A STUDY OF A DORMANT SPRAY CONTAINING DIFFERENT PROPORTIONS OF OIL AND DINITRO-ORTHO-CYCLO-HEXYL-PHENOL WITH EMULSIFIERS VARYING IN QUANTITY AND COMPOSITION

A Thesis submitted to the Graduate
Committee in partial fulfillment of
the requirements for the degree of

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in
Horticulture

by
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Approved:

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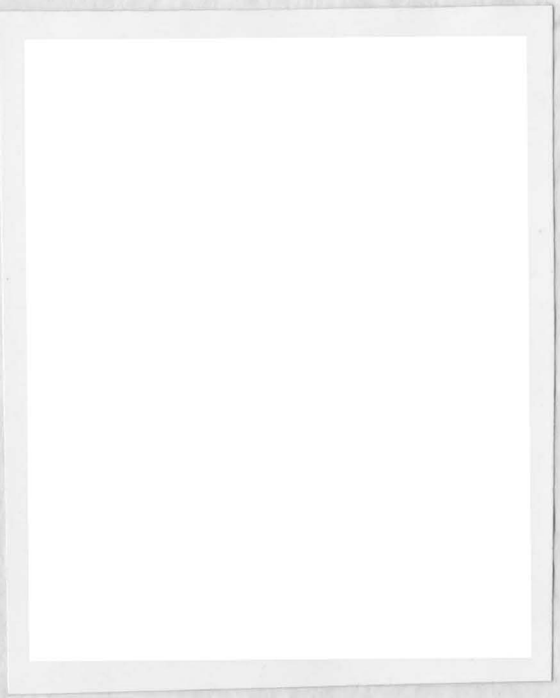
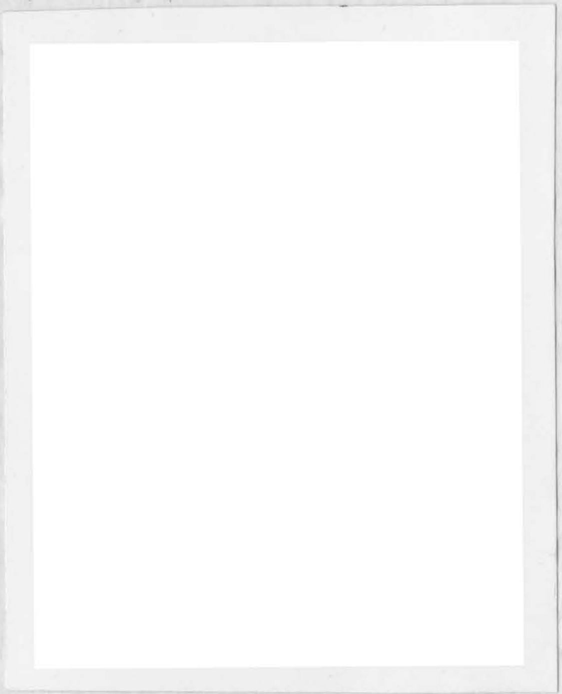
DEDICATION





To H.L. Price, dean of agriculture, and my father, A.H. Teske, professor of horticulture, I dedicate this thesis. Without the help and inspiration given freely by these two men, horticulture in the State of Virginia and at Virginia Polytechnic Institute would not have reached its present height and standing.

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The author wishes to express his appreciation and thanks to H.L. Price, dean of agriculture, to A.H. Teske, professor of horticulture, and to other members of the staff of the Virginia Polytechnic Institute; to [illegible] of the [illegible] and to those fruit growers throughout the State of Virginia whose cooperation has made this work possible. The author also wishes to express his thanks and appreciation to the commercial companies, especially the [illegible] for their invaluable assistance in furnishing information and materials.

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INTRODUCTION

This investigation was planned to study the new dormant spray, Dinitro-ortho-cyclo-hexyl-phenol in relation to its use under Virginia conditions for the control of certain insects with which the Virginia orchardist has constantly to deal.

HISTORY

An extensive survey of the available literature indicates that oils have been used as insecticides for more than a century and a half. According to Mason (48) "Goese, in 1763, wrote 'Petroleum, turpentine and other oils are also recommended for combating plant lice, but care must be taken in their use, since they also act upon plants, making them sick and even killing them.' The same observations pertain today." A number of years later (in 1825) Murray (52), working with hyacinths and tulips in an effort to find a satisfactory method of destroying earthworms, recommended putting a drop of oil in each worm hole and then pouring in water. Fennel (24), in 1839, reported that oil and soot well mixed together and applied with a brush were effective against woolly aphis. A kerosene emulsion was first used in 1868 against the currant worm (48), and in 1874 the Hubbard-Riley kerosene emulsion formula was published (48), remaining the standard oil spray until 1901 when there appeared the materials which were the forerunners of our present oil emulsions and miscible oils. In the next year (1875), it was recommended that a little oil be mixed with a moderately strong soap suds, the dilution of which, however, must be suitable for the plant requiring treatment (47). From this time on, it is evident that there was a wide spread interest exhibited in the use of oils as insecticides. A statement by J.A. Lintner (45) in 1883 indicates that paraffin oil obtained by the distillation of cannel coal had already been used as an insecticide in England. The use of crude tar oil (against grape phylloxera) was first mentioned in 1890 (63). Some experimental work carried on in 1899 (67) showed that crude undiluted petroleum or crude petroleum in 25 per cent and 40 per cent solutions could be applied during the winter without injury to the trees. These dilutions were applied to orchard trees (with the exception of cherry) varying in age from nursery stock to old trees in full bearing. In some instances it was found that the oil acted as a stimulant and the trees actually showed greater vigor and better foliage than those which were not treated.

In 1897, W.B. Alwood of Virginia recommended the use of kerosene as a winter wash for old fruit trees, pointing out that low grades of kerosene are more dangerous to plants than high grades and that they should be used only on bright warm days when the plants are dry (1). In 1898, he observed that kerosene may be safely used upon all the fruit trees in the dormant season (2). The next year, in carrying his experiments further, he stated that pure kerosene and a 30 per cent mixture of kerosene and water had been used on young trees without injury and that no live scale could be found on the trees so treated (3). In 1903, Alwood stated that he did not recommend the use of pure kerosene except when absolutely necessary, but that mixtures of kerosene and water could be used safely and successfully if care was taken in making the application. He also said that crude petroleum could be used only on dormant trees (4).

During the period 1900-1911, there probably was exhibited a more intense interest in dormant spraying than at any other time before or since. This interest was due primarily to the widespread and destructive action of the San Jose scale. It was during this period that the crude petroleum and miscible oils got their start.

E.P. Felt (19, 20, 21) stated in 1900 that it was not safe to use pure kerosene or crude petroleum on fruit trees since injury or even killing had resulted in nearly every case. He stated further that a 20 per cent mixture of crude oil and water could be used with a fair degree of success, and that the use of kerosene and crude petroleum in mechanical mixtures and emulsions made with soap was comparatively safe if applied to fruit trees before the buds were open. Spring applications of kerosene and kerosene mechanical mixtures, however, gave poor results. In a continuation of his work with San Jose scale, Felt (22) found that a mechanical mixture of 20 per cent crude petroleum was very effective and that little injury resulted from several early spring applications, but that its continued use over a period of four years caused increased thickness and roughness of the bark. The use of undiluted crude petroleum on pear, plum and peach trees caused some injury (28), however, no damage was apparent after the application of 15 per cent and 30 per cent mixtures of petroleum and water to plum and peach trees. At the same time a 15 per cent and 20 per cent mechanical mixture of kerosene was applied; however, the mixture of crude petroleum seemed more effective.

In these experiments the bloom was not injured, although in some cases the buds were swelling, just ready to burst or actually opening.

C.A. Keffer of Tennessee (41) also did some work with the use of oil combating San Jose scale. He stated that crude petroleum when used in a 20 to 25 per cent solution (kerowater) was reliable but dangerous to apply because of injury. He stated further that its use was not recommended because of this fact and also because it checked growth in the spring.

It was in 1904 that Scalecide was introduced by the B.J. Pratt Company. It was one of our first commercial oil sprays and is still on the market.

Perhaps the best summary of this period (1900-1911) is found in a Cornell bulletin (80) which has this to say about petroleum and miscible oils "Some have used these materials with excellent results; others report complete failure; while others find that the results are inconsistent in character." Those of us who are working with dormant sprays at the present time can understand why this might be true, since poor results are due primarily to faulty spraying. Even with our much-improved methods of spraying, we find people condemning certain reliable sprays, when the fact is that they have failed to obtain complete coverage.

The period from 1911 to 1920 was a rather quiet period from the standpoint of oil sprays. It might be classed as a dormant period in which recommendations were based on the findings of previous periods.

According to Quaintance (61, 62) the kerosene and petroleum preparations were being replaced as dormant or winter sprays by miscible oils. In 1913 Felt (23) stated that the use of oils or oil preparations had, in several cases, resulted in severe injury. According to Felt, a power of a tree to resist penetration and injury by oils undoubtedly varies with the seasons and probably from year to year. These variations are due to climatic and cultural conditions. It is impossible to be sure that injury will not result from spraying dormant trees since certain weather conditions are more conducive to injury by oils than others. On the whole there seems to be less danger in spring treatments than in fall treatments. Apparently there is more resistance to the penetration (and consequent injury) of the oil in the spring just before growth begins, and also, at this time destroyed tissue is more quickly replaced.

Further experiments with miscible oils by Essig of California (16) show that in oil emulsions, distillate caustic soda water mixture and miscible oils often separate out, if the water contains very much mineral matter. Therefore, in order to avoid oil injury to the trees, such emulsions should always be applied with a good power machine equipped with a forceful agitator which must be kept going.

While oils were generally used for the control of scale insects, nicotine was used as a contact insecticide in the pre-blossom sprays for the control of rosy aphis and other sucking insects. Nicotine, however, was costly, and could not always be relied upon to secure satisfactory results in the control of rosy aphis.

With the large increase of San Jose scale about 1920, the interest in lubricating oils was again revived in the Middle West. The insecticidal value of oil sprays is due chiefly to their asphyxiating effect (36). Some of them may also have a certain degree of corrosive effect. To be killed by the spray, however, an insect must be actually hit. Oil sprays possess a peculiar creeping power which enables an operator to cover a tree even under unfavorable conditions. It should be noted that distinct injury has sometimes followed the use of these oils. Oil tests made at strengths down to one to four resulted in the control of San Jose scale without injury to the apple trees sprayed (27). Dormoil and fuel oil used in the spring as the buds began to swell gave nearly 100 per cent control of Oyster Shell scale, yet apparently no injury occurred (17).

In 1924, G.F. McLeod of New York (49) found that oils delayed egg hatching for two weeks after the unsprayed eggs had developed. According to McLeod, a miscible oil, from the standpoint of control, should possess the ability to penetrate the protective coat of the egg masses when applied at a strength which would not result in injury to the tree.

P. Garman (25), in his work with European Red mite in 1922, found that Jarvis compound gave the highest kill (99 per cent) of the materials tried. This was a miscible oil containing phenol 1 to 15. This experiment clearly indicates the value of miscible oils as ovicides. Garman points out, however, that such oils, if used in excessive quantities, may become dangerous to apple trees, particularly to the trunk and larger limbs. In the very late sprays there is also danger to the flower buds - more so than with lime sulfur or substitutes - since the oil works in more among the buds.

In 1925 there appeared a formula for making a boiled fish oil soap (60). This lubricating oil emulsion at a strength of 2 per cent was used chiefly for San Jose scale in the dormant season. With the use of a properly prepared emulsion, no injury has resulted nor has any cumulative injury appeared as yet in the use of this oil.

Tattersfield, Gimingham and Morris (72), in their study on Quantitative Examination of the Insecticidal Action of the Chlor-, Nitro-, and Hydroxyl Derivatives of Benzene and Naphthalene, state:

"Both 2 : 4 - dinitro-phenol and 3 : 5 dinitro-o-cresol proved highly toxic to the aphids, the cresol-derivative, both weight for weight and mole for mole, being somewhat the more toxic of the two. In summarizing the position with respect to these compounds tested, it appears to be established that their toxicity runs in the following order: phenol o-nitro-phenol m- and p-nitro-phenol 2 : 4 -dinitro-phenol tri nitro-phenol (picric acid) and the same order would apply to the cresols and their corresponding derivatives."

Antinonnine, which is a potassium salt of dinitro-o-cresol mixed with soap, was put on the market as an insecticide in the form of a paste more than 30 years ago by a German firm with the claim that it destroyed both biting and sucking insects (72). Lodeman (46) used antinonnine in 1893 on apple, gooseberry, raspberry, blackberry and quince, but this was applied as a foliage spray which gave quite severe injury to the foliage.

In 1922, de Ong (14) mentions that spraying with oil should be avoided when the trees are very dry, for example: following a heavy north wind because of the fact that there is a greater possibility of absorption of the oil by the trees at such times, since the amount of moisture in the twigs has been reduced. Concerning the use of mineral oil sprays, certain objections have been raised. (1) A cumulative effect following the use of oil year after year may cause injury. It is pointed out, however, by Melander (50) that in California, oils used continuously in some orchards for nearly twenty years have caused no apparent injury, and that this has also been true in Washington. (2) Trees sprayed by oils are subject to winter injury. The experiences of Melander (50) in Washington show that the proper use of oils is not related to winter injury although oils should not be applied in the fall, during freezing weather, or soon after extremely cold weather. (3) A setback to certain trees in orchards sprayed with oil has occurred. This is probably due (50) to the use of the wrong oil, using too strong a concentration, spraying too late or applying the last part of a tank of poorly emulsified or unstable spray. It was noticed, however, that trees checked by late spraying recovered; and, when buds were killed by too strong or the wrong oil, no serious permanent injury to the tree resulted. When leaves were burned, they were replaced by new growth. According to Harman (30), there is always more or less danger of injuring the buds and sometimes the trees when using sprays containing 6 to 8 per cent oil. Therefore, the application should not be delayed until too late, that is: after green tissue is showing on the buds. Even under ideal circumstances, a little injury has occurred, but never of a serious nature. He also states that an 8 per cent oil spray used for three successive seasons failed to show any signs of cumulative injury. Kelley (42) found that during the dormant season (before the separation of the bud scales), all the oils accelerated respiration; however, when applied just after this period (before the leaves had unfolded), they retarded respiration. It is interesting to note that of all varieties tested, Stayman and Winesap have proved to be the most susceptible to oil injury (60) and that no cumulative injury has resulted from the use of oil sprays on peach, apple and cherry trees (71).

Tar oils were first used to any appreciable extent in Germany and

England for the control of aphis. Tar oils as dormant sprays were introduced into England in 1920. They were first used in the United States (in an experimental way) by R.H. Hurt in 1927, who found that the tar oils, when applied to orchard trees in the dormant state, were effective in destroying the eggs of rosy aphis (39-40). Probably our first definite information as to the effects of yearly applications of oils on trees was from Maryland (8), (Re: pine tar oils in the control of woolly aphis). Two applications per year of an 8 per cent solution seems to offer the best promise for control of plant lice with a minimum risk of injury to the tree. Repetition of the two applications per year for three years caused a considerable amount of injury. The tar oils, however, were not found effective in controlling scale insects. During a five year test of tar washes (33) using concentrations ranging up to 12½ per cent, no injury occurred on any varieties except Twenty Ounce when the concentration was not over 7½ per cent. The tar oils, however, were not found effective in controlling scale insects (12).

