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G91-1019 Set Up of Tillage, Planting and Directed Spray Equipment

Elbert C. Dickey
University of Nebraska - Lincoln, edickey1@unl.edu

Robert Grisso
University of Nebraska - Lincoln

Alex Martin
University of Nebraska - Lincoln, amartin2@unl.edu

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Set Up of Tillage, Planting and Directed Spray Equipment

This NebGuide discusses how to set up and operate liquid herbicide application equipment on tillage, planting and directed spray equipment.

Robert Grisso, Extension Agricultural Engineer
Elbert Dickey, Extension Agricultural Engineer
Alex Martin, Extension Weeds Specialist

Some herbicides require incorporation to obtain consistent weed control. Maintaining residue cover to reduce soil loss on erodible soils makes it necessary to incorporate herbicide while minimizing tillage. This need, combined with many row crop producers' preference for band application to reduce herbicide costs, creates some application challenges.

Applying Herbicides During Tillage

Many herbicides do not require mechanical incorporation because they do not dissipate rapidly from the soil surface and can be carried into the soil by rainfall or sprinkler irrigation. Some soil-applied herbicides, however, require mechanical incorporation to reduce volatilization and photodecomposition losses.

To incorporate herbicide during tillage, select the proper nozzle, (see NebGuide *G89-955, Nozzles--Selection and Sizing*), properly adjust the tillage implement (see NebGuide *G90-983, Equipment Adjustments for Herbicide Incorporation*), and properly mount, space and orient the nozzles on the tillage implement. Examine the implement for potential limitations before selecting spray components. Limitations include possible interference of the spray pattern by the implement frame or tongue, limited

places to mount the nozzles, and lack of clearance between the implement and rear tractor tires when turning. Proper nozzle selection and proper set up can alleviate many of these limitations.

Since nozzles used on tillage implements are often in a dusty environment, select a nozzle with performance that won't be hindered by dust accumulating around the orifice. Flood and Raindrop nozzles are most commonly used for soil-incorporated herbicides. Other recommended nozzles include the full-cone and flat-fan nozzles.

The flood nozzle provides a fan-like spray pattern and should be operated between 10 and 25 psi. When the flood nozzle sprays straight down, a greater concentration of herbicide occurs along the edges of the spray pattern. Rotating the nozzles 30 to 45 degrees so they spray forward in the direction of travel improves uniformity. Raindrop nozzle spacing should not exceed 60 inches and should be operated between 20 and 45 psi. Nozzles should be oriented about 30 to 45 degrees (*Figure 1*) forward to the direction of travel.

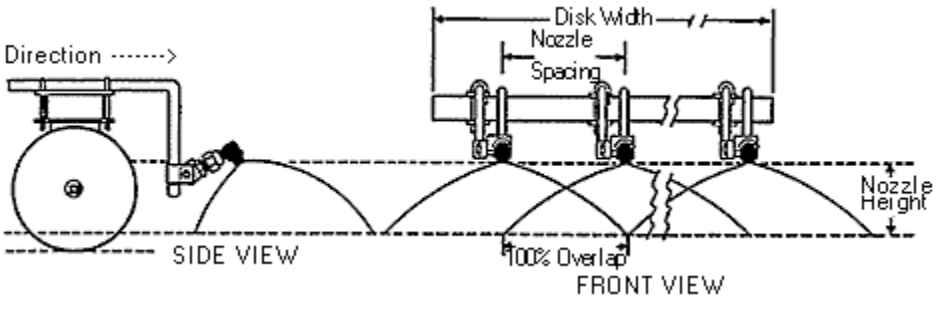

Figure 1. Orient nozzles for 100 percent overlap and 30 to 45 degrees forward to the direction of travel.

Both flood and Raindrop nozzles have spray angles between 115 and 125 degrees, and should be mounted for 100 percent overlap. This overlap helps assure adequate coverage as the implement moves across uneven ground. Nozzle height and spacing for various implement widths can be selected from *Table I*. Adjusting the nozzle orientation and height can achieve 100 percent overlap, as shown in *Figure 1*. Nozzle spacing may have to be decreased and the height reduced to prevent the implement frame or tongue from interfering with the spray pattern. A boom mounted on the belly of the tractor is one alternative if the implement tongue interferes with the spray pattern.

