THE UNIVERSITY of TENNESSEE Extension

Sprayer Calibration

By Mark Halcomb, UT Extension Area Nursery Specialist

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Calibration is the process of modifying or adjusting a sprayer to give the desired application rate with uniform coverage. There could be 3 or 4 steps. First, we may need to modify the spray unit to spray a band from a nozzle mounted on the front bumper so it can be controlled and watched. Second, determine how many gallons of water the unit is applying per acre as it is. Third, make the proper changes to the unit so it will apply the desired number of gallons of water per acre. Fourth, calculate the amount of pesticide to be added per tank, based on the rate desired per acre after referring to the label. Most labels can be found at http://www.cdms.net/

Do not allow the word 'calibration' to intimidate as I did before I understood the process. I'm not very smart but I can figure and follow directions. Farmers can figure.

Applying pesticides correctly is very important to obtain control without wasting product. Herbicide labels recommend a volume of water per acre; unlike insecticide or fungicide labels that recommend a rate based on 100 gallons of water.

Before you can know how much herbicide to add to a tank, you must first figure how many gallons of water the sprayer is applying per acre (output). There is more than one accurate method to determine sprayer output.

It is possible to apply 10 to well over 100 gallons of spray water per acre. Once it is determined how many gallons of spray water is being applied per sprayed acre, there is a simple calculation to determine how much pesticide to add to the tank. This is explained in steps 12 and 13 of the calibration section.

Check the spray output at least annually and every time the pump is replaced. If the tractor speed has not been affected by engine work or new tires since the last check, then merely catch the spray output for the pre-determined travel time.

I will be happy to give ideas on how to rig a sprayer to band or help figure out how many gallons of water a sprayer is applying per acre and explain the process as we perform the steps together. I want you to be able to determine your sprayer's output and calculate the amount of pesticide to add to the tank with confidence.

It is essential to know how many gallons of water your sprayer is applying or spraying per acre in order to know how much pesticide to add to the tank.

Rigging to Band Spray

Band spraying is a preferred way to apply herbicides to nursery stock rows. While broadcast spraying is faster, there is no need to spray middles that can be mowed or may be cultivated later. In fact, vegetation in the middles is not harmful to the nursery crop, as long as a sufficiently wide weed free strip is maintained in the row. Vegetated middles reduce erosion on slopes. Banding reduces the amount of chemical required by one-third to one-half but does require more labor and machinery costs to drive down each side of the row.

Cultivation or herbicides can be used to maintain a weed free strip 12-18 inches wide on each side of the planted row during the first year. The strip can be widened each year to a maximum of 2-3 feet on each side of the row if desired.

It is possible to rig a nozzle on the rear of the spray tank to spray toward the base of the plants in the row, but it can't be watched as easily as one mounted on the front. Most operators prefer mounting a spray arm with a single nozzle on the front bumper of a small tractor, with a 50 gallon PTO spray tank mounted on the 3-point hitch. The driver can drive to wet the lower 2-3” of the tree trunks to achieve the correct overlap needed. A clogged nozzle or an empting tank can quickly be noticed. This eliminates the wiggle created when the front of the tractor makes a slight maneuver.

A 3-4 foot length of 1-1/4 inch square metal tubing can be mounted horizontally on the front bumper to hold another 18 inch length of 1 inch tubing that can be slid inside to achieve horizontal adjustment. Drill and weld a nut with a bolt to tighten it in place. (Perforated metal tubing available at hardware stores will also provide horizontal adjustment but vertical adjustment must be achieved by the mount.)

Mounting: The 3' tube can be slid through the weight handles of some tractors. It can be secured with multiple zip ties or with 2 pieces of 10" long 2x4 cut diagonally, with a piece driven in from each side. The 3’ tube can also be bolted or welded permanently, but the piece that slides inside and all hoses could be easily removed for storage when not needed. Link

Attach a nozzle on the end of the 1 inch tube. Run a reinforced spray hose (not anhydrous ammonia hose) to the nozzle from the tank, perhaps under the tractor, avoiding hot areas that will melt the hose. Zip ties are great and allow the hose to be suspended in places.

A great idea to reduce driver fatigue and increase safety is to run the hose across the right rear fender (for right handed operators). Cut the hose and install a 1/4 turn ball valve. (Add a second hose and valve if spraying both sides.) This prevents the driver from having to turn around in a straining reach to turn the valve off or on while also attempting to throttle down and turn around, while not running over the end plants.