Later it was found that the tar oils and petroleum oils could be combined (30) for a satisfactory control for both scale and aphis in the proper proportions.

By 1935, (66, 83, 10, 65, 81, 82) the combination of petroleum and tar oils had become the standard dormant spray for the control of scale and aphis. While the tar oils and combination of tar oils and lubricating oils were efficient dormant sprays for the control of scale and aphis, there was, however, one serious drawback to using a spray containing tar oil and petroleum oil, namely; the caustic property, causing injury such as irritation and burns to those who were applying them.

In 1936, a new dormant spray appeared which was also effective in controlling rosy aphis in the egg stage as well as controlling scale insects. This new material was di-nitro-ortho-cyclo-hexyl-phenol, dissolved in lubricating oil. Not only is it efficient in controlling rosy aphis, scale and other sucking insects, but further, does not have the disadvantage of having a burning or caustic property.

OBJECT

The object of this study is to determine what effects the varying amounts of dinitro-ortho-cyclo-hexyl-phenol, either in oil or water sprays, with different emulsifiers, has on penetration, injury and effectiveness.

Procedure

A. Materials

Materials and descriptions which were used in this study will be found in Tables I and II.

B. Methods

1. Laboratory Studies

a. Laboratory studies were used in trying to determine the effects of the different emulsifiers on the depositing qualities of the various materials. The laboratory equipment consisted of:

(1) Four-ounce sample bottles. In order to get uniform results, it was necessary to apply the spray to some surface which would have a constant weight. It was decided, therefore, to use four-ounce oil sample bottles having an area of 24.4 square inches on the sides exclusive of the area of the neck and top. They were fitted with copper wire around the neck and with a loop of the wire over the top. This loop could be moved from side to side and provided a means of handling the bottles with tongs, thus eliminating the necessity of actually touching the bottle itself.

(2) Beeswax. A pure white beeswax of high melting point was used to coat the bottles prior to spraying them. This wax was

TABLE I

DORMANT SPRAY COMPOSITION

Designation	Oil Used	Added Components: Name	Added Components: %	Properties of Mix: Lbs. per Gallon	Properties of Mix: Gallons used per 100 Gallons of Diluted Spray	Emulsifier Mix: % Goulac	Emulsifier Mix: % Benton-ite	Emulsifier Mix: % DNOCHP	Emulsifier Mix: # used per 100 Gallons of Diluted Spray	Sent to Blacksburg, Virginia
38-D-1	10224	DNOCHP	4	7.711	1,2,3					20 gal. Standard Oil of Indiana Formula 10224
-2	"	"	3	7.686	"					20 gal.
-3	"	"	2	7.653	"					20 gal.
-5	"	"	0	7.620	"					40 gal.
-6	527	"	4	7.676	"					20 gal. Standard Oil of N.J. Orchard spray #527
-7	"	"	3	7.671	"					20 gal.
-8	"	"	2	7.627	"					20 gal.
-9	"	"	0	7.587	"					40 gal.
-22						21.0	63.4	15.6	1.5	15 lb. Dry mix corresponding to 38-D-2 @ 1/100
-23						18.2	54.8	27.0	1.75	15 lb. Dry mix corresponding to 38-D-2 @ 2/100
-24						16.1	48.2	35.7	1.98	15 lb. Dry mix corresponding to 38-D-2 @ 3/100
-31						50	50		$1\frac{1}{2}$	40 lb.
-32						25	75		$1\frac{1}{2}$	2 cases
-33						10	90		$1\frac{1}{2}$	30 lb.

10224 oil = 110-115 Sec. Saybolt viscosity
527 " = 155-165 " " "

See tabulation at end of this report (Plate No. A-779). The following notes are given to clarify items in the tabulation.

<u>38-D-22</u>: Goulac used in this and following dry mix compositions was purchased from the American Gum Products Company. The bentonite was purchased from the Wyodak Chemical Company. This dry mix composition is to be used at 1.5 pounds per 100 gallons and with 1 gallon of oil to make a spray mixture corresponding to 38-D-2 or 7 at 1 gallon per 100 gallons.

<u>38-D-23</u>: This dry mix composition is to be used at 1.75 pounds per 100 gallons and with 2 gallons of oil to make a spray mixture corresponding to 38-D-2 or 7 at 2 gallons per 100 gallons.

<u>38-D-24</u>: This dry mix composition is to be used at 1.98 pounds per 100 gallons and with 3 gallons of oil to make a spray mixture corresponding to 38-D-2 or 7 at 3 gallons per 100 gallons.

<u>38-D-31</u>: This is an emulsifier composition to be used at 1¼ pounds per 100 gallons with the oil-dinitro composition listed above.

<u>38-D-32</u>: This is our standard emulsifier composition to be used 1¼ pounds per 100 gallons with the oil-dinitro compositions listed above.

<u>38-D-33</u>: This is an emulsifier composition to be used at 1¼ pounds per 100 gallons with the oil-dinitro compositions listed above.

The oil used in 38-D-1, 2, 3, 4, and 5 is from the Standard Oil of Indiana and is designated 10224 oil, and is purchased under these specifications:

Sp. Gr. 60/60° F.	.88 - .92
Viscosity at 100° F.	100 - 115 seconds Saybolt
Cold Test	-20° F. or less
Sulphonation Value (Whiting Method).	89% or less

Orchard Spray Oil No. 527 was purchased from Penola Incorporated (Standard Oil of New Jersey) under these specifications:

Sp. Gr. 60/60° F.	.91- .02
Viscosity at 100° F.	155 - 165 seconds Saybolt
Pour Point	-6° F. or lower
Sulphonation Value (Whiting Method).	89% or less

TABLE II

DORMANT SPRAY COMPOSITIONS

Designation	Oil Mix						Emulsifier Mix							Amount Shipped
	Oil Used			Toxicant			Toxicant							
	Name	Visc. in Saybolt Sec. at 100°F.	Oil	Name	%	Wt. in # per gal.	Name	oz. per bag	%	% Goulac	% Bent.	% Soy Flour	#Mix per bag	
39-D1	10224	108	96	DNOCHP	4	7.71								50 gal.
39-D5	10224	108	100	none		7.62								100 gal.
39-D22							DNOCHP	8	28.6	35.7	35.7		1.75	25 bags
39-D31							DNOCHP	8	40		40	20	1.25	50 bags
39-D39										50	50		1.25	3 cartons

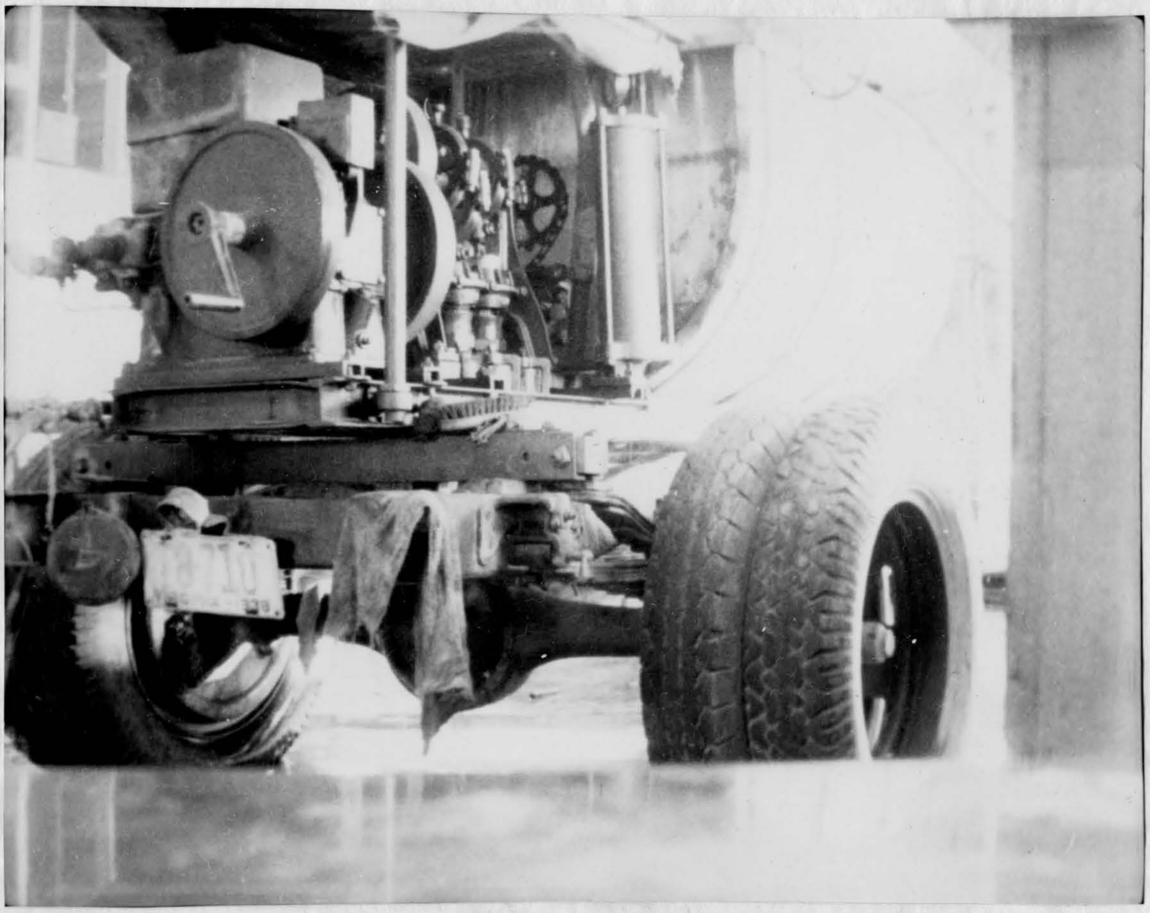
used to coat the bottles, so as to give as uniform a surface as possible, bark and twigs having a very non-uniform surface.

(3) Balance. A Christian-Becker Inc. balance, weighing accurately to 1/10000 of a gram, was used.

(4) Oven. A Phipps & Bird electric oven, thermostatically controlled was used for heating the beeswax and the bottles. It was fitted with hooks in such a manner that the bottles were suspended while in the oven.

(5) Spraying apparatus. The apparatus for spraying the bottles, as set up in the laboratory, consisted of a Bean portable sprayer (tank capacity 200 gallons), mounted on a truck, and pumping about eight gallons per minute at 250 pounds pressure. (Fig. I) The spray rod used was a four nozzle Hardie broom placed five feet from the nearest bottle. (Fig. II) The rod was so placed and fastened that it remained stationary throughout the various runs. The hose was left connected to the rod so as not to change the position of the broom. For mixing the material, another line of hose and a Friend spray gun were used, the materials being pumped back on themselves to insure a good emulsion. A shield which could be raised or lowered by means of a rope and pulley, was placed between the nozzle of the broom and the bottles, so that even pressure and average material could be obtained before the actual spraying of the bottles began. (Fig. II) To hold the bottles while they were being sprayed, five wooden pegs were so constructed as to fit into holes bored at intervals about the circumference of a ten inch wooden disc, and these pegs were removable and of such a size that they would fit inside the

Fig. I



Bean Sprayer Mounted on Truck

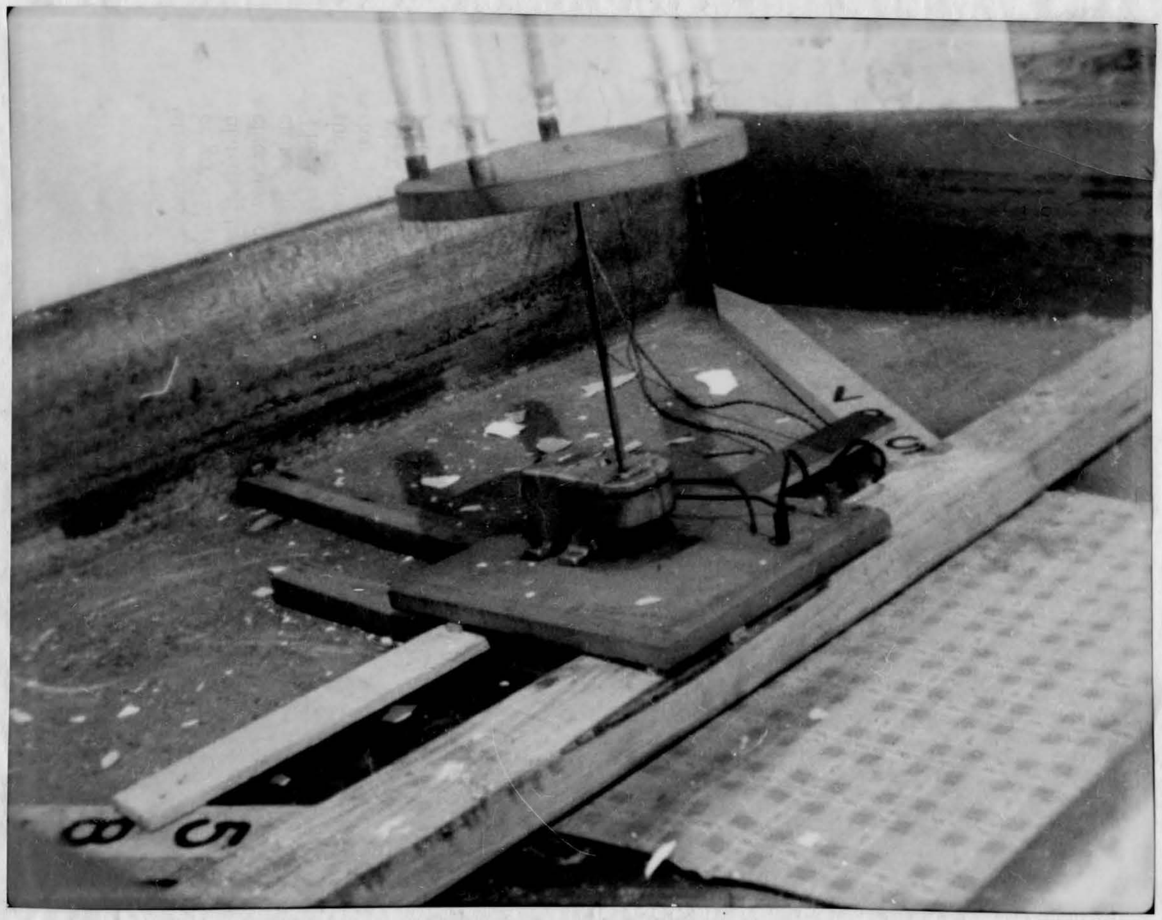
Fig. II

View Showing Hardie Broom; Shield; and Bottles ready to be sprayed bottles holding them one inch above the disc. The intervals at which the holes were bored around the circumference of the disc were so arranged that no bottle was at any time between another bottle and the nozzle of the spray rod. In other words, some part of each of the five bottles placed on the disc at one time was receiving some of the spray material during the entire spraying process. The wooden disc was mounted on a ten inch shaft which was revolved by a Type 952 W Speedway motor at the rate of eleven revolutions per minute. (Fig. III)

The bottles were first placed in the oven and heated to a temperature of 100° C. They were then dipped in the beeswax which had been heated to the same temperature. From the start of the experiment until the end, the bottles were handled only with tongs by means of the wire loop previously described. After dipping, the bottles were hung in the oven and allowed to remain at 100° C. for ten minutes to allow the excess wax to drain off and to insure a thin even coating. The bottles were then removed from the oven and suspended from hooks attached to a wire, strung up in the laboratory, and allowed to dry at room temperature for at least two hours. This was done to insure a complete hardening of the wax coating before weighing and spraying. The bottles were then weighed. During the weighing process, the bottles were suspended from the arm of the balance rather than placed on the pan. The bottles were sprayed as soon after weighing as possible. A wooden peg was inserted in the bottle and the other end of the peg was placed firmly in a hole on the wooden disc described above.