Table I. Nozzle arrangements for various tillage implements when using nozzles with 120 degree spray angle

Implement Width (feet)	Number of Nozzles	Nozzle Spacing (inch)	Nozzle* Height (inch)	40-inch Row Conversion Factor.
6	2	36	12	1.11
7	2	42	14	0.95
8	2	48	16	0.83
9	2	54	18	0.74
9	4	27	9	1.48
10	4	30	10	1.33

11	4	33	12	1.21
12	4	36	13	1.11
13	4	39	14	1.02
14	4	42	15	0.95
15	4	45	16	0.89
16	6	32	11	1.25
17	6	34	12	1.18
18	6	36	13	1.11
19	6	38	14	1.05
20	6	40	14.5	1.00
21	6	42	15	0.95
22	6	44	16	0.91
23	6	46	16	0.87
24	6	48	16	0.83
22	8	33	11	1.21
23	8	34.5	11	1.16
24	8	36	12	1.11
25	8	37.5	13	1.07
26	8	39	14	1.03
27	8	40.5	14	0.99
28	8	42	15	0.95
29	8	43.5	15.5	0.92
30	8	45	16	0.89
31	8	46.5	16	0.86
32	8	48	16	0.83
29	10	35	12	1.14
30	10	36	12	1.11
31	10	37	12	1.08
32	10	38	12	1.05
33	10	39	13	1.03
34	10	40.5	13	0.99
35	10	42	14	0.95

* These heights will not give a 100 percent overlap. The heights listed provide only minimum overlap. To increase overlap for more uniform distribution, tilt the nozzles forward and/or raise the height until 100 percent overlap is achieved.

Tillage implement spray kits are available to securely mount the spray nozzles onto the implement frame. Select brackets made from non-corrosive, unbreakable materials. If custom-made brackets are used, have them constructed so nozzle height and orientation angle can be adjusted easily.

Base nozzle selection on operating speed, operating height, implement width and label spray volume recommendations. Select a nozzle that delivers the desired nozzle discharge at the desired speed. Most nozzle catalogs list the broadcast spray volume for a 40-inch nozzle spacing. If the nozzle spacing is different from 40 inches, divide the desired broadcast spray volume by the conversion factors in *Table I* to compare the broadcast spray volume in the catalog listing. Follow the recommended steps in NebGuide *G89-955, Nozzles--Selection and Sizing*, for proper nozzle selection. The following example demonstrates selection principles for proper set-up of spray kits on tillage equipment.

Tillage Incorporation Example. Suppose the pesticide label recommends a spray volume of 15 gallons per acre (gpa). Application will be made with a 22 foot tandem disk operating at 5.5 miles per hour (mph). *Table I* shows two possibilities for a 22 foot implement: six nozzles with a 44-inch nozzle spacing at a height of 16 inches, or eight nozzles spaced at 33 inches with an 11-inch height.

Suppose the drawbar tongue prevents mounting nozzles above 14 inches in height; the second configuration is the best choice since the nozzle height is 11 inches. The required nozzle discharge in gallons per minute (gpm) is calculated as:

$$\text{Discharge} = \frac{5.5 \text{ mph} * 33 \text{ inches} * 15 \text{ gpa}}{5940} = 0.458 \text{ gpm}$$

Since nozzle catalog data is based on a 40-inch spacing, the catalog spray volume for this 40-inch equivalent is 15 gpa divided by the conversion factor (1.21) in *Table I* which gives 12.4 gpa. Use the catalog spray volume of 12.4 gpa to compare nozzles in the catalog based on 40-inch spacing.

Consult a nozzle catalog. These are available at various places, including many farm stores and extension offices. NebGuide *G89-955, Nozzles--Selection and Sizing*, carries a list of nozzle manufacturers you can contact directly. Suppose a Raindrop nozzle was selected as the appropriate nozzle type. After reviewing the catalog (page 30 of 1990 Delavan Catalog 1609P), three nozzles within this type are close to the discharge rate (0.458 gpm) at various pressures (*Table II*).

Table II. Raindrop nozzle information for tillage incorporation example

Nozzle	*Catalog*[+]		*Calculated**	
	psi	*gpm*	*psi*	*gpm*
RA-4	50	0.45	52	0.458
RA-5	30	0.44	34	0.458
RA-6	20	0.43	23	0.458

[+] 1990 Delavan Catalog 1609P, pg 30
* Equation [1] from *Nozzles--Selection and Sizing*, (NebGuide G89-955).

The RA-4 nozzle is outside the recommended pressure range of 20 to 45 psi and should not be selected. Either RA-5 or RA-6 nozzles may be used. Of the two nozzles, RA-6 may be preferred because it can operate at a lower pressure that creates larger drops and could provide better insurance against drift.

After the nozzle orifice is selected, mount the nozzle brackets, flush the system, install nozzles, adjust spray heights and orientation for 100 percent overlap, and calibrate.

Band Application of Herbicides

Many row crop producers prefer band application of herbicides to save money. When compared to broadcast application, the savings can be substantial.

