Oil Sprays for Fruit Trees

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G. W. Pearce

Petroleum oils are used in several ways to control pests. Some kill insects and mites directly through their own action. Some supplement the action of other insecticides as co-toxicants, solvents and carriers, stickers, or stabilizers.

In the water-borne oil sprays commonly applied to fruit trees, the oil usually is the sole or primary insecticidal agent. That is also true of oils used to rid bodies of water of mosquitoes.

Light petroleum fractions are widely used as solvents and carriers for many insecticides. The original fly sprays are a good example. The introduction of DDT and other organic insecticides has meant a great increase in the use of oil as the carrier for applying insecticides, especially the chemicals used to control household and building pests. These oil-insecticide mixtures usually are applied in the form of fine mists. With heat and a suitable generator they can be applied also as thermal fogs, which remind one of military smoke screens.

Often oils are added to insecticidal and fungicidal spray, dust, and poisonbait formulations as stickers, stabilizers, and conditioning agents.

In this chapter we discuss the water-borne oil sprays as they are used to control pests of citrus and deciduous fruit trees.

Kerosene was apparently the first petroleum product used for the control of plant pests in the United States. A. J. Cook of Michigan State College introduced in 1877 a kerosene-soap emulsion which was widely employed to combat aphids and scale insects.

Entomologists sought something more effective and turned to crude pe-
troleum. It proved to be too injurious to most plants. A search was then started for some fraction or series of fractions of petroleum that would be highly effective as insecticides, but relatively noninjurious to plants. Progress has been made in the search.

Oil sprays are used most commonly in horticulture to control scale insects and mites, among which are many of our major fruit pests. Oil sprays are also used to control psyllids (pear psylla), plant bugs (apple red bugs), mealybugs, aleyrodids (whiteflies, citrus blackfly), thrips, aphids (newly hatched), membracids (buffalo tree-hopper), and others. Oil sprays readily destroy eggs of many lepidopterous pests, like the codling moth, oriental fruit moth, various leaf rollers, and cankerworms. Those insects are now more commonly controlled in the larval stage with the newer insecticides.

More than 15 million gallons of oil are used annually in this country for horticultural sprays. Emulsified and diluted to a 2-percent strength, that amount makes 750 million gallons of spray—enough to provide for the single coverage of 40 million to 50 million orange or apple trees.

Tree spray oils are of two classes. Those intended for use on the hardy tree fruits during the dormant period are called dormant oils. Those applied to trees in foliage are the summer oils. The oils used on citrus in California may be classed as summer oils. The two groups differ chiefly in the degree of refinement of the oil and in its heaviness, or viscosity. Summer oils have been more highly refined and are of lighter weight than dormant oils. The classification is rather arbitrary, and because the trend has been toward using the so-called dormant oils after growth starts and using more highly refined products, the distinction between dormant and summer oils has had less and less meaning.

The first major step in refining petroleum is its division into fractions by distillation. First to distill over are the low-boiling naphthas, then come increasingly higher-boiling lots, through gasoline, kerosene, fuel oils, and, finally, the lubricant fractions. Horticultural spray oils are derived from the fuel-oil and light-lubricant portions of petroleum; those from the lubricant portion predominate.

Crude petroleums vary greatly in composition. Differences exist among crudes from the major production fields and even among wells in one field. We recognize three general types—paraffinic base, asphaltic or naphthenic base, and mixed base or midcontinent crudes. Spray oils have been prepared from all crude classes. Asphaltic-base crudes are utilized in California primarily because the local petroleum supply is generally of that class. East of the Rockies the midcontinent crudes are more commonly used.

