HERBICIDE APPLICATION

Tips for Proper Mixing*

1. See that **equipment is clean and in good running condition,** free of oil, grease or residue.
2. Always **follow label instructions** about mixtures.
3. If there's any question about compatibility, **do a jar test first.**
4. Add chemicals in W-A-L-E sequence.

   Wettable powders or water dispersible granules
   Agitation
   Liquids (flowable liquids)
   Emulsifiable concentrates
5. Start with **tank ¼ full** of carrier, and add **all** W or WDG chemicals first.
6. Get good, strong agitation with a rolling effect on the surface of the carrier. Allow time for good dispersal.
7. Have a shut-off valve installed in the bottom of each tank.
8. Use a 16-mesh suction screen to allow chemicals to circulate through the pump.
9. Empty the tank as much as possible before mixing a new batch.

Compatibility Test: Since liquid fertilizers can vary, even within the same analysis, always **check compatibility with herbicide(s) each time before use.** Be especially careful when using complete suspension or fluid fertilizers as serious compatibility problems are more likely to occur. Commercial application equipment may improve compatibility in some instances. The following test assumes a spray volume of 25 gallons per acre. For other spray volumes, make appropriate changes in the ingredients. Check compatibility using this procedure:

1. Add 1 pint of fertilizer to each of 2 one-quart jars with tight lids.
2. To **one** of the jars add ¼ teaspoon or 1.2 milliliters of a compatibility agent approved for this use, such as Compex or Unite (¼ teaspoon is equivalent to 2 pints per 100 gallons of spray). Shake or stir gently to mix.
3. To **both** jars add the appropriate amount of herbicide(s). If more than one herbicide is used, add them separately with dry herbicides first, flowables next and emulsifiable concentrates last. After each addition, shake or stir gently to thoroughly mix. The appropriate amount of herbicides for this test follows:

   Dry herbicides: For each pound to be applied per acre, add 1.5 level teaspoons to each jar.

   Liquid herbicides: For each pint to be applied per acre, add 0.5 teaspoon or 2.5 milliliters to each jar.
4. After adding all ingredients, put lids on and tighten, and invert each jar ten times to mix. Let the mixtures stand 15 minutes and then look for separation, large flakes, precipitates, gels, heavy oily film on the jar or other signs of incompatibility. Determine if the compatibility agent is needed in the spray mixture by comparing the two jars. If either mixture separates but can be remixed readily, the mixture can be sprayed as long as good agitation is used. If the mixtures are incompatible, test the following methods of improving compatibility: (A) slurry the dry herbicide(s) in water before addition, or (B) add ½ of the compatibility agent to the fertilizer and the other ½ to the emulsifiable concentrate or flowable herbicide before addition to the mixture.

Checklist for Proper Spray Application

If you cannot check all the following (where applicable), perhaps you have a weakness in your weed control program that can be corrected.

( ) 1. Use flat fan or other nozzle designed for uniform distribution when making broadcast applications.
( ) 2. Use "E" (even-spray) nozzles for banding behind press wheel.
( ) 3. Use flat fan or OC nozzles for postdirected.
( ) 4. Use a minimum screen size of 50 mesh for wettable powders or flowables.
( ) 5. Use stainless steel, ceramic or nylon tips for wettable powders or flowables.
( ) 6. Accurately measure band width.
( ) 7. Convert broadcast rates for band.
( ) 8. Accurately calibrate sprayer.
( ) 9. Refer to label and precautions in this publication to choose proper spray volume and pressure for herbicide used.
( ) 10. Have proper equipment for the herbicide.
( ) 11. Have proper agitation (not just bypass) for powders and flowables.

Herbicide Application

The success of any herbicide treatment depends upon proper application. The following information should provide some guidelines for proper application. This material lacks detail in several areas such as nozzle selection, agitation, etc. However, detailed information on most aspects of spray application is available from your county Extension agent.

Spray Volumes

In general, spray volumes should be in the 5 to 20 gpa range (ground application) for broadcast, soil-applied herbicides. For band applications, a volume equivalent to ½ gallon per inch of band is sufficient (i.e., 10 gpa on a 20-inch band). These volumes are usually adequate for postemergence herbicides, but there are exceptions. Refer to the comments on each herbicide to note any specific application instructions.

Sprayer Tank Agitation

The type of pesticide formulation dictates the need for agitation. Soluble liquids, soluble powders and emulsifiable concentrates require little agitation. Usually the flow from the bypass hose maintains a uniform mixture.

