in Table VII.

EXPERIMENTS IN ORLEANS COUNTY.

Test 5. Orchard of H. H. Freeman, Kent.—There was set apart in this orchard a block of seventy-two Greening trees, averaging 30 to 35 years of age, of which three trees were reserved as checks. The orchard had been in sod for a number of years until the spring of 1915, when clean cultivation was adopted. The trees were well pruned and put into excellent condition for spraying, in which respects they had heretofore been neglected.

The aphides were very abundant on the trees and the opening buds were thickly covered with the creatures, which could be found on almost every blossom bud. The oat aphid especially and the green aphid were the most numerous, although the rosy aphid was pretty well scattered over the trees. The oat aphid had evidently hatched several days before the date of treatment as shown by individuals of this species in the second stage.

The experimental plat was sprayed on April 22 at which time the buds were well advanced and many of the leaves of the terminal buds were beginning to separate. Those, however, in the more ad-

TABLE VII.—RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.*	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
Greening	Row	Lime-sulphur and nicotine	0	0	13	0	No.	No.	No.
"	1, tree	"	0	0	13	0	13	0	72
"	1, "	"	0	0	18	0	18	0	90
"	1, "	"	0	0	25	0	25	0	125
"	1, "	"	4	0	0	0	4	12	20
"	1, "	"	15	0	43	0	58	15	280
"	1, "	"	15	0	16	0	31	15	180
"	1, "	"	5	0	7	0	12	5	40
"	1, "	"	1	0	16	0	17	1	85
"	1, "	"	2	0	17	0	19	2	76
"	1, "	"	0	0	25	0	25	0	142
"	1, "	"	5	0	73	5	83	19	305
"	1, "	"	6	0	14	5	25	6	108
"	1, "	"	0	0	9	1	10	0	88
"	2, "	"	4	0	19	0	23	12	103
"	2, "	"	0	0	107	0	107	0	421
"	2, "	"	11	0	0	0	11	40	60
"	2, "	"	14	0	13	0	27	14	55
"	2, "	"	5	0	37	0	42	25	160
"	2, "	"	0	0	20	0	20	0	100
"	2, "	"	0	0	11	2	13	0	102
"	2, "	"	0	0	12	0	12	0	51
"	2, "	"	2	0	39	0	41	2	198
"	2, "	"	6	0	30	0	36	0	200
"	2, "	"	8	0	17	0	25	0	105
"	2, "	"	0	0	9	0	9	0	32
"	2, "	"	1	0	0	0	7	0	23
"	2, "	"	1	0	28	0	29	1	61
"	3, "	Check.....	121	0	642	0	763	686	3,052
"	3, "	".....	800	0	0	0	800	987	3,800

* Omitted numbers in series indicate trees not infested. (Row 1, trees 4, 5 and 9; Row 2, trees 6 and 10.)

vanced stages of growth were still compact and were not sufficiently opened to afford protection to the young aphides. Lime-sulphur and Black Leaf 40 at recommended strengths was applied as a coarse, drenching spray, using the material at the rate of ten gallons per tree.

On April 28 it was quite difficult to find aphides of either species on the sprayed trees. No individuals of the oat aphid were observed, but they were abundant on the checks. Scattering individuals of the rosy aphid occurred in the treated plat, while on the checks they were fairly numerous. On May 20 occasional colonies of rosy aphid were noted on the sprayed trees, while the checks were becoming quite seriously infested. As on the previous date, the sprayed plat was entirely free of the oat aphid. Quite similar conditions prevailed on June 16, at which time comparatively few of the leaves of the treated trees showed evidences of infestation, and the foliage was dense and of a healthy appearance. On the contrary the checks revealed considerable numbers of curled leaves. Unfortunately, very few fruits set on any of the trees but, as it was, the untreated trees showed a larger number of "cluster" apples. By July 14 the rosy aphid had entirely disappeared, at which time the work of the aphides on the check trees was plainly manifested by the discolored leaves, which were then dropping. An examination was made of each tree in the experimental plat, and the data as collected are tabulated in Table VIII.

Test 6. Orchard of John Larwood, Albion. — There was chosen for this test a block of fifty-eight Baldwin apple trees averaging from 35–40 years of age. The orchard to which they belong is regularly sprayed and tilled. Until the present season no special treatment has been made to combat the different aphides that attacked the fruit and foliage, notwithstanding important losses have been occasioned by these pests. On April 22 when the spraying operations commenced, the buds, though showing green tissues at the ends, were for the most part still compact. Occasionally the terminal buds were somewhat more advanced, and showed tips of leaves. Owing to a warm rain and high temperatures the trees made a rapid growth and by the following day many buds showed young leaves that were well apart at the tips. Plant lice were present in large numbers on the majority of the trees, and these belonged chiefly to the green apple aphid and the oat aphid. The spray was a combination of