Always allow extra hose so the nozzle on the slide bar can be adjusted to its widest point. Leaving a little extra will be handy for repairs. Hoses cannot make 90 degree turns without collapsing.

Vertical adjustment can be provided with a few more minutes of welding. Vertical adjustment controls the band width. Unlike on a boom, a single nozzle can be carried at any height to achieve the width desired.

Another spray arm and nozzle can be mounted on the other side of the front bumper using the same 3-4 foot 1 ¼ inch tube, allowing the two inside strips to be sprayed, (a strip on either side of the tractor, parts of two rows), cutting the trips in half. This works if the rows are not too wide. So what if the rows are not perfectly straight? Satisfactory weed control will still be achieved by the 18-24 inch band sprayed on each side.

It used to be common to find rigs applying 50+ gallons of water per acre with 8004 tips, due to the slow tractor speed. Changing the tip size to 8002 cut the water in half, but produced a finer spray that was more difficult for the driver to see and easier for the wind to move. I prefer 25 gal/acre of water for convenience and because most rigs have a 50 gal tank. An 8003 tip has provided a compromise for some operators. Seeing the spray helps guide the driver to spray the lower 2-3" of each shade tree trunk for proper overlap of the spray pattern.

Spray Tips: Standard flat fan spray tips require a minimum of 30 psi to develop a full pattern. (This is critical for a boom, but not for single spray tips, as long as the desired width is achieved.) A TeeJet XR (Extended Range) tip will develop a full pattern at 15 psi. Both will operate up to 60 psi. The VisiFlo tip is color coded for output and convenience. The code on an 8004 tip might read XR8004VS. These tips have a stainless steel center for extended wear and the rest is colored nylon.

TeeJet offers tips ranging from 8001 to 8015 (but not 8009, 8011-8014). The 8003-8005 size tips are commonly used to apply pre and postemergence herbicides. Avoid purchasing an ‘Even’ tip, designated with the letter ‘E’ after the size. (8004E) An even tip applies a full rate on both ends, not a feathered edge. It is not designed for use on a boom. It will either produce a double rate where it overlaps or zero water where it does not meet. It does not fit our needs in nursery. I find them on booms and offered for sale locally mixed in with the other tips. Be cautious.

Hardware (nozzle body, caps, etc) can be purchased in brass or nylon. Brass is more durable than nylon. It is easy to cross thread a brass cap used on a nylon nozzle body.

An off-center (OC) tip reaches out further from the tractor and is useful in some applications such as banding down a nursery row with low branches. An OC-02 will apply the same volume as a TeeJet 8002. Brass off-center tips cost about $8.50 compared to $3.50 for regular flat fan tips and are available in most sizes.

I liked and recommended them for several years until I realized they did not produce a feathered edge. They apply a full rate at the end. An off-center tip will either apply a

double rate if it overlaps or a void if the spray does not meet. We strive to overlap the coverage when we drive both sides of each row applying pesticides.

Some producers like to mount a swivel nozzle body to direct the spray toward the row. Some will use a double swivel nozzle body to produce a wider spray pattern. A uniform pattern is probably not achieved but the producers are satisfied with the control. Postemergence herbicides would be more forgiving.

A Boom: Spray tips should generally be mounted 20 (16-24) inches apart and carried 17 to 19" above the target on a boom. An 80 degree tip (Ex. 8004) will cover a swath 30" wide when carried 20" above the target. A 110 degree tip will cover a swath 38-42" wide when carried 20" above the target. The target may be bare soil or the average height of weeds to be sprayed.

Strainers are recommended for use within the nozzle body. Clean strainers as often as necessary with a soft discarded toothbrush under running water. The outside end tips on a boom collect trash first. Remove all tips and strainers (including the filter under the tank) occasionally and flush the system with clean water. A check valve strainer will stop dripping and cost about $3.50 each. The check valve strainer requires approximately 10 extra psi to operate. Re-calibrate the sprayer system after adding them.

Water Volume: Preemergence herbicide labels recommend a sufficient water volume to obtain uniform coverage. Individual herbicides require different amounts of water to achieve maximum weed control. Some may suggest 20 gallons per acre, while others may state a range of 20 to 100. Refer to the label to learn how much water is required by the specific herbicide being used. Any more than the recommended spray volume merely wastes time to fill the tank up more often. This can be significant if the tractor has to be driven a long distance to a water source.