Wettable powder and flowable formulations are only in suspension, and they require vigorous agitation to prevent settling out. Every year, many instances can be cited where insufficient agitation has resulted in excessive crop injury, loss of crop and/or lack of weed control.

Jet Agitation in a Nutshell

1. Insufficient agitation can cost more than the entire sprayer cost.
2. Running a bypass hose into the tank is not agitation.
3. Agitation can be expected to use more pump capacity than the nozzles require.
4. Pre-mixing wettable powders will get pesticides into suspension; insufficient agitation allows them to drop out. Continue agitation until all the spray is distributed.

Nozzle Tips

Herbicides are best applied with the proper nozzle tip design. For broadcast application of soil- or foliar-applied herbicides, use a flat fan tip such as an 8003, LF3-80°, etc. The tip size will depend on the pressure and speed. For postemergence directed herbicides, use a **flat fan** tip such as 8002 and LF2-80° or an **off center** tip such as an OC-02. For band application behind the planter, use an **even spray** tip such as 8003-E or LE3-80°. Note the band application behind the planter is the only use for the even spray tips.

For wettable powder application, use stainless steel, ceramic or nylon tips and a 50-mesh screen. For more information on nozzle selection and special applications, refer to manufacturers' catalogs.

Nozzle Selection

Manufacturers of spray nozzles provide a wealth of information about the selection, setup and use of their products in their catalogs. These include such things as hose flow information and nozzle selection guides. It would be impractical to reprint all that information here. Manuals or catalogs for the type of product you are using are obtained from dealers. If you cannot locate a personal copy, each county Extension office usually keeps at least one copy of popular brand item catalogs.

Nozzle manufacturers continue to offer more types of tips to improve spray applications. Most nozzle tips are now color coded to improve size distinction. Nozzle caps are now designed for easy on/off to facilitate cleaning when necessary. Most nozzle tips have a code stamped on them somewhere. These codes describe the nozzle characteristics, size and material type. Examples – 8002VK is an eighty degree flat fan, size number 2, ceramic tip, and a LFR80-3 Thermoplastic is an eighty degree extended range flat fan tip in size 3 made of thermoplastic material. Tips are available in a number of materials. Stainless steel, nylon and ceramics offer the best wear characteristics. Most manufacturers offer an extended range type flat fan nozzle which helps eliminate some drift potential if operated at lower pressures. Low operation pressures also extend tip life.

Many nozzle manufacturers now utilize air induction chambers to help control the droplet spectrum. This helps avoid the development of so many fine spray particles. Nozzle chambers also help stabilize the droplet spectrum over a wider pressure range.

A good tool of any spray operation is a current manufacturer's catalog. Obtain one for the type spray components you are using and read it carefully to improve your spray accuracy. Several nozzle manufacturer addresses and web pages are listed here. Most have excellent web pages with a wealth of information. Web pages and catalogs should be studied carefully for nozzle selection, setup and operation.

Spray Equipment Addresses:

Teejet Midwest
3062 104th Street
Urbandale, IA 50322
Phone: 515-270-8415
http://www.teejet.com

Greenleaf Technologies
P. O. Box 1767
Covington, LA 70434
Phone: 800-881-4832
sales@turbodrop.com
www.greenleaftech.com

Lurmark Nozzles
Hypro Corporation
375 Fifth Avenue NW
New Brighton, MN 55112-3288
www.hypropumps.com

Wilger, Inc.
Mark H. Bartel
16540 Hwy 104 North
Lexington, TN 38351-6358
Phone: 877-968-7695
wilgeresc@netease.net
www.wilger.net

Wind Compensation

When wind velocity is too high to be practical, the best solution is to park the sprayer. However, there are approaches to compensate for some wind. One solution is to change tips. Use a larger tip (i.e., an 8005 instead of an 8003), and lower the spray pressure (i.e., go up on the nozzle size and down on the pressure). Also, consider a wider angle tip such as a 9503 instead of an 8003. This allows the nozzle to be adjusted closer to the ground without changing the width of the spray pattern where it impacts on the ground. Properly used low pressure tips and Raindrop nozzles will reduce the drift possibility. Low pressure nozzles will substitute for flat fans. Raindrop nozzles (RA series) should be angled either 45° forward or back. Follow the manufacturer's recommendations. The new air induction style nozzles emit fewer fines and may be a very good tool to avoid drift potential. Air induction tips are typically not as sensitive to droplet size changes as operating pressures increase. This helps avoid small droplet formations when the sprayer is operating at higher speeds and the flow control is increasing pressure to ensure the correct dosage.