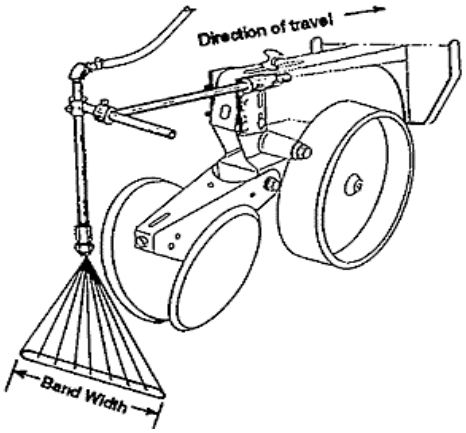

Figure 2. Spray kit to mount banding nozzle onto a planter

Herbicide banding on the row can be done either at crop planting time (*Figure 2*) or postemergence, after the crop and weeds have emerged. Mechanical cultivation can control weeds between the rows. Even flat-fan nozzles are recommended for band application since they provide a uniform application across the entire width of the band.

Banding during planting: To properly set up band spray equipment on a planter, follow these steps:

Step 1. Consult the pesticide label. Does the label give guidelines on band width? Unless otherwise specified, application rates are given on a broadcast basis. For band application, the rate per treated acre should be the same as the label rate. Remember the total amount of pesticide used is less because only a portion of the field is treated. If the spray volume is not specified on the label, use one gallon per inch of band width.

Step 2. Select operating conditions. Select the planter ground speed in miles per hour. If speed is unknown, measure the speed following the method given in NebGuide *G88-865, Fine Tuning a Sprayer with the 'Ounce' Calibration Method*. Select the desired band width in inches and band spray volume. Select a band width that controls weeds in and adjacent to the row where mechanical cultivation is not possible. Band widths of 12 to 14 inches are appropriate with most cultivation equipment. Narrower band widths can be used if the cultivator is equipped with a guidance system.

Step 3. Calculate required nozzle discharge. Using the band spray volume, band width, and travel speed, calculate the required nozzle discharge as follows:

$$\text{Nozzle Discharge} = \frac{\text{Travel Speed} * \text{Band Width} * \text{Band Spray Volume}}{5940}$$

where: Nozzle Discharge--gallons per minute (gpm)
Travel Speed--miles per hour (mph)
Band Width--inches (in)
Band Spray Volume--gallons per treated acre (gpa)

Step 4. Consult the nozzle catalog. Use the manufacturer's catalog to select the appropriate even flat-fan nozzle. Even flat-fan nozzles usually are available in three spray angles (40, 80 or 95 degrees). Select a spray angle that doesn't limit the mounting location on the planter. Select an orifice size that gives the required discharge rate at a pressure between 15 and 30 psi. Operating in this pressure range reduces the drift potential and the stress on the spray system.

Mounting height of the nozzle is critical in controlling band width. Mounting the nozzle too low results in a narrow band and herbicide is over-applied. Mounting the nozzle too high results in a wider band and under-application, plus increased potential for drift. Use Table III as an initial setting, then "fine-tune" the band width with the unit running.

Planter spray kits are available to securely mount the spray nozzle behind the planting units. If custom-made mounting kits (*Figure 2*) are used, construct the brackets so nozzle height and angle can be adjusted easily.

Table III. Band width adjustments for various spray angle tips

Band Width (inch)	*Approximate Height (inch)*		
	40°-series	*Spray Angle 80°-series*	*95°-series*
8	10	5	4
10	12	6	5
12	14	7	6
14	17	8	7
15	19	9	8
16	20	10	9

Step 5. Calibrate the sprayer. After the nozzles are selected and the mounting kits assembled, flush the system before putting the nozzles on. This removes any foreign material that may be in the lines from installation. Then calibrate. The best way to "fine-tune" the pressure is to use the "Ounce" Calibration Method (NebGuide G88-865), and adjust the pressure until the discharge equals the desired spray volume.

The broadcast spray volume is used to determine how many acres the tank mixture will spray before refilling is required. Calculate by multiplying the band spray volume by the ratio of the band width to row spacing:

$$\left[\begin{array}{c}\text{Broadcast}\\ \text{Spray Volume}\end{array}\right] = \left[\frac{\text{Band Width}}{\text{Row Spacing}}\right] \left[\begin{array}{c}\text{Band}\\ \text{Spray Volume}\end{array}\right]$$

Band application example. Suppose a label recommends a spray volume of 20 gallons per acre and the producer operates a planter at 6 miles per hour. Based on pervious experience with crop cultivation, a 12-inch band width is desired. The row spacing is 30 inches. To select the proper orifice size, calculate the required nozzle discharge:

$$\text{Discharge} = \frac{6 \text{ mph} * 12 \text{ inches} * 20 \text{ gpa}}{5940} = 0.24 \text{ gpm}$$

After examining the manufacturer's catalog for even flat-fan nozzles, three nozzles operate close to the desired discharge rate (0.24 gpm) (see *Table IV*). The nozzles are listed in the table without spray angles. Nozzles "--02E" and "--04E" are outside the recommended pressure range, and should not be selected. Nozzle "--03E" can be operated at 26 psi and "fine tuned" to obtain 0.24 gpm.