Never fill sprayers near wells. Normal filling procedures will put some pesticide on the ground but a spill of the concentrate would be more dangerous. The fear is that pesticides will eventually reach and contaminate our groundwater. Work away and downhill from wells.

Water quality is also important. Water used for spraying should be free of any particles that would interfere with the flow, clog filters and increase down time. The pH can affect the stability of some pesticides, shortening the time they remain effective. Determine the pH of any non-public water source and refer to the label to learn if pesticides you use are in jeopardy. Public water sources, surface and ground water around Warren County Tennessee generally test 7.0 to 7.4 and pose no issues that this author is aware of at this writing.

Spare Parts: Always keep spare parts of each item that could stop progress in the field: especially pressure gauges, pressure regulating valves, nozzle body strainers, pump, commonly used tips, etc. A trip to the store to replace a part will cost more than any money saved initially plus the down time with labor on clock.

The 1/128th of an Acre Method Explained

The 1/128th of an Acre Method is based on a gallon of liquid containing 128 fluid ounces (fl oz). If an area equal to 1/128 of an acre is sprayed for calibration purposes, the number of fluid ounces applied is equal to the application rate in gallons per acre. (If we catch sprayer output for a time equal to the drive time, the ounces caught equal gallons per acre.) There are no mathematical equations.

(One acre = 43,560 sq ft) (43,560 divided by 128 = 340) 1/128th of an acre = 340 sq ft. We need to determine how long it takes us to spray 340 sq ft and how many gallons of water would be applied with our sprayer set-up. We must determine how wide we are spraying or how wide we need to spray. Once we learn how wide we are spraying, we then need to determine how many feet we would have to travel to spray 340 sq ft. (length x width = sq ft) The length of the course can be calculated easily by dividing 340 by the width in feet of the sprayed area covered by one nozzle.

Key to the success of the 1/128th acre method is to select the proper course length, accurate measurement of the course, obtaining accurate drive times and accurately measuring the ounces caught.

If spraying a band, use the effective band width to determine the course length to drive and time. If using a spray boom, use the nozzle spacing. Catch the output for the required travel time to spray the 340 sq. ft. course. The procedure is outlined below but feel free to ask your local Extension agent.

Once the output is known, divide the gallons of water put in the tank by the output to determine the acreage sprayed per tank. If tank size is 50 gal and output is 27 gallons of water per acre: (50 divided by 27 = 1.85 acres sprayed with 50 gallons). Then multiply the acreage sprayed per tank times the Amount of product desired per acre to determine how much product to add to each tank.

The Calibration Steps, for pre and post-emergent herbicides or any soil applied pesticide.

1. Hook up sprayer and insure that it works properly. If the sprayer hasn't been used since last season; remove all spray tips, strainers, filters, plug and filter below the tank. Flush the tank. Replace the plug, add water and flush the entire system with clean water. Fill at least half full with clean water.

2. Insure that the pressure gauge works and that the pressure can be adjusted with the pressure regulator valve. Regular flat fan spray tips require a minimum of 30psi to achieve their full pattern. Up to 60 pounds pressure (psi) may be required when spraying a post-emergent herbicide down into dense, tall vegetation. A liquid filled pressure gauge is easier to read. Repair all significant leaks, etc. Plumber’s pipe thread compound is easier and more effective than Teflon tape and remains pliable. It is available where plumbing supplies are sold.

3. Determine the location of the spray tip; one or both sides of front bumper, mid-point under tractor belly, or rear of tank, etc.

4. Determine the desired spray **width** and how to achieve. Raising or lowering a single nozzle body is okay to make spray band width changes. A spray boom is generally carried 17 to 19 inches above the target to achieve a proper spray pattern. A single nozzle can be used at any height to achieve the width desired.

5. A standard flat fan spray tip is designed to provide a feathered edge, so that when they are mounted side by side on a boom correctly, the spray pattern will be uniform across the width of the boom. This is why it is so critical for the tips to be mounted a consistent 20 inches apart and then the boom be carried 17 to 19 inches over the target so there are no patterns of stripping in the control.

When banding with one tip carried about 18 inches high, you can safely assume the outside 3 inches on both sides is not applying the full rate. (4" when carried higher) Spraying while stationary, out of the wind, at the intended pressure and rpm, measure the widest wetted area and subtract 6 inches to obtain the effective spray width.