Before we consider specifications for horticultural spray oils, it is well to have an understanding of their nature. The spray oils are composed essentially of hydrocarbons—compounds containing hydrogen and carbon. The arrangement of the atoms of the two elements in individual molecules is varied and complex. Only three basic classes of carbon structures occur, however—paraffin chains, aromatic rings, and naphthene rings. It is possible by analysis to determine the approximate percentage of each structure-class in any oil. As will be brought out later, oil composition has an important bearing on both insecticidal efficiency and plant safety. The composition one might find for spray oils, manufactured from paraffinic and naphthenic crudes, is:

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<th>Type of oil</th>
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</tr>
<tr>
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<td>Moderate acid</td>
</tr>
<tr>
<td>Naphthenic</td>
<td>Conventional</td>
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<table>
<thead>
<tr>
<th>Percentage of each structure</th>
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</table>
Oil Sprays for Fruit Trees

Research workers learned long ago that the safety of spray oils to plants in leaf is related to the aromatics and other unsaturates present. It is now generally agreed that oils can be made increasingly safer for use on evergreen plants and on deciduous plants in their growth period by lowering the aromatic-ring content. That may be accomplished in part in refining operations by treating the oil with strong sulfuric acid or its equivalent. The aromatics and other unsaturates react to form sulfonates, which can be separated from the remainder of the oil. The process has given rise to the term unsulfonated residue, or U. R. The term is widely used to indicate the degree of refinement of the oil or its degree of freedom from aromatic structures. Oils intended for foliage sprays have U. R. values ranging from about 90 to 96 percent. Products used on deciduous trees in the dormant period may range from about 50 to 90 U. R.

Until 1940 or so, oil composition was thought to have little practical relation to the insecticidal efficiency of horticultural spray oils. Since then, however, studies made at the New York State Agricultural Experiment Station and elsewhere have established that efficiency is related to the paraffinic character of an oil. Thus efficiency increases as the paraffinic character in oils increases. The relationship has been demonstrated in the case of the major oil-susceptible pests of both deciduous and citrus fruit trees. It should not be inferred that the so-called naphthenic oils make unsatisfactory spray oils. They are in a sense simply low paraffin oils and consequently are used at greater strengths in the spray mixture to achieve results equal to those had with highly paraffinic items.

Another factor affecting the insecticidal value of an oil is the size of its molecules. More familiar but less accurate terms for this property are viscosity and relative heaviness: Oils of small molecular size, such as kerosene, for example, have little separate value in killing horticultural pests, but there seems to be a 20 advantage in going above a certain molecular size.

Viscosity and boiling-range data are the criteria most commonly used in commerce to indicate the molecular-size property of an oil. Viscosity is measured at certain temperatures by recording the time required in seconds for a sample to flow through a standard opening. It depends on the principle that molecular size controls flow speed, with the rate decreasing as size increases. In addition to size, however, flow rate is also affected by the shape of the molecules. That means that one cannot depend on viscosity measurements alone to classify products as to their suitability for horticultural sprays among oils of different origin. For example, a highly paraffinic oil having a viscosity of only 50 seconds Saybolt at 100° F. may be more effective insecticidally than extremely naphthenic products of 125—130 seconds. Viscosity measurements are useful in indicating heaviness ranges among oils of common origin and manufacture.

A more accurate indication of molecular size in an oil can be obtained from distillation- or boiling-range data. Moreover, that measure has two advantages over viscosity data for spray-oil purposes: It indicates molecular-size range, and it permits a fairly close practical comparison, insecticidally, even among oils of different composition.

The California Department of Agriculture in 1932 established distillation-range standards to regulate the sale of spray oils in that State. Five grades of summer or foliage-spray oils and three grades of dormant oils were set up, based on a minimum U. R., and the percentage of the product that distilled over at 636° F. The system has not been adopted generally, but it has worked out well on the west coast, partly because spray oils in the area are made from the same general class of crude petroleum.
Oil sprays kill insects and mites by what appears to be essentially a smothering action. By enveloping the pest with a continuous film of oil, the oil interferes with its respiration and ultimately causes death. That is the conclusion to be drawn from studies made by E. H. Smith and G. W. Pearce, who used eggs of the oriental fruit moth as test subjects. That the action is largely physical was shown by the ability of some eggs to survive 24-hour exposure to a lethal dosage of oil. In the experiment the oil was removed 24 hours after application through the use of an oil solvent.