Band Application

All rates are given as broadcast rates. For band application, you **must** adjust the rate by the following formula:

$$\frac{\text{Band width}}{\text{Row width}} \times \text{Broadcast Rate} = \text{Band Rate}$$

Refer to calibration examples on following pages.

Sprayer Calibration

Useful Formulas

$$\text{GPM (Per Nozzle)} = \frac{\text{GPA} \times \text{mph} \times \text{W}}{5{,}940}$$

$$\text{GPA} = \frac{5{,}940 \times \text{GPM (Per Nozzle)}}{\text{mph} \times \text{W}}$$

GPM – gallons per minute
GPA – gallons per acre
mph – miles per hour
W – nozzle spacing (in inches) for broadcast spraying
– spray width (in inches) for single nozzle, band spraying or boomless spraying
– row spacing (in inches) divided by the number of nozzles per row for directed spraying

Measuring Travel Speed

Measure a test course in the area to be sprayed or in an area with similar surface conditions. Minimum lengths of 100 and 200 feet are recommended for measuring speeds up to 5 and 10 mph, respectively. Determine the time required to travel the test course. To help ensure accuracy, conduct the speed check with a loaded sprayer and select the engine throttle setting and gear that will be used when spraying. Repeat the above process and average the times that were measured. Use the following equation or the table on page 6 to determine ground speed.

$$\text{Speed (mph)} = \frac{\text{Distance (ft)} \times 60}{\text{Time (seconds)} \times 88}$$

Miscellaneous Conversion Factors

One acre = 43,560 square feet = 0.405 hectares

One hectare = 2.471 acres

One gallon per acre = 9.35 liters per hectare

One mile = 5,280 feet = 1,610 meters = 1.61 kilometers

One gallon = 128 fluid ounces = 8 pints = 4 quarts = 3.79 liters = 0.83 imperial gallons

One pound per square inch = 0.069 bar = 6,896 kilopascal

One mile per hour = 1.609 kilometers per hour

No single aspect of spray application is as important and so abused as sprayer calibration. There is no way to accurately apply a herbicide without accurately calibrating the sprayer and figuring the tank mix. Using the following method and examples, you can calibrate quickly, so do it!

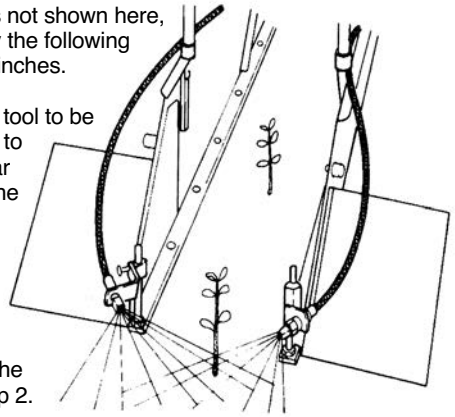
Determining Gallons Per Acre (ounce method)

1. Check the table below for the proper distance related to the row or nozzle spacing on your sprayer. For broadcast, use nozzle spacing; for band application such as post directed or band behind press wheel, use row spacing. Mark off this distance in the field you will be spraying.

Row or Nozzle Spacing (Inches)	Calibration Distance (Feet)
40	102
38	107
36	113
34	120
32	127
30	136
28	146
26	157
24	170
22	185
20	204
18	227

For row or nozzle spacings and calibration distances not shown here, any calibration distance (feet) may be determined by the following equation: 4080 / (average row or nozzle spacing) in inches.

2. Attach row conditioner, Triple-K, planter or whatever tool to be pulled by the tractor when spraying. Engage the tool to the proper depth and use the throttle setting and gear that will be used for spraying. Note on a stopwatch the time in seconds that it takes to drive the calibration distance measured.



3. Catch the nozzle discharge for the noted time in Step 2 in a container graduated in ounces (plastic measuring cup, baby bottle, etc.). If you are using a broadcast boom with nozzles spaced evenly, catch the output from one nozzle for the time measured in Step 2. If more than one nozzle per row is used (directed, insecticide or fungicide rig), catch the spray from each nozzle for the time noted in Step 2. Then combine the amount from all nozzles spraying on a single row.

4. The total discharge measured in ounces is equal to the gallons per acre applied. With a broadcast boom, this is the amount caught from one nozzle. Where you have used row spacing in Step 1, all nozzles directed to that row must be measured to determine the gallons per acre.

