TECHNICAL NOTES
U.S. DEPARTMENT OF AGRICULTURE BERKELEY, CALIFORNIA SOIL CONSERVATION SERVICE

TN - Agronomy - 8 November 5, 1962

SIMAZINE - A New Herbicide
for Use in Orange Groves

NONTILLAGE FOR AVOCADO ORCHARDS

The attached data was provided by Frank Brooks for a technical note. This technical note is for the avocado and orange producing regions, and is applicable only to the following Resource Areas:

No. 20 (our local number H-4)
No. 31 (our local number H-10)
No. 35 (our local number F-5)

The material is reprinted from articles by C. D. McCarty, of the Agricultural Extension Service, University of California, Riverside; and B. E. Day and L. S. Jordan, of the Department of Horticultural Science, University of California Citrus Research Center.

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Att.

Simazine - A New Herbicide For Use in Orange Groves

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SIMAZINE has been registered for use as a pre-emergence herbicide for the control of seedling weeds in California orange groves. This clearance does not apply to other varieties of citrus and specifically excludes the Coachella, Imperial and Palo Verde valleys of Southern California where light-textured soils make citrus trees more susceptible to injury.

Simazine is one of a group of compounds known as triazines which possess herbicidal properties. The technical material is a white crystalline compound which has a very low solubility in water (5 ppm) and is only slightly soluble in organic solvents.

The commercial formulation is sold as an 80 percent active wettable powder. It should be used in sprayers with mechanical agitators. It is nonvolatile, noncorrosive and of extremely low toxicity to warm-blooded animals. Simazine can be removed from spray equipment by a thorough rinsing with water. However, if the rig is left standing without agitation the simazine will settle to the bottom of the tank and must be loosened before removal.

Moves to Leaves

Simazine is not a contact herbicide and causes little injury when applied to plant foliage. When applied to the soil and leached into the root zone, it is readily absorbed by the roots of young plants and moves with the transpiration stream to the leaves where its herbicidal action takes place. Therefore to be effective against seedling weeds, simazine should be applied to bare soil and leached in by rainfall or sprinkler irrigation before the weed seeds germinate.

Little is known about the herbicidal action of simazine. It is believed that simazine causes death by interfering with one of the vital processes of photosynthesis. Simazine's action is not rapid, and it may take several weeks for the death of seedling weeds to occur. Injury symptoms are a yellowing of the leaves, followed by tip and marginal burning.

Simazine is effective against a wide range of grass and broad leafed weed species found in California citrus orchards. Applied at the rate of 2 pounds of commercial formulation per acre, simazine has controlled chickweed, purslane, lambs quarter, *Amaranthus* sp., shepherd's purse, wild mustard, wild oats, annual blue grass and sow thistle. Marginal control of prostrate spurge, puncture vine, hairy crabgrass, cup grass and turkey muellein has occurred in a few localities.

Narrow Band

Because of its low solubility and strong absorption by soil colloids and organic matter, simazine is fixed in a very narrow band, perhaps an inch or so thick, at the surface of most soils. Deep-rooted perennials or well-established annual weeds which would be susceptible if they germinated as seedlings escape injury. Also some weeds may escape by germinating from depths below the simazine-treated area.

Some plants are resistant to simazine because they contain an enzyme which destroys simazine as soon as it is absorbed by the plant. Corn contains this enzyme and will grow in soil heavily treated with simazine.

Citrus owes its resistance to simazine to two factors: (1) a slight fundamental resistance as a species characteristic, and (2) failure of the simazine to move downward into the root zone. The extent of downward movement in soils is determined by the colloidal and organic properties of the soil. Certain desert soils low in clay and organic content have little capacity to retain simazine against leaching. Applications of 2 pounds of simazine per acre have caused injury to citrus trees in sandy soil in the desert areas of Southern California.

Safety Margin

It is difficult to establish hard and fast rules concerning the tolerance of citrus to simazine on different soil types. However, numerous field tests carried out since 1957 in all of the citrus-growing areas of the state indicate that, with the exception of sandy soils, a considerable margin of safety exists between the amount of simazine required to control seedling weed growth and that which will injure citrus trees.

Mature Washington navel orange trees, valencia orange trees and lemon trees have been treated with rates of simazine as high as 32 pounds per acre with no injury. In one case a sweet orange seedling in Santa Barbara County was treated in October of 1960 with simazine at the rate of 64 pounds per acre. To date no injury symptoms have appeared either on foliage or fruit.

In March of 1959, a long-term plot was established at Riverside to determine the effect on mature citrus trees of repeat applications of simazine at the rate of 2 pounds per acre. To date four applications have been made with no injury to the trees.