Similar results were obtained earlier by this technique on the winter eggs of the fruit tree leaf roller. In that instance, some eggs hatched after having been exposed a week to a deposit that would have killed all eggs had it not been removed.

Oil sprays may kill hatched forms of insects in essentially the same manner as just described for eggs. Instead of a direct exchange of gases through the wall or shell, as in the case of an egg, however, respiration in hatched forms usually takes place through openings—spiracles—in the body wall connected with branching tubes extending inwards (the tracheal system). Killing seems to be effected by oil flowing into the tracheae and plugging them, with death resulting from suffocation. In his studies on California red scale, Walter Ebeling found that the usual route of oil to the insect proper is under the scale covering from its edge. Some oil may penetrate directly through the armor. Besides killing the individuals that it touches, an oil film on the plant interferes with the successful establishment of the young that may hatch for some days following treatment. Such a residual effect is an important part of the total action achieved in the control of citrus mites and scale insects.

Oil and water, despite the old saying, can be made to mix in the form of emulsions wherein the oil is dispersed as minute droplets throughout the water. Oil is usually applied to fruit trees in the form of emulsions containing about 1 percent to 4 percent oil. Emulsification is brought about by agitation and the addition of a substance, known as an emulsifying agent, that reduces interfacial tension.

Oils are applied as emulsions primarily to regulate the amount of oil deposited on the plant. That is important: A rather direct relationship exists between oil deposit and both insecticidal efficiency and plant injury. The object is to lay down a deposit sufficient to kill the pests present and yet below that which will cause plant injury. Often the operational margin is quite narrow. Oil-deposition rate is determined chiefly by four factors: The oil strength in the spray mixture, the kind and amount of emulsifying agent used, the nature of the plant surface sprayed, and the amount of spray applied.

The first requirement of an emulsifying agent, of course, is that it produce a satisfactory emulsion. It also should maintain a uniform concentration of oil throughout the batch of dilute emulsion in the spray tank. These conditions can be met by forming highly stable emulsions. Unfortunately stable emulsions generally lay down low oil deposits in spraying. To obtain at least moderate-deposition properties in the mixture, one must sacrifice some stability. Actually, agitation can largely offset this disadvantage. Most modern spraying machines are equipped with agitation systems that permit the use of relatively unstable emulsions.

The influence of the emulsifier on oil-deposition rate in spraying may be great. An emulsion prepared with one emulsifier may lay down as much oil on the plant at a 1-percent strength as others used at 2-, 3-, or even 4-percent strengths. Further wide variations in deposition can be expected as the amount of any given emulsifier is varied. The deposition rate for a given emulsifier generally decreases as the amount used is increased.

Another factor is the nature of the plant surface—whether bark, leaves, or
Oil Sprays for Fruit Trees

fruit, or, indeed, old and new bark, young and mature fruit, old and new leaves, and often the upper and lower surfaces of leaves. The surface factor is of less importance in treating deciduous fruit trees during the semidormant period, when relatively small variations in bark surface are involved. The treatment of trees in leaf is something else again. The surface factor is of special importance in treating citrus trees for the control of pests like the California red scale, which occurs on all parts of the tree. If a pest must be controlled on two or more types of surfaces, the amount of emulsifier should be so adjusted that at least a minimum effective dosage will be laid down on all surfaces.

Thus, any recommendations for oil sprays should consider the concentration of oil in the spray mixture and its oil-deposition rate as well. There has been a trend towards adjusting deposition rates to common standards. Probably no single oil-deposition standard will prove satisfactory for all purposes. When the oil deposit must be rigidly controlled, as in spraying oil-sensitive shade trees during dormancy and deciduous fruit trees in leaf, a relatively stable light-depositing emulsion is indicated. But deciduous fruit trees are relatively tolerant of oil in the dormant period. Some overdosing of all or part of the tree then would be of little importance. Consequently less stable emulsions may then be used on fruit trees.

Growers can buy a stock oil product in which the emulsifying agent is incorporated or buy the straight oil and emulsifier separately and prepare the emulsion themselves in the spraying machine immediately before use. The latter is called tank mixing. Satisfactory spray-strength emulsions can be prepared by tank mixing as well as through the use of commercial stocks. Tank mixing costs less, but factory-made formulations offer convenience in handling and uniform performance.

