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Herbicide Calibration and Application[1]

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Improper application of herbicides account for most of the unsatisfactory results from herbicide programs in citrus. Inadequate rates and uneven distribution will result in poor weed control, while excessive rates and spray pattern overlap may result in young tree injury. Ultimately, the need for reapplication and/or excessive herbicide usage will increase the cost of the weed control program.

Adequate spray pattern overlap is critical to uniform weed control. Proper boom height above the surface to be sprayed along with correct nozzle spacing are essential for the desired degree of overlap. As each nozzle type has different overlap characteristics, determining the requirements for optimum overlap will ensure even herbicide distribution over the target area.

EQUIPMENT

Pump

The pump is the big component of the herbicide applicator and must have the capacity to deliver enough spray mix to provide required boom delivery rate and enough return flow for proper agitation if hydraulic agitation is used. The pump must be able to function at pressures desired for the correct operation of nozzle types selected. Operating pressures should range from 20 to 40 psi. Pump types used in citrus weed control operations include:

- Roller pumps which deliver medium volumes at low to medium pressure. The abrasive action of wettable powders will result in wear of their internal parts.
- Piston pumps which deliver low to medium volumes at high pressures. A surge tank is needed to reduce pressure surges caused by piston speed variation.
- Centrifugal pumps which deliver high volumes at relatively low pressures.

Agitation

All herbicide products, particularly wettable powders, water dispersible granules, and flowable formulations require agitation to achieve initial thorough mixing. Mechanical agitation is best, but hydraulic agitation may be used provided an adequate amount of turbulent flow energy from a combination of pressure and volume is transported back to the bottom of the tank. Improper agitation will cause an accumulation of product at the bottom of the tank with the resulting uneven herbicide concentration throughout the volume of carrier in the tank. This can lead to excessive application rates early in the operation and inadequate rates at the end. Possible end results include phytotoxicity symptoms in trees and poor weed control, respectively.

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Strainers and Screens

Strainers and screens are essential components of herbicide application equipment to avoid plugging of nozzle tips and possible damage to pumps, pressure regulators, and gauges. In-line strainers should be situated on the suction line between the tank and pump where roller and piston pumps are used, and between the pump and pressure regulator for centrifugal pumps.

Nozzle screens should be placed in each nozzle housing and equipped with check valves to minimize drip when the boom is not in operation.

Regulators and Gauges

Regulators and gauges are essential components of all herbicide applicators. Pressure regulators control the system pressure by allowing part of the pump output to return to the tank and also relieves excess pressure when the boom is not in operation. As pressure is an integral part of calibration, an accurate, easily read gauge is essential. Liquid-filled gauges are more easy to read as they are less subject to minor pressure fluctuations and vibrations. Both regulators and gauges should be in easy reach of the operator.

Booms

Booms of a wide variety may be found in the citrus industry, and are frequently locally constructed and adapted to the needs of the particular grove operation. Their construction should, however, incorporate certain features including:

- sufficient length to cover the area between the tree trunk and the outer tree canopy so that good spray overlap of the tree middle is obtained
- protection from low-lying tree limbs in the form of a cover or shield while allowing for clear operator visibility of the nozzle spray patterns
- spring-loaded or hydraulic flexibility to protect boom on contact with obstructions such as tree trunks and large woody weed species, while allowing its return to normal operation automatically and rapidly
- versatility such as double plumbing to allow the application of different rates through each of two booms when young resets require lower herbicide rates than older trees. Such versatility might also extend to the use of two tanks, each serviced by separate booms for the application of separate herbicides in sequence such as Roundup and soil residuals

Nozzles

Nozzle types, too numerous to describe here, are listed with detailed specifications in various catalogs, most notably those of Spraying Systems and Delavan.

Flat Fan Nozzle

Flat fan nozzle tips produce a tapered edge pattern with good spray penetration. They should be operated at pressures of 15 to 30 psi with the emission of medium to coarse droplets less likely to drift than fine droplets at higher pressures. Nozzles should be placed on 8 to 10 inch centers on the boom at an operating height of 8 to 12 inches. A spray pattern overlap of 30% to 50% is suggested for uniform spray coverage of the sprayed surface. Tips in several spray pattern angles may be selected including 80 and 110 degrees.