5. Check each nozzle to assure equal spray distribution across the width of the sprayer. Repeat Steps 3 and 4 to assure that nozzles do not vary more than 10 percent across the width of the sprayer.

Determining Tank Mix

Divide tank refill capacity by the calibrated gallons per acre (determined in Step 4). This is the number of acres the sprayer will cover per refill. Multiply the broadcast rate of herbicide (or band rate) times the acreage per refill to get the amount of herbicide (commercial product) to be put in the tank.

Example 1 – Broadcast Application

A grower will apply Anychem 1 with a broadcast boom having nozzles spaced 20 inches apart while pulling a disk for incorporation.

Step 1 The distance to travel for 20-inch **nozzle** spacing is 204 feet. Measure 204 feet in the field to be sprayed.

Step 2 Select the desired gear and throttle setting with the disk down. Let's say it takes 20 seconds to cover the 204 feet.

Step 3 Set the pressure to be used and catch one nozzle's output for 20 seconds (the time required to travel the 204 feet).

Step 4 The output in ounces is the amount applied in gallons per acre. If the nozzle output was 15 ounces in 20 seconds, the sprayer applies 15 gpa.

Step 5 Repeat Step 4, checking each nozzle.

Let's assume you have a 200-gallon tank and wish to apply one pint of Anychem 1 per acre.

$$\frac{200 \text{ gal/refill}}{15 \text{ gpa}} = 13.3 \text{ acres covered per tank (or refill)}$$

Since you wish to use 1 pt/A, you would use 13.3 pints of Anychem 1 per refill, i.e., 1 pt/A x 13.3 acres = 13.3 pints.

[See Note in Example 2]

Example 2 – Band Behind Planter

A grower will apply Anychem 2 behind his planter with a 14-inch spray band on a 38-inch row.

Step 1 The distance to travel for a 38-inch row is 107 feet.

Step 2 Select the planting speed and travel the measured 107 feet with planter down. Let's say it takes 18 seconds in this example.

Step 3 Set the pressure and catch one nozzle's output for 18 seconds (the time required to travel 107 feet).

Step 4 The output in ounces is the amount applied in gallons per acre. If the nozzle output was 10 ounces in 18 seconds, the sprayer applies 10 gpa. (This is all on a band.)

Step 5 Repeat Step 4, checking each nozzle.

Let's assume a 400-gallon tank (two 200-gallon saddle tanks) refill capacity and the rate of Anychem 2 50W for your soil is 1 lb/A **broadcast**. Reduce this rate to a 14-inch band.

$$\frac{14\text{" band}}{38\text{" row}} \text{ X 1 lb/A = 0.37 lb/A to be applied on the band}$$

$$\frac{400 \text{ gal/refill}}{10 \text{ gpa}} = 40 \text{ acres per tank refill}$$

40 acres x 0.37 lb/A = 14.8 lbs of Anychem 2 50W per tank refill; i.e., 7.4 lbs in each 200-gallon saddle tank.

NOTE: Plan on the amount of water required to refill the tank, **not** the capacity of the tank itself. For example, if you have the above 200-gallon saddle tanks but you have 50 gallons of spray left in each when you refill, it only takes 300 gallons to refill them.

Therefore:

$$\frac{300 \text{ gal/refill}}{10 \text{ gpa}} = 30 \text{ acres per refill}$$

30 A/refill x 0.37 lb/A = 11 lbs of Anychem 2 50W per refill (5.5 lbs in each of the two tanks).

Example 3 – Directed Spray

A grower will apply Anychem 3 + Anychem 4 on a 16-inch band on a 32-inch row using 2 OC-02 nozzles per row (one on each side).

Step 1 The distance to travel for a 32-inch row is 127 feet.

Step 2 Select speed and drive the 127 feet. Assume it takes 15 seconds.

Step 3 Set the pressure and catch each of the 2 nozzles per row for 15 seconds or time determined in Step 2.

Step 4 Add the quantity from the two tips. The amount in ounces is the gallons per acre.

Assume 5 ounces per tip for a total of 10; therefore, a 10 gpa output.

Step 5 Repeat Step 4, checking the nozzles on each row.

Let's assume two 200-gallon saddle tanks and the **broadcast** rate is 1 lb Anychem 3 50W + 1 pt Anychem 4 per acre. Reduce the rates for the 16-in band:

16⁄32 x 1 lb = ½ lb Anychem 3 16⁄32 x 1 pt = ½ pt Anychem 4/A

$$\frac{400 \text{ gal tank capacity}}{10 \text{ gpa}} = 40 \text{ acres per refill}$$

40 acres x ½ lb Anychem 3 = 20 lb Anychem 3
40 acres x ½ pt Anychem 4 = 20 pts Anychem 4
Put ½ this amount (10 lb Anychem 3 + 10 pt Anychem 4) in **each** tank.

