## CAUTION

Legal limitations pertaining to the use of monuron, diuron, and simazine in local areas are subject to change. Information concerning these limitations is available from local regulatory officials, through agricultural chemical trade channels, and from the University of California Farm Advisor's office. Restriction will also be found on the manufacturer's label.

To simplify the information, it is sometimes necessary to use trade names of products or equipment. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

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# DIURON AND SIMAZINE FOR WEED CONTROL IN WALNUT ORCHARDS

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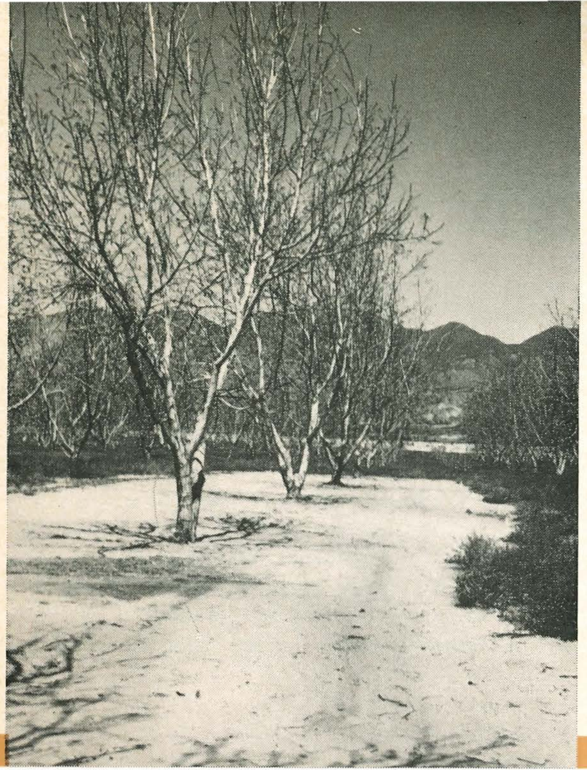

## Diuron and Simazine for Weed Control In Walnut Orchards

Weeds can safely and economically be controlled in walnut orchards by proper use of herbicides such as diuron (Karmex®), simazine, and weed oils. Diuron and simazine are soil-applied herbicides which provide long-term control of weeds by killing germinating seedlings. Weed oils are used as supplemental treatments to control established perennials and weeds that have matured beyond the seedling stage.

### WHAT ARE DIURON AND SIMAZINE?

Although diuron and simazine are essentially unrelated chemicals, their herbicidal properties with respect to their use in walnut orchards are nearly identical. Both herbicides are applied as wettable powders containing 80 per cent active ingredients, and both are for practical purposes insoluble in water and oil. They are noncorrosive, nonvolatile, stable in storage, and are of relatively low toxicity to humans, livestock, and pets. These herbicides are applied to the soil surface and must be leached into the soil by rainfall or irrigation. Excessive irrigation can leach the herbicides out of the soil of irrigation furrows or other heavily watered areas.

Complete weed control, showing results from simazine and diuron applied at rates of 2, 4, and 8 pounds per acre in adjacent tree plots.

### HOW DO THEY WORK?

Diuron and simazine are not toxic to weed seeds before germination, but are primarily effective against seedling weeds. Weeds pick up the herbicide through their roots, and if the herbicides are applied and leached into the soil prior to weed seed germination they prevent the establishment of most annual weeds.

At rates of as low as 2 to 5 pounds per acre, diuron and simazine are toxic to germinating weed seedlings for periods ranging from 3 months to a year or more, depending upon soil type, temperature, and amount of moisture. Both herbicides are ultimately broken down by soil microorganisms; this happens faster in warm, moist soils than in cold or dry soils. The herbicides are generally ineffective in controlling mature annual weeds and some established perennials (see below).

### WHAT WEEDS ARE KILLED?

Seedling weeds are killed by diuron and simazine by amounts which can be used with safety in walnut orchards. Most annual grasses and broadleaf weeds, such as the following, are easily killed: chickweed, nettle, filaree, Russian thistle, common nettle, lambs-

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quarter, nightshade, henbit, shepherdspurse, yellow starthistle, crabgrass, sour clover, sunflower, water hemlock, oxtongue, volunteer barley, mustard, pigweed, annual bluegrass, pineapple weed, purslane, tarweed, bur clover, ground cherry, annual brome, wild radish, knotweed, corn spurry, ripgut, and annual rye.