The bottles were sprayed in sets of five, a different spray material being applied to each set. In the laboratory, 30 different

Fig. III



Apparatus for holding and rotating bottles during spraying emulsions were used. With 110-115 viscosity oil, the following proportions of oil and dinitro-ortho-cyclo-hexyl-phenol were used: (1) 96 per cent oil and 4 per cent dinitro, (2) 97 per cent oil and 3 per cent dinitro, and (3) 98 per cent oil and 2 per cent dinitro. Each of the three mixtures was used at concentrations of 2 per cent or two gallons of oil and dinitro per 100 gallons of water, and 1½ per cent, or 1½ gallons of oil and dinitro per 100 gallons of water. With each of the resulting mixtures, three different emulsifiers, composed of goulac and bentonite in the following proportions, were used: (1) 50 per cent goulac and 50 per cent bentonite used at the rate of 1.25 pounds per 100 gallons, (2) 25 per cent goulac and 75 per cent bentonite used at the rate of 1.25 pounds per 100 gallons, and (3) 10 per cent goulac and 90 per cent bentonite used at the rate of 1.00 pound per 100 gallons. With the 155-165 viscosity oil, the oil and dinitro-ortho-cyclo-hexyl-phenol were used in proportions of 97 per cent oil and 3 per cent dinitro and 98 per cent oil and 2 per cent dinitro at the same concentrations and with the same emulsifiers as the 110-115 viscosity oil.

The emulsions were made in 50 gallon lots. Twenty gallons of water were added first, covering the lower agitator blade, and the emulsifier was then added. This was pumped back into the tank for about three minutes to insure an even distribution of the emulsifier. The oil was then added and the mixture pumped back on itself for about five minutes. Then the rest of the water was poured into the tank. When an even 250 pounds pressure was reached, the shield was raised and the bottled were sprayed for 16 seconds or during three complete revolutions of the disc. The shield was then dropped again. The tank was drained and thoroughly washed out before the next spraying. In removing the bottles, the peg holding the bottle was taken from the disc and the wire loop grasped with tongs. The peg was then turned upside down, thus removing the bottle from the disc without any jar or without having to touch the bottle with anything foreign other than the tongs. The bottles were then suspended from the hooks attached to the wire and allowed to dry for 48 hours. At the end of the drying period, the bottles were again weighed. The difference in the weights obtained before and after spraying gives the weight of the oil deposited. The bottles were next cleaned thoroughly with xylol and were then ready to be used again.

If more work had been done, two changes would have been made in the procedure outlined above, making it possible to secure more accurate results, as well as to facilitate the handling of the bottles: (1) In checking the electrical charge exhibited by the beeswax, it was found to have a positive charge. In order to have the laboratory conditions approximate more closely the actual conditions in the field, some coating having the same charge (negative) as exhibited by the trees, should be used. (2) Instead of taking the bottles from the pegs after spraying, enough pegs should be provided to accomodate the number of bottles desired and also a drying board large enough to take care of them should be used. In this way, it would not be necessary to use the same set of pegs for all of the spray runs and neither would it be necessary to transfer the sprayed bottles from the pegs to the hooks.

b. Plans for this thesis originally included laboratory studies to determine the point of penetration and the location of injury. These studies were to be based on the micro-technique for observing oil penetration after staining and sectioning. It was not possible, however, to make these studies because samples of injured material were not available in 1938. It was also impossible to conduct an investigation into the injury occurring on buds due to the fact that the tissue would have to be dehydrated before one could embed the buds in paraffin blocks for sectioning and the dehydrating reagents would also remove the oil and the dinitro-ortho-cyclo-hexyl-phenol. This method for studying the degree of penetration in the buds was thus eliminated. It was first thought that injury occurring on buds could be studied by the use of a microtome with a freezing attachment, thus eliminating the use of the dehydrating reagents. However, no instrument of this kind was available. The penetration and injury studies had, therefore, to be abandoned.

It was also thought at the time this study was begun, that it would be possible to find a stain for the dinitro-ortho-cyclo-hexyl-phenol, but in trying to work out this phase, either the material was present in such small quantities or the results of the staining reagents were so indefinite that no work along this line could be conducted. In Table III are listed the reagents, at least one of which, it was thought, might be used. Because of existing conditions, however, as well as to the limited equipment available, none was found to be suitable.

In a preliminary investigation made of the results of the materials applied this year, it is apparent that injury is initiated at the bud, for upon cutting into the injured tissue, it was found that the tissue connected with the bud and extending back into the limb for a short distance was the tissue which had been affected. In most cases, however,

TABLE III

	Lead Acetate	Ammoniacal Copper Sulphate	Bromine Water	Caustic Soda Solution and Ammonium Sulphide	Zinc with Hydrochloric Acid over a period of 24 hours
o-Nitrophenol	Orange Precipitate	---	Precipitation	Blood-red	---
p-Nitrophenol	Yellow Precipitate	---	Precipitation	Brown-red	---
Dinitro-o-cresol	---	---	---	(Yellow, slightly brown)	Change from bluish to red and finally to brown-red
Dinitro-alpha-naphthol	---	---	---	(Yellow)	Change from orange to yellow-red then to brown-red
Naphthol yellow	Precipitate	Precipitate	---	(Yellow)	Yellowish-red
Picric Acid	Precipitate	Precipitate	Gradual turbidity	Blood-red	From yellow-green to green. (Precipitation likewise)
Trinitro-m-cresol	Precipitate	Thick, transparent, greenish precipitate	Gradual turbidity	Red-yellow	Greenish, then green
Trinitro-resorcin	Precipitate	No immediate precipitate	Turbid	Yellowish red	Brown, then reddish brown

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the injury was not severe enough to kill the branches, for adventitious shoots have, in a number of cases, been sent out from the side of the dead or injured buds. In the majority of cases in which branches were injured, the terminal buds have put out normal leaves and flowers and in only a few cases have the limbs been actually killed. The buds that have been killed were apparently killed at once, for no growth has been observed since the application of the spray.

2. Field Studies

The field studies were carried on in several orchards in different fruit growing sections of the state. The major experimental work in the field, however, was done in Trinity Vale Orchard, located just outside of Blacksburg, Virginia.

The trees in this orchard were sprayed with oils of two viscosities, 110-115 and 155-165, and dinitro-ortho-cyclo-hexyl-phenol. The compositions of the three different emulsions used with each viscosity oil were as follows: (1) 96 per cent oil and 4 per cent dinitro, (2) 97 per cent oil and 3 per cent dinitro, and (3) 98 per cent oil and 2 per cent dinitro, used at concentrations of ½ per cent or ½ gallon of oil and dinitro per 100 gallons of water, 1½ per cent or 1½ gallons of oil and dinitro per 100 gallons of water, and 2 per cent or 2 gallons of oil and dinitro per 100 gallons of water. Each of these concentrations of toxic material was used with both the 110-115 viscosity oil and the 155-165 viscosity oil. With each of these mixtures, four different emulsifiers were used. The emulsifiers were composed of goulac and bentonite in the following proportions: (1) 50 per cent goulac and 50 per cent bentonite used at the rate of 1.25 pounds per 100 gallons, (2) 25 per cent goulac and 75 per cent bentonite used at the rate of 1.25 pounds per 100 gallons, (3) 25 per cent goulac and 75 per cent bentonite used at the rate of .50 pounds per 100 gallons, and (4) 10 per cent goulac and 90 per cent bentonite used at the rate of 1.00 pound per 100 gallons. The orchard was divided into 72 plots and a spray of different composition applied to the trees in each plot. The plots were all laid out in the same orchard in order to secure, in so far as possible, uniform conditions and comparable results. The sprays were applied with a 200 gallon capacity Bean portable sprayer mounted on a truck and pumping about eleven gallons per minute at 350 pounds pressure. A four nozzle Hardie broom having an extension of nine feet, was used and Number 3 discs were used in the nozzles. The spray was applied by the regular man at the orchard under close supervision to insure complete coverage of every tree. One hundred gallons of each material was applied. In making up the various emulsions, enough water was first put into the tank to cover the lower agitator blade (approximately twenty gallons). The emulsifier was then added and the material pumped back on itself for about three minutes to insure even distribution of the emulsifier. The oil was added next and the mixture pumped back on itself for three minutes more. Then the water was allowed to run slowly into the tank, pumping the material back on itself until the 100 gallon mark was reached. The spray motor was kept running until the spraying was completed and the tank was complately drained after each application.

a. It was intended that this experiment should include bud counts made over representative parts of the trees sprayed. The same trees were to be checked again one month later for possible injury by the different concentrations and compositions. The twigs were tagged and the number of buds counted and recorded. Before the end of the month when the buds were to be recounted and examined for injury, a heavy frost or freeze occurred, during blossoming time, killing the majority of the fruit buds. It was, therefore, impossible to make a second bud count which would be at all comparable to the first.

b. Counts were made of the aphis colonies and aphis apples present on the trees. In order to have these counts as free from prejudice and as accurate as possible, the spray chart was not referred to while it was being made. Two counters were used, one for recording the aphis apples and the other for recording the aphis colonies. Every tree in each plot was examined. In making these counts, the entire exterior of the tree was first checked from top to bottom. The next step was to check the inner lower half of the tree, starting with the trunk and working out, and the third step was to climb up into the center of the tree and check the inner upper half. The tree was then completely rechecked in reverse order in an effort to eliminate any possible errors.

RESULTS

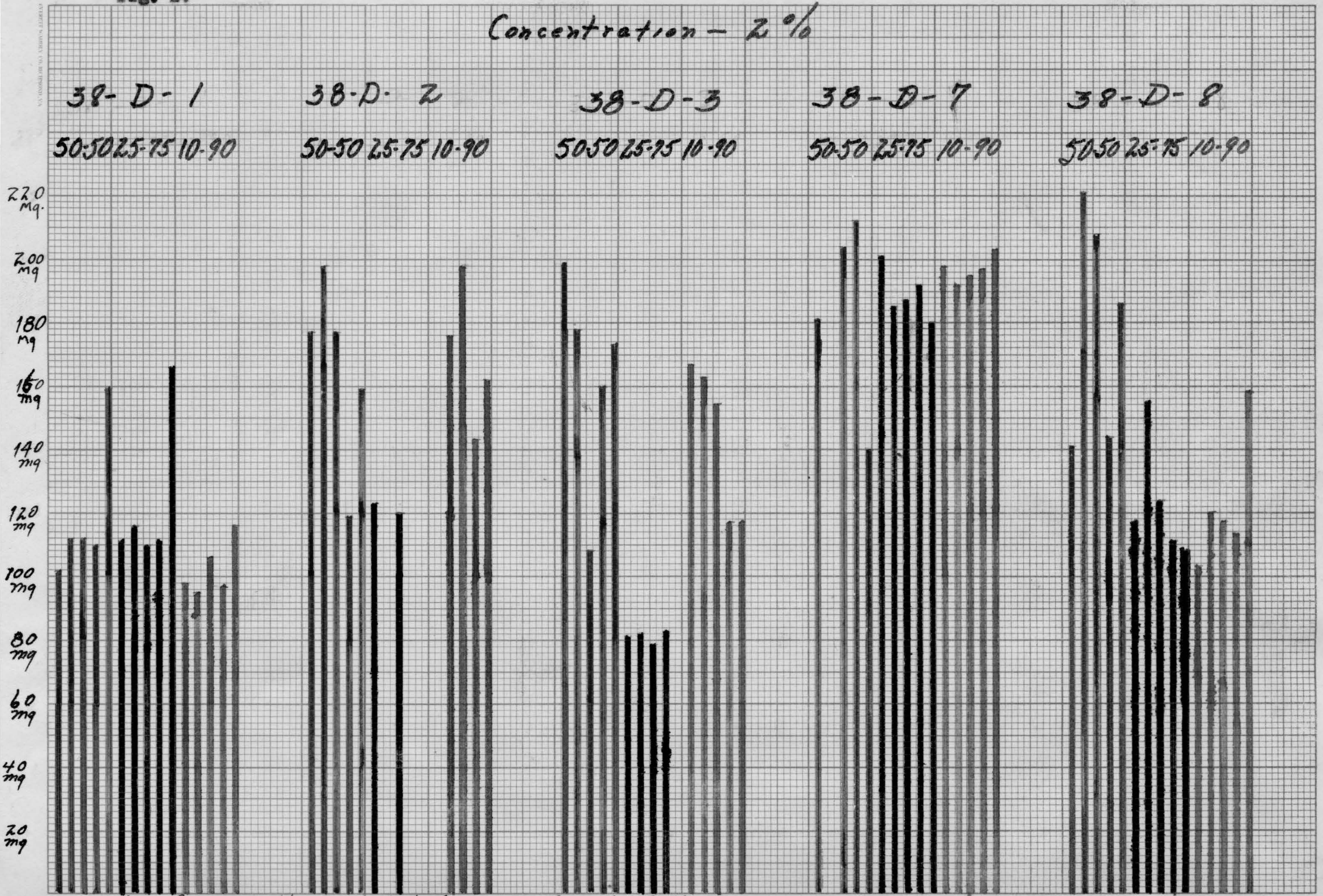
Laboratory Studies

The results of the laboratory studies are shown in graph form in Figs. IV and V.

Observations made while making these studies under the prevailing conditions indicate that: (1) The 50 per cent goulac and 50 per cent bentonite emulsifier apparently resulted in a faster rate of drying, less free oil, an emulsion which remained stable longer after agitation ceased, and a more uniform distribution over the bottles sprayed. (2) The emulsifier containing 10 per cent goulac and 90 per cent bentonite had more free oil under the same conditions of preparation and the emulsion appeared less stable, a considerable quantity of oil separating out within 15 minutes after agitation ceased. (3) From the standpoint of stability, the emulsifier containing 25 per cent goulac and 75 per cent bentonite was somewhat better in these tests than the 10-90 emulsifier, but still did not appear to reach the stability of the emulsifier containing 50 per cent goulac and 50 per cent bentonite.