Postemergence Spray Application

Following are some guidelines and diagrams for properly applying postemergence directed herbicides and for ground application of contact/systemic materials.

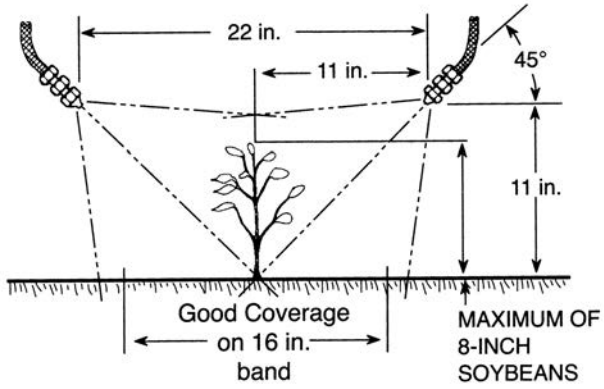
Nozzle Arrangements for Row Banding Overtop Herbicides

Guidelines

Adjust sprayer to apply a minimum of 20 gal/A broadcast at 20-60 psi.
Two-nozzle arrangements effective on 6 inch tall or smaller weeds.
Keep nozzles a minimum of 10 inches from soybean canopy to develop pattern width.
Nozzles should never be angled less than 45° to horizontal because part of the spray will be aimed upward.
Spray should overlap cultivated ground at least 4 inches to assure weed-free row shoulders.
Coverage is essential (contact herbicide).

Soybeans Up to 8 Inches Tall

TWO NOZZLE ARRANGEMENT



Nozzles can be angled greater than 45° or moved to spacings narrower than 22 inches where soybeans and weeds are small.

Special 95° tips can be used where nozzle support doesn't permit adequate nozzle spacing. Angle these tips downward at least 50° from horizontal and keep them a minimum of 8 inches from soybean canopy.

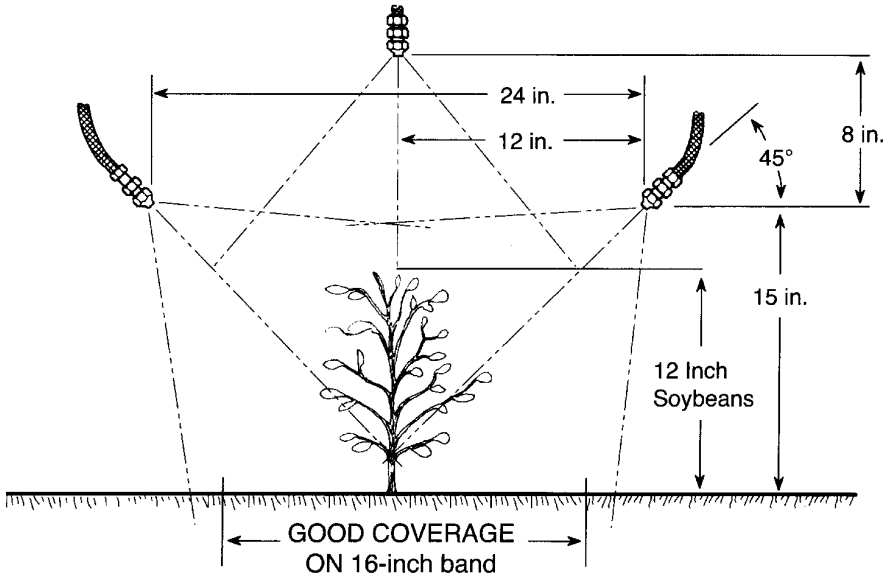
Always measure the band width to determine proper herbicide tank mix.

Nozzle Tip Options
(two nozzles on 38-inch row)*

Speed (mph)	Flat Fan (50 psi)
4	LF2-80°, 8002 (17 gpa)
6	LF2-80°, 8002 (12 gpa)
8	LF3-80°, 8003 (13 gpa)

*EXAMPLE ONLY – lower pressures may be selected and corresponding rate determined.

THREE NOZZLE ARRANGEMENT



The three nozzle arrangement is better if weed pressure is heavy and if cocklebur and soybeans are the same height and good coverage is needed in terminal region.