"No Residue" Basis

Analysis of fruit harvested from treated orchards indicates that residues of simazine do not occur in the fruit in sufficient quantity to be detected by present analytical methods. Therefore, simazine has been registered by the Federal Food and Drug Administration on a "no residue" basis. In applying simazine to the soil, care should be taken to keep the herbicide off the tree foliage and off the fruit which could become contaminated.

Tests to determine the longevity of simazine in the soil were started in the fall of 1957. Plots established at Riverside and in Tulare County showed that a 2-pound-per-acre application leached into loam or clay soils would prevent seedling weed growth for periods of one year. This represents an advantage since the grower need make only one application of herbicide per year. However, due to the low solubility of simazine, more rainfall is required to leach it into the soil where it is effective.

In the soil, simazine is gradually broken down by micro-organisms. The time for decomposition to the point where weeds are no longer controlled is variable. There are indications that the residual life of simazine is shorter in soils high in clay and organic content. This is probably because such soils provide a more favorable habitat for soil bacteria than do soils low in colloids or organic material. The main avenue for the disappearance of simazine in sandy soils is probably leaching. Breakdown of simazine is also favored by high temperatures and available moisture.

Orchard Preparation

Preparation of the orchard for nontillage and application of simazine is the same as for other soil sterilant pre-emergent type herbicides. The grove should be laid out in final form in regard to the position of furrows, basins or sprinkler irrigation systems. Simazine should be applied to the soil while it is free of weed growth and before the germination of weed seeds. Preferably this should be done in the fall as close to rainfall as practical since maximum efficiency is obtained if simazine is leached into the soil immediately. Poor weed control has resulted where the soil contains enough moisture to germinate weed seeds while the simazine remains on the soil surface without being leached in.

Sprinkler irrigation is an effective method of leaching simazine into the soil, but sprinkler patterns do not always give uniform coverage and spotty control sometimes results.

Simazine should be applied with care. Accuracy of application cannot be overemphasized since a safe weed control program depends on using the minimum amount of herbicide required to control weed growth while leaving a wide margin of safety for the trees. It is very easy to overdose in local spots by spilling, slowing or inadvertent stopping of the rig before the boom is turned off.

Weigh Carefully

The amount of simazine going into the spray tank should be carefully weighed and should be added after the tank is partially filled with water and while the agitator is running. Simazine must be kept in suspension during spraying.

Simazine should not be mixed with weed oil for use in orchards. Spraying large clumps of weeds with oil-simazine mixtures leads to overdosage with simazine in local areas. If perennial or annual weeds are present and cannot be conveniently removed by cultivation, they should be sprayed with oil before application of simazine.

Simazine should not be sprayed where it will come in contact with other crops.

In summary, simazine is a powerful and effective herbicide. Once fixed in the soil by adequate moisture, it is highly residual and will prevent seedling weed growth for a year or more in most California citrus soils. Field trials have shown that a large margin of safety exists between the amount of simazine necessary to control weed growth and the amount which will cause injury to the trees on loam and clay soils. However, it should be remembered that a weed control program of this type must be carried out with precision and care.

USDA-SCS-PORTLAND, OREG. - 862

Nontillage for Avocado Orchards

By C. D. McCarty, B. E. Day and L. S. Jordan

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AVOCADO trees possess an extensive feeder root system which grows in the top few inches of soil. Under an established mulch, avocado roots come to the soil surface. Tillage destroys surface roots, and the trees are dependent on roots below the cultivated area and in undisturbed soil under the tree skirt. For practical purposes the tilled soil is of little value to the tree.

Continual cultivation destroys the tilth of the soil by breaking down soil particles which run together and compact. This compaction decreases water penetration and aeration. In many soils cultivation causes the formation of a plow-sole, which further retards water penetration and is too tightly packed to serve as a medium for good root growth (figure 1).

Two types of nontillage practices have developed (figure 2).

In the most popular system, sprinkler irrigation is used and weeds are controlled by mowing. When this is done, upright growing weeds are destroyed and a Bermuda grass turf develops. Bermuda grass thrives when mowed and sprinkled and is a product of an environment created by cultural practice.

A mowed turf offers several disadvantages. Bermuda grass is a heavy competitor for water and fertilizer. Long-term competition for nutrients may be of little importance since mowed clippings are returned to the soil as organic matter, but competition for moisture during periods of water shortage is a serious problem. Frequent mowing does not reduce the amount of water used by the grass, and a solid stand may use more water than the trees.

Another disadvantage, associated with any type of cover crop, is that rodents tend to work more freely where weeds are present.