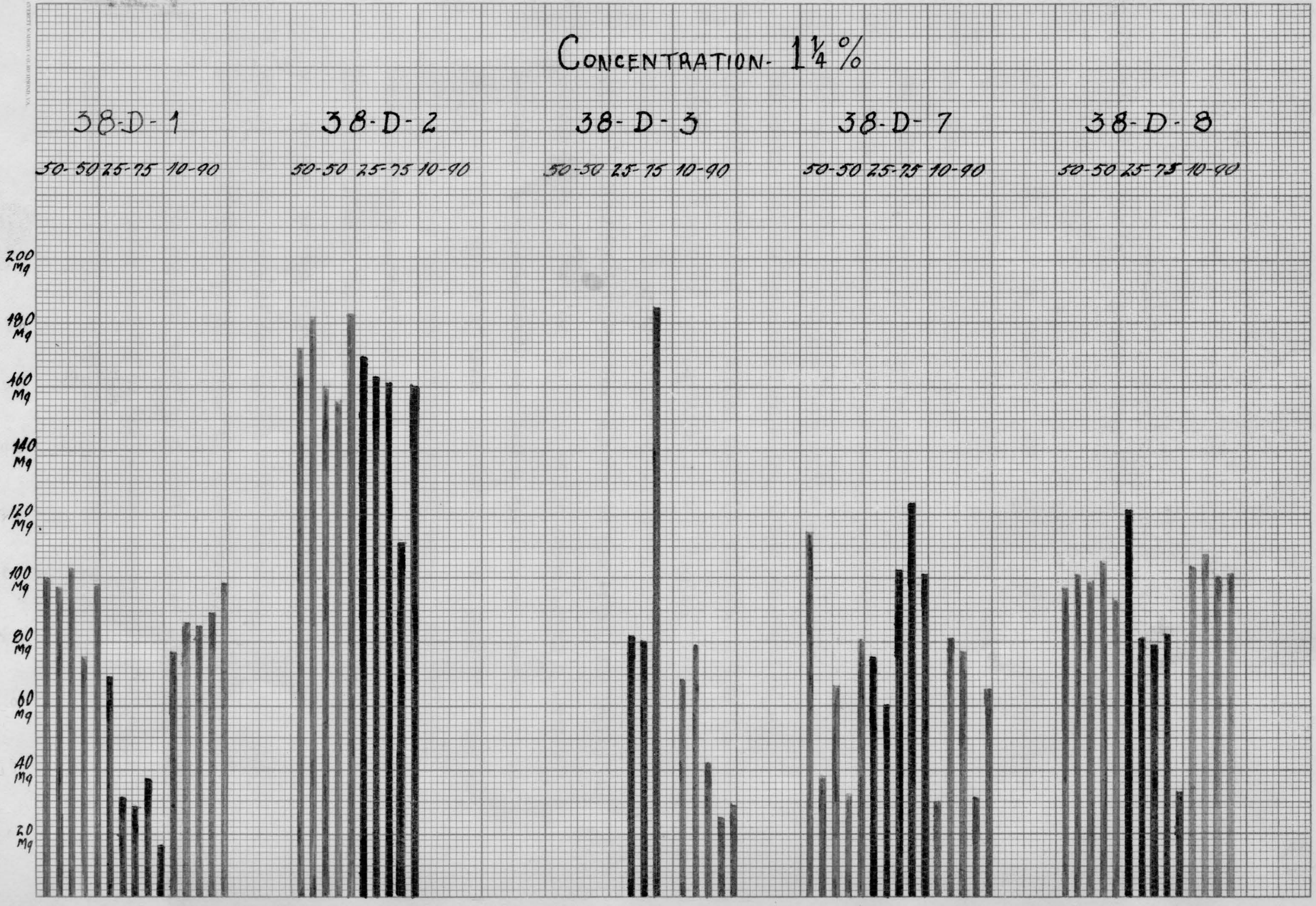
The tests indicate that there is a correlation between the percentage of oil and dinitro-ortho-cyclo-hexyl-phenol in the emulsion and the depositing quality of the spray material.

Fig. IV



Each Bar Represents the Deposit Left on one Sample Bottle

Fig. V



Each Bar Represents the Deposit Left on One Sample Bottle

Field Studies

Beverly Manor Orchard

The Beverly Manor Orchard is located about three miles northwest of Staunton, Virginia. Some sections of this orchard were sprayed with a tar oil emulsion; the rest of the orchard, however, was sprayed with Dow Dormant spray used at the rate of 2½ gallons per 100 gallons of water in addition to two gallons of California Kleenup ready mis. One block of trees was treated with two applications of this mixture. No injury was found in the orchard except in one block. The section of the orchard in which the rather extensive injury occurred, is situated at a higher elevation than the rest of the orchard. The varieties represented in it are Stayman, Winesap and York. It was noted that a number of the trunks of the trees in this block were in poor condition. In the majority of the cases, the injury was present or more severe on the sides of the trees having a northwest exposure. Upon preliminary examination the injured branches, it was found that in a number of cases, the terminal buds were free from injury, since they had developed in a normal manner. The other buds, however, were apparently killed at once for no further development had taken place in these buds after the application of the spray. It was noticed, however, that a great many adventitious buds were being put out at the sides of the injured buds. By cutting into the branch at the point where the bud joined it, dead areas could be detected running into the bud and extending a short distance on the branch.

A later check-up in the orchard showed that the larger branches had been injured by what seemed to be winter injury, and, by getting a history of the orchard, it was learned that winter injury had occurred in this same block in years previous. However, branches one-half inches or less in diameter did not, in the majority of cases, show this winter injury, and it was this wood which showed the most injury to the buds. Winter injury may have occurred in November of 1938, the following conditions having existed at that time: (1) A period of very low rainfall existed from September to January. (2) It is doubtful if the trees had become dormant. (3) Temperature reports for Staunton show that in November, sudden and extreme drops in temperature occurred in four different 24-hour periods. In the block of trees showing injury (Fig. VI) there were quite a few trees which showed no apparent injury (Fig. VII).

Several possible causes of this injury may be considered: (1) An error may have been made in the mixing of the spray materials, though the manager of the orchard feels sure that this was not the case. The area in which the injury occurred was of a size large enough to require four or five tanks of spray material and it does not seem logical that the same mistake in mixing would be made four or five times in spraying one particular section and not be made in the mixing of the materials applied elsewhere in the orchard. (2) There may not have been a proper emulsification of the materials. However, the same objections may be raised in regard to this possibility as were discussed in regard to a possible error in the mixing of the materials. (3) It is entirely possible that the injured trees were dessicated by the north and northwest winds (more so than the rest of the orchard because of the higher elevation of this section) and that oil was therefore

Fig. VI

Tree Injury in Beverly Manor Orchard

Fig. VII

Healthy Tree in Beverly Manor Orchard

taken into the tissues more readily. (4) The spray material may have been applied on this block at too low a temperature, however, the manager states that no spraying was done when the temperature was below 40° F. (5) A freeze may have occurred shortly after this section was sprayed for temperature records show that on the nights following some of the applications, the temperature went down to 26° F. (Table IV). (6) The most plausible explanation, based on the evidence gathered, seems to be that injury resulted from the oil entering the tree and bud tissue, due to a weakened and dessicated condition brought on by winter injury and drouth conditions.

B.R. Price Orchard

Injury occurred in the B.R. Price orchard in Bedford county, Virginia, in 1938. In checking up on the history of the case, it was learned from Mr. Price that the spray tank was filled about one-half to two-thirds full with water. The oil and dinitro combination was added next and then the rest of the water. The injured trees had evidently received a higher concentration of oil than the other trees and quite a few of the limbs were completely dead. The positions of the injured trees seemed to indicate that they had received the last of the spray material in the tank and that the spray solution in the bottom of each tank contained a higher percentage of free oil. It was evident that the injury resulted from improper emulsification by adding the concentrate to a large amount of water and failure to pump the material back on itself under pressure. In the opinion of the writer, no injury would have resulted had the spray solution been prepared properly.

TABLE IV

Material Applied - 2½% Dow Dormant plus 2% California Kleenup Ready Mix

Date Applied	Temperature (F.) Maximum	Minimum
March 6	58	29
7	71	37
8	60	50

Temperature for November on days in which large drops in temperature were recorded

Date Applied	Temperature (F.) Maximum	Minimum	Difference
Nov. 10	62	26	36
25	32	11	21
26	33	11	22
27	33	9	24
28	34	9	25

Guerrant Orchard

Dr. Guerrant made his dinitro spray up into a stock emulsion (using an extra gallon of oil with each two gallons of dinitro), from which he made his diluted emulsion. Judging from the manner in which he handles his materials, one would expect to find considerable injury resulting from the application of the spray. This has not been the case, however. He has a Friend and a Bean sprayer with power take-offs. He uses trucks equipped with tanks to haul the spray material to the sprayer. A truck comes into the filling station and, while the water is running into the tank, the stock emulsion is added. There are no agitators in the tanks of the supply trucks. When the tank is full, the supply truck carries it to the sprayer and the material is transferred to the spray tank. In one instance, the material was allowed to stand in the sprayer for more than an hour before it was applied, however, no injury occurred even on the trees sprayed with that emulsion.

E.B. Bonham Home Tract Orchard

Injury occurred on a few trees in the E.B. Bonham Home Tract orchard, in 1938 and the tips of some limbs about an inch in diameter were killed. In this orchard, Mr. Bonham has a stationary spraying system with two 400 gallons mixing tanks. While the emulsion is being made up in one tank, spraying is done from the other. It was discovered that there was a break in the partition between the two tanks and it was thought that this was the cause of the increased oil content of the spray. This does not seem to be the only answer for in Bonham's spraying in 1939, similar injury has occurred in another of their orchards, with just a few scattered trees being injured. Since, in applying their sprays, they start spraying from the laterals closest to the mixing plant, it is entirely possible that the material in the line ahead has had a chance to separate out and that they were spraying this material on the trees, thereby getting the injury. This seems to be the best answer to the problem for in no case was a whole tree injured. The injury seems to be present only in certain sections of a tree. It might, however, be due to some other cause, such as a weakened tree, winter injury or greater dessication, a condition which allows more oil to be taken into the tissue. Considering all factors, however, it appears, in this case, that the injury was due to spraying the trees with material in which the oil had separated out.

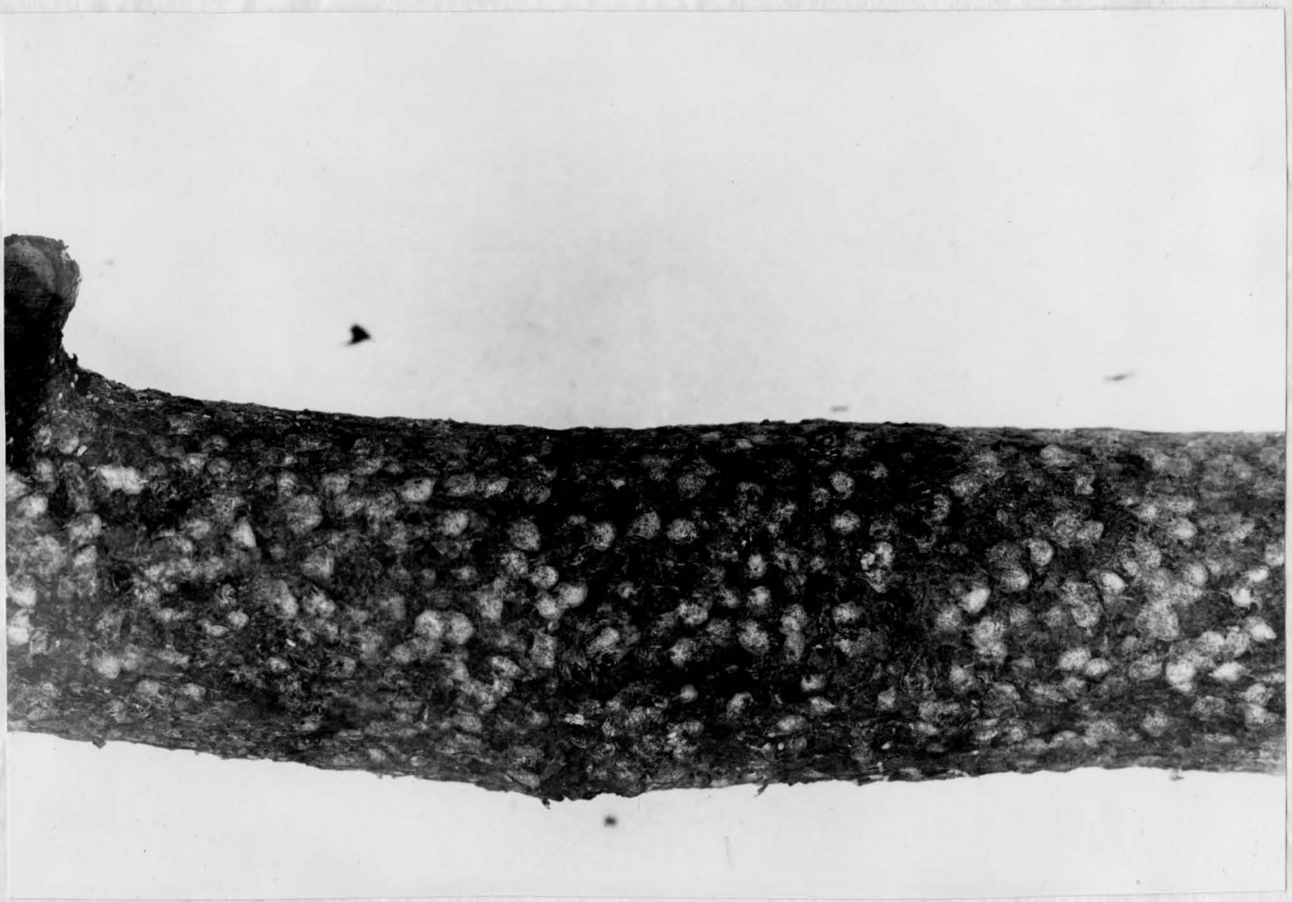
Wampler Orchard

This orchard is located about ten miles from Harrisonburg, Virginia. The orchard is heavily infested with Scurvey scale (Fig.VIII), the larger limbs and branches being almost completely incrusted. The scale had been present so long that on cutting into the bark of the branches, the necrotic areas in the forms of tubes sometimes extended down into the branch for a distance of one-quarter of an inch. This orchard was sprayed by Mr. Wampler with two per cent Dow Dormant except for four plots which were sprayed by the writer. (For results, see Table V)

No aphis was found in any part of this orchard.

The trees in that part of the orchard sprayed by Mr. Wampler were poorly covered and do not show as good results as were obtained in

Fig. VIII



A portion of a limb showing infestation of Scurvey Scale in the Wampler Orchard

TABLE V

Plot	Material	Dead	Alive	SCURVY SCALE Empty	Counted	% Killed
I	2½% Dow Dormant (110 vis.)	170	103	60	333	51.0
II	2½% Dow Dormant (150 vis.)	209	105	39	383	54.7
III	2½% Tarocide B and 3% oil	826	18	42	886	93.2
IV	2½% Unknown Central	78	105	129	312	25.
Check	2% Dow Dormant (110 vis.)	150	155	72	377	39.7

the four experimental plots. Because of its location, the orchard is exposed to a great deal of wind, making thorough spraying difficult. Another factor influencing the control of scale in the orchard is that it is bounded on three sides by other orchards all infested with scale and none of which are treated with a dormant spray.

It was thought that injury might result from the oil and dinitro because of the injured tree tissue and its somewhat dessicated condition. Although the trees were examined carefully, no evidence of spray injury was found.

Trinity Vale Orchard

A large part of the experimental work was done in Trinity Vale orchard, located at Blacksburg, Virginia. In no case was there any injury apparent when the materials were applied in the dormant period. There was, however, some burning on the buds when they had developed to the point of the leaves extending one-fourth inches. (Fig. IX).

Extreme care was used in making the emulsions to be sure that they were well emulsified.

In the plots containing the two per cent emulsion of the material containing 96 per cent oil of 155-165 viscosity and four per cent dinitro, it was felt sure that injury would result because the weather at the time of spraying was very foggy and the trees did not dry in 36 hours. In one case, the trees were sprayed twice, one spray being applied the last thing one day and the other spray being applied the first thing the following day. No injury developed however.

Fig. IX

Twig Showing Stage of Bud Development When Last Spray was Applied

The results of these experiments, with all pertinent data may be found in Table VI. and Table VII.

