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The Fruit Tree Leaf Roller

Its Control in Southern Idaho by the Use of Oil Emulsion Sprays

By

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*In cooperation with U. S. Department of Agriculture.

THE FRUIT TREE LEAF ROLLER

Its Control in Southern Idaho by the Use of Oil Emulsion Sprays

CLAUDE WAKELAND

This bulletin is intended to furnish timely information on the preparation and use of oil emulsion sprays for controlling the fruit tree leaf roller in southern Idaho and is based on the results of extensive experiments in 1923 and 1924. Our knowledge of oil emulsions is changing rapidly and it is recognized that a bulletin of the scope of this one may serve its purpose for but a single season and be supplanted by others as additional information is obtained.

Experiments in 1923

Experiments conducted in the laboratory and under field conditions in 1923 included attempts to control the fruit tree leaf roller by oil emulsion sprays directed against the egg masses and by arsenate of lead sprays intended to kill the larvae after they had begun to feed on the buds and leaves. Laboratory tests were conducted at the Entomological Field Station, Parma, and field tests were made at Apple Valley, Emmett and Twin Falls. Results of these tests are briefly summarized as follows:

TABLE I

Comparative Effectiveness of Oil Emulsion Sprays Against Leaf Roller Egg Masses, 1923

Per cent Eggs Dead (4336 egg masses examined)

Locality	Checks, unsprayed	Material Used			Dormant Soluble Oil, 6.64% oil
		Dormoil 6.64% oil*	Diamond Paraffin Oil-potash fishoil soap emulsion 6.64% oil	Target Scale Destroyer 4.50%	
Apple Valley	4.16	85.81		48.29	45.44
Emmett	0.00	70.13	90.08	84.71	75.25
Twin Falls	5.94	88.72		82.68	75.76
Average of field tests	3.35	81.55		71.89	65.48
Laboratory tests, Parma	34.04	99.83	80.02	88.52	66.29
Average of field and laboratory tests	18.70	90.69	85.04	80.20	65.88

*The percentage of oil as shown in all of the tables included in this bulletin was calculated by determining the number of gallons of mineral oil in 100 gallons of dilute spray solution. The approximate amounts of mineral oil in the stock emulsions is as follows: Dormoil, 83 per cent; Dormant Soluble Oil, 83 per cent; Target Scale Destroyer, 90 per cent; Freemulsion, 75 per cent; fishoil soap emulsion, 66⅔ per cent; calcium caseinate emulsion, 66⅔ per cent. Upon recommendation of the manufacturer, Target Scale Destroyer was used at the dilution named.

To test the value of poisoning the larvae, powdered lead arsenate was used at the rate of 8 pounds per 200 gallons of water to which was added 1½ pounds 3S brand calcium caseinate. Applications were made at two different periods. One spray was applied when the fruit buds were swelling and just before the color showed. Some of the more advanced varieties at this time had a small percentage of buds in the pink stage. Another application was made at the time of the regular codling moth calyx spray. These were designated the pre-pink and the calyx sprays. Results were measured by examining the fruit at picking time. It has been noted that the percentage of hatched eggs is not always a true indication of the degree of control obtained by oil, for larvae, that have apparently been weakened or injured by it, often die after they have gnawed their way out of the egg shells. For this reason, fruits on oil-sprayed blocks were examined as well as those on plots sprayed with lead arsenate.

TABLE II

Comparison of Results Obtained with Oil Emulsion Sprays and With Arsenate of Lead

Oil Sprays	Sound Apples		Injured Apples	
	Total number	Average percentage	Total number	Average percentage
Target Scale Destroyer plus 3S spreader	2932	95.94	124	4.06
Target Scale Destroyer	3538	96.14	142	3.86
Dormoil	5018	94.46	294	5.54
Dormant Soluble Oil	2597	93.49	170	6.51
Total and average	14085	95.00	730	5.00
Lead arsenate sprays				
Pre-pink	2804	84.99	495	15.01
Calyx	1392	83.10	283	16.90
Pre-pink and calyx	809	81.06	189	18.94
Total and average	5005	83.80	967	16.95

	Fruit Injured
Average of all oil-sprayed blocks	4.78 per cent
Average of all lead arsenate sprayed blocks	16.95 per cent
Average of trees unsprayed excepting with lime-sulfur and with regular codling moth applications	18.16 per cent

From the data in Table II it is apparent that oil sprays were very much more effective than lead arsenate in the control of the fruit tree leaf roller. Lead arsenate at double the strength ordinarily used for codling moth control and applied in both the pre-pink and calyx sprays proved to be of little value.