TABLE VIII.—RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
Greening	Row	Lime sulphur and nicotine	0	0	0	0	No.	No.	No.
"	1, tree	"	0	0	0	0	0	0	0
"	1, " 2	"	0	0	0	0	0	0	0
"	1, " 3	"	0	0	7	0	7	0	42
"	1, " 4	"	0	0	11	0	11	0	42
"	1, " 5	"	2	0	3	0	5	4	15
"	1, " 6	"	1	0	4	15	20	3	99
"	1, " 7	"	12	0	5	8	25	24	110
"	1, " 8	"	0	0	18	5	23	0	74
"	1, " 9	"	0	0	4	0	4	0	18
"	1, " 10	"	0	0	9	19	28	0	175
"	1, " 11	"	3	0	26	0	29	9	110
"	1, " 12	"	0	0	12	6	18	0	99
"	1, " 13	"	0	0	23	0	23	0	92
"	2, " 1	"	0	0	4	6	10	0	45
"	2, " 2	"	3	0	14	11	28	6	124
"	2, " 3	"	0	0	1	1	2	0	7
"	2, " 4	"	0	0	2	1	3	0	14
"	2, " 5	"	0	0	6	1	7	0	20
"	2, " 6	"	2	0	10	49	61	5	334
"	2, " 7	"	4	0	4	3	11	8	44
"	2, " 8	"	0	0	0	1	1	0	6
"	2, " 9	"	0	0	7	0	7	0	22
"	2, " 10	"	2	0	10	39	51	4	328
"	2, " 11	"	20	0	147	7	174	60	813
"	2, " 12	Check	39	0	58	42	139	94	823
"	1, " 13	"	22	0	122	43	187	31	812
"	2, " 14	"							
"	2, " 1	"							

lime-sulphur, arsenate of lead and Black Leaf 40, which were used at standard strengths. The mixture was applied as a coarse, driving spray at the rate of ten gallons to a tree.

On April 24 it was difficult to find live aphides on the sprayed trees, and dead individuals, ranging as high as ten specimens to a bud, could be observed with little difficulty. On May 20 the sprayed plat was quite free of infestation by the insects and that which occurred consisted of occasional leaf clusters occupied by the oat aphid. One small branch only was infested with the rosy aphid. No specimens of the green aphid were detected. On the other hand, the checks harbored considerable numbers of the oat aphid, and while not numerous, the rosy aphid was more conspicuous than on the sprayed trees. At the time of the final examination on June 16 the treated plat showed only an occasional injured cluster, and while the conditions in this respect were better than with the checks, the differences in the two lots of trees were not marked.

Test 7. Orchard of John Beckwith, Lyndonville.— There was reserved in this planting a block of fifty large Greenings, about forty years old. The careful attention given to this orchard seems to have made the trees increasingly susceptible to rosy aphid in spite of special treatments to control the pest. On April 21, when the test was begun, the buds were well advanced, showing generally green tissues at the ends. While in some instances the tips of young leaves had separated, lime-sulphur, with Black Leaf 40, was applied at the rate of twenty-two gallons per tree. At the time of spraying, the buds were well infested with aphides, varying from fifteen to fifty of the insects on the buds in the most advanced stages of growth. The oat aphid and the green apple aphid were most abundant, and subsequent events showed that the rosy aphid must also have been quite plentiful. As it was not deemed desirable to leave untreated trees in this orchard, a plat of Greenings across a lane was left unsprayed to serve as check.

On May 28 the unsprayed trees were abundantly infested with all three species of aphides while the sprayed trees were quite free of the insects, showing only scattering colonies of the oat aphid and the rosy aphid. By June 16, great differences developed between the sprayed block and the adjacent unsprayed Greenings. The contrast was due to the relatively larger number of small, deformed apples on the untreated trees and the sickly appearance of the

affected leaf clusters, many of the leaves of which were turning yellow and dropping.

Test 8. Orchard of H. B. Gibson, Albion.—Twenty-three trees were reserved for the test in this orchard. These were Greenings, about thirty-seven years old, which, with the remainder of the planting, have received systematic attention with respect to cultivation, spraying, etc. No efforts have in the past been made to control plant lice, which during some years have caused considerable damage to fruit yields. The spraying was not attempted until April 24, when the development of the buds was more pronounced than in any other of the experimental plantings. Many of the outer leaves of the buds had separated at the ends and had grown to considerable size. On the whole, the aphides were not abundant, although they were well distributed among the different trees, ranging generally from one to ten of the creatures to a bud. Most of them belonged to the oat aphid, but intermixed with these there were scattering numbers of the rosy aphid. The spraying mixture consisted of lime-sulphur, arsenate of lead and Black Leaf 40 in combination, which was applied at the rate of nine gallons per tree.