Under the conditions in which this study was made, whenever any of the materials were applied at temperature of 65° F. and above, burning resulted on the buds in direct ratio to the increase in the temperature about 65° F. It is especially interesting to note that, at these high temperatures, approximately the same amount of burning was obtained with the one-half per cent as with the one and one-half per cent and the one per cent. Other experiments made when the trees were in full leaf substantiated these findings. The dry form of dinitro-ortho-cyclo-hexyl-phenol combined with an emulsifier was put into solution and the trees sprayed with the mixture on an afternoon when the temperature was in the neighborhood of 80° F. Approximately 75 per cent of the leaves were burned so severely as to cause defoliation of these leaves, and all the fruit hit by the spray was injured, resulting in the killing of several of the outer cell layers as illustrated by Fig. X. An interesting fact that should be noted is that there was less injury on the sides of the trees away from the sun's rays than on the sides towards the sun. Another block of trees in full leaf was sprayed with the same dry form, but this was applied at night. No injury resulted from this spray for two days during which time high temperatures and sun exposure prevailed. Injury of the same type but to a lesser degree occurred on the third day only after a slight shower followed by a hot sun.

TABLE VI

TRINITY VALE ORCHARD

This orchard is located about two miles north of Blacksburg, Virginia. The crop is a large one and the weather was favorable for the development of rosy apple aphis.

No injury was noticed from the different sprays.

The small percentage of aphis clusters and apples present could easily be due to certain limbs and parts of the tree being missed, this appears to be true from the way in which aphis damage showed up.

The trees in this orchard are 25 years old and vary from about 10 feet to 35 feet in height.

The varieties are alternating in the spray rows.

Varieties present in this orchard and located in plots are:

Grimes Golden
York Imperial
Rome Beauty
Stayman
Winesap (few)
Delicious (few)

The orchard is in permanent sod which was broken up twice during this season, once in the early spring and again in the early summer.

Excellent cultural practices have been maintained this year and the previous two years. Before this time the orchard had no spraying or cultural practices.

Trinity Vale Orchard (continued) TABLE VI

Materials	Variety	Number Trees	Aphis Clusters No.	Aphis Clusters Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
2½% .034F (powdered)	Grimes	3	20	6.66	2	.66	82	0.015
	Stayman	2	15	7.5	13	6.5	13	1.0
	Rome	4	26	6.5	0	0	62½	0.0
	York	6	36	7.33	44	7.33	159½	0.17
	Totals	15	97	6.46	59	3.93	317	0.127
2½% D.N. (liquid)	Grimes	10	413	41.3	845	84.5	223 3/4	2.36
	Stayman	17	438	25.76	536	31.58	110 3/4	4.83
	Rome	18	436	24.22	800	44.44	155	5.16
	York	19	1630	85.78	2363	124.36	300	4.92
	Winesap	2	34	17.0	35	17.5	15	1.45
	Totals	66	2951	44.71	4579	69.22	804½	4.05
1½% D.N. (liquid)	Grimes	9	97	10.7	144	16.0	227	0.39
	Stayman	6	37	6.16	43	7.16	115	0.37
	Rome	8	40	5.0	47	5.87	102 3/4	0.45
	York	7	574	82.0	777	111.0	182	2.66
	Delicious	1	3	3.0	4	4.0	14 1/2	0.25
	Totals	31	751	24.0	1051	32.7	641 1/4	1.18
2% D.N. (liquid)	Grimes	11	278	27.18	482	43.81	260 1/2	1.15
	Stayman	3	6	2.0	7	2.33	41 1/4	0.16
	Rome	4	6	1.50	5	1.25	24 1/2	0.20
	York	12	355	29.75	565	47.08	331 1/2	1.06
	Totals	30	645	21.5	1059	35.30	657 3/4	1.04
Spray Cream 6-200 plus 2½% D.N. (powder)	Grimes	5	103	20.6	165	33.0	166	0.62
	Rome	4	0	0	0	0	46	0.0
	York	9	232	25.8	413	45.88	243 1/2	1.06
	Totals	18	335	18.61	578	32.11	455 1/2	0.82
Spray Cream 5-200 plus 2% D.N. (powder)	Grimes	1	27	27.0	41	41.0	19	1.34
	York	4	95	23.75	161	40.25	112 1/2	0.89
	Totals	5	122	24.5	202	40.4	131 1/2	0.96
2% D.N. (liquid)	Grimes	8	40	5.0	69	8.5	181	0.23
	York	9	211	23.45	425	47.22	268 1/2	0.98
	Totals	17	251	14.76	494	29.05	449 1/2	0.68
Tarocide 6-200	Grimes	10	32	3.2	61	6.1	217 1/2	0.17
	York	6	5	.83	10	1.66	117 1/2	0.05
	Winesap	2	12	6.0	12	6.0	17 1/2	0.42
	Totals	18	49	2.72	83	4.61	352 1/2	0.14
3% D.N. (powdered)	Grimes	10	121	12.1	237	23.7	527 1/2	0.28
	Stayman	3	121	40.33	165	55.0	36 1/2	4.52
	York	6	0	0	0	0	193	0.0
	Delicious	1	9	9.0	20	20.0	5	3.63
	Totals	20	251	12.55	422	21.1	762	0.35
Check	Grimes	3	4344	1448.0	7483	2494.33	100	46.76
	York	3	4530	1510.0	7913	2637.66	55 1/2	89.11
	Totals	6	8874	1479.0	15396	2566.00	155 1/2	61.88

Fig. X

Apple Showing Injury Caused by Dry Dinitro-ortho-cyclo-hexyl-phenol in Water

Judging from these experiments, it seems that injury comes about through the entrance of the dinitro through the stomata of the leaf, since no injury occurs when the stomata openings are closed or when the spray is applied and allowed to dry before the opening of the stomata.

TABLE VII

March 14, 1938	PLOT 1							
Wind Velocity Low		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Approx. Temperature 50	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Weather Foggy								
Material 2 gal. 38-D-6	Stayman	2	0	0	0	0	2	0.0
Emulsifier 1.25# of 50-50	Rome	6	2	.33	0	0	18 3/4	0.0
Amount Applied 100 gal.	York	5	6	1.2	0	0	0	0.0
	Grimes	2	5	2.5	0	0	6 3/4	0.0
	Totals	15	13	.86	0	0	27 1/2	0.0

March 14, 1938	PLOT 2							
Wind Velocity Low								
Approx. Temperature 50	Stayman	3	4	1.33	4	1.33	11	0.36
Weather Foggy	Rome	5	0	0	0	0	17	0.0
Material 2 gal. 38-D-6	York	3	0	0	0	0	0	0.0
Emulsifier 1.25# of 25-75	Grimes	3	0	0	0	0	15 1/2	0.0
Amount Applied 100 gal.	Totals	14	4	.28	4	.28	43 1/2	0.07

March 14, 1938	PLOT 3							
Wind Velocity Medium								
Approx. Temperature 50	Stayman	5	30	6.	13	2.6	12	1.08
Weather Foggy	Rome	4	27	6.75	15	3.75	7	1.94
Material 2 gal. 38-D-6	York	3	50	16.66	0	0	0	0.0
Emulsifier 1. # of 10-90	Grimes	1	0	0	0	0	1/4	0.0
Amount Applied 100 gal.	Totals	13	107	8.23	28	2.15	19 1/4	1.39

March 14, 1938	PLOT 4							
Wind Velocity Medium								
Approx. Temperature 50	Stayman	6	42	7.	61	10.16	19 1/2	3.12
Weather Foggy	Rome	3	26	8.66	44	14.66	3 1/2	6.75
Material 2 gal. 38-D-6	York	8	1	1.12	3	.37	0	- -
Emulsifier .5# of 25-75	Grimes	1	5	5.	5	5.	2	1.78
Amount Applied 100 gal.	Totals	18	74	4.11	113	6.27	25	4.32

March 16, 1938			PLOT 5					
Wind Velocity Medium		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Approx. Temperature 50	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Weather Foggy								
Material 2 gal. 38-D-1	Stayman	2	13	6.5	23	11.5	9	2.55
Emulsifier .5# of 25-75	Rome	4	111	27.75	173	43.25	19¼	8.16
Amount Applied 100 gal.	York	6	12	2.	14	2.33	0	- -
	Grimes	3	105	35.	146	48.66	26	4.01
	Totals	15	241	16.06	356	23.73	54¼	5.34

March 16, 1938			PLOT 6					
Wind Velocity High								
Approx. Temperature 50	Stayman	1	5	5.	6	6.	2	3.0
Weather Foggy	Rome	5	92	18.4	163	32.60	27¼	5.43
Material 2 gal. 38-D-1	York	11	5	.45	6	.54	0	- -
Emulsifier 1.25# of 50-50	Grimes	2	127	63.33	178	89.	3¾	33.90
Amount Applied	Totals	19	229	12.05	353	18.57	33	6.39

March 16, 1938			PLOT 7					
Wind Velocity High								
Approx. Temperature 50	Stayman	1	8	8.	12	12.	1	12.00
Weather Clear	Rome	8	239	29.87	402	50.25	29¾	12.27
Material 2 gal. 38-D-1	York	10	0	0	0	0	0	0.0
Emulsifier 1.25# of 25-75	Grimes	2	48	24.	80	40.	9½	6.01
Amount Applied 100 gal.	Totals	21	295	14.04	494	23.52	40¼	10.50

March 17, 1938			PLOT 8					
Wind Velocity Medium								
Approx. Temperature 50	Stayman	1	1	1.	1	1.	½	2.
Weather Fair	Rome	2	36	18.	56	28.	3½	14.54
Material 2 gal. 38-D-1	York	10	7	.7	9	.9	1/3	20.
Emulsifier 1. # of 10-90	Grimes	2	1	.5	1	.5	6	.11
Amount Applied 100 gal.	Totals	15	45	3.	67	4.46	10 1/3	5.07

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March 17, 1938 — PLOT 9	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approx. Temperature 35								
Weather Clear								
Material 2 gal. 38-D-2	Rome	6	18	3.	37	6.2	25½	1.31
Emulsifier 1.25# of 50-50	York	7	0	0.	0	0.	0	0.0
Amount Applied 100 gal.	Grimes	1	6	6.	14	14.	5	2.0
	Totals	14	24	1.71	51	3.64	30½	1.45

March 17, 1938 — PLOT 10	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity High								
Approx. Temperature 55	Rome	1	0	0	0	0	1¼	0.0
Weather Clear	York	5	0	0	0	0	0	0.0
Material 2 gal. 38-D-2	Grimes	2	0	0	0	0	10¼	0.0
Emulsifier 1.25# of 25-75	Totals	8	0	0	0	0	11½	0.0
Amount Applied 100 gal.								

March 17, 1938 — PLOT 11	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity High								
Approx. Temperature 52	Rome	9	2	.22	2	.22	17½	0.10
Weather Cloudy	York	5	2	.4	3	.6	0	- -
Material 2 gal. 38-D-2	Totals	14	4	.28	5	.35	17½	.25
Emulsifier 1. # of 10-90								
Amount Applied 100 gal.								

March 17, 1938 — PLOT 12	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity High								
Approx. Temperature 50	Rome	1	0	0	0	0	1	0.0
Weather Cloudy	York	7	0	0	0	0	0	0.0
Material 2 gal. 38-D-2	Grimes	5	59	59	125	125	47 3/4	1.86
Emulsifier .5# of 25-75	Totals	13	59	4.53	125	9.61	48 3/4	1.83
Amount Applied 100 gal.								

March 17, 1938 — **PLOT 13**

Wind Velocity High
Approx. Temperature 44
Weather Cloudy
Material 2 gal. 38-D-7
Emulsifier 1.25# of 50-50
Amount Applied 100 gal.

Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Stayman	4	1	.25	1	.25	6	.25
Rome	2	9	4.5	19	9.5	4	2.87
York	5	0	0	0	0	0	0.0
Grimes	1	0	0	0	0	14	0.0
Totals	12	10	.83	20	1.66	24	.66

March 18, 1938 — **PLOT 14**

Wind Velocity High
Approx. Temperature 42
Weather Cloudy
Material 2 gal 38-D-7
Emulsifier 1.25# of 25-75
Amount Applied 100 gal.

Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Stayman	1	0	0	0	0	3	0.0
Rome	2	0	0	0	0	4	0.0
York	6	0	0	0	0	0	0.0
Grimes	2	0	0	0	0	13½	0.0
Totals	11	0	0	0	0	20½	0.0

March 18, 1938 — **PLOT 15**

Wind Velocity Medium
Approx. Temperature 55
Weather Clear
Material 2 gal. 38-D-7
Emulsifier 1. # of 10-90
Amount Applied 100 gal.

Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Stayman	2	10	5	21	10.5	4	5.25
York	5	0	0	0	0.	3¼	0.0
Grimes	4	50	12.5	153	38.25	28¼	3.86
Totals	11	60	5.45	174	15.8	35⅝	3.62

March 18, 1938 — **PLOT 16**

Wind Velocity Medium
Approx. Temperature 60
Weather Clear
Material 2 gal. 38-D-7
Emulsifier .5# of 25-75
Amount Applied 100 gal.

Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Rome	3	10	3.33	22	.6	19	1.05
York	5	3	.6	3	.6	0	- -
Grimes	2	16	8.	33	16.5	18¼	1.29
Totals	10	29	2.9	58	5.8	37¼	1.24

March 18, 1938	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
PLOT 17								
Wind Velocity High								
Approx. Temperature 55								
Weather Clear								
Material 2 gal. 38-D-8	Rome	3	0	0	0	0	3½	0.0
Emulsifier 1.25# of 50-50	York	4	12	3.	16	4	0	- -
Amount Applied 100 gal.	Grimes	3	0	0	0	0	20¼	0.0
	Totals	10	12	1.2	16	1.6	23¾	.49

March 18, 1938	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
PLOT 18								
Wind Velocity Medium								
Approx. Temperature 55	Stayman	2	10	5.	16	8.	2¾	5.81
Weather Clear	York	4	0	0.	0	0.	0	0.0
Material 2 gal. 38-D-8	Grimes	6	10	1.66	21	3.5	26¾	.56
Emulsifier 1.25# of 25-75	Totals	12	20	1.66	37	3.08	29½	.92
Amount Applied 100 gal.								

March 18, 1938	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
PLOT 19								
Wind Velocity High								
Approx. Temperature 55	Rome	3	8	2.66	17	5.66	10	1.54
Weather Clear	York	7	5	.71	8	1.14	0	- -
Material 2 gal. 38-D-8	Grimes	4	14	3.5	26	6.5	39	.47
Emulsifier 1. # of 10-90	Totals	14	27	1.92	61	4.35	49	.92
Amount Applied 100 gal.								

March 18, 1938	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
PLOT 20								
Wind Velocity Medium								
Approx. Temperature 50	Rome	4	8	2.	10	2.5	46	.19
Weather Clear	York	8	16	2.	25	3.12	170½	.10
Material 2 gal. 38-D-8	Grimes	3	0	0.	0	0.	74½	0.0
Emulsifier .5# of 25-75	Totals	15	24	1.6	35	2.33	291	.08
Amount Applied 100 gal.								

March 18, 1938			PLOT 21					
Wind Velocity Medium		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Approx. Temperature 50	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Weather Clear								
Material 2 gal. 38-D-3	Stayman	1	18	18.	25	25.	5½	4.54
Emulsifier 1.25# of 50-50	York	6	8	1.33	13	2.16	½	19.11
Amount Applied 100 gal.	Grimes	7	74	10.57	100	14.28	26¼	2.72
	Totals	14	100	7.14	138	9.85	32¼	3.21

March 19, 1938			PLOT 22					
Wind Velocity Low								
Approx. Temperature 45	Rome	1	11	11	17	17.	2	7.72
Weather Clear	York	7	36	5.14	34	4.85	5½	4.51
Material 2 gal. 38-D-3	Grimes	5	43	8.6	72	14.4	38	1.35
Emulsifier 1.25# of 25-75	Totals	13	90	6.92	123	9.46	45½	1.95
Amount Applied 100 gal.								