Commercial spray-oil stocks are of two classes, concentrated emulsions and emulsible oils. Such terms as emulsive oils, miscible oils, and soluble oils are also applied to the second type. Concentrated emulsions—preformed emulsions in a concentrated state—resemble a thin, whitish paste and usually contain about 83 percent oil by volume. The concentrated emulsions will flow readily through the standard 2-inch bung for metal drums.

The emulsible oils consist of oil in which one or more emulsifying agents have been dissolved. They usually contain 95 to 99 percent oil and often resemble straight oil in appearance. They are not emulsions in the state in which they are sold but produce emulsions when added to water in the spray tank. They vary in the readiness with which an emulsion is formed in the tank. Some formulations produce an emulsion instantly; others first require some preliminary agitation in the presence of only a small amount of water. Some authorities prefer to designate the former type of product as miscible oils, reserving the term emulsible oil for the latter. Although the so-called miscible oils emulsify readily, they lay down low oil deposits in spraying.

The tank-mixing procedure is quite simple in principle. A 2-percent oil spray mixture can be prepared thus, in a high-pressure orchard-spraying machine equipped with a 400-gallon tank: With the engine running, just enough water is drawn into the tank to operate the pump—15 to 25 gallons. The emulsifying agent is added, then the oil (which would be 8 gallons in this example). A spray gun directed into the tank is next opened and held open for 1 to 2 minutes. The circulation of water, oil, and emulsifier through the pump and its discharge or injection under high pressure into the tank effects emulsification. At this point the mixture should have a uniform, creamy appearance. The final step is to fill the tank with water, and the mixture is ready for use.

The foregoing procedure will produce the most satisfactory type of tank-mixed emulsion, but it is not absolutely
necessary to pass the mixture through a spray gun. In the citrus area of California a general practice is to wait a minute or two before filling the tank for the agitators to create the emulsion. An improvement on the practice is to operate the pumps under full pressure during the prefill mixing.

Many emulsifying agents may be used in tank mixing. Blood albumin has been widely used. In California a 25-percent product is used at the rate of 4 ounces for each 100 gallons of spray-strength emulsion. An 8-ounce rate is advised in New York.

Application of more of the oil-spray mixture than may be needed to cover all or part of the tree usually causes no harmful effects. There is a limit to how much oil can be deposited in continuous spraying when most dilute emulsions are used. It simply runs off beyond this point. An important exception is when part of a tree may be sprayed twice with a drying period between. The situation may occur when growers follow the practice of spraying one side of the row when the wind, say, is in the west, and covering the east side several days later when the wind shifts. Almost twice as much oil will be deposited where the two coverages overlap as elsewhere on the tree. One should try to cover the whole tree in one operation. If each side of the row is sprayed separately, the opposite side should be treated 15 or 20 minutes later, or before the spray applied in the first half of the operation has dried.

Petroleum-oil sprays have been used on citrus trees since about 1900. Commercial control of the major pests in most California citrus districts can be had with a single annual application of an oil spray. Such a program, the most economical of those available, has been widely followed in California. The dominant position of oil sprays on citrus is being challenged as the search continues for more efficient insecticides and for ones without the objectionable effect on trees and fruit that is attributed to oil.

**Yearbook of Agriculture 1952**

Different practices are followed with oil sprays on citrus in Florida because of differences in climate, cultural practices, varieties, and in marketing. Florida citrus trees are apparently more tolerant of oil sprays than are those of California—at least there seems to be greater latitude in the kinds of oil that can be used with relative safety on citrus in Florida. Growers in Florida in 1945 were using oils that ranged in viscosity from 69 to 108 seconds Saybolt at 100° F. and from 75 to 92 percent in U. R. Both naphthenic- and paraffinic-type products were employed. Practices in California were more standardized; the spray oils were prepared from much the same class of crude (California naphthenic-base) stock, refined to a U. R. of 90 percent or higher, and were available in a series of relatively narrow boiling fractions.