If weeds beside the drill are the primary cause for spraying, maintain the center nozzle height 10 inches above the soybeans. Increase the rate on the shoulders by increasing the 45° angle slightly and lowering the side nozzles (but no lower than 10 inches from the ground).

If weeds in the canopy are the primary cause for spraying, but they are no more than 4 inches above the canopy, maintain the dimensions shown. Raise all nozzles equally if larger weeds are a problem. For example, when weeds are 7 inches above the canopy, raise all nozzles 3 inches (7 − 4 = 3 inches).

Always measure the band width to determine proper herbicide tank mix.

Nozzle Tip Options*
(three nozzles on 38-inch row)

Speed (mph)	Flat Fan (50 psi)
4	LF2-80°, 8002 (27 gpa)
6	LF2-80°, 8002 (17 gpa)
8	LF3-80°, 8003 (13 gpa)

*EXAMPLE ONLY – lower pressures may be selected and corresponding rate determined.

Directed Spray Nozzle Arrangements for Cultivator-Mounted and Shoe-Mounted Nozzles

Guidelines

One-half to one gallon per inch of band is adequate.

Nozzles should not spray higher on the crop than the herbicide label allows, but positioning is largely dependent on the primary weed problem. One-third up the soybean stem is a good rule of thumb.

Two nozzles per row are generally sufficient. Two are much easier to adjust and maintain than four nozzles. Spray weeds early so herbicides are more effective and crop competition is eliminated.

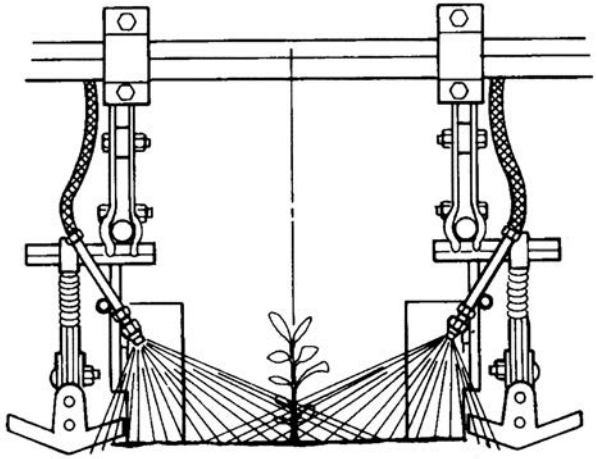
These rigs can be used carefully on 6-inch or taller soybeans, but the height differential is essential.

Thorough coverage is necessary.

Nozzle Tip Options
(two nozzles on 38-inch row)

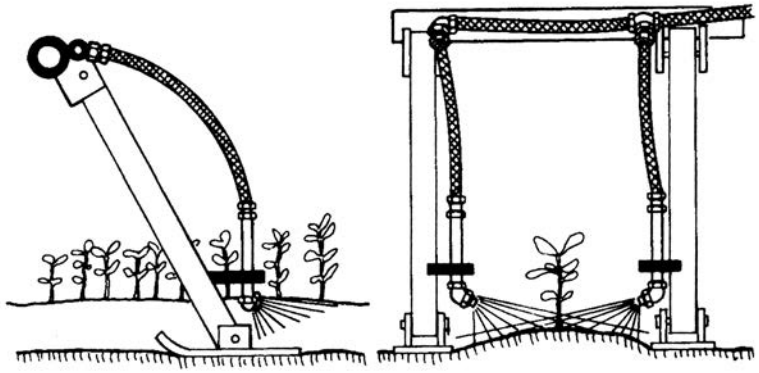
Speed (mph)	Flat Fan Tips (30 psi)	Off Center Tips (30 psi)	Volume of Spray (gpa)
4	8002, LF2-80°	OC-02, LX-2	14
6	8003, LF3-80°	OC-03, LX-3	13

Early Postdirected Spray on Cultivator



View From Front
(Flat Fan Tips)