March 19, 1938			PLOT 23					
Wind Velocity Low								
Approx. Temperature 50	Rome	1	1	1.	3	3.	1½	1.81
Weather Clear	York	7	65	9.28	79	11.28	13	4.30
Material 2 gal. 38-D-3	Grimes	5	85	17.	164	32.8	33 3/4	3.47
Emulsifier 1.# of 10-90	Totals	13	151	11.61	246	18.92	48¼	3.70
Amount Applied 100 gal.								

March 19, 1938			PLOT 24					
Wind Velocity Medium								
Approx. Temperature 50	York	7	106	15.14	139	19.85	0	- -
Weather Clear	Grimes	3	19	6.33	25	8.33	20 3/4	.86
Material 2 gal. 38-D-3	Totals	10	125	12.5	164	16.4	20 3/4	5.64
Emulsifier .5# of 25-75								
Amount Applied 100 gal.								

March 19, 1938 — **PLOT 25**

Wind Velocity Low
Approx. Temperature 55
Weather Clear
Material 1¼ gal. 38-D-6
Emulsifier 1.25# of 50-50
Amount Applied 100 gal.

Variety	Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Stayman							
York							
Grimes							
Totals							

March 19, 1938 — **PLOT 26**

Wind Velocity Medium
Approx. Temperature 55
Weather Clear
Material 1¼ gal. 38-D-6
Emulsifier 1.25# of 25-75
Amount Applied 100 gal.

Variety	Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Rome	2	0	0	0	0	1½	0.0
York	7	311	44.42	417	59.57	27	11.4
Totals	9	311	34.55	417	46.33	28½	10.97

March 19, 1938 — **PLOT 27**

Wind Velocity Medium
Approx. Temperature 60
Weather Clear
Material 1¼ gal. 38-D-6
Emulsifier 1. # of 10-90
Amount Applied 100 gal.

Variety	Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Rome	3	13	4.33	31	10.33	7	4.0
York	8	44	5.5	52	6.52	1½	25.7
Grimes	5	39	7.8	60	12.	28½	1.5
Totals	16	96	6.0	143	8.93	37	2.88

March 19, 1938 — **PLOT 28**

Wind Velocity Low
Approx. Temperature 60
Weather Clear
Material 1¼ gal. 38-D-6
Emulsifier .5# of 25-75
Amount Applied 100 gal.

Variety	Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Stayman	1	0	0	0	0	1	0.0
York	4	70	17.5	98	24.5	4½	16.1
Grimes	5	76	15.2	144	28.8	20½	5.0
Totals	10	146	14.6	242	24.2	26	6.76

March 19, 1938			PLOT 29					
Wind Velocity Medium		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Approx. Temperature 60	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Weather Clear								
Material 1¼ gal. 38-D-1	Stayman	1	5	5.	9	9.	7	1.2
Emulsifier 1.25# of 50-50	York	5	7	1.4	8	1.6	5	1.1
Amount Applied 100 gal.	Grimes	2	0	0.	0	0.	7½	0.0
	Totals	8	12	1.5	17	2.12	19½	.70

March 19, 1938			PLOT 30					
Wind Velocity Medium								
Approx. Temperature 60	Stayman	1	0	0	0	0	2	0.0
Weather Clear	Rome	2	4	2.	15	7.5	4	3.4
Material 1¼ gal. 38-D-1	York	5	43	8.6	46	9.2	1½	22.6
Emulsifier 1.25# of 25-75	Grimes	3	56	18.66	112	37.33	20½	3.9
Amount Applied 100 gal.	Totals	11	103	9.36	173	15.72	28	4.65

March 19, 1938			PLOT 31					
Wind Velocity Medium								
Approx. Temperature 60	Stayman	1	27	27.	50	50.	6	8.3
Weather Clear	Rome	3	5	1.66	8	2.66	12	.6
Material 1¼ gal. 38-D-1	York	8	9	1.12	17	2.12	0	- -
Emulsifier 1. # of 10-90	Totals	12	41	3.41	75	6.25	18	3.90
Amount Applied 100 gal.								

March 19, 1938			PLOT 32					
Wind Velocity High								
Approx. Temperature 70	Stayman	1	3	3.	4	4.	1½	2.6
Weather Clear	Rome	2	0	0.	0	0.	3½	0.0
Material 1¼ gal. 38-D-1	York	5	1	.2	2	.4	1	1.4
Emulsifier .5# of 25-75	Grimes	4	0	0.	0	0.	14 2/5	0.0
Amount Applied 100 gal.	Totals	12	4	.33	6	.5	20 2/5	.22

March 21, 1938 PLOT 33

Wind Velocity Medium		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Approx. Temperature 52	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Weather Clear								
Material 1½ gal. 38-D-7	Stayman	1	0	0	0	0	3	0.0
Emulsifier 1.25# of 50-50	York	5	38	7.6	43	8.6	8	3.9
Amount Applied 100 gal.	Grimes	6	81	13.5	126	21.	21	4.2
	Totals	12	119	9.91	169	14.08	32	3.91

March 21, 1938 PLOT 34

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approx. Temperature 60	Stayman	1	9	9.	14	14.	8	1.7
Weather Clear	York	6	0	0	0	0	0	0.0
Material 1¼ gal. 38-D-7	Grimes	1	0	0	0	0	4 3/4	0.0
Emulsifier 1.25# of 25-75	Totals	8	9	1.12	14	1.75	12 3/4	.95
Amount Applied 100 gal.								

March 21, 1938 PLOT 35

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approx. Temperature 60	Stayman	2	2	1.	6	3.	5½	1.0
Weather Clear	York	4	6	1.5	10	2.5	½	14.7
Material 1½ gal. 38-D-7	Grimes	4	3	.75	10	2.5	9 3/4	1.3
Emulsifier 1.# of 10-90	Totals	10	11	1.1	26	2.6	15 3/4	1.31
Amount Applied 100 gal.								

March 21, 1938 PLOT 36

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Low								
Approx. Temperature 65	Rome	4	24	6.	42	10.5	5½	6.9
Weather Clear	York	7	0	0.	0	0.	0	0.0
Material 1½ gal. 38-D-7	Grimes	3	62	20.66	93	31.	12 3/4	5.3
Emulsifier .5# of 25-75	Totals	14	86	6.14	135	9.64	18 1/4	5.64
Amount Applied 100 gal.								

PLOT 37

March 21, 1938	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Low								
Approx. Temperature 70								
Weather Clear								
Material 1½ gal. 38-D-2	Rome	3	0	0.	0	0.	3	0.0
Emulsifier 1.25# of 50-50	York	7	0	0.	0	0.	0	0.0
Amount Applied 100 gals.	Grimes	4	105	26.25	157	39.25	13½	8.2
	Totals	14	105	7.5	157	11.21	16½	7.07

PLOT 38

March 21, 1938	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Low								
Approx. Temperature 72	York	5	0	0.	0	0.	0	0.0
Weather Clear	Grimes	7	52	7.45	91	13.	18 3/4	3.47
Material 1½ gal. 38-D-2	Totals	12	52	4.33	91	7.58	18 3/4	3.47
Emulsifier 1.25# of 25-75								
Amount Applied 100 gal.								

PLOT 39

March 21, 1938	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Low								
Approx. Temperature 85	Stayman	1	11	11.	6	6.	1½	4.0
Weather Clear	York	7	18	2.57	39	7.	½	57.3
Material 1¼ gal. 38-D-2	Grimes	4	21	5.25	30	7.5	8	2.6
Emulsifier 1. # of 10-90	Totals	12	50	4.16	75	6.25	10	5.63
Amount Applied 100 gal.								

PLOT 40

March 21, 1938	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approx. Temperature 86	Rome	6	4	.66	4	.66	2½	1.5
Weather Clear	York	7	0	0.	0	0.	0	0.0
Material 1¼ gal. 38-D-2	Grimes	4	113	28.25	158	39.5	15	7.5
Emulsifier .5# of 25-75	Totals	17	117	6.88	162	9.52	17½	6.82
Amount Applied 100 gal.								

March 21, 1938 — PLOT 41

Wind Velocity Low		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Approx. Temperature 88	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Weather Clear								
Material 1½ gal. 38-D-8	Stayman	1	1	1.	2	2.	1½	1.3
Emulsifier 1.25# of 50-50	Rome	3	23	7.66	40	13.33	3	12.1
Amount Applied 100 gal.	York	8	11	1.37	17	2.12	0	- -
	Grimes	2	4	2.	5	2.5	7½	.4
	Totals	14	39	2.78	64	4.57	11 3/4	4.28

March 21, 1938 — PLOT 42

Wind Velocity Medium								
Approx. Temperature 74	York	6	0	0.	0	0.	2 1/5	0.0
Weather Clear	Grimes	5	19	3.8	22	4.4	10	1.6
Material 1½ gal. 38-D-8	Totals	11	19	1.72	22	2.	12 1/5	1.29
Emulsifier 1.25# of 25-75								
Amount Applied 100 gal.								

March 22, 1938 — PLOT 43

Wind Velocity Medium								
Approx. Temperature 70	Stayman	3	18	6.	32	10.66	3	10.6
Weather Clear	York	7	7	1.	7	1.	0	- -
Material 1½ gal. 38-D-8	Grimes	4	7	1.75	9	2.25	1	6.4
Emulsifier 1. # of 10-90	Totals	14	32	2.28	48	3.42	4	10.91
Amount Applied 100 gal.								

March 21, 1938 — PLOT 44

Wind Velocity Medium								
Approx. Temperature 60	York	5	13	2.6	17	3.4	0	- -
Weather Clear	Grimes	7	101	14.42	154	22.	20	5.5
Material 1½ gal. 38-D-8	Totals	12	114	9.5	171	14.25	20	6.12
Emulsifier .5# of 25-75								
Amount Applied 100 gal.								

March 22, 1938 — PLOT 45

Conditions	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approximate Temperature 50								
Weather Clear								
Material 1¼ gal. 38-D-3	Rome	1	0	0.	0	0.	0	0.0
Emulsifier 1.25# of 50-50	York	6	3	.5	4	.66	0	- -
Amount Applied 100 gal.	Grimes	5	103	20.6	142	28.4	15	6.7
	Totals	12	106	8.83	146	12.16	15	6.95

March 22, 1938 — PLOT 46

Conditions	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approximate Temperature 70	Stayman	1	0	0.	0	0.	0	0.0
Weather Clear	Rome	6	6	1.	8	1.33	6½	1.1
Material 1¼ gal. 38-D-3	York	6	1	.16	1	.16	½	1.4
Emulsifier 1.25# of 25-75	Totals	13	7	.53	9	.69	7	1.14
Amount Applied 100 gal.								

March 22, 1938 — PLOT 47

Conditions	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approximate Temperature 80	Stayman	1	5	5.	7	7.	1½	4.6
Weather Clear	Rome	1	0	0.	0	0.	2	0.0
Material 1¼ gal. 38-D-3	York	8	3	.37	3	.37	0	-.-
Emulsifier 1. # of 10-90	Grimes	3	72	24.	148	39.33	5 3/4	18.3
Amount Applied 100 gal.	Totals	13	80	6.15	158	12.15	9 1/4	13.44

March 22, 1938 — PLOT 48

Conditions	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approximate Temperature 80	Stayman	2	23	11.5	31	15.5	17 3/4	1.7
Weather Clear	York	4	7	1.75	11	2.75	0	- -
Material 1¼ gal. 38-D-3	Grimes	3	79	26.33	136	45.33	13 1/4	7.3
Emulsifier .5# of 25-75	Totals	9	109	12.11	178	19.77	31	4.90
Amount Applied 100 gal.								

March 22, 1938			PLOT 49					
Wind Velocity Low		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Approximate Temperature 82	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Weather Clear								
Material ½ gal. 38-D-6	Stayman	1	4	4.	4	4.	2	2.0
Emulsifier 1.25# of 50-50	York	7	0	0.	0	0.	0	0.0
Amount Applied 100 gal.	Grimes	3	50	16.66	66	22.	0	- -
	Totals	11	54	4.90	70	6.33	2	35.

March 22, 1938			PLOT 50					
Wind Velocity Medium								
Approximate Temperature 80	Stayman	1	1	1.	1	1.	1½	.6
Weather Cloudy	York	7	18	2.57	22	3.34	1 3/4	9.3
Material ½ gal. 38-D-6	Grimes	5	11	2.2	14	2.8	3	3.3
Emulsifier 1.25# of 25-75	Totals	13	30	2.30	37	2.84	6 1/4	4.59
Amount Applied 100 gal.								

March 22, 1938			PLOT 51					
Wind Velocity Medium								
Approximate Temperature 76	York	6	0	0	0	0	½	0.0
Weather Cloudy	Grimes	5	67	13.4	114	22.8	13½	6.5
Material ½ gal, 38-D-6	Totals	11	67	6.09	114	10.36	14	5.84
Emulsifier 1. # of 10-90								
Amount Applied 100 gal.								

March 22, 1938			PLOT 52					
Wind Velocity Medium								
Approximate Temperature 75	Stayman	2	136	68.	206	103.	6	34.3
Weather Cloudy	Rome	2	9	4.5	16	8.	1	14.5
Material ½ gal. 38-D-6	York	2	0	0.	0	0.	0	0.0
Emulsifier .5# of 25-75	Grimes	2	33	16.5	52	26.	4	9.2
Amount Applied 100 gal.	Totals	8	178	22.25	274	34.25	11	21.57

March 22, 1938	PLOT 53							
Wind Velocity Medium		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Approximate Temperature 70	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Weather Cloudy								
Material ½ gal. 38-D-1	Rome	3	1	.33	1	.33	5½	0.1
Emulsifier 1.25# of 50-50	York	2	2	1.	2	1.	0	- -
Amount Applied 100 gal.	Grimes	3	31	10.33	48	16.	6 1/5	5.5
	Totals	8	34	4.25	51	6.37	11 3/4	3.46

March 22, 1938	PLOT 54							
Wind Velocity Medium								
Approximate Temperature 70	Stayman	3	170	56.66	179	59.66	7	25.5
Weather Cloudy	York	2	54	27.	61	30.5	3	15.0
Material ½ gal. 38-D-1	Grimes	5	15	3.	24	4.8	12¼	1.3
Emulsifier 1.25# of 25-75	Totals	10	239	23.9	264	26.4	22¼	9.36
Amount Applied 100 gal.								

March 23, 1938	PLOT 55							
Wind Velocity Low								
Approximate Temperature 52	Stayman	2	54	27.	84	42.	1½	56.
Weather Cloudy	York	10	1	.1	3	.3	0	- -
Material ½ gal. 38-D-1	Grimes	1	40	40.	50	50.	0	- -
Emulsifier 1.# of 10-90	Totals	13	95	7.30	137	10.53	1½	91.33
Amount Applied 100 gal.								