The California Department of Agriculture in 1932 established specifications for spray oils that were based on certain U. R. and distillation standards. The latter property was measured as the percentage of the product that distilled up to 636° F.

Five grades of oils were established for use on citrus fruit trees—light, light-medium, medium, heavy-medium, and heavy. The minimum required standards for each grade are given in the accompanying table. Kerosene and mineral-seal oil are also included because they have sometimes been applied on citrus.

Citrus oil sprays are usually used in California at an actual oil concentration of 1.66 to 1.75 percent—the rate used in tank mixing or in employing commercial emulsible oil stocks. Concentrated emulsion stocks—containing 80 to 85 percent of oil—are commonly used at a 2-percent strength. The general plan has been to keep the oil dosage in the spray mixture more or less constant and to vary the oil heaviness to achieve the desired results in pest control or as tree tolerance may dictate. In general, pest-control efficiency as well as plant-injury hazards increase as oils of increasing heaviness are used.
Oil Sprays for Fruit Trees

Spray Oils Used on Citrus in California

<table>
<thead>
<tr>
<th>Grade</th>
<th>U. R. tilled at</th>
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<tbody>
<tr>
<td>Grade</td>
<td>635° F. Saybolt</td>
</tr>
<tr>
<td>Light</td>
<td>90 64-79 55-65</td>
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<tr>
<td>Light-medium</td>
<td>92 52-61 60-75</td>
</tr>
<tr>
<td>Medium</td>
<td>92 40-49 70-85</td>
</tr>
<tr>
<td>Heavy-medium</td>
<td>92 28-37 80-95</td>
</tr>
<tr>
<td>Heavy</td>
<td>94 10-25 90-105</td>
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</table>

STANDARD GRADES OF FOLIAGE SPRAY OILS

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<tr>
<th>Grade</th>
<th>Light</th>
<th>Light-medium</th>
<th>Medium</th>
<th>Heavy-medium</th>
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<td>60-75</td>
<td>70-85</td>
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LIGHT OILS SOMETIMES USED ON CITRUS

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<tr>
<th>Grade</th>
<th>Kerosene</th>
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<th>Mineral seal oil</th>
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<tr>
<td>Viscosity (cent)</td>
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<td>95</td>
</tr>
<tr>
<td>Viscosity (percent)</td>
<td>100</td>
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<td>40-50</td>
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1 Viscosity values of oils lighter than mineral seal oil are much lower; comparable determinations are difficult to obtain and relatively unimportant.

The main consideration is selection of the proper grade, tree tolerance being a limiting factor. One has to consider the kind of citrus fruit to be treated, the insect or mite present, the general district, previous experience with oil in the particular orchard or locality, and the season. The factors are interrelated.

The tolerance of the California citrus fruits to oil sprays may be listed in the following decreasing order: Lemon, grapefruit, Valencia orange, navel orange, tangerine, and lime. A heavier grade oil is generally applied to lemons than to oranges.

Mites and scale insects comprise the two major groups of oil-susceptible citrus pests. Unarmored scale insects, such as the black scale and the citrus coccidae scale, may be controlled with a lighter grade oil than armored species like the California red scale, yellow scale, and purple scale. A light-medium oil is considered enough for unarmored ones.

Growers who depend on a single annual treatment to control the armored scales usually apply a medium-grade oil on oranges and a heavy-medium on lemons. Satisfactory control of the California red scale and citrus red mite on lemons is obtained in some localities with two applications—one in the spring and the other in the fall—of a light-medium oil.

The oil sprays applied against scale insects will also control the citrus red mite and citrus bud mite. In fact, in certain localities oil sprays may be applied primarily for the control of mites. Oil heaviness is apparently not a factor in controlling the citrus bud mite, but against the red mite there is a correlation between the length of the protective period afforded by treatment and oil heaviness.

