STATUS REPORT:

HORTICULTURAL SPRAY OILS FOR TREE PEST CONTROL

By WARREN T. JOHNSON

Figure 1. *The dark spots on the undersides of Amur maple illustrate an injury symptom caused by a spray containing excessive oil.*

Figure 2. *The tiny purplish spots with yellow halos illustrate injury symptoms on Redbud from spray containing excessive amounts of oil.*

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Why should we expand the use of oil for pest control at a time in history when this would further deplete a non-renewable resource? If we reflect for a moment that the pesticide industry is mostly a petrochemical industry, the question becomes no more pertinent to horticultural spray oil than it is to synthetic pesticides.

Then why do we pick a 100-year old commercial product and reinstate it into a pest control program when the claim for modern chemicals is that they do a more efficient job? This is an appropriate question, but to respond requires an analysis of the situation and a bit of historical reminiscence. First, the history.

Oil is one of the oldest *natural* pesticides. In the first century A.D., the Roman scholar Pliny wrote that mineral oil would control certain plant pests. It was also known at that time that the oil was liable to injure plants. Jumping ahead several centuries and to the United States, oils were used to control insects before the Civil War, and by 1865, kerosene (then known as coal oil, because it was derived principally from oil-bearing bituminous shales) was recommended for the control of scale insects on Florida citrus. By World War I, U.S. Department of Agriculture entomologists were recommending an oil emulsion that was later dubbed "United States Government boiled emulsion" for the control of San Jose scale on apples.

Between 1942 and 1970, teams of petroleum chemists and entomologists made great strides in spray oil science and technology. Now, there is a good understanding about the components of oil that cause phytotoxicity and the oil fraction needed to kill insects and mites.

During the three decades prior to 1970, every major oil company had its favorite horticultural oils and much marketing competition. Most of these were sold for dormant use with a viscosity range from ca. 100 to 220. None were exactly alike in terms of physical properties (see Table 1). There were four state agricultural experiment stations—Florida, Texas, California, and New York—that had scientists studying the various oil properties. These scientists established specifications for the oils to be used in the control of fruit insects and mites in their respective states, based upon the needs of their fruit growers.

Arborists and nurserymen benefited from the work on fruit trees because many of the pests controlled by oil were the same pests that injured shade trees and shrubs. Remembering that spray oils were developed for fruit trees, it is easier to understand why some of these oils when applied to certain shade trees and shrubs, not only killed arthropods, they occasionally injured the plants that the applicator was trying to protect. The development of so-called 60- and 70-second viscosity superior spray oils added to our confidence in the phytosafety considerations of ornamental plants because they evaporated more rapidly from treated plants.

Table I.
Specifications for Superior Spray Oil

Properties	Standard
Saybolt Universal Viscosity at 100° F, seconds maximum	*
Gravity, ° API (minimum)	30°
Unsulfonated residue (UR) (minimum) (%)	92%
Pour point, °F (maximum)	20°
Distillation at 10 mm Hg, °F	
50% point	420 ± 8°F
10-90% range (maximum)	80°F

*For technical reason, a specific viscosity standard has not been made a part of these specifications. Oils otherwise defined here may fall within the 68-74 second visocity range.

The 1982 Spray Oil

Today, superior horticultural oils are being produced by four oil companies. Chevron refines horticultural oil primarily for use in California. They have withdrawn their product, Ortho Volck spray oil, effective in 1982 because they can make a greater profit from other kinds of petroleum products. Exxon and Gulf have a 70 second viscosity superior oil in tank car and barge shipment quantities for use on citrus in Florida and the Rio Grande Valley. This oil is refined to meet the Florida-Texas citrus spray oil specifications. The Sun Refining and Marketing Company supplies spray oil to a wide range of markets throughout the United States with sales largely to agricultural chemical companies for repackaging and marketing. The Ag chemical companies prepare their own labels and sell in small quantities (1 pint to 55 gallons) to home gardeners, arborists and other spray contractors. The oil you use in 1982 will have the typical properties shown in Table I, some of which will be stated on the label.