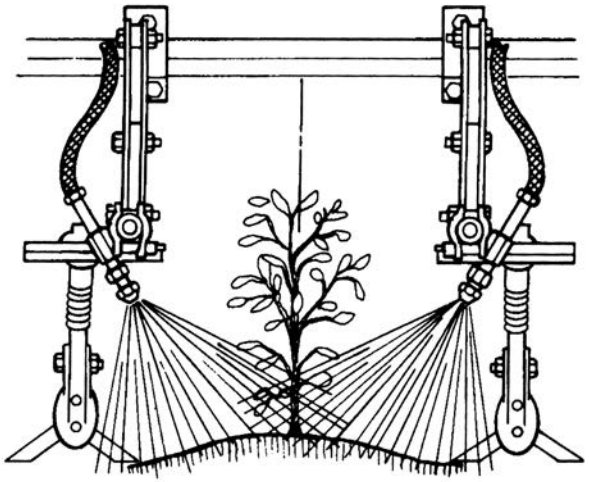
Early Postdirected Rig Adjustment



Side Rear

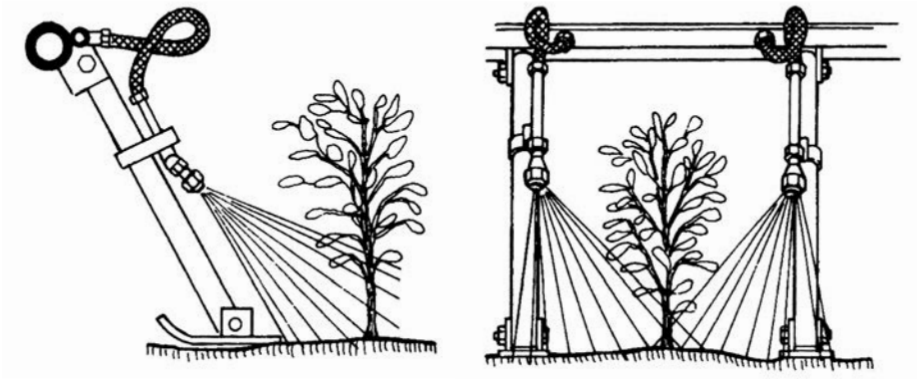
(Off-Center Tips)

Later Season Cultivator Mount

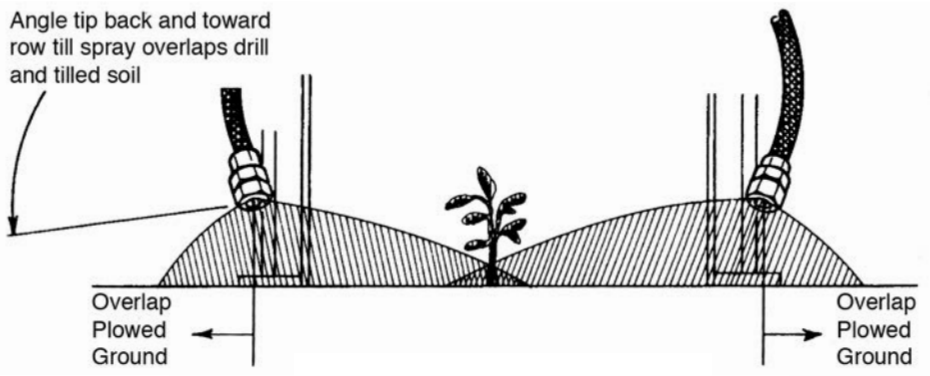


View From Rear
(Flat Fan Tips)

Later Season Postdirected Rig Adjustment



Side Rear



Summary

If postdirected application is a new concept, it is certainly worth considering. For very little investment, directed spray can solve morningglory, cocklebur and red rice problems in soybeans. In fact, one of the rigs pictured is the only postdirected sprayer needed for many chemicals, if operated properly.

Nozzle Tip Options
(two nozzles on 38-inch row)

Speed (mph)	Flat Fan Tips (30 psi)	Off Center Tips (30 psi)	Volume of Spray (gpa)
3	9502 or 8002	OC-02	18
4	9502 or 8002	OC-02	14
5	9502 or 8002	OC-02	11

(LF2-80° is nearly the same as 8002; LF2-95° is nearly the same as 9502; and LX-2 is nearly the same as OC-02.)

NOTE: Early postemergence is an excellent application of the special 95° flat fan tips (9502) because the spray pattern taps the drill and shoulder when mounted low.

Nozzle Arrangements for Precision Postemergence [Fenders]

Guidelines

One-half gallon per acre per inch of band is desirable.

Position nozzle about as high as the crop is tall.

Spray should overlap cultivated ground at least 4 inches to assure weed-free row shoulders.