Although diuron is most effective when absorbed by the roots, many annual weeds can also be killed by application to the foliage. Simazine has little or no effect on standing weeds and must be applied to clean soil prior to weed germination.

## WHAT WEEDS ARE RESISTANT?

Established perennial weeds such as bermudagrass, johnsongrass, morningglory, bindweed, smartweed, nutsedge, (nutgrass), and curly dock will thrive in simazine- or diuron-treated walnut orchards because they are not competing with annual weeds.

Weed seedlings resistant to diuron are turkey mullein, common groundsel, several species of spurge, puncture vine, common mallow, and wild oats.

Simazine controls barnyardgrass (watergrass) crabgrass, and mustard soon after application, although these species are among the weeds first to grow back in simazine-treated soils. Puncture vine is usually not controlled by simazine at the rates used for control of other annual weeds in walnut orchards. Like many plant species, walnuts tolerate relatively high dosages of diuron and simazine when mature, yet are susceptible to injury as seedlings. Accordingly, these chemicals should not be used in nurseries on light soils.

## HOW MUCH TO APPLY

The amount of diuron or simazine needed to prevent establishment of weeds, and the length of time the herbicides will be effective, depends upon the weed species present, the amount of rainfall and irrigation, and the amount of clays and organic matter in the soil. Higher dosages are required for heavy soils containing much organic matter if there is high rainfall or frequent irrigation. When diuron and simazine are leached into the soil a certain percentage is adsorbed on the clays and organic matter, and the adsorbed material is unavailable to the roots—only that portion remaining in the soil solution is available for absorption by seedling roots. Heavy soils, and soils high in organic matter, adsorb more herbicides than do light or sandy soils and therefore require higher dosages.

Variation in dosage requirements is not always related solely to soil classifications (as expressed by available soil surveys). Amounts adequate for weed control in summer or winter can be determined only by experience, but 2 pounds per acre should be tried initially; in later treatments the rate can be adjusted as needed. A fall application of 3 to 5 pounds of Karmex® 80W or 2½ to 5 pounds of simazine 80W will control most annual weeds in winter in most walnut production areas. A 2 to 3 pound Karmex® application per acre in spring while trees are still dormant will control summer weeds. For economy and tree safety, it is best to apply the lowest amount needed for adequate weed control for the period that control is desired.

## WHEN TO APPLY

For maximum effectiveness, herbicides should be applied just before or during the rainy season. If the orchard is sprinkler irrigated, both herbicides may be applied at any time during the dormant season.

Diuron and simazine decompose to some extent when exposed to sunlight for extended periods of time, but once they are leached into the soil sunlight is no longer a factor. Thus, it is best to apply them just prior to or during the rainy season. Treatments are most effective when applied to bare ground before weed seed germination. If weeds are present at time of

Simazine toxicity symptoms in pot-grown walnut seedlings.

Diuron toxicity symptoms in pot-grown walnut seedlings.

application, a contact herbicide such as weed oil should be applied separately or in combination with the residual herbicide. Soil disturbance by mechanical equipment during the period of herbicide effectiveness greatly reduces weed control.

## PROGRAMS

Annual weeds can be controlled by application of approximately 2.4 pounds per acre of diuron (that is, 3 pounds of Karmex® 80W) in 40 to 60 gallons of water applied after harvest and prior to fall rains; in areas of heavy soils and high rainfall a second application in spring is often desirable. Applications can be made over the entire orchard floor, in strips down the tree rows, or in small areas around the base of the trees. Regardless of method used, it is essential to make accurate applications *on the basis of the area of soil sprayed.* Diuron should be used only on well-established, 1 year or older, walnut trees; it should never be used in desert valleys or on certain sandy soils—that is, those low in organic matter. Diuron can also be used as a single application after harvest and prior to weed germination at the rate of 3 to 5 pounds of Karmex® 80W and 40 to 60 gallons of water per acre. The lower rate (3 pounds) has usually been adequate in light soils, but in heavy soils with high organic matter content 5 pounds has given better weed control, with sufficient safety for well-established walnut trees 1 year or older.