Citrus is grown under three somewhat distinct climatic zones, coastal, intermediate, and interior, in southern California. Citrus trees generally are more tolerant of oil spray in the cooler coastal zone than in the warmer, more arid interior zone. Experience has shown that oils heavier than light-medium should not be used on oranges in the interior, although lemons there will generally tolerate a medium-grade oil. By contrast, a heavy-medium oil (or, on occasion, a heavy oil) can be used on lemons in the coastal zone. Medium oil may be used on oranges in the intermediate zone and a heavy-medium grade on lemons.

Oil sprays are most commonly applied in California from late July through September. A time is selected when the younger, more susceptible stages of the scale insects predominate. Growers of lemons are inclined to delay treatment until October and November to avoid high temperatures, which could result in fruit drop should they occur immediately after the application is made.

Most of the serious effects encountered in the early use of spray oils, such as leaf burn and heavy leaf and fruit drop, largely have been overcome by the use of better oils, minimum effective dosages, and better timing of sprays. Certain more subtle effects remain, however. It has been fairly well established, for example, that the juice of oranges from oil-sprayed trees will usually have a somewhat lower total content of soluble solids than that from untreated trees or trees fumigated with
hydrogen cyanide. Flavor of the fruit is linked to the soluble solids; any appreciable lowering of these constituents is undesirable.

Other difficulties charged to the use of oil sprays include: Retarded fruit rind-color development; inhibition of "degreening"—development of color with ethylene gas—of the fruit after harvest; accentuation of the "water-spot" condition of navel oranges grown in certain districts in California; and in Florida a possible predisposition of trees to winter injury. Difficulties with rind-color development can be minimized by spraying at the recommended season and by avoiding applications immediately prior to harvest.

Oil sprays have been suspected—wrongly—of lowering crop yields, of reducing the size of the fruit, of increasing the tendency of stems and small branches to die out, and of lowering the over-all vigor of the trees. Dinitro compounds, such as dinitro-o-cyclohexylphenol, and sulfur may be applied to citrus trees. Neither is compatible with oil sprays and should not be used in combination with them. Besides, injury may result if an oil spray is applied within 2 weeks of a dinitro treatment or up to 2 months following the use of sulfur.

Spraying should be done as closely after an irrigation as practicable. Spraying should be discontinued when it is evident that temperatures will rise above the safe maximum for the district. It may be possible to escape injury by working during the cooler parts of the day, but it is better to cease work when hot weather is forecast for several days in succession. The safe maximum is 80° F. for the California coastal region and 95° for the interior district. Spraying should also be avoided during periods of very low humidity and possible frosts.

The leaf- and fruit-drop difficulties can be greatly reduced by putting a minute amount of some growth-regulating substance, like 2,4-D, in the oil spray. The recommendation stems from research done by W. S. Stewart, L. A. Richl, and others at the California Citrus Experiment Station. Dosages suggested, in acid equivalent, are 4 parts per million of ester preparations or 8 p. p. m. of metallic or alkanoamine salts. The amounts refer to the concentration of 2,4-D that will occur in the dilute spray mixture.

The compound cryolite also may be added to oil sprays to save the cost of making a separate treatment. Cryolite is applied to control orange tortrix and similar species. Rotenone is said to improve the efficiency of oil spray against scale insects; rotenized oil sprays may be helpful against the black scale, but against California red scale it has not proved effective enough to warrant a general recommendation.

Oil sprays are usually applied in California with high-pressure spraying equipment mounted on trucks. Spraying is done from the ground with 60- to 75-foot leads of hose and single-nozzle spray guns. The most satisfactory equipment also has an hydraulically operated telescoping tower topped with a platform. It permits a man to work 30 feet from the ground so he can cover the tops of trees. A spray crew normally has two ground sprayers, a tower man, and the truck driver.

To control red scale, particularly, the interior of the tree has to be sprayed as thoroughly as the outside. The growth of citrus trees often is dense, and the necessary coverage cannot be attained by spraying from the outside alone. For inside coverage, most spray men insert their spray gun through the foliage at four points around the circumference.