Spray oil specifications are couched in the jargon of petroleum chemistry but this important information should not be difficult to understand. *Viscosity* is a measurement of oil heaviness; the time it takes for a given amount of oil to flow through a hole of precise size and measured in seconds. The *gravity* test is another technique to weigh oil. When related to viscosity and unsulfonated residue (UR) it provides an index to the oil paraffinicity; spray oils must be largely paraffinic to be safe for plants. The gravity specification is measured in terms of degrees; the higher the number, the more paraffinic the oil. Thirty (30°) degrees is the minimum standard. The *unsulfonated residue*, expressed in percent, is a measure of purity or degree of refinement. The process involves the chemical reaction of oil with concentrated sulfuric acid. That part of the oil that reacts with the acid (aromatic portions) can be separated, leaving the unsulfonated residue or paraffinic oil. White mineral oil is a paraffinic oil that goes through the sulfonization process several times and is used for pharmaceutical purposes, e.g. lotions, cosmetics and laxatives. It has a UR of about 99.5%. *Distillation* temperature range is a measure of the volatility of an oil and is the most valuable criterion for determining the pesticidal activity and paraffinicity of an oil. Volatility is monitored by controlling the 50% point of the distillation range to a narrow specified range and the 10%-90% range to a maximum of 80°F. The distillation profile and the unsulfonated residue are the two most important tests assuring an acceptable spray oil. Without the above specifications, there is no scientifically acceptable way to compare pest control or phytotoxicity results with other oils.

Mode of Insecticidal Action

Modern spray oil can kill arthropods in two ways: (1) by penetrating the egg and interfering with the vital metabolic processes or (2) by preventing respiration through egg shells or respiratory passages (tracheae) of both immature and mature insects. In the egg, a growing embryo must have a constant exchange of gases. Interrupting this gas exchange, even for a few hours, may bring about its death. A dormant egg in autumn or winter has a minimal need for gas exchange. An oil film around a dormant egg may evaporate before vital processes are seriously affected. If an oil-sprayed, dormant, overwintering immature or adult insect can "hold its breath" for a week or more, it may overcome the presence of oil. One may extend the oil residual period by increasing the dose. The key feature in oil efficacy is the arthropod's oxygen requirement. During the dormant season, the dosage may range from three to five percent. During the summer, or verdant season, most insects require an uninterrupted source of oxygen. If impeded for a few hours in the case of eggs, the arthropod will not be able to survive. Normal dose for summer treatment varies from 1 to 3%.

Oil Phytotoxicity - Its Mode of Action

"Do not spray on oil sensitive plants!" This admonition is often found on old superior oil labels, but who knows what it means? Some very delicate annual flowering plants such as Impatiens will show

TABLE 2

An abbreviated sample of a proposed label as submitted to the Environmental Protection Agency.

SUNSPRAY 6E

A SUPERIOR HORTICULTURAL SPRAY OIL

CAUTION: KEEP OUT OF REACH OF CHILDREN
HARMFUL IF SWALLOWED. IF SWALLOWED, DO NOT INDUCE VOMITING.
AVOID BREATHING OF VAPORS AND SPRAY MISTS. DO NOT POLLUTE FISH AND WILDLIFE WATERS BY RINSING OR DRAINING OF EQUIPMENT. SEE OTHER CAUTIONS

55 GALLONS NET • U.S. STANDARD

EPA REG. 862-11

ACTIVE INGREDIENT:	BY WEIGHT
PARAFFINIC OIL*	98.8%
INERT INGREDIENTS	1.2%
	100%

Sun Oil Company, 1608 Walnut St., Philadelphia, Pa. 19103

*Unsulfonated Residue .... 92% min.
Grade of Oil Superior/FC-412-66/Unclassified
Weight per Gallon .... 7.1 lbs.

CAUTION

General—All horticultural oils interfere with or slow plant transpiration and respiration during the period of evaporation. **Do not apply during periods of drought or when plants exhibit moisture stress.** Never apply concentrated spray oil to any part of a plant. Do not use 6E in combination with or immediately preceding or following applications of dinitro compounds, sulfurs, captan, folpet, Dyrene, Karathane, Morestan, or Sevin. Check tank mixtures for chemical and physical compatability.