Experiments in 1924

Experiments in 1924 were confined to the use of oil emulsion sprays directed against the egg masses. An effort was made to determine the more desirable type of emulsion to use, whether home-mixed or commercial, the best grade of oil and the most satisfactory emulsifier, cost and efficiency considered. The experimental orchard at Emmett was divided into fourteen plots each containing Jonathan and Rome Beauty trees. One tree of each variety in each sprayed plot and two of each variety in the unsprayed block were chosen as count trees. Before spraying was undertaken the extent of the infestation was determined and all egg masses not of the current year were eliminated. This was done by examining carefully all of the surface area on each count tree, making a record of the number of live egg masses and destroying all the old hatched or shriveled egg masses. On the thirty-two count trees it was determined that there was an average of 132 live egg masses per tree with a maximum of 269 and a minimum of 54. The greatest number of eggs per mass was 99, the smallest 7 and the average 33.74.

Spraying was conducted April 14 and 15, hatching of eggs had been completed May 3 and counts to determine results were made May 6, 7 and 8. In the final count all totally unhatched egg masses were recorded and those in which eggs had hatched were examined thru a hand lens and the number of eggs that had hatched per mass was recorded. From these data determinations of percentages were made.

TABLE III

Comparative Effectiveness of Oil Emulsion Sprays Against Leaf Roller Egg Masses, 1924

Plot No.	Per cent oil in dilute spray	Materials used	No. eggs examined	Percentage eggs unhatched		
				Low	High	Average
1	6.64	Diamond paraffin oil-potash fishoil soap emulsion containing 8% crude phenol	4994	91.62	97.68	95.65
2	6.64	Diamond paraffin oil-potash fishoil soap emulsion	3357	94.14	98.41	96.27
3	6.64	Diamond paraffin oil-potash fishoil soap emulsion	8199	83.35	90.05	86.70
4	6.64	Union brown neutral oil-calcium caseinate emulsion	8135	76.93	97.73	87.33
5	6.64	Atlantic red engine oil-calcium caseinate emulsion plus 1½ pounds 3S spreader per 200-gallon tank	8208	90.25	94.92	92.58
6	6.64	Atlantic red engine oil-calcium caseinate emulsion	5990	86.25	99.43	92.84
7	6.00	Freemulsion	6476	79.97	95.14	87.55
9	6.64	Dormant Soluble Oil	6035	76.85	86.93	81.89
10	4.50	Target Scale Destroyer	4794	79.59	91.42	85.50
11	6.64	Dormoil plus 1½ pounds 3S spreader per 200-gal. tank	5561	93.28	96.88	95.08
12	6.64	Dormoil	8943	83.46	99.46	91.46
13	8.30	Dormoil	7151	92.28	92.63	92.45
14		Check trees, sprayed with lime-sulfur but not with oil	2962	9.77	10.97	10.37

Under force of circumstance spraying was done during weather that was not entirely desirable. Gusts of wind sometimes made uniform application impossible which fact doubtless accounts for the wide range between the low and the high percentages of kill on trees sprayed with the same material.

Summary of Results 1924

Results are summarized as follows: The highest percentage of kill on an individual tree was obtained by Dormoil at a dilution of 6.64 per cent; the highest average percentage of kill occurred when Diamond paraffin oil-potash fishoil soap emulsion was used at a dilution of 6.64 per cent; the lowest individual kill and the lowest average kill were obtained by Dormant Soluble Oil at a dilution of 6.64 per cent. The addition of phenol did not increase the efficiency of the emulsion and increasing the percentage of the oil gave no better results. In comparative efficiency the three general classes of oil sprays ranked as follows: Home-mixed

potash fishoil-soap emulsion, home-mixed calciuum caseinate emulsion and commercial oil emulsions. The degree of difference in results with many of the emulsions was so slight that selection of the best oil under practical conditions would be determined largely by price.

Effect of Hard Water

Commercial preparations and home-mixed emulsions that contain soap emulsifiers may give trouble when used with some of the hard waters of southern Idaho, in which case free oil will float on the surface of the dilute mixture or the spray will have a curdled appearance. Agitation in the tank will often cause the curds to form into balls or chunks. To correct this condition, the water should be softened with sal soda or washing soda at the rate of one-half pound to one pound per 200-gallon tank. Where hard water must be used, calcium caseinate emulsions are to be preferred since they are not broken down in such water.