Under the second type of nontillage program, weeds are controlled with herbicides and a leaf mulch is allowed to build up in the orchard. This mulch, coupled with shading as the trees grow larger, produces an environment which discourages weed growth.

In orchards where no Bermuda grass or other established perennial weeds exist, monuron may be applied to the soil to kill germinating weed seedlings. Unfortunately, Bermuda grass is established in over half of the avocado acreage in the state.

Several systemic herbicides are under study for use against Bermuda grass in avocado groves; so far these materials have proved to be either toxic to the tree or the margin of selectivity between the amount of herbicide required to kill the grass and that which will cause tree injury is so narrow that the herbicide cannot be used with safety.

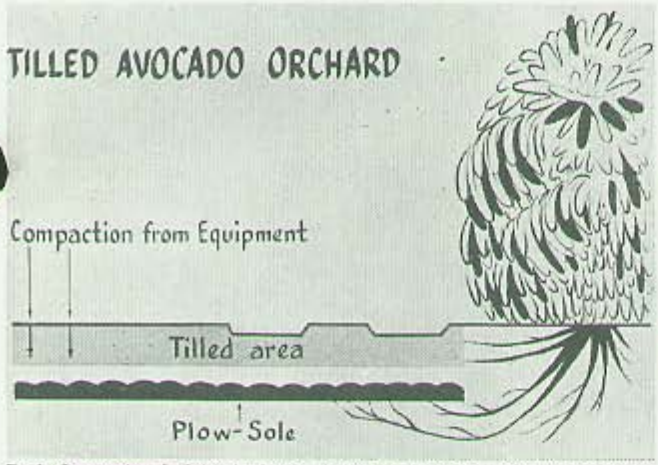

Fig. 1. Cross section of tilled orchard. Roots destroyed in tilled area, poor water penetration through plow-sole. Soil in tilled area is of little value to tree.

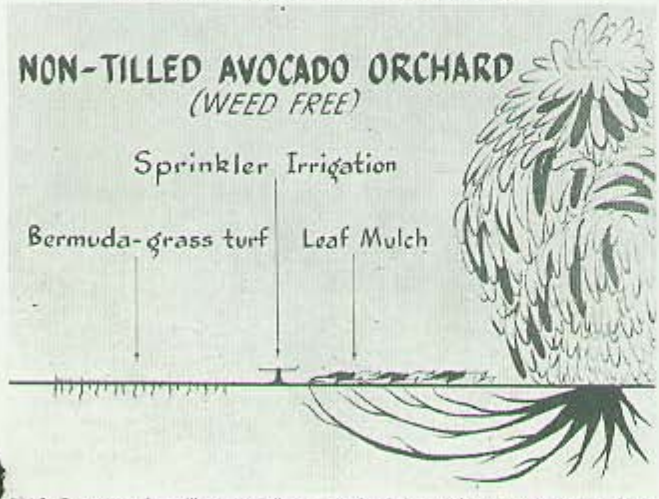

Fig. 2. Two types of nontillage. (1) Full use is made of the soil, but Bermuda grass turf uses water and fertilizer. (2) Mulch holds moisture, prevents water runoff, provides ideal environment for root growth.

Repeated Oil Spraying

At present the recommended procedure for the control of Bermuda grass is repeated oil spraying (figure 3). Once a control program is begun, retreatment must be carried out with regularity to assure beneficial results. The first oil spraying kills the foliage but does little damage to roots and rhizomes. The regrowth uses food that has been stored in underground plant parts.

For maximum efficiency, each successive spraying should be made when regrowth has depleted root and rhizome food reserves to a maximum and before new foliage can manufacture enough food to replenish these reserves. If a spraying is missed, or delayed too long, the grass grows to a point where it sends food back into the root system in larger quantities than is being used and the food reserves are rapidly replenished. If oil treatments are spaced too closely together, the newly sprouting grass is killed before it depletes the food reserve to a maximum; therefore, it will take a larger number of treatments before the grass is eventually starved out.

The amount of regrowth which occurs before more food is transported into the root system than is being used is critical, and the length of time between spray applications will vary due to differences in growing conditions in various locations.

Determining Time Interval

Experiments indicate that the rate of regrowth following the first oil spraying can be used as an index to determine the time interval between treatments. Retreatment should be made when approximately 20 percent regrowth of the original stand has occurred. The period between the first two applications establishes a time interval adjusted to local environmental conditions which can be used as an interval between subsequent sprayings. As the rate of recovery of the grass drops off, one should not become negligent in retreating or the benefit of the whole program is lost.