Ornamental Plants—Oil will remove the glaucus (blue) bloom from such evergreens as Colorado blue spruce and Koster spruce. Use with caution and reduce dosage for summer applications to Japanese red maple, Amur maple and black walnut.

Timing of Treatment—You must determine the precise timing to fit local growth and climatic conditions.

MIXING DIRECTIONS

1. Add sufficient water to the mixing tank to allow proper agitation by pump or paddles.
2. Add other desired pesticides as listed on left panel mixing thoroughly prior to the addition of oil.
3. Add oil under agitation when ¾ full topping off with water to form milky solution.
4. Maintain agitation until solution is used.
5. In small equipment lacking agitators—stir or shake diluted spray frequently during application.

DIRECTIONS FOR USE

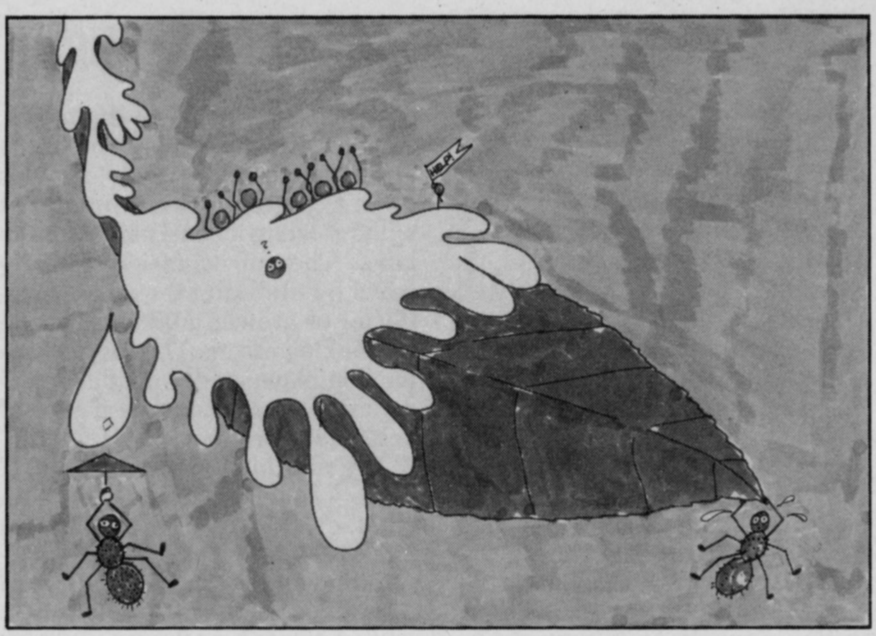
CROP	INSECTS AND MITES	Application Rate 6E Gallons per 100 Gallons of Dilute Spray	Time of Application (Stage of Development)
APPLES	Apple Red Bug	2	Dormant
	European Fruit		Dormant
	Lecanium Scale	2	Dormant
	Fruit Tree Leaf Roller	3	Dormant
	European Red Mite	2	Green Tip to Delayed Dormant ½" Green
	San Jose Scale	2	Delayed Dormant ½" Green
	Scurfy Scale	3	Delayed Dormant ½" Green
PEARS	Fruit Tree Leaf Roller	3	Dormant
	Pear Leaf Blister Mite	3	Dormant
	Pear Psylla	2	Late Dormant
PECANS	Obscure Scale	3	Dormant
PEACHES	Cottony Peach Scale	3	Dormant
PLUMS & PRUNES	Eurpean Red Mite	2	Dormant to Delayed Dormant ½" Green
	European Fruit		
	Lecanium Scale	2	
TREES & SHRUBS	Spider Mites	3-4 2-3	Dormant Verdant
	Eriophyid Mites	3-4 1-3	Dormant Verdant
	Scales & Mealybugs	3-4 2-3	Dormant Verdant
	Psyllids & Whiteflies	2-3	Verdant
	Aphids & Adelgids	3-4 2-3	Dormant Verdant
	Plant Bugs,		
	Treehoppers	3-4	Dormant
	Leafhoppers	2-3	Verdant
	Leafrollers,		
	Leaf Tyers		
	Webworms	3-4	Dormant
	Cankerworms	2-3	Verdant