Commercial Oil Emulsions

Commercial oil emulsions of known merit are more expensive than home-mixed preparations but, under average conditions of use, they doubtless will give more uniform results with less trouble to the grower since they are standardized and their composition is constantly tested by the manufacturers. Many growers will not attempt to mix their own spray emulsions, preferring to pay more for a product that is known to be dependable and that is ready for use.

Preparation of Home Mixed Emulsions

The Idaho Agricultural Experiment Station has prepared emulsions for field and laboratory tests in which potash fishoil soap and calcium caseinate have been the emulsifying agents. These emulsions have become generally known as the Government formula and the Missouri Station formula.

Government Formula (Modified), Hot Mix

Lubricating oil	2 gallons
Potash fishoil soap	1½ pounds
Water to make a total of	3 gallons

The amount of soap in the regular Government formula was reduced one-fourth after tests were made by the Chemist of the Idaho Agricultural Experiment Station. In preparing the stock emulsion the ingredients are boiled together until a uniform, creamy liquid is formed and the soap is dissolved. The container is then removed from the fire or the fire is "pulled" and the mixture pumped twice while hot thru a hand force pump. In preparing stock emulsions for the orchard tests outlined in a preceding

paragraph the mixture was boiled in a headless steel barrel set on iron stakes at sufficient height above the ground for a small fire to be maintained beneath the barrel. In another headless steel barrel a barrel pump was mounted with which the material was forced thru a regular orchard spray nozzle equipped with a coarse disk. With this equipment one man may prepare sufficient stock emulsion for a 200-gallon spray tank during the time required to apply a tankful of the dilute spray. A bucket force pump will produce a satisfactory emulsion but its capacity is small.

When the oil mixture begins to boil it is likely to boil over unless the fire is very low and precautions should be taken in advance for "pulling" the fire or for removing the barrel from the fire if need arises.

Missouri Station Formula, Cold Mix

Lubricating oil	2 gallons
Water	1 gallon
Calcium caseinate	4 ounces

Dissolve the calcium caseinate in the water. This can easily be done by placing the calcium caseinate with some water in a large can having a tight top and shaking them together vigorously. Another method of dissolving it is to turn the stream of water from a spray gun into the pail containing the calcium caseinate and allowing it to run until all goes into solution. After the calcium caseinate has been dissolved, add the oil, stir the ingredients together and then pump the mixture under pressure three or four times. The equipment described for preparing the hot-mix formula is satisfactory also in the preparation of this formula.

Preparing Calcium Caseinate Emulsions in the Spray Tank

Some growers will prefer to prepare their calcium caseinate oil emulsions in the spray tank for immediate use. This can be safely done by taking precautions to pump the mixture long enough to insure thoro emulsification before filling the remainder of the tank with water. A necessary precaution is for the grower to determine the length of time required to pump the emulsion thru once. This readily can be done by pumping it into a barrel or other container. After this time is determined he can prepare each batch of stock of emulsion by pumping it back onto itself in the spray tank and continuing the pumping four times as long as he has determined is required for it to pass once thru the pump. In preparing the stock emulsion the required amount of water is placed in the tank and the calcium caseinate is dissolved in it. The oil is then added and after it has been mixed with the calcium caseinate solution by the agitator the spray gun is opened and turned into the tank. When the stock emulsion has been prepared in this manner it is ready for di-

lution by filling the remainder of the tank with water. Under practical conditions there usually is sufficient liquid remaining in the bottom of the tank after it has been emptied so that the calcium caseinate may be dissolved in the tank without the addition of more water. To prepare a 7 per cent dilution of oil in a 200-gallon tank, 28 ounces of calcium caseinate are dissolved in 7 gallons of water, or in the solution remaining in the tank, and 14 gallons of oil are then added.

Kinds of Oil

The oils that have been used most widely in the preparation of home-mixed emulsions are lubricating oils of light or medium body. The fuel oils, distillates, etc., have been removed but the lubricatnig oils have not been refined sufficiently to be used as motor oils. In this class come Atlantic red engine oil, Diamond paraffin oil, Junior red engine oil, Nabob oil, etc. Another class is composed of the neutral oils. These, whi'e they come from the portions from which lubricating oils are derived, are much less expensive than the finished lubricating oils because they need not be highly refined or treated. A representative of this class of oil that was tested by the Idaho Agricultural Experiment Station is Union brown neutral oil.