To cut labor costs, growers have been interested in the development of more mechanized means of spraying. Several new kinds of vertical spray booms have proved satisfactory, especially when the aim is to get fast outside coverage. Other equipment works on the principle of carrying the spray into the tree by means of an air-blast. The booms and air-blast-type machines, however, had not been adopted for general use on citrus in California in 1952.
Oil Sprays for Fruit Trees

Florida citrus, as we indicated, apparently is not so sensitive to the oil sprays as are citrus trees in California. Consequently growers can use a variety of oils. The usual concentration of oil in Florida is about 1.2 to 1.33 percent of actual oil. July is considered the best time to apply oil sprays. Treatments made then give good control of scale insects and avoid unfavorable effects that may result from the misuse of oil sprays. High-pressure equipment and air-blast machines are widely used by citrus growers in Florida.

Deciduous fruit trees are commonly treated with oil sprays in spring, when the trees are semidormant. Highly refined oils used to be included in many summer sprays, but the practice has been greatly curtailed since the introduction of DDT, parathion, and other new toxicants, which have largely replaced summer oils.

Considerable differences exist in Eastern and Western States in the kind of oils and the ways they are used. Custom accounts for some of the differences. Other factors involve differences in petroleum supply, climate, and pest problems.

In the Pacific Northwest oil sprays are applied in the spring before any green tissue appears in the buds. Later applications of dormant oils are not advised because of the danger of injuring the buds. If oil is used alone in dormant sprays, it is at strengths of 3 to 4 percent. Such treatment is advised for San Jose scale, pear psylla, and the European red mite and clover mite, which overwinter as eggs.

Another practice in the Northwest is to combine oil with liquid lime-sulfur for a dormant treatment; the oil is used at a 1- or 2-percent strength and the lime-sulfur at 3 percent. This combination spray is effective against scale insects, pear leaf blister mite, and apple rust mite; if 2 percent oil is used, it will also destroy winter eggs of European red mite and clover mite.

The dormant spray oils used west of the Rockies are made from California petroleum crudes. Specifications call for an oil of 100-120-second Saybolt viscosity at 100° F. and allow an unsulfonated residue value of 50 to 70 percent.

Some Canadians have favored heavier viscosity oils than those generally advised in the United States. Products of 200-220 seconds viscosity are preferred. The oils used in British Columbia are naphthenic, being produced from California crudes. Heavier viscosity oils are favored in British Columbia because they are thought safer and apparently more efficient than the 100-120-second naphthenic oils.

Fruit growers in Northeastern States commonly apply early-season oil sprays after some new growth has appeared in the buds rather than in the full dormant stage. On apples that avoids combining oil with dinitro insecticides, which must be applied when the buds are dormant. Oil-dinitro mixtures may cause serious bud injury. Another reason for later spraying is that a higher kill of winter eggs of the European red mite is had. The eggs become increasingly more susceptible to oil as their hatching period approaches. A higher kill of mite eggs may be expected with a 2 percent oil spray applied in the delayed-dormant stage than the same oil applied in the dormant period at a 4-percent strength. Apple trees are considered to be in the delayed-dormant stage when about a half inch of leaf tissue is exposed in blossom buds.

To insure reasonable safety in dormant oils after new growth has appeared, oils, different from the ones formerly used in the Northeast (and still favored in the Northwest) were needed. Such oils, called superior dormant tree-spray oils, were perfected largely as the result of research by chemists and entomologists at the New York State Agricultural Experiment Station. The oils are widely used by orchardists in New York and are rapidly gaining acceptance elsewhere in
the Northeast. They have these specifications:

- **Viscosity (Saybolt, at 100°F).** 90–120 seconds
- **Viscosity index (Kinematic).** 90 (minimum)
- **Gravity (A. P. I. degrees).** 31 (minimum)
- **Unsulfonated residue (A. S. T. M.).** 90 (minimum)
- **Pour point.** Not greater than 30°F.
- **Homogeneity.** A relatively narrow boiling distillate portion of petroleum.


Those specifications define an oil of high paraffinic character and fairly low aromatic content. The paraffinicity relates primarily to insecticidal efficiency and the aromatics to plant safety considerations. Oils having a 90 percent unsulfonated residue rating or higher—roughly 10 percent or less aromatics—generally have proved safe to use on New York apple trees in the delayed-dormant bud stage.