Simazine is also recommended for annual weed control in walnut orchards and should be applied at the rate of 2½ to 5 pounds of simazine 80W in 40 to 60 gallons of water after harvest (before annual weeds germinate in the fall). There is more latitude of timing with sprinkler irrigation; with furrow irrigation it is essential to apply both simazine and diuron prior to rains so that the herbicides may be leached into the root zone of germinating weed seeds.

Annual weeds can also be controlled with 40 to 100 gallons per acre of a 50:50 mixture of weed oil and water, the rate depending upon height and density of weed growth: the lower rates are sufficient for young weeds in the 1-to 2-inch stage; older weeds will require closer to the 100 gallons per acre. When using weed oil in walnut orchards extreme care must be taken to keep oil off the trunks, particularly of young trees, *as severe damage may result from applying weed oil to the foliage or trunks of young trees.*

## CONTROL OF RESISTANT WEEDS

If resistant annual weeds are increasing after continued use of diuron *or* simazine, a change to the other herbicide will often solve the problem. With either herbicide, supplemental use of weed oil will give control.

Perennial weeds can be controlled by frequent applications of 80 to 100 gallons of weed oil per acre. This is expensive if the infestation is large, but newly-spreading perennial weeds can be controlled relatively inexpensively by frequent applications of such contact herbicide.

Bindweed can be controlled by repeated applications of oil throughout the growing season; this method has also given control of other broad-leaf perennial weeds. Applications after harvest and before the first frost have also been generally successful.

## HOW TO APPLY

Carefully weigh the amount of diuron or simazine going into the spray tank. (Volume measurements of the powder, and other approximate methods, are not sufficiently accurate.) Add herbicide to the tank *after* it has been partially filled with water and while the agitator is in motion. Continuous agitation is necessary to keep the material in suspension. Mechanical agitation is preferred, as hydraulic agitation may produce excessive foaming and part of the herbicide may be trapped in the foam. If agitation is stopped, make sure the herbicide is resuspended before continuing spraying. This may be checked by probing the tank, especially the corners.

Piston or centrifugal pumps are most often recommended for spraying wettable powders. Gear pumps are satisfactory, but tend to wear excessively with wettable powders. Use hoses and booms with small diameters to keep the velocity high and prevent "settling out" of herbicide inside the hose or boom. Screens and strainers should be at least 50-mesh to prevent clogging.

The pressure at which the rig is operated should be accurately controlled, and the speed of movement through the orchard must be kept constant in order to obtain uniform coverage. Take care to prevent local overdosing as a result of double passes over the same row, momentary slowing of the rig, and turning at the ends of the rows. Always turn off the boom before the rig is brought to a stop. Following use, clean spray equipment with several rinses of water.

A fixed boom with small "break-away" boom on the end is the most practical method of spraying. The area between the trees may also be sprayed with a hand gun if a break-away boom is not available. There is danger of overdosage in spraying with a hand gun. One pass over the area with the hand gun is sufficient, moving it at the same rate at which the rig moves through the orchard. Avoid cross-spraying with a boom rig, as this doubles the rate in the overlap area.

Nozzles giving a flat fan pattern of distribution are suitable and commonly used. Hardened stainless steel disc-type nozzles, although more expensive, last 10 to 20 times as long as soft brass. Set them so that there is a slight overlap at ground level—this compensates for the thinning effect at the edges of the fans. Do not overlap fans so much that partial double coverage occurs.

Moderate drift of simazine or diuron within the orchard, or wetting of the tree trunks, will not cause damage—but drift should be kept to a minimum.

## CALIBRATION METHOD

Herbicide application should be based on the area actually covered, and not on total acreage of orchard.

A simple method of calibrating a spray rig for accurate application of an herbicide is to determine the amount of carrier (water, in this case) needed to cover a known area and then calculate the amount of herbicide to be added. This can be done as follows.

1. Measure a known distance over which to run the rig. Multiply this distance by the width of the boom swath. This will give the area covered.

2. Fill the spray tank with a known amount of water. Drive the spray rig over the measured distance, *operating it at the same speed and pressure at which the spraying is to be done in the orchard.*

3. Measure the amount of water left in the tank and, by subtraction, find out how much water was applied over the measured area.