Since weed oil is the only safe method of control, growers may

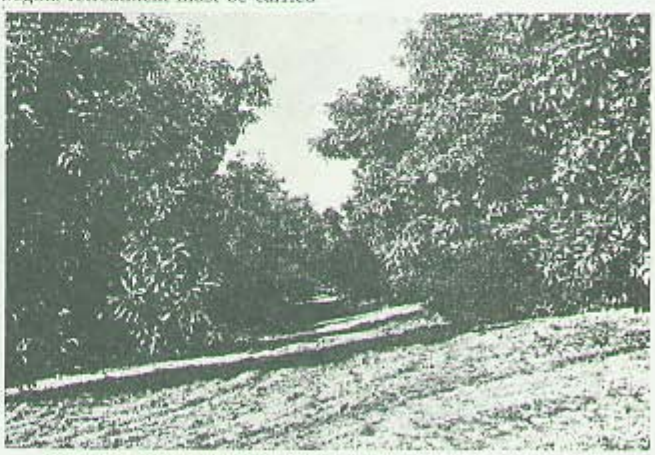

Fig. 3. Bermuda grass turf in this orchard has been controlled with weed oil spray.

find some of the principles governing oil phytotoxicity of interest.

Petroleum oils are divided into two groups called saturated and unsaturated hydrocarbons. Saturated hydrocarbons have single valence bonds between carbon atoms and are relatively nonphytotoxic. Unsaturated hydrocarbons have double and triple bonds between carbon atoms and possess a high degree of plant toxicity.

Hydrocarbons are further divided into straight chain and branched chain compounds and into compounds in which the carbon atoms form a ring. Hydrocarbons with unsaturated chain linkages are called olefins, and those with unsaturated ring structures are known as aromatic compounds. Aromatics are more phytotoxic than olefins.

Fig. 4. Excellent avocado planting. Enough native growth has been left to prevent erosion on steep slope. Infestations of perennial weeds can be sprayed with weed oil. Monuron can be used to control seedling weeds.

The amount of aromatic material in a given oil is expressed as a percentage of either volume or weight. Weed oils containing 50 percent or more of aromatic compounds with a specific gravity of 25° to 30° API (based on a scale adopted by the American Petroleum Institute) make excellent all purpose weed killers.

Oil deficient in aromatic toxicants can be "fortified" to increase their toxicity by the addition of pentachlorophenol, dinitrocresol, dinitro-ortho-secondary butylphenol and other oil soluble dinitro compounds. (These fortifying materials have a zero tolerance and fruit contaminated with them cannot be marketed.)

Highly toxic oils, or oils fortified to increase their killing power, may be emulsified with water to produce a larger volume of spray to spread the oil over a greater area. Nothing is gained by making emulsions of oils of medium or low toxicity, since they already have enough volume to spread their toxic action to a maximum.

When oil-water mixtures are used, the spray rig should be equipped with an agitator powerful enough to keep the material in the spray tank emulsified. Most weed oils meant to be applied as an emulsion contain an emulsifying agent; if not, the addition of an emulsifier may be helpful.

For economy, weed oils should be sufficiently toxic to be effective when applied as a light film. Drenching sprays should not be necessary, although heavier applications may be required on persistent perennial grasses such as Johnson and Bermuda grass. For best results on these weeds, sufficient volume must be applied to permit the oil to creep inside the leaves which sheath the growing points. Less oil can be used with equally satisfactory results if the grass is mowed before spraying. However, the mowed stubble must not be protected from the spray by a cover of mowed clippings.

When young orchards are planted on virgin soil, it is easier to prevent a Bermuda grass infestation than to eradicate one once it becomes established. In starting a new orchard, the native vegetation should be cleared sufficiently to plant the young trees, leaving enough native growth to prevent erosion (figure 4).

Two-Pound Rate

Infestations of new seedling weeds can be prevented by applying monuron at the rate of 2 pounds of commercial formulation (80 percent active) per acre. This should be applied outside the root zone of the young tree. Normally, monuron is applied in the fall just before the beginning of the rainy season so that the herbicide is leached into the soil where it can be absorbed by the roots of germinating weeds. If sprinklers are used, monuron may be applied any time and leached into the soil by sprinkler irrigation.

At the 2-pound-per-acre rate, monuron is not effective against established annual or perennial weeds. Such growth may be treated with oil at intervals sufficient to insure its control.

Weeds which sprout in the root zone of newly planted trees can also be sprayed with oil. Care should be taken to protect the trunk of the tree from accidental spraying.

Several new herbicides are under study for use in avocado orchards. Of these, simazine has been particularly promising. Avocados are resistant to this herbicide, which is applied in the same way as monuron. Simazine has not yet been registered for use in avocado groves by the Federal Food and Drug Administration.

USDA-SCS PORTLAND, OREG. 1962