March 23, 1938	PLOT 56							
Wind Velocity High								
Approximate Temperature 62	Stayman	1	0	0	0	0	3½	0.0
Weather Clear	York	6	9	1.5	11	1.83	1/5	40.7
Material ½ gal. 38-D-1	Grimes	1	7	7.	8	8.	½	11.4
Emulsifier .5# of 25-75	Totals	8	16	2.	19	2.37	4 1/5	4.25
Amount Applied 100 gal.								

March 25, 1938 — PLOT 57

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Low								
Approximate Temperature 40								
Weather Clear								
Material ½ gal. 38-D-7	Stayman	1	24	24.	37	37.	2	18.5
Emulsifier 1.25# of 50-50	Rome	1	60	60.	106	106.	½	- -
Amount Applied 100 gal.	York	4	297	74.25	346	86.5	27 ½	9.3
	Grimes	5	59	11.8	70	14.	5	10.0
	Totals	11	440	40.	559	50.81	35	11.97

March 25, 1938 — PLOT 58

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Low								
Approximate Temperature 40	Stayman	1	17	17.	3	3.	3	1.
Weather Clear	Rome	2	50	25.	81	40.5	4 ½	16.3
Materials ½ gal. 38-D-7	York	3	0	0.	0	0.	0	0.0
Emulsifier 1.25# of 25-75	Grimes	1	9	9.	16	16.	6	1.9
Amount Applied 100 gal.	Totals	7	76	10.85	100	14.28	13 ½	6.11

March 25, 1938 — PLOT 59

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approximate Temperature 40	York	8	65	8.12	80	10.	2¼	23.6
Weather Clear	Grimes	5	79	15.8	160	32.	26½	4.3
Material ½ gal. 38-D-7	Totals	13	144	11.07	240	18.46	28 3/4	5.98
Emulsifier 1. # of 10-90								
Amount Applied 100 gal.								

March 25, 1938 — PLOT 60

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approximate Temperature 50	York	9	3	.33	3	.33	2	1.1
Weather Clear	Grimes	4	10	2.5	21	5.25	1	15.
Material ½ gal. 38-D-7	Totals	13	13	1.	24	1.84	3	5.85
Emulsifier .5# of 25-75								
Amount Applied 100 gal.								

March 25, 1938		PLOT 61						
		No.	Aphis Colonies		Aphis Apples		Bushels	% Aphis Apples
Wind Velocity Medium	Variety	Trees	No.	Av.	No.	Av.	Produced	of Total Prod.
Approximate Temperature 50								
Weather Clear								
Material ½ gal. 38-D-8	York	6	15	2.5	20	3.33	0	-.-
Emulsifier 1.25# of 50-50	Grimes	4	15	3.75	28	7.	12	1.6
Amount Applied 100 gal.	Totals	10	30	3.	48	4.8	12	2.84

March 25, 1938		PLOT 62						
Wind Velocity Medium								
Approximate Temperature 48	Rome	3	75	25.	172	57.33	5 1/2	28.3
Weather Clear	York	6	0	0.	0	0.	3 1/2	0.
Material 1/2 gal. 38-D-8	Grimes	1	0	0.	0	0.	2 1/6	0.
Emulsifier 1.25# of 25-75	Totals	10	75	7.5	172	17.2	11 1/6	12.45
Amount Applied 100 gal.								

March 25, 1938		PLOT 63						
Wind Velocity Medium								
Approximate Temperature 48	Rome	1	15	15.	21	21.	2	9.5
Weather Clear	York	5	0	0.	0	0.	0	0.0
Material ½ gal. 38-D-8	Grimes	2	0	0.	0	0.	3 1/2	0.0
Emulsifier .1# of 10-90	Totals	8	15	1.87	21	2.62	5 1/2	2.95
Amount Applied 100 gal.								

March 25, 1938		PLOT 64						
Wind Velocity Medium								
Approximate Temperature 50	York	6	5	.83	7	1.16	0	- -
Weather Clear	Grimes	5	37	7.4	64	12.8	28	1.6
Material ½ gal. 38-D-8	Totals	11	42	3.81	71	6.46	28	1.81
Emulsifier .5# of 25-75								
Amount Applied 100 gal.								

March 25, 1938 — PLOT 65

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approximate Temperature 54								
Weather Clear								
Material ½ gal. 38-D-2	York	5	5	1.	5	1.	0	- -
Emulsifier 1.25# of 50-50	Grimes	1	5	5.	7	7.	1 1/2	3.3
Amount Applied 100 gal.	Totals	6	10	1.66	12	2.0	1 1/2	5.76

March 25, 1938 — PLOT 66

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Medium								
Approximate Temperature 56	York	7	2	.28	4	.57	0	- -
Weather Clear	Grimes	5	7	1.4	8	1.8	5 3/4	0.9
Material ½ gal. 38-D-2	Totals	12	9	.75	12	1.	5 3/4	1.49
Emulsifier 1.25# of 25-75								
Amount Applied 100 gal.								

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March 25, 1938 — PLOT 67

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity High								
Approximate Temperature 52	York	8	6	.75	6	.75	-	- -
Weather Cloudy	Grimes	3	10	3.33	11	3.66	-	- -
Material ½ gal. 38-D-2	Totals	11	16	1.45	17	1.54		
Emulsifier 1. # of 10-90								
Amount Applied 100 gal.								

March 25, 1938 — PLOT 68

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity High								
Approximate Temperature 48	York	6	41	6.83	50	8.33	-	- -
Weather Cloudy	Grimes	6	50	8.33	75	12.5	-	- -
Material 38-D-2	Totals	12	91	7.58	125	10.41		
Emulsifier .5# of 25-75								
Amount Applied 100 gal.								

March 25, 1938 — PLOT 69

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity High								
Approximate Temperature 46								
Weather Cloudy								
Material 38-D-3	Stayman	1	5	5.	7	7.	-	- -
Emulsifier 1.25# of 50-50	Rome	1	24	24.	48	48.	-	- -
Amount Applied 100 gal.	York	7	61	8.71	62	8.85	-	- -
	Grimes	4	15	3.75	21	5.25	-	- -
	Totals	13	105	8.07	138	10.61		

March 25, 1938 — PLOT 70

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity High								
Approximate Temperature 46	York	4	20	5.	22	5.5	-	- -
Weather Cloudy	Grimes	6	19	3.16	22	3.66	-	- -
Material 38-D-3	Totals	10	39	3.9	44	4.4		
Emulsifier 1.25# of 25-75								
Amount Applied 100 gal.								

March 28, 1938 — PLOT 71

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Low								
Approximate Temperature 40	York	1	21	21.	29	29.	-	- -
Weather Clear	Grimes	5	102	20.4	134	26.8	-	- -
Material 38-D-3	Totals	6	123	20.5	163	27.16		
Emulsifier 1. # of 10-90								
Amount Applied 100 gal.								

March 28, 1938 — PLOT 72

	Variety	No. Trees	Aphis Colonies No.	Aphis Colonies Av.	Aphis Apples No.	Aphis Apples Av.	Bushels Produced	% Aphis Apples of Total Prod.
Wind Velocity Low								
Approximate Temperature 48								
Weather Clear	Grimes	9	234	26.	419	46.4	-	- -
Material 38-D-3								
Emulsifier .5# of 25-75								
Amount Applied 100 gal.								

WILLIAM BOAZ ORCHARD

Located in a mountain cove just to the west of Covesville. This orchard is in permanent sod. Good cultural practices are maintained. The trees are about 35 years of age in the plots where Dow Dormant spray was applied, and approximately 30 feet in height. The tarocide plot was in a different part of the orchard and was sprayed first with tarocide B three gallons to the 100 and later that same day re-sprayed using seven gallons of tarocide B to the 100.

Material	Variety	Number of Trees	Total Aphis Apples	Total Aphis Clusters	Av. No. of Aphis per Tree Apples	Av. No. of Aphis per Tree Clusters
2½% D.N. (liquid)	Winesap	6	0	0	0	0
2½% D.N. (Liquid)	Winesap	11	26	23	2.36	2.09
2½% .034F	Winesap	11	3	3	.27	.27
(D.N. powder)	Ben Davis	1	2	10	2.0	10.0
plus 3% Spray Cream	Totals	12	5	13	.41	1.08
Tarocide B 7-100	Pippin	7	16	13	2.28	1.85

B.J. WOOD ORCHARD

The B.J. Wood orchard is located at Flint Hill in the upper Shenandoah Valley. The trees are about 40 years old with some 12 year old trees which have been replants. The older trees are 25 to 35 feet in height and the younger ones between 10 and 20 feet. The orchard is in permanent sod which is grazed by hogs. Proven orchard cultural practices are used.

Here, as in some of the other plots, the crop set was very small this year, thus reducing the dependability of the results.

The check plot was located in an adjoining orchard of young trees about 12 years old which did not have a dormant spray. The trees were between 10 and 15 feet in height.

The weather conditions for the development were favorable.

Material	Variety	Number of Trees	Total Aphis Apples	Total Aphis Clusters	Av. No. of Aphis per Tree Apples	Av. No. of Aphis per Tree Clusters
1½% D.N. (liquid)	Stayman	3	187	273	62.33	91.0
	York	2	205	169	102.5	84.5
	Bonum	4	9	19	2.25	4.75
	Totals	9	401	561	44.56	62.33
Tarocide B 6½ gallons to 100	Stayman	1	0	0	0	0
	York	1	8	10	8.0	10.0
	Winesap	3	6	5	2.0	1.33
	Totals	5	14	15	2.8	3.00
Check	York	2	1535	985	767.5	492.5
2½% D.N. (liquid)	Stayman	3	22	33	7.33	11.0
	York	1	0	0	0	0
	Winesap	2	0	1	0	.5
	Delicious	3	1	1	.33	.33
	Totals	9	23	35	2.55	3.88

T.J. ANDREWS ORCHARD

This orchard is located at Hollins Station about ten miles north of Roanoke. The trees in this orchard are about 35 years old and range from 20 to 30 feet in height. The orchard is in permanent sod and is well cared for.

The trees as a whole had a very small set this year.

The plots were sprayed at two times - half of the trees on March 19 and the other half on March 23 due to high winds and the impossibility of spraying efficiently the whole tree.

No injury was noticed due to the Dormant spray.

Material	Variety	Number of Trees	Total Aphis Apples	Total Aphis Clusters	Av. No. of Aphis per Tree Apples	Av. No. of Aphis per Tree Clusters
2½% D.N. (liquid)	Black Twig	5	12	9	2.4	1.8
2% D.N. (liquid)	Winesap	5	72	66	15.4	13.2
2½% D.N. (powdered)		6	0	0	0	0
3% Spray Cream - no aphicide	York	3	1222	865	407.33	288.33

NININGER ORCHARD

This orchard is located at Daleville. The trees are about 35 years old and ranging from 20 to 30 feet in height. The orchard is in permanent sod and is well cared for. Although there was not enough of a fruit set to make a fair test, the Dow Dormant was noticeably superior to a straight spray cream spray.

Thinning further reduced the dependability of the results. All trees on which records were taken had been thinned about the same - thus giving approximately uniform results on the remainder.

Material	Variety	Number of Trees	Total Aphis Apples	Total Aphis Clusters	Av. No. of Aphis per Tree Apples	Av. No. of Aphis per Tree Clusters
2½% .034F (powdered)	York	4	0	0	0	0
D.N. plus 4%	Black Twig	3	9	9	3	3
Spray Cream	Totals	7	9	9	1.28	1.28
2% .034F (powdered) D.N.	Black Twig	8	31	56	3.88	7.0
2½% D.N. (liquid)	York	6	2	15	.33	2.5
2% D.N. (liquid)	York	8	95	208	11.87	26.0
3% Spray Cream	Black Twig	1	248	350	248.0	350.0
	York	2	455	685	227.5	342.5
	Totals	3	703	1035	234.2	345.0

WOODRUM ORCHARD

Situated on Bent Mountain about 15 miles southwest of Roanoke is the Woodrum orchard. The trees in these plots are about 60 years of age and for the most part 35 to 40 feet high. There is only one variety in this orchard, namely pippins. Although the average number of aphis clusters and apples is high, the material's effectiveness is probably as good if not better than in any of the other orchards in which plots are located due to the large crop set.

No injury to the tree was noticed. The orchard has been in sod for the last few years.

Materials	Variety	Number of Trees	Total Apples	Total Aphis Clusters	Av. No. of Apples per Tree	Av. No. of Aphis Clusters per Tree
2% D.N. (liquid)	Pippin	6	717	560	119.5	93.33
2½% D.N. (liquid)	Pippin	5	777	451	155.4	90.2

DICKENSON ORCHARD

This orchard is located at Woodstock, is in permanent sod and the trees are about 25 years old and approximately 25 feet high. Cultural practices have been poor until the last two years.

The crop set was poor as this is the off-year for the Ben Davis which is a biennial bearer, and because of poor pollination for the Stayman, Blacktwig and Winesap.

Scurvy scale was abundant in this orchard but it was hard to find live scale on the Dow Dormant plots - about 98% control was noticed. Those on which powdered tar was used showed about 50% control and the oil emulsion 25% less control. There did not seem to be any difference due to strength of material. This was not based on any actual count but upon observation.

The check plot for rosy aphis was not as representative as it might have been. In another part of the orchard about 75% of the fruit and foliage was damaged by aphis.

The Dickenson Orchard (continued)

Materials	Variety	Number of Trees	Total Aphis Apples	Total Aphis Clusters	Av. No. of Aphis per Tree Apples	Av. No. of Aphis per Tree Clusters
2.2 lbs. per 100 gals. D.N.(powder)	Stayman	5	307	307	61.4	73.8
	Black Twig	1	11	73	11.0	73.0
	Winesap	1	0	12	.0	12.0
	Ben Davis	13	59	180	4.53	13.84
	Totals	20	377	634	18.85	31.7
2½ gal. per 100 D.N. (liquid)	Stayman	6	119	278	19.83	46.33
	Black Twig	1	0	0	0	0
	Winesap	1	0	12	0	12.0
	Ben Davis	12	9	233	.75	19.41
	Totals	20	128	523	6.4	26.15
1 3/4 lbs. D.N. per 100 (powder)	Stayman	6	136	248	22.66	41.33
	Black Twig	1	3	35	3.0	35.0
	Winesap	1	0	0	0	0
	Ben Davis	10	22	201	2.2	20.1
	Totals	18	161	524	8.94	29.11
2 gals. D.N. per 100 (liquid)	Stayman	4	121	167	30.25	41.75
	Black Twig	1	1	7	1.0	7.0
	Winesap	2	102	88	51.0	44.0
	Ben Davis	13	31	311	2.38	23.92
	Totals	20	255	573	12.75	28.65
8 lbs. tar per 100 (powdered tar)	Stayman	5	315	391	63.0	78.2
	Black Twig	1	19	98	19.0	98.0
	Winesap	1	8	14	8.0	14.0
	Ben Davis	13	113	1118	8.69	86.0
	Totals	20	455	1621	22.75	81.05
5 lbs. tar per 100 (powdered)	Stayman	2	157	188	78.5	94.0
	Black Twig	2	155	252	77.5	126.0
	Winesap	1	64	71	64.0	71.0
	Ben Davis	10	102	696	10.2	69.6
	Delicious	2	8	15	4.0	7.5
	Totals	17	486	1222	28.58	70.88
	Stayman	6	226	283	37.66	47.16
	Black Twig	1	140	168	140.0	168.0
	Ben Davis	10	119	367	11.9	36.7
	Totals	17	485	818	28.52	48.11

FUNSTON ORCHARD

This orchard is at Greenwood, Virginia. It has about 50% crop set for this year. The trees are about 40 years old and have had excellent care.