SEE MIXING DIRECTIONS ON OPPOSITE PANEL

no adverse reaction to oil used at summer dosage. What, then, are the oil sensitive plants? First, lets deal with some basics. Concentrated oil is a herbicide. As a concentrate it penetrates both bark and leaf tissues wreaking havoc with living cells. Oil painted in narrow bands on the bark of certain young trees such as red maple or sumac will kill them.

When diluted oil is sprayed on foliage, twigs, and small branches, the stomates of the leaves and the lenticles of the bark get covered with a thin deposit of oil that interferes with the exchange of gases. This becomes the basis for phytotoxicity. There are other factors too, that may cause plants to react adversely. Usually, it's the state of growth that makes the difference. A dormant plant can tolerate a heavier deposit of oil than a plant growing actively. Some of the hundreds of leaf stomates may be closed by a film of oil but whether symptoms of injury will appear depends upon the number of stomates that are closed, the amount of oil that is deposited, how fast the oil is evaporating and the clearing capacity of the stoma guard cells. Some plants, such as Scots pine, can tolerate a tremendous dose of oil on new and old needles (33% oil) even in early July with the temperature exceeding 90° F. Other plants, such as the Japanese maple, can tolerate no more than 3% oil under the best of growing conditions. Other trees and shrubs sensitive to oil are Amur maple, black walnut and Aucuba. This is not to say that oil should never be used on them for insecticidal purposes, but other factors need to be considered.

Environmental conditions such as soil moisture, relative humidity and wind speed are of major importance. Any plant suffering from moisture stress is a candidate for severe foliage injury if it is sprayed with oil. I am of the opinion that any common woody ornamental plant can tolerate 2% of oil in the verdant condition if it is healthy, the soil moisture is adequate, and



the relative humidity creates conditions for fairly rapid evaporation of the oil. Under normal application temperatures, (35° - 100°F), it appears that temperature alone is not a factor.

Oil Persistence on Foliage

Immediately following a spray treatment, the foliage will have a pleasing, shiny luster, the result of a thin film of glistening oil. The actual amount of oil that will remain on a leaf will depend largely upon the pubescence and other physical characteristics of the leaf. Honeylocust leaves, for example, sprayed with 4% oil will have a shiny appearance, particularly on the upper surface, for more than eight days. Plants with abundant leaf hairs (trichomes) on the undersurface will have an altogether different appearance when oil is on them. They will feel oily but will not glisten. Some leaves with large numbers of leaf hairs will appear to be soaked with oil.

Plant leaves with a vast number of trichomes hold a larger volume of the spray solution and thus receive a higher concentration of oil after the water evaporates. Because the concentration of oil is higher, the oil remains on the plant longer and takes longer to evaporate. Leaf hairs may be both beneficial and deleterious. On the one hand, they retain the oil on the insect for a longer period, but on the other, they block the stomates for a longer period, also. In general, leaves with dense pubescence should be considered oil-sensitive and should receive a lower rate of oil.

Symptoms of Phytoxicity

When leaves are deprived of stomatal functions for any reason, the foliage becomes slightly yellow. This symptom occurs when an excessive amount of oil is uniformly distributed over the leaves. More often than not, there will be a larger deposit of oil at the leaf tip or margins. If the oil on the margins remain too long, the margins become yellow; later they darken appearing water soaked, not unlike some stages of edema, and later they become dark purple. The ultimate symptom is brown, necrotic tissue. The injury is not always marginal but may occur as small spots following the same symptom sequence (Figure 2). If the symptoms do not progress beyond the water soaked stage (Figure 1) the leaf recovers or at least can function with a fair degree of efficiency.