Using a 12-inch band on 30-inch rows gives the broadcast spray volume as:

Broadcast Spray Volume = (12 inch / 30 inch) 20 gpa = 8 gpa.

Table IV. Even flat-fan nozzle information for band example

Nozzle	*Catalog*[+]		*Calculated**	
	psi	*gpm*	*psi*	*gpm*
--02E	40	0.20	58	0.24
--03E	30	0.26	26	0.24
--04E	20	0.28	15	0.24

[+]1990 Spraying Systems Catalog, No 41, pg 16
* Equation [1] from *Nozzle--Selection and Sizing*, (NebGuide G89-955).

A 40, 80 or 95 degree nozzle can be selected. Final selection depends on the clearance behind the planting unit. In this case, the mounting height would be 14, 7, and 6 inches for the respective spray angles (*Table III*). Mount nozzles and readjust the height until the band width is achieved.

Follow the "ounce" calibration procedures found in NebGuide G88-865. For 30-inch row spacing, measure out 136 feet in the field where planting will occur. If the tractor/planter unit is traveling at 6 mph, it should cover 136 feet in 15.5 seconds. With the planter in a stationary position, set the pressure at 26 psi. The number of ounces collected over 15.5 seconds the number of gallons per acre. Using an ounce graduated cylinder and a stop watch, adjust the pressure until the nozzle discharges 8 ounces during 15.5 seconds. Measure the output for all nozzles to get actual operating performance.

The band spray volume of 20 gpa is used to calculate the correct amount of herbicide to be added to the tank. The broadcast spray volume (8 gpa) determines how many acres the tank of material will cover before refilling is required.

To complete this example, suppose the planter/spray unit has two-200 gallon saddle tanks. The herbicide label rate is 2 pints per acre. The spray tanks need refilling after 50 acres (400 gallons/8 gpa). The amount of herbicide added to each saddle tank is 20 pints ([200 gallons/20 gpa]*[2 pt/ac]).

Banding using post directed spray. Directed spraying is an application method where pesticide is applied to a specific area. Directed applications reduce crop injury by treating only the lower, less sensitive portions of the crop. The application is directed onto small weeds that may be covered by the crop canopy.

Figure 3. Spray application directed to the base of the crop.

Drop hoses are useful for applying herbicides to the lower portion of tall crops. Drops reduce the risk of crop injury. Drop hoses can be equipped with dual swivel nozzle bodies (*Figure 3*) which give greater freedom for adjustment. For total row coverage a special nozzle referred to as double outlet flat-fan can be used.

A directed application may be focused on the row middles as a substitute for row cultivation. Often twin-jet nozzles are used to provide smaller droplets and two spray pattern directions (30 degrees ahead and behind). These nozzles give better coverage and foliage penetration than a single orifice nozzle. Even flat-fan nozzles can be used to treat row middles.

Row banding postemergence. Band applying postemergence herbicides has economic benefits. A multiple nozzle configuration often is used when foliage penetration or crop height limits the use of a single nozzle. Two or three-nozzle configurations give better underside leaf coverage than a single nozzle (*Figure 4*). When the existing crop is taller than 3 inches, the top or center nozzle should be removed and used in a two-nozzle configuration. This reduces the risk of crop injury because the crop doesn't intercept a large portion of the herbicide. To reduce drift and keep the band width within the desired area, many crop producers have added shrouds or plastic hoods to the nozzle assemblies.

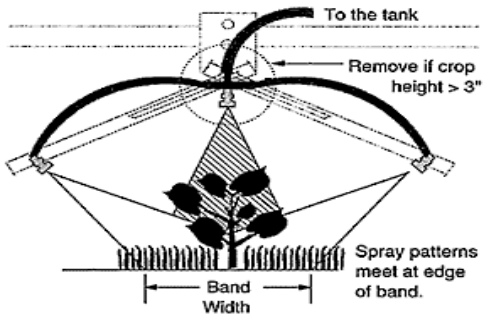

Figure 4. Nozzle configuration for postemergence band application. (Remove the top or center nozzle when crop is taller than 3 inches.)

When sizing nozzles, the procedure is similar to sizing a band application at planting except there is output from more than a single nozzle. Thus, divide the required discharge within the band by the number of nozzles. During calibration, the output from all nozzles within the band is combined.

Conclusions

Properly applied pesticides are expected to return a profit. Improper application can result in wasted chemical, marginal pest control, excessive carryover or crop damage. Proper nozzle selection, sprayer set up, calibration and operation minimize application costs.

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