As shown in Table III the highest percentage of kill obtained by a calcium caseinate emulsion was with a lubricating oil. The highest percentage would appear to more nearly represent the true value of an oil than the average since low percentages, which are included in calculating the average, are likely to be occasioned by incomplete covering. The percentage of kill with a neutral oil was relatively high and, considering cost and efficiency, the small increase in the effectiveness of lubricating oil over that of neutral oil is not worth the difference in price.

When to Spray

In southern Idaho eggs of the fruit tree leaf roller are deposited in late June and early July but do not hatch until the following spring. The time of hatching varies with different years in relation to both date and the development of the trees. If spraying is delayed until the buds begin to burst there are seasons when eggs will have begun to hatch and it is then too late to obtain the best results. A rule that will meet all conditions is that the leaf roller spray should be applied after the mild weather of spring has come and before the buds begin to open.

The Need of Thoroness

The importance of thoroness of application of oil sprays for control of this insect scarcely can be over-emphasized. It must be born in mind that every egg mass must be covered completely with the dilute emulsion

and with a heavy coating. This means that every bit of surface of bark on a tree must receive a liberal film of spray. Wasting of a large amount of material cannot be avoided if all of the surface is covered and for this reason more material is required per tree in dormant spraying than for cover sprays. Sufficient pressure must be maintained to force the spray mist entirely thru the tree and it is doubtful if entirely satisfactory results can be obtained without spraying both from the ground and from a tower when the trees are twelve years of age or older.

Injury From Oil

Reasonable care must be exercised that oil sprays, of sufficient strength to kill leaf roller eggs, are applied during periods of moderate weather. It is probable that there is never a spring in southern Idaho when a period of favorable weather cannot be utilized for spraying if the orchardist has his equipment in readiness. During late March and early April, in 1924, a month of mild weather prevailed but most of the dormant spraying was done after that period had passed. On the experimental plots, spraying was conducted April 14 and 15 and during the morning of April 16 the temperature on Emmett Bench dropped to 18 degrees above zero. Serious injury to the fruit and foliage of the current year's crop resulted from this combination of oil and of low temperature. No injury resulted from sprays applied a week earlier or a week or two weeks later when the temperature was mild. Instances of oil injury are rare, their occurence usually can be avoided and they need not prevent the grower from using oil emulsion sprays. However, it is known that injury can be caused by oil emulsions and the grower should exercise care to use them under conditions that he knows are safest.

Leaf Roller Spray Controls San Jose Scale

Since the percentage of oil in the dilute spray for leaf roller is greater than is necessary for control of San Jose scale no separate spray is necessary for this insect where the leaf roller is being combatted. When San Jose scale alone is to be controlled a 3 per cent spray has been found to be effective under southern Idaho conditions. A summary of results of tests of oil sprays against San Jose Scale is given in Table IV.

TABLE IV

Comparative Effectiveness of Oil Dilutions Against San Jose Scale, 1923

Material used	Percentage oil in dilute spray	Percentage of scale insects dead
Target Scale Destroyer	2.22	100.00
Dormoil	3.00	99.96
Diamond paraffin oil-potash fishoil soap emulsion	2.00	95.37
Dormoil	1.00	90.60
Dormoil	2.00	80.20
Check, unsprayed		50.60

Calculating Dilutions

Before attempting to calculate the amount of an emulsion to use to obtain a certain percentage of dilute spray, the percentage of oil in the emulsion must first be known. Knowing this, multiply the number of gallons of dilute spray to be made by the percentage of oil desired in the spray and divide the product by the percentage of oil contained in the stock emulsion. For example: To make 200 gallons of dilute spray containing 3 per cent oil from a stock emulsion that contains 66 2-3 per cent oil, multiply 200 by 3 and divide the product by 66 2-3. By this calculation it is determined that such a spray requires 9 gallons of the stock emulsion to a 200-gallon tank of dilute spray.

Recommended Strengths

In southern Idaho 7 per cent oil in the dilute spray is recommended for the control of the fruit tree leaf roller and 3 per cent oil for the control of San Jose scale.

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