You can also spray over level bare soil, concrete, asphalt, small gravel at a slower speed but at correct pressure and rpm. Mark both outside edges. The outer few inches will dry faster than the portion of the band that received the full rate. Do this more than once.

Determining the effective width is critical, sometimes extremely challenging and always debatable.

Because this is important, but also difficult to explain, here is another explanation:

Operate the sprayer at the desired RPM and psi, but at a much slower speed in order to determine the ***effective*** **spray width.** (The spray pattern will be more visible with the greater volume of water applied at the slower speed. It will be easier to see on concrete, asphalt, gravel, etc.) Work on level ground and out of the wind. This is the most important step to be accurate.

A standard flat fan spray tip sprays a feathered edge so that the dose will not be doubled when used side by side on a spray boom. Also so there will not be a void either. Approximately 4-6 inches on each side is feathered. If banding with a single nozzle the final adjustment on the nozzle height should be made in the field prior to the application. The weight of the tractor will sink into loose soil and the nozzle body may need to be raised to compensate and provide the desired spray width.

6. Accurately measure and clearly mark a course length based on the width of the spray band. See Table 1 or calculate yourself by dividing 340 feet by the spray width in feet; (divide width in inches by 12; a 20 inch band is 1.67 feet).

7. The actual driver that is familiar with the tractor, that will be making the application, should assist. The driver should know the gear and rpm that is preferred; otherwise, determine a safe speed that can be used over the entire farm. Make this determination by driving and spraying down a typical row, not on a hard surface.

Time the tractor and sprayer operating through the course. Do a running start instead of a dead start from the line. (Begin 10 feet before reaching the starting line, with everything operating; the gear, rpm, psi, etc.) Don't hesitate to begin over if the driver will be more comfortable, more confident with a different gear, etc. Begin over if the driver alters the speed.

8. Repeat the procedure on the return trip. Have the driver readjust the rpm between runs. Average the runs. Average 4 runs if they vary in time.

9. Park the tractor. With the engine running at the same rpm, psi, etc., **catch** the output for the travel time in a bucket. Measure accurately in fluid ounces. (If 2 nozzles spray side by side to achieve the width required, with only the normal overlap; catch their output separate. Their output should be equal. If more than 1 nozzle is spraying the same band, (in order to increase the output) catch all and add together for the output per acre.)

Ounces caught equal gallons per acre with this method. Any changes in rpm require re-timing on the course. The output should remain the same as long as the gear, rpm, pressure, spray tip size, etc. remain the same. Re-check the output at least annually because the pump gets weaker or may freeze during the winter. It is critical that the pressure can be adjusted with the pressure regulating valve with a functioning pressure gauge and tach.

10. **To increase output**: Increasing spray pressure and/or slowing the tractor speed will make slight increases in the output. Changing to a larger spray tip is the simplest and easiest way to increase output. See Table 2 to learn the type of change expected.

11. **To decrease output**: Decreasing spray pressure and/or increasing the tractor speed will make only slight decreases in the output. Changing to a smaller spray tip is the simplest and easiest way to decrease output. See Table 2 to learn the type of change expected.
NOTE: Re-time the tractor on the course if you change the gear or rpm.

12. Use this formula to determine the acres sprayed per tank & the amount of product to add to the tank. It is not the tank size; but the number of gallons put in it.

$$\frac{\text{Gallons in Tank}}{\text{Gal. applied/acre (or Output)}} \times \text{Amount of Product desired per acre} = \text{Amount of product to add to tank}$$

13. To determine the amount of product (Surflan, Princep, etc.) to add to each tank, multiply the amount of pesticide required or desired per acre, times the number of acres sprayed with each tank, (2.0 above) 2.0 x 2 qts Surflan/acre = 4qts put into the 50 gallon tank. Two acres covered; 2 qts per acre.

$$\text{Ex.} \frac{\text{50 gallon tank}}{\text{25 gals. sprayed/acre}} = \text{2 acres/tank x 2qts Surflan/acre = 4qts Surflan per tank}$$

The example is for a 50 gal. tank, on a spray rig applying 25 gallons of water per acre. Each 50 gallons will cover 2 sprayed acres. If banding, more than 2 acres will be driven across to actually spray 2 acres of ground. We desire to apply 2 quarts of product per acre. Put 4 qts in each 50 gal.

14. If an 18" band is sprayed on both sides of a row; a 36" or 3' strip is sprayed per row. A sprayed 3' strip in a 6' row spacing treats half of the field. Two acres are driven over to spray one acre. Four acres are driven across to actually spray 2 acres, which can be done with one 50 gal. tank that applies 25 gal. of water per acre.