As we pointed out, all spray oils contain some paraffinic structures, but differ in degree of paraffinicity. The oil content of a spray, to achieve control, may be decreased as products of increasing paraffinic content are used. This relationship has been shown for the following: San Jose scale, European fruit lecanium, cottony peach scale, scurfy scale, apple red bug (eggs), eggs of the European red mite and probably the clover mite, fruit tree leaf roller and related species, and the eggs of codling moth, oriental fruit moth, grape berry moth, and eye-spotted bud moth.

Superior dormant tree-spray oils are sold as straight oil for tank mixing or as commercial concentrated emulsions or emulsible oils. Many New York growers tank-mix and use blood albumin as the emulsifying agent.

A fungicide is usually included in delayed-dormant applications of oil on apple trees in the Northeast to provide protection against apple scab. Bordeaux mixture, 2–4–100, or its equivalent in a proprietary copper fungicide are commonly used.

For the most resistant pests, such as scurfy scale, cottony peach scale, apple red bug, and fruit tree leaf roller, superior oils are employed at a 3-percent strength. A 2-percent concentration is considered adequate under New York conditions for the control of San Jose scale, pear psylla, European fruit lecanium, and the European red mite.

In areas south of New York, a 2-percent concentration is considered insufficient for the control of the San Jose scale. Strengths of 2.5 and 3 percent are advised there to combat the pest. The suggested spray concentrations are based on the oil-deposition properties imparted to an emulsion by blood albumin. Higher or lower dosages may be needed if the emulsions used differ greatly from blood albumin emulsions in oil-deposition rate.

Dormant or semidormant treatments are used to control the various species of aphids that are troublesome to the hardy fruits. They may be applied with the object of killing either the overwintering eggs or the newly hatched aphids on the opening buds. Conventional spray oils are not particularly effective aphicides in either case. In the Pacific Northwest green-tip or delayed-dormant applications of oil are suggested for the control of fruit aphids.

Growers in the East rely on dormant applications of dinitro insecticides to destroy the eggs of the clover mite, fruit tree leaf roller and related species, and the eggs of codling moth, oriental fruit moth, grape berry moth, and eye-spotted bud moth.
example, that aphid eggs are highly susceptible to such aromatic products as cresylic acid and the tar oils. From this one might conclude that there would be an advantage in using oils of high aromatic content, that is, having low U. R. values. Unfortunately, such oils apparently cannot be depended upon alone to control aphids; furthermore, their use must be restricted to dormant applications.

The older types of summer oils have declined in popularity. Much of this situation can be attributed to their incompatibility with fungicides and other insecticides. Sulfur has long been the stumbling block to the more extensive use of summer oils in the Eastern States. Serious direct foliage burn or delayed leaf drop may result from the use of oil and sulfur on the hardy tree fruits. Similar harmful effects have been noted with DDT and oil combinations.

No very definite specifications have been established for summer spray oils. A product meeting the following specifications should prove satisfactory for use in the East: A narrow-boiling-range product having a Saybolt viscosity at 100° F. of 65–70 seconds, a minimum U. R. of 92 percent, and an A. P. I. gravity of 33. Such an oil would be used at a 1-percent concentration to combat summer infestations of mites, the cottony peach scale, and, combined with nicotine sulfate or rotenone, the pear psylla.

The use of oil sprays in the future depends on several considerations. Most of the objections to them revolve around unfavorable plant responses. If safer oils could be produced, particularly for use on the more sensitive plants, the use of oil should increase. It should be possible to produce safer and more efficient oils—synthetic oils and special fractions of petroleum, for example.

Oils are less toxic than many other insecticidal materials to man. Their relative safety in that respect recommends them for wider use.

Insects have shown a disturbing ability to develop resistance to some insecticides, but so far not to oils. The way oils kill insects and mites, apparently through physical means, merits attention; it may prove to be a valuable quality in the future use of chemical treatments for the control of pests.

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