The orchard has been sprayed in the dormant period for the last twenty years and in two of the last five years tarocide has been used.

The trees are between 20 and 35 feet in height. They are uniform in size. The orchard is in permanent sod.

Materials	Variety	Number of Trees	Total Aphis Apples	Total Aphis Clusters	Av. No. of Aphis per Tree Apples	Av. No. of Aphis per Tree Clusters
2½% D.N. (liquid)	Winesap	7	154	255	22.0	36.42
Lime sulphur 12½ gal. to 100	Winesap	5	1970	3089	394.0	617.8

CONCLUSIONS

Conclusions which may be drawn from the work discussed in this thesis are: (1) That the 50 per cent goulac and 50 per cent bentonite emulsifier used at the rate of 1.25 pounds per 100 gallons is seemingly the best material among those tested. However, under the conditions in which trials were made this year, a dry form of dinitro-ortho-cyclo-hexyl-phenol mixed with an emulsifier containing bentonite and soy flour appears to be superior in preliminary tests, either in oil or water sprays, due to its better wetting power.

(2) That injury which has been examined apparently occurs at the bud and enters the branch through the bud.

(3) That the dinitro-ortho-cyclo-hexyl-phenol in oil and water sprays should be applied only in the dormant season, although no serious injury has followed its use in the plots used for this study even when the buds have pushed out leaves as much as one quarter of an inch.

(4) That in the plots treated, the powder and water form of dinitro-ortho-cyclo-hexyl-phenol gave satisfactory control of Rosy aphis.

(5) That time, care and the following of directions should not be sacrificed in the making up of the emulsions.

BIBLIOGRAPHY

(1) Alwood, W.B., Notes on the Treatment of San Jose Scale with directions for Winter Work, Va. Agr. Exp. Sta. Bul. 72, pp. 11

(2) Alwood, W.B., Summer Treatment of San Jose Scale, Va. Agr. Exp. Sta. Bul. 74, pp. 28-34

(3) Alwood, W.B., Second Report of the Virginia State Inspector for San Jose Scale, pp. 34

(4) Alwood, W.B., Orchard Studies; IV. Remedial Measures Against San Jose Scale, Va. Agr. Exp. Sta. Bul. 131, pp. 149-169

(5) Austin, M.D., Jary, S.G., and Martin, H., Studies on the Ovicidal Action of Winter Washes, 1933 Trials. Jour. S.W. Agr. Col., Wye, Kent, No. 34, pp. 114-135, Fig. 3, (1934)

(6) Borden, Arthur D., and Hensill, George S., A Method of Studying Comparative Oil Deposits of Proprietory Oil Emulsions. Jour. of Ec. Ent., Vol. 27, No. 4, August, 1934

(7) Chandler, S.C., Flint, W.P., and Huber, L.L., Recent Insecticide Experiments in Illinois with Lubricating Oil Emulsions. Art. 2, Vol. 16, State of Ill., Div. of Natural History Survey

(8) Cory, E.N., Experiments of the Control of the Woolly Aphis, Univ. of Md. Agr. Exp. Sta. Bul. 252

(9) Cressman, A.W., and Dawsey, L.D., Oil Retention, Oil-Emulsifier Ratio and Oil-Water Ratio as Affecting the Insecticidal Efficiency of Emulsions., Jour. Agr. Res., (U.S.) 49, (1934) No. 1, pp. 1-19, Fig. 9

(10) Crosby, C.R., Mills, W.D., Blauvelt, W.E., Protecting Orchards Crops from Disease and Insects in Western New York, N.Y. State Ext. (Cornell) Bul. 313

(11) Cutright, C.R., Apple Aphids in Ohio, Ohio Agr. Exp. Sta. Bul. 464

(12) Cutright, C.R., Apple Aphids, 54th Annual Report, Ohio Agr. Exp. Sta. Bul. 561

(13) Dawsey, L.H., A Laboratory Method for Determining Approximately the Evaporation of Petroleum Spray Oils under Field Conditions., Jour. Ec. Ent., 26, (1933) pp. 735-736

(14) de Ong, E.R., Control of Red Spiders in Deciduous Orchards, Agr. Exp. Sta., Berkley, Calif., Bul. 347

(15) English, L.L., Some Properties of Oil Emulsions Influencing Insecticidal Efficiency, State of Ill. Div. of Natural History Survey, Art. 5, Vol. 17

(16) Essig, E.O., The Olive Insects of California, Calif. Agr. Exp. Sta. Bul. 283, pp. 41-64

(17) Evans, H.H., Oyster Shell Scale, Agr. Jour. of British Columbia, Vol. 7, No. 7, pp. 154-155

(18) Farrar, M.D., and Kelley, V.W., The Accumulative Effect of Oil Sprays on Apple Trees, Jour. Ec. Ent. 28, (1935), No. 2, pp. 257-260

(19) Felt, E.P., Crude Petroleum as an Insecticide, Country Gentleman, Vol. LXV., No. 2476, 12 July, 1900, pp. 569-570

(20) Felt, E.P., Some Effects of Early Spring Applications of Insecticides on Fruit Trees, U.S. Div. of Ent. Bul. 26, (n.s.) pp. 22-25

(21) Felt, E.P., Further Notes on Crude Petroleum and Other Insecticides, U.S. Div. of Ent. Bul. 31 (n.s.) pp. 49-51

(22) Felt, E.P., Nineteenth Report of State Entomologist on Injurious and Other Insects of the State of New York 1903, N.Y. State Mus. Bul. 76, pp. 91-235

(23) Felt, E.P., The Use of Oils on Dormant Trees, 28th Report of State Entomologist on Injurious and Other Insects of the State of New York, N.Y. Mus. Bul. 165, pp. 265

(24) Fennell, J.H., Gardner's Gazette, London, Nov. 23, 1839; No. 151, pp. 147

(25) Garman, P., Notes on the European Red Mite, Paratetranychus Pilosus, C. and F., Conn. Agr. Exp. Sta. Bul. 234, pp. 146-152

(26) Gentner, L.G., and Norris, R.K., Dormant Sprays and Their Use for the Control of Insect Pests of Fruit Trees in Rogue River Valley, Ore. State Agr. Col. Exp. Sta. Bul. 321

(27) Goodwin, W.T., Oil Spraying Tests on Apple Trees, Jour. Agr. Dept. of New Zealand, Vol. 21, No. 2, pp. 78

(28) Gossard, H.A., Report of the Entomologist, Fla. Agr. Exp. Sta. for 1899 and 1900; pp. 53-75

(29) Green, J.R., Chemical and Physical Properties of Petroleum Spray Oils, Jour. Agr. Research, Vol. 44, No.10, May 15, 1932

(30) Harman, S.W., The Fruit Tree Leaf Roller in Western New York, N.Y. State Agr. Exp. Sta. (Geneva) Bul. 561

(31) Hartzell, F.Z., and Parrott, P.J., Tar Distillate Emulsions for the Control of the Rosy Aphis and Other Fruit Insects, N.Y. State Agr. Exp. Sta. (Geneva) Bul. 636

(32) Hartzell, F.Z., Tar Distillate Emulsions for the Control of the Black Cherry Aphid, N.Y. State Agr. Exp. Sta. Bul. 637 (Geneva)

(33) Hedrick, U.P., Investigations of Tar Distillate Sprays, 52d Annual Report for 1933, N.Y. State Agr. Exp. Sta.

(34) Hensill, G.S., and Hoskins, W.M., Factors Concerned in the Deposit of Sprays, 1) - The Effect of Different Concentrations of Wetting Agents, Jour. Ec. Ent. (28), (1935), pp. 942-950

(35) Hoerner, J.L., A Progress Report on the Testing of Sulfonated Oxidation Products of Petroleum for their Insecticidal Properties, Univ. of Md. Agr. Exp. Sta. Bul. 310

(36) Holland, E.B., Bourne, A.I., and Anderson, P.L., Insecticides and Fungicides, Mass. Agr. Exp. Sta. Bul. 201

(37) Hoskins, W.M., The Penetration of Insecticidal Oils into Porous Solids, Calif. Agr. Exp. Sta. (Hilgardia) Vol. 8, No. 2, Nov. 1933

(38) Hough, W.S., The Efficiency of Tar Distillate Sprays in Controlling San Jose Scale in 1932, Rept. Jour. Ec. Ent. 26:470-473

(39) Hurt, R.H., Tar Oil Distillates as Dormant Spray Materials for Fruit Trees, Va. Agr. Exp. Sta. Bul. 293

(40) Hurt, R.H., Tar Oil Distillates as Dormant Spray Material for Fruit Trees, Proc. 36th Annual Meeting, Va. Hort. Soc., 1931

(41) Keffer, C.A., The San Jose Scale, Tenn. Agr. Exp. Sta. Bul., Vol. 16, No. 2, pp. 23-32

(42) Kelley, Victor W., Effect of Certain Hydrocarbon Oils on Respiration of Foliage and Dormant Twigs of the Apple, Univ. of Ill. Agr. Exp. Sta. Bul. 348

(43) Kelley, Victor W., Effect of Certain Hydrocarbon Oils on the Transpiration Rate of Some Deciduous Tree Fruits, Univ. of Ill. Agr. Exp. Sta. Bul. 353

(44) Knight, Hugh, A Microtechnique for Observing Oil Penetration in Citrus Leaves after Spraying, Science, Vol. 68, Dec. 7, 1928

(45) Lintner, J.A., First Annual Report on the Injurious and Other Insects of the State of New York, (1883) pp.384

(46) Lodeman, E.G., New York (Cornell) Agr. Exp. Sta. Bul. 60, Report for 1893

(47) M., J.W., Kerosene Oil for Insects, Gardner's Chronicle, Vol. VIII, (n.s.), No. 4, pp. 106

(48) Mason, A. Freeman, Spraying, Dusting and Fumigating of Plants, MacMillan, N.Y.

(49) McLeod, G.F., The Fruit Tree Leaf Roller in New York, Proc. Annual Meeting N.Y. State Hort. Soc., pp. 95-104

(50) Melander, E.L., Sprays for San Jose Scale and Leaf Roller, Wash. State Coll. Agr. Exp. Sta. Pop. Bul. 126

(51) Melander, A.L., Tolerance of San Jose Scale to Sprays, Wash. Agr. Exp. Sta. Bul. 174

(52) Murray Mem. Royal Caledonian Hort. Soc., Vol. III, pp.176-177

(53) O'Kane, W.C., and Baker, W.C., A Technique for Tracing Penetration of Petroleum Oil in Insect Eggs. Some Determinations of Oil Penetration into Insect Eggs. N.H. Agr. Exp. Sta. Tech. Bul. 60

(54) O'Kane, W.C., Westgate, W.A., Glover, L.C., and Lowry, P.R., Surface Tension, Surface Activity and Wetting Ability in Factors in the Performance of Contact Insecticides. N.H. Agr. Exp. Sta. Bul.39

(55) O'Kane, W.C., and Baker, W.C., Further Determinations of Oil Penetration into Insect Eggs, N.H. Agr. Exp. Sta. Bul. 62

(56) O'Kane, W.C., Glover, L.C., and Westgate, W.A., The Performance of Certain Contact Agents on Various Plant Surfaces. N.H. Agr. Exp. Sta. Bul. 68

(57) O'Kane, W.C., Walker, G.L., Guy, H.G., and Smith, O.J., Studies of Contact Insecticides -- VI, N.H. Agr. Exp. Sta. Bul. 54

(58) Parrott, P.J., Hodgkiss, H.E., and Hartzell, F.Z., The Rosy Aphis in Relation to Abnormal Apple Structures, N.Y. Agr. Exp. Sta. (Geneva) Bul. 66

(59) Parrott, P.J., and Glasgow, Hugh, The Rosy Aphis in Relation to Spray Practices in 1929. N.Y. State Agr. Exp. Sta. (Geneva) Bul. 582

(60) Porter, B.A., Lubricating Oil Emulsions, 54th Annual Report of Mich. State Hort. Soc. for 1924, pp. 116-122

(61) Quaintance, A.L., The San Jose Scale and Its Control, U.S.D.A. Jour. of Ent. Circ. 124, pp. 18

(62) Quaintance, A.L., The San Jose Scale and Its Control, U.S.D.A. Farmer's Bul. 650, pp. 27

(63) Riley, C.V., Insect Life, Vol. III, No. 5, pp. 183-196 (1890)

(64) Rohrbaugh, P.W., Penetrations and Accumulation of Petroleum Spray Oils in the Leaves, Twigs and Fruit of Citrus Trees. Plant Physiology 6: 699-750, October 1934

(65) Rollins, H.A., Spray Program for Apple and Peach, Conn. State Coll. Ext. Serv. Bul. 216

(66) Sherwood, E.C., Orchard Spraying Guide for West Virginia, Univ. of W.Va. Ext. Div. Circ. 304

(67) Smith, J.B., Crude Petroleum as an Insecticide, N.J. Agr. Exp. Sta. Bul. 138, pp. 22

(68) Smith, R.H., Studies of the Oil Depositing Qualities of Oil Spray Mixtures, Jour. Ec. Ent. 24 (1931) No. 5, pp. 985-991

(69) Spuler, A., Overly, F.L., and Green, E.L., Oil Sprays for Dormant Use, Wash. State Coll. Agr. Exp. Sta. Bul. 247

(70) Strand, A.L., Some Remarks on the Physiological Action of Oil Sprays, Jour. Ec. Ent. 25 (1932), No. 5, pp. 991-994

(71) Talbert, T.J., and Swartout, H.G., Spraying Investigations, Univ. of Mo. Agr. Exp. Sta. Bul. 301

(72) Tattersfield, F., Gimingham, C.T., and Morris, H.M., Studies on Contact Insecticides, Annals of Applied Biology, Vol. 12, No. 2 May, 1925

(73) Tattersfield, F., Gimingham, C.T., and Morris, H.M., Studies on Contact Insecticides, Annals of Applied Biology, Vol. XII, No. 1, February 1925

(74) Tattersfield, F., Gimingham, C.T., and Morris, H.M., Studies on Contact Insecticides, The Annals of Applied Biology, Vol. XIII, No. 3, August 1926

(75) Tattersfield, F., Gimingham, C.T., and Morris, H.M., Studies on Contact Insecticides, The Annals of Applied Biology, Vol. XIV, No. 2, May 1927

(76) Tattersfield, F., Gimingham, C.T., and Morris, H.M., Studies on Contact Insecticides, The Annals of Applied Biology, Vol. XIV, No. 3, August 1927

(77) Thurston, H.W., Jr., and Worthley, H.N., Some Problems in Apple Spraying in Pennsylvania, Pa. Agr. Exp. Sta. Bul. 324

(78) Young, P.A., and Morris, H.E., Injury to Apple by Petroleum Oil Sprays, Jour. Agr. Res., 47, No. 7, pp. 505-552, Oct. 1, 1933

(79) Young, P.A., Penetration, Distribution and Effect of Petroleum Oils in Apple. Jour. Agr. Res. 49: 559-571, Sept., 15, 1934

(80) Cornell University Horticultural Department Spray Calendar, 1907

(81) Directions for Spraying Fruits in Illinois, Univ. of Ill.
Agr. Exp. Sta. and Ext. Serv. Circ. 429
March 1935

(82) Information for Virginia Fruit Growers, Va. Poly. Inst.
Bul. 131, 1935

(83) Maryland Spray Calendar for Apples and Peaches, Univ. of
Md. Ext. Serv. Circ. 109