Flooding Flat Fan Nozzles

Flooding flat fan nozzle tips produce wide angle, flat fan patterns suitable for the application of herbicides and mixtures of herbicides and fertilizers. The optimum pressure range is 15 to 20 psi when spaced 10 to 12 inches apart on the boom. Unlike the ordinary flat fan nozzle tips, increased pressure increases the spray pattern width. Boom height should be adjusted to allow for 100% spray overlap. Because of their larger orifices, these tips are less likely to become plugged.

Off-Center Nozzles

Off-center nozzles produce an off-center spray pattern of relatively uniform distribution. They are usually placed at the bottom of the boom to give extended coverage beyond the tree line. They should be mounted 2 to 4 inches beyond the last main nozzle and mounted on a swivel body. Such nozzles should be at least a size or two larger than the other nozzles and adjusted to cover 1-1/2 the area of the flat fan.

Other Type Nozzles

In addition to the nozzle types commonly used in citrus weed control, a number of others including low volume atomizing and rotary atomizing types are being evaluated. These low volume nozzles are being used to evaluate lower application rates of systemic herbicides such as glyphosate, predominately. Before reliable conclusions can be drawn, these nozzles should be evaluated at different dosage rates and on different weed species at different stages of maturity and varying weed stand density. For example, top kill or brownout with subsequent regrowth of a perennial grass species should not be confused with total kill when no recovery takes place.

Nozzle Construction and Care

Nozzle tips are available in a variety of materials including brass, stainless steel, hardened stainless steel and plastic (nylon). Brass is the least expensive but wears quickly when abrasive wettable powders are used. Such orifice wear will result in increased output and, therefore, incorrect application rates. Stainless steel nozzle tips will not wear as quickly and not have to be changed as frequently. Nozzle tips should never be cleaned with metallic objects, but with a toothbrush or toothpick.

CALIBRATION

Initial, and thereafter periodic, accurate calibration of herbicide application equipment is an essential component of a successful weed control program. After you have selected the nozzle types for the equipment, select the nozzle size based on the delivery rate in gallons per acre (GPA) desired. To select the nozzle size use the gallons per minute (GPM) calculation.

Field Calibration

1. Select a speed between 2 and 4 mph.

2. Select a gear which will give you this speed with the engine running at least 1500 rpm to get adequate bypass agitation.

3. Determine the size of the nozzle required for the desired gallons per acre. The required output can be calculated with the formula shown in Equation 1:

$$GPM = GPA \times S \times N$$

GPM = gallons per minute
GPA = gallons per acre
S = ground speed in mph
N = nozzle spacing in inches

4. From the nozzle manufacturer's tables, and at a pressure between 30 and 40 psi, select a nozzle size nearest the required output.

5. With nozzles discharging at selected engine speed, set pressure as determined in step 3.

6. Measure at least 1/10 acre (4356 sq.ft.) for the purpose of calibration. For example, a 4 ft. sprayed width would require 4356/4=1089 ft

7. Fill the tank with water.

8. Spray test area at selected ground speed and pressure.

9. Refill the tank to the original level and record gallons sprayed. Use the formula in Equation 2 to determine gallons per acre output.

$$GPA = \frac{43{,}560 \times G}{D \times B}$$

G = gallons of water sprayed
D = distance traveled in feet
B = boom width in feet
GPA = gallons per acre

Stationary Calibration

1. Set the pressure between 30 and 40 psi with nozzles discharging.

2. Place 1 gallon cans under each of the functional nozzles.

3. Record number of seconds for nozzles to fill cans.

4. Determine gallons per minute delivered from nozzles by dividing the number of seconds into 60.

Use the formulas in Equation 3, Equation 4, Equation 5 and Equation 6 to determine gallons per acre (GPA):

$$GPA = \frac{5940 \times A}{S \times N}$$

A = average gallons per minute per nozzle
S = ground speed in mph
N = nozzle spacing in inches
GPA = gallons per acre

$$GPA = \frac{O \times 4083}{N \times S}$$

O = ounces per minute per nozzle
N = nozzle spacing in inches
S = ground speed in feet per minute
GPA = gallons per acre

Using a 12-inch nozzle spacing, for example:

$$GPA = \frac{495 \times A}{S}$$

A = average gallons per minute per gallon
S = Ground speed in mph
GPA = gallons per acre

$$H = \frac{T \times P}{GPA}$$

H = amount of herbicide to add to tank
T = tank capacity in gallons
P = desired product per acre in pounds
GPA = gallons per acre

RESETS

Water Ring Application

There are several products available to growers that can be used in water rings as a drench treatment. If rates are not given for a drench treatment, then the rate per acre must be used as a guideline. It is very easy to over-dose trees in a water ring with a drench. Not only may you be 5 to 10 times over the recommended rate, but you would also be forcing the product into the root zone of the tree and saturating that root area. If a wettable powder is being used, the tank must have an agitation system.