4. From this figure, calculate gallons per acre applied and the amount of herbicide to be added.

Example: Width of boom swath = 10 feet
Measured distance = 1,000 feet
$10 \times 1{,}000 = 10{,}000$ square feet area covered

$$\frac{10{,}000}{43{,}560} \text{ (Number of sq. ft. in an acre)} = 0.23 \text{ acres}$$

If it is found that 10 gallons of water were used in the calibration run, then

$$\frac{10 \text{ gallons}}{0.23 \text{ acres}} = 43.4 \text{ gallons of water will be applied per acre.}$$

Thus, if a 2-pound-per-acre rate is required, 2 pounds of herbicide should be added for every 43.4 gallons of water in the spray tank. If the tank holds 100 gallons, the amount of herbicide to be added may be calculated as follows:

$$\frac{2 \text{ lb. per acre}}{43.4 \text{ gal. per acre}} = \frac{X \text{ (amount to be added)}}{100 \text{ (capacity of spray tank)}}$$

$$X = \frac{2 \times 100}{43.4}$$

$= 4.6$ lb. herbicide to be added per 100 gallons water

To determine the amount of water used in spraying, it is often convenient to calibrate a stick with notches on it at 5 or 10-gallon intervals. This can be done by adding 5 gallons of water at a time to the tank and marking each level on the stick. Use of a measuring stick of this type allows the operator to measure accurately the amount of water in the spray tank.

All nozzles on the boom must deliver the same amount of liquid. Check each nozzle by measuring the amount of spray delivered in 30 seconds, and replace nozzles delivering excess material. (Nozzles tend to wear with use of wettable powders, and as they wear they deliver a larger volume).

The amount of water used per acre is not critical so long as adequate coverage is maintained. *The important thing is to apply a known quantity of herbicide over a known area.*

This information can be applied directly to the calibration of spraying equipment through the use of precalculated charts supplied by nozzle manufacturers (see table 1).

TABLE 1. RATES OF NOZZLE APPLICATION WITH No. 4 NOZZLES SPACED 20 INCHES APART ON BOOM

| Liquid pressure at nozzle (lb. per sq. in.) | Nozzle capacity (gal. per min.) | Gallons per acre at various speeds: 2 mph | 3 mph | 4 mph | 5 mph |
|---|---|---|---|---|---|
| 25 | 0.32 | 47 | 31 | 24 | 19 |
| 30 | 0.35 | 51 | 34 | 26 | 21 |
| 40 | 0.40 | 59 | 40 | 30 | 24 |
| 50 | 0.45 | 66 | 44 | 33 | 27 |
| 60 | 0.49 | 73 | 49 | 36 | 29 |

Select nozzles to give the approximate rate of spray application desired at a practical speed and pressure.

Corrections for different nozzle spacings and speed can be made on a ratio basis, as follows:

The spray equipment happens to have a nozzle spacing of 15 inches, and it is desired to apply 50 gallons per acre at an approximate speed of 3 miles per hour. In table 1, Number 4 nozzles are used, and their delivery rate is 40 gallons per acre at 40 psi (pounds per square inch) at a speed of 3 mph when spaced 20 inches apart. With 15-inch nozzle spacing, the delivery rate would be $\frac{20}{15} \times 40$, or 53 gallons per acre at the same speed and pressure. If 50 gallons per acre is to be applied, speed should be increased by $\frac{53}{50} \times 3 = 3.17$ mph. Thus the spray rig would be equipped with Number 4 nozzles, the pressure adjusted to 40 psi, and the sprayer driven at 3.2 mph to deliver 50 gallons per acre with 15 inch nozzle spacing.

## REMEMBER . . .

- Established weeds are not controlled by diuron or simazine.
- Continuous agitation in the spray rig is necessary. If agitation is stopped, be absolutely certain that the herbicide is resuspended before continuing spraying. Check by probing bottom of the tank.
- Avoid overdosing by spilling, overlapping, slowing, turning, and stopping.
- Do not disturb soil after application of diuron or simazine.
- Do not apply near other crops, nor where runoff water from the grove comes in contact with roots of other crops or ornamentals.
- Avoid spray drift to other crops.
- Spray rig should be calibrated in the field to check accuracy of calculations.

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