During the period of April 28 to May 4 the insects were not numerous on any of the trees, irrespective of the treatment they had received. By May 20 occasional colonies of rosy aphid were observed on the sprayed trees, while the checks showed evidences of considerable infestation. When the final examination was made on July 15 there was no appreciable evidence of injury to the foliage of the treated plat, while the checks showed extensive curling of the leaves, some of which were turning yellow or brownish and dropping. Conditions of the trees with respect to fruit injuries by the rosy aphid are indicated in the accompanying table.

Test 9. Orchard of G. E. Snyder, Albion.—This planting has sustained great losses from the rosy aphid, and the attacks have been most severe in a block of Greenings with some Holland Pippins used in this experiment. The trees are about 35–40 years of age. The spraying was done on April 22, at which time the buds were well advanced and tips of young leaves were beginning to separate. The oat aphid and the green apple aphid were well distributed among the buds, and while not as numerous as the foregoing species, the rosy aphid was fairly abundant on the lower areas of the trees. In general the infestation of the buds by the different aphides was lighter than in

TABLE IX.—RESULTS OF SPRAYING AGAINST ROSY APHIS.

VARIETY.	Row and tree.	Treatment.	CONDITIONS WITH RESPECT TO INJURIES.				Centers of infestation.	Fruits injured.	Leaves curled.
			Fruit clusters affected.	Terminal shoots affected.	Leaf clusters affected.	Water sprouts affected.			
Greening.....	Row	1, tree	0	0	0	0	No.	No.	No.
".....	"	"	0	0	0	4	0	0	0
".....	"	"	2	0	2	9	6	0	33
".....	"	"	5	0	5	4	16	6	81
".....	"	"	0	0	0	0	9	12	32
".....	"	"	9	0	0	13	13	0	100
".....	"	"	0	0	10	9	28	18	130
".....	"	"	0	0	0	2	2	0	4
".....	"	"	0	7	7	2	16	0	37
".....	"	"	17	0	14	4	35	33	118
".....	"	"	0	0	3	0	3	0	10
".....	"	"	0	0	1	7	8	0	36
".....	"	"	4	0	7	9	20	10	114
".....	"	"	0	0	0	1	1	0	2
".....	"	"	0	0	2	6	8	0	32
".....	"	"	0	0	8	0	8	0	22
".....	"	Check.....	88	0	37	0	125	225	467
".....	"	"	48	0	24	12	84	87	314
".....	"	"	14	0	24	16	54	23	400

the other experiments. The spraying mixture consisted of lime-sulphur, arsenate of lead and Black Leaf 40 in the usual proportions, and was applied as a mist-like spray at the rate of 14 1-2 gallons per tree.

On April 28, as the blossom buds were showing pink, it was difficult to find aphides on either the sprayed or unsprayed trees. By May 19 the insects were more conspicuous and both the oat aphid and the rosy aphid were quite plentiful on the checks, while scattering numbers of the latter species were observed on the treated trees. On June 16 the infestation was light in both cases, and while there was not any material damage there were however fewer evidences of affected leaf and fruit clusters on the sprayed plot than on the check trees. Conditions similar to the foregoing existed until July 16, the date of the last examination, except that the checks showed more browning and dropping of leaves, which were, however, unimportant in extent.

Test 10. Orchard of Lynn Burrows, Albion.— This test was made in a planting of one hundred trees of Wealthy, interplanted with Duchess. The trees are twelve years old and are, because of the careful attention they have received, large for their age. For the past seven or eight years aphides have been very abundant and have checked the growth of some of the trees. Spraying was done on April 23 with lime-sulphur, arsenate of lead and Black Leaf 40 in the usual proportions, using two gallons of the mixture per tree. The buds were green at the ends and generally infested with plant lice, the oat aphid being the most numerous of the three species.

On April 28 few lice could be found on the sprayed block, while the checks showed much greater infestation. An examination on May 19 found the treated trees quite free of the insects, while the checks were generally infested with aphides, among which were scattering numbers of the rosy aphid. Similar conditions prevailed as late as July 14, when the sprayed plot was still in an excellent state of health.

DISCUSSION OF RESULTS OF AUXILIARY EXPERIMENTS.

The rosy aphid was not generally injurious in most of the apple orchards in Niagara and Orleans counties. As was, however, the experience of individual growers, the insect was quite abundant in a number of the orchards under experiment. In two of the auxiliary tests the rosy aphid was of no importance, while in the remaining plant-

ings, eight in number, the pest caused more or less damage. The trees which were sprayed as the buds were expanding showed, on the whole, appreciable benefits from the treatments. While in all of the experiments there were slight infestations on many of the sprayed trees, the injuries by the insects were scattered and there were no important losses in fruit yields. The general conditions of the trees following the spraying were, as compared with the appearances of the checks, excellent.