15. More examples explained:

$$\frac{\text{50 gallon tank}}{\text{30 gallons sprayed/acre}} = 1.67 \text{ acres/tank x 2 qts.} = 3.33 \text{ qts/tank of 50 gal.}$$

Since it is difficult to measure a fraction of a unit, convert to ounces or liquid ounces. (0.33 qts x 32 fl oz = 10.56 fl. oz.; so, 3 qts and 10.56 fl. oz. = 3.33 qts. Or 3.33 qts x 32 = 106.56 fl. oz.

Situation: We have sprayed several tanks, and we like 1 more block. We estimate that 15 gallons of solution will finish the job. We place 15 gallons of water in the 50 gallon tank to finish. This is why we have stated not to use the tank size but the number of gallons added to it.

$$\frac{\text{15 gal in tank}}{\text{25 gallons sprayed/acre}} = 0.60 \text{ acres/tank x 2 qts} = 1.2 \text{ qts / 15 gal}$$

Table 1

Band Width in inches	Course length in feet	Band Width in inches	Course length in feet
14	292	22	185
16	255	23	177
18	226	24	170
19	215	26	157
20	204	28	146
21	194	30	136

Table 2
Standard flat fan spray tips, operated at 30 psi and 4 mph, will spray the following amounts per sprayed acre. (Most of our band applications are made at travel speeds between 1 - 2.4 miles per hour.) The output will be greater at slower speeds.

Spray Tip	Output in gallons per acre	Spray Tip	Output in gallons per acre
8001	06.4 gallons	8006	39 gallons
8002	13	8008	52
8003	19	8010	64
8004	26	8015	97
8005	32		

It is not necessary to know the tractor speed with this method; but, if you would like to know, here are 2 easy formulas. Time the travel time for a known distance greater than 200 feet and average 2 or 3 runs for greater accuracy. The first method is the easiest.

Distance in feet x 0.68 and Divide that by the travel time in seconds = mph

Or $\frac{\text{Distance in feet x 60}}{\text{Time in seconds x 88}}$ = Speed in miles per hour

Units in = units out: The answer will be in the same unit as used.

It may be more accurate to convert everything to ounces however, rather than trying to guess at 3.7 qts, for example. (2 qts = 64 fluid ounces)

$\frac{\text{50 gal}}{\text{27 gallons}}$ x 64 fl oz = 118.4 fl. oz. or 3.7 qts. or 3 qts + 22.4 fl oz

[118.4 divided by (32 fl oz in 1 qt) = 3.7] (0.7 x 32 = 22.4)

Mark A. Halcomb, UT Area Nursery Specialist, Warren Co Extension, 201 Locust St. #10, McMinnville, TN 37110 mhalcomb@utk.edu 931-473-8484 Fax: 931-473-8089

Revisions available under 'Weed Control' at http://www.utextension.utk.edu/mtnpi/index.html

Comm/Weed Control/Calibration/Sprayer Calibration

UT Extension

Sprayer Calibration Sheet

by Mark Halcomb 931-473-8484; fax 931-473-8089

Nursery _____ Date _____
Tractor _____ Tank size _____
Gear _____ rpm _____ psi _____
18" band; 227' course; _____ seconds
____" band; _____' course; _____seconds
Tip size _____ psi _____
Tip size _____ psi _____

(Due to the variability in soil conditions and some rows are on ridges; it is the responsibility of the nursery (owner, driver) to adjust the nozzle height to obtain the correct width. The dampened width will be 6" wider than the effective width, due to the feathered edge made by flat fan spray tips. The spray of pre-emergent herbicides should wet the lower 2" of each plant stem from both sides.)

_____gallons per acre

$$\frac{\text{Gallons in tank}}{\text{Output (gal per acre)}} = \text{Acres covered}$$

$$\frac{\text{Gallons in tank}}{\text{Output (gal per acre)}} \times \text{Amount of Product Desired per acre} = \text{Amount to add to Tank}$$

Regardless of the pesticide used, if the rate per acre is:
1 qt/acre

1.5 qt/acre

2 qts/acre

2.5 qts/acre

Additional Sprayer Calibration Sheets available under 'Weed Control' at http://www.utextension.utk.edu/mtnpi/index.html
Comm/Equip/Calib sheet for herb. 7-09