Efficacy

Since much of the oil used ten or even five years ago was not the same as that used today, efficacy comparisons may seem inappropriate. Fortunately, data taken from plants treated with 60 and 70 second oils compare favorably with the oil that is currently available. With the distillation, UR, and gravity properties of older oils for comparison, one can interpolate the probable efficacy of the new oil. From interpolated data we can assume that the currently refined spray oil (Table 1) will kill the eggs of any of the following arthropod groups: spider and eriophyid mites, armored and soft scales, mealybugs, psyllids, asphids, adelgids, whiteflies, plant bugs, leafhoppers, treehoppers, leafrollers, leaftyers, webworms and cankerworms. We can also assume that the new oil will control a wide range of arthropods in stages other than the egg. Some of the recommendations found on the new label is based on such interpolated data.

A film of oil interferes with the feeding capabilities of viruliferous sucking insects, but except for this spray oil (Stylet Oil*) seems to have little if any tactile effect on crawling insects, or flying insects migrating to oil treated surfaces.

***trade name registered in Florida**

Labels and Brand Names

Because of the inherent safety to humans and mammals of purified paraffinic oils, the Environmental Protection Agency has exempted these products from many of the regulations imposed upon the promoter's of synthetic organic pesticides, namely residue requirements. There has also been a relaxed attitude regarding the way oils are described on their labels. Some labels' ingredient statements were so vague (before EPA) that the product described would have also been a good description for a machinery-lubricating oil.

Since superior horticultural spray oil has no precise formula, it is impossible to provide a precise ingredient statement. The source of the crude oil makes a major difference in the product that comes from the distillary's pipes. Likewise, a few degrees of difference in the distillation temperature can make a difference in the potential for phytotoxicity and pesticidal activity. Nonetheless, today's product must have a better identity via the ingredient statement. Green Industry users of horticultural spray oils have been without a property description largely because it was not on the label and further, few knew that it existed. It was assumed, erroneously, that an oil label was as complete and as explicit as the label for a synthetic organic insecticide.

We are closer now to a standard

product than ever before, in part because there are fewer refineries in the business of making horticultural oil, and in part because only one oil refining company actively promotes its product beyond the citrus industry.

In March 1982 the Sun Refining and Marketing Company presented EPA officials with a change in their horticultural oil label which may prove to be the best thing that has happened to promote spray oil in the past thirty years. In terms of its physical properties, Sun's oil comes fairly close to the specifications developed by the several agricultural experiment stations, but it does represent a compromise. The abbreviated label (Table 2) shows some of the major changes and additions under consideration.

For the first time there is an attempt to provide an acceptable common name—*Superior Horticultural Spray Oil.* The use recommendations and directions are greatly expanded with some specific and some general directions. General directions allow the user a greater degree of freedom to use his own experience and judgment without being inconsistent with the label. This, of course, works two ways by allowing the spray contractor or grower a greater chance for making errors. The former distinction between dormant and verdant oils now becomes a matter of dosage; the product is the same.

The caution statement gives a short, condensed sentence about what oils do to plants; "(They) interfere with our slow plant transpiration and respiration while the oil remains on the plant." The most critical point about the potential for phytotoxicity is in the admonition "Do not apply during periods of drought or when plants exhibit moisture stress." Specific precautions are limited to conifers with a glaucus bloom; reduced dosage is suggested when oil is used on Japanese red maple, Amur maple and black walnut.

There will continue to be brand names, but if a standard label is developed the only difference will be in the art work and the visual appeal of the label.

Summary

With one major producer of superior horticultural oil and one basic label there should be one set of recommendations. The user can expect control over a wide range of species and if the applicator maintains proper "quality control" over mixing and spraying there should be no problem with phytotoxicity. With phytotoxicity based upon excessive dose, and tree and shrub turgor, oil will take its rightful place in the arsenal of weapons for use in integrated pest management. If the new proposed label is approved, the arborist and spray contractor will legally be able to use oil on hundreds of woody ornamental plants, and, if his judgments are just and reasonable, he will be able to do a better job at less cost to the consumer while properly using one of our safest insecticides. **WTT**