METHOD OF TREATMENT.

FORMULAS FOR SPRAYING MIXTURES.

FORMULA I, NICOTINE SOLUTION.

Nicotine solution 40 per ct.....	$\frac{3}{4}$ pt.
Water.....	100 gals.
Soap.....	3 to 5 lbs.

FORMULA 2, KEROSENE EMULSION.

Kerosene.....	2 gals.
Fish-oil soap.....	$\frac{1}{2}$ lb.
Soft water.....	1 gal.

Directions for making kerosene emulsion are as follows:

Dissolve the soap, which has been finely divided, in one gallon boiling water. Remove the vessel from the stove and add the oil. Then agitate the mixture violently for from three to five minutes by pumping into itself under high pressure until a creamy mass is formed, from which the oil does not separate. Fruit growers are advised not to employ an emulsion which shows a separation of the oil as application of such preparations may cause injuries to the trees. This is used with success by some growers for summer spraying against the lice at a dilution of one gallon of the emulsion to eight gallons of water.

FORMULA 3, FISH OIL SOAP.

Fish oil soap.....	12 to 20 lbs.
Water.....	100 gals.

To prepare for use, slice the soap and dissolve in boiling water. Soap varies greatly in its water content, and before undertaking extensive operations the grower should make a preliminary test to determine the amount of material required to make an efficient spray, judging by the effects of the dilution on insects and foliage.

FORMULA 4, CARBOLIC ACID EMULSION.

Fish-oil soap.....	15 lbs.
Carbolic acid (crude).....	1 pt.
Water.....	100 gals.

Dissolve the soap in a small quantity of water. Add the carbolic acid in small quantities at a time, stirring vigorously.

COMBINATIONS OF SPRAYING MATERIALS.

Many pests of fruit trees pursue their injurious activities at similar periods of time and some of them are jointly susceptible to a single application of an insecticide or to a combination of spraying materials. As the expense of insecticides is usually much less than the cost of labor and team, it is desirable from the standpoint of economy and time to reduce the number of applications to the minimum. One means to this end is to employ combination mixtures or, as they are popularly called, "two in one" or "three in one" sprays, according to the number and nature of constituents contained in them.

From the standpoint of safety to expanding buds and leaf tissues, and effectiveness against insects, the most satisfactory combination is three-fourths of a pint of nicotine solution (40 per ct.) to one hundred gallons of lime-sulphur solution at winter strength for bud treatment or to one hundred gallons of lime-sulphur at summer strength with arsenate of lead for foliage applications. While this combination lacks somewhat the spreading properties of soap mixtures, oil emulsions or nicotine solution with soap, this deficiency is probably more than compensated by the saving in labor in avoiding an extra application and by the thoroughness of spraying in the bud treatment when lime-sulphur is directed also against the San José scale. Drenching of the trees with this combination as the buds are breaking may injure the tips of the unfolding leaves. However, the damage is usually inconsequential and should cause no apprehension.

DIRECTIONS FOR SPRAYING.

On the basis of the experiments conducted by this Station the most promising means of combating the lice is a thorough spraying of the trees at the time when the insects are assembled on the ends of the buds showing green and while the buds are compact and the tips of the

unfolding leaves are barely showing. (See Plate VI.) As the creatures that appear on the opening buds are the progenitors of many broods that are to follow, and constitute the first and only forms that infest leaf and fruit clusters at this period, special efforts should be made to allow as few as possible of these insects to escape this treatment. To this end apply the spraying mixture in liberal quantities and under high pressures, using nozzles with rather coarse apertures and endeavoring to wet all of the buds thoroughly.

TIMING OF SPRAYING OPERATIONS.

It is common knowledge that varieties differ as to the time of opening of buds, and that trees of the same variety may show retarded or accelerated growth, according to the conditions of their environment. For these reasons the grower needs to take into consideration the stages of growth of the different varieties, waiting until the lice are massed on the opening buds and keeping in mind the importance of killing the insects before they obtain protection in fuzzy, unfolding leaves of the opening buds.

LATER APPLICATIONS.

The grower should endeavor to combat the pests by the foregoing measures and thus avoid, if possible, the necessity of later sprayings. If bud treatment has been omitted or this application has not given entirely satisfactory results, one should spray with one of the foregoing mixtures as soon as the aphides are detected in numbers, endeavoring by high pressures to reach as many of the creatures as possible. Since curling of the leaves and production of the second generation begin at the time of blossoming it appears from experiments to date that the supplementary treatment should be made before blossoming preferably or soon after the petals drop. There are serious objections to spraying during late May or early June because of the danger of early injuries to fruit and leaf clusters and the difficulty of reaching the lice in the curled leaves, which becomes greater as the infestation increases. The protection gained by this spraying will afford some measure of relief and perhaps tide the trees over a critical period.