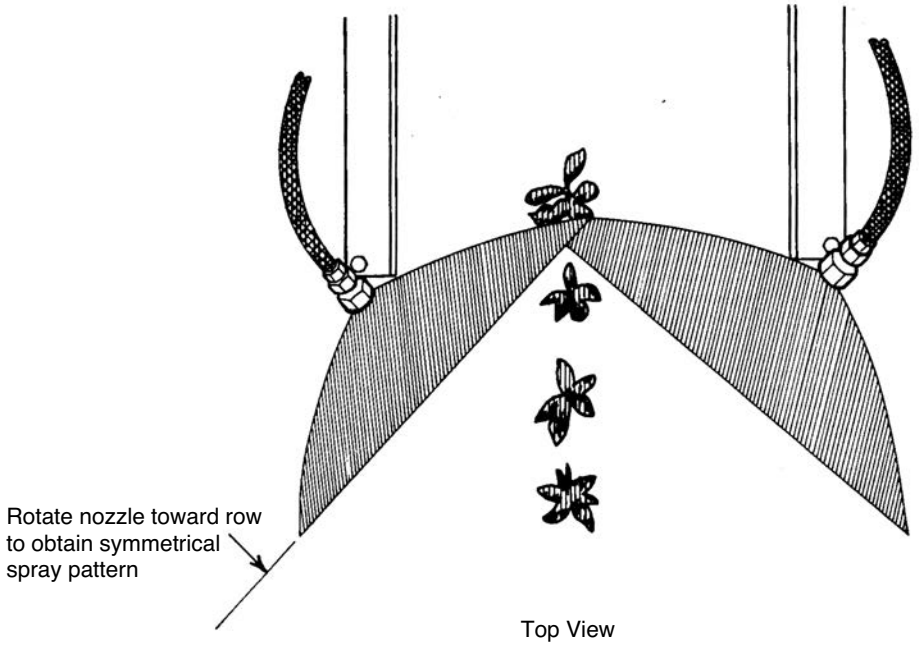
Position nozzles so spray intersects crop no higher than the label of the herbicide permits. Consider bed height and field roughness.

Attempt to obtain uniform distribution of spray where pattern strikes the soil.

Two nozzles per row is adequate when nozzles provide uniform coverage from drill to 4-inch "plow" overlap.

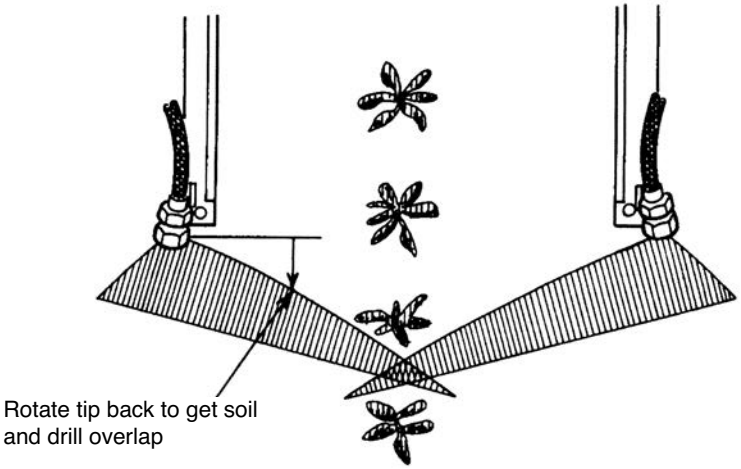
Coverage is essential (contact herbicide), but crop must be taller than weeds to use equipment to an advantage.

Flat Fan Tips

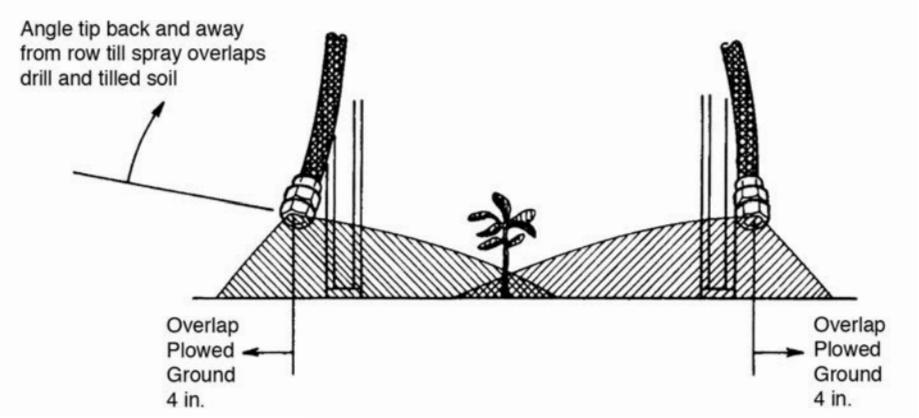


Top View

Off-Center Tips



Top View



Rear View