Water Ring Calibration

Here are several steps to determine proper water ring drench treatment amounts.

1. Determine area of the water ring - the area of a circle is 3.14 x radius squared (the radius of the distance from trunk to ring).

2. Know exactly how much water will be applied to each tree - use a 5 gallon bucket if necessary.

3. Determine the area covered by 1 tank of water. (Gallon in tank/gallons per tree, then multiply this by the area of the water ring.)

4. Determine what part of an acre this is: area covered by one tank (answer to #3)/43560 sq.ft./acre.

5. Take the recommended rate per acre and multiply to the answer to #4 and add this amount to the tank.

EXAMPLE: You have a 500 gallon water tank; you are applying 5 gallons per tree, and the recommended rate of the material is 5 lbs. per acre. Your water ring is 4 ft. across.

1. 3.14 x 2 sq. = 3.14 x 4 = about 12.5 sq.ft.
2. 5 gallons per tree.
3. 500 gallons/5 gallons per tree = 100 trees. 100 trees x 12.5 sq.ft. = 1250 sq.ft. per tank.
4. 1250/43560 = .029 or .03 acres.
5. .03 acres x 5 lbs./acre = .15 lbs. .15 lbs. is the proper amount to add to the tank. To convert this to ounces, multiply .15 lbs x 16 oz./lb. = 2.4 oz. 2.4 oz. may not seem like much, but it would be the equivalent of 5 lbs./acre.

You can see how important it is to know exactly how much water is going into each ring. If you were to apply 10 gal. per tree, only half the area just determined would be covered, and only 1.2 oz. of product would be needed.

TANK MIXING

Tank mixing usually involves pesticides and some kind of liquid carrier, most commonly water. Herbicide formulations used in Florida citrus include:

- wettable powders (WP), which are dry products that disperse in the carrier and must be kept in suspension by agitation
- water dispersible granules (WDG), small pellets that wet quickly and disperse easily in the carrier
- flowable liquids (L) or suspensions, which mix relatively easily
- emulsifiable concentrates (EC), oil-like liquids that disperse quickly in the carrier
- true water soluble liquid formulations
- dry flowables (DF)

For best dispersion and uniformity in the tank mixture, wettable powders and water dispersible granules should be added first to 1/4 to 1/2 filled tank, followed by thorough agitation. Flowable liquids, emulsifiable concentrates, liquids, and surfactants should be added to the tank lastly.

MISAPPLICATION OF HERBICIDES

Misapplication of herbicides or pesticide can damage or kill desirable plants and citrus trees, ultimately cause undesirable environmental effects, and possibly result in legal proceedings. Problems can arise following the application of herbicides at to high a rate, too close to desirable vegetation especially susceptible to the particular herbicides, on sloping terrain where heavy rainfall can move the chemical into the root zones of desirable plants.

If the problem of misapplication is detected immediately, then the treated soil surface layers may be removed, although a somewhat laborious process. If some time has elapsed, then activated charcoal may be incorporated into the surface soil at the rate of about 7 lbs. per 1000 sq.ft. If damage to desirable plants is already apparent, a trenching machine may have to be employed to sever the root system of the plants that are in contact with the contaminating chemical. Hopefully, this will minimize further absorption of the chemical, although sometimes corrective action is futile. Caution would dictate that no herbicide be used within a distance of three times the canopy radius of desirable plants. Sterilant rates of herbicide applied to ditchbanks bordering citrus groves can result in tree injury where roots permeate the area to be sprayed. Do not mix or dispose of herbicide mixes in areas near water sources such as wells, ponds, and lakes or in grove locations where tree roots would be in the area of the discharged material.

In order to reduce the impact of herbicides on the environment outside the immediate target area, efforts should be directed towards:

- minimizing drift by not applying under windy conditions and using low pressures and, if necessary, drift control additives
- minimizing application concentrations within recommended ranges for weed control
- better irrigation management to reduce leaching
- monitoring drainage outflows to determine levels of herbicides in water

- erosion control to avoid movement of excessive amounts of surface applied chemicals into ponds, lakes, and waterways
- thorough on-site cleanup to avoid tree damage and contamination of adjacent water sources
- maintaining crop residue levels within the approved ranges by keeping application rates within recommended ranges and avoiding excessive herbicide spray contact with fruit on trees.