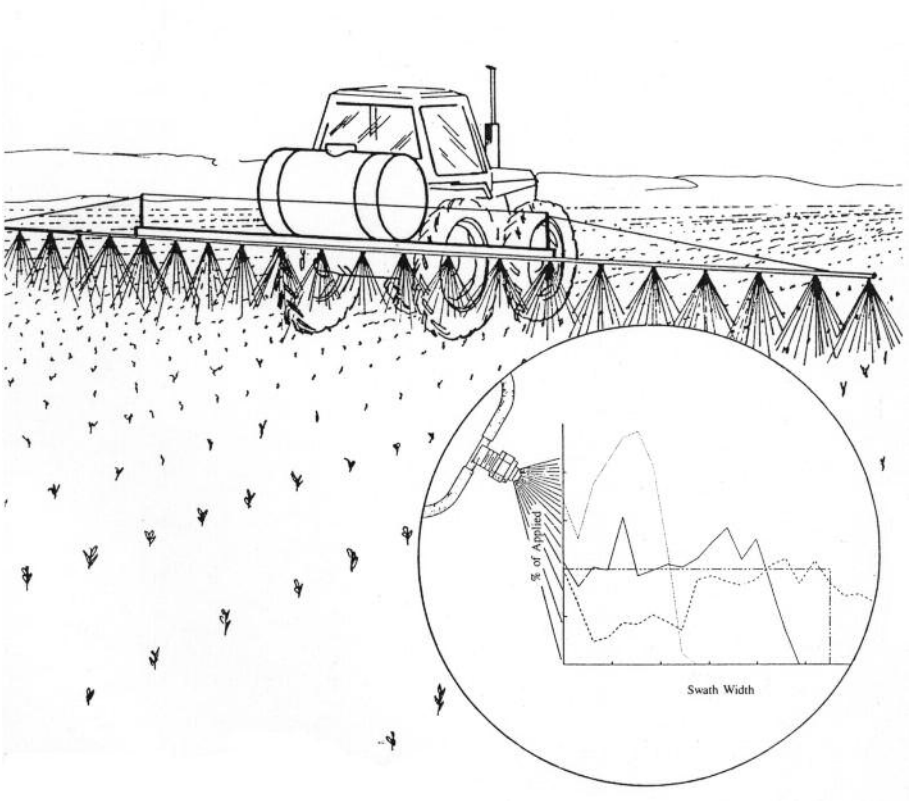
Improving the Uniformity
of Ground-Applied Broadcast Sprays



Much research has been conducted on the selection of spray nozzle types and sizes, atomization pressures, nozzle spacings, tilt angles (i.e., angle between the spray sheet and a downward, vertical plane), and boom heights. But these studies were conducted under laboratory conditions.

Under these idealized conditions, the effects of variables—wind velocity and the forward velocity of the spray vehicle—are not taken into account. You should use the laboratory-derived data as a starting point for further field evaluations.

Several studies have quantified and evaluated the uniformity of across-the-swatch deposits. Most ground-applied sprays are likely to result in at least a two-fold variation based on the largest and smallest pesticide deposits in a given field. The range of deposits actually occurring is likely to be much more than two-fold because ground-spray booms bounce considerably on uneven soil surfaces. Boom heights vary, and inexact overlapping (streaking or double spraying) often occurs.

The information in this publication is intended to provide specific recommendations about **how to apply broadcast sprays as uniformly as possible**.

MISSISSIPPI STATE UNIVERSITY
EXTENSION SERVICE

Interpreting Deposit Data

The uniformity of spray deposit data can be characterized by calculating the coefficient of variation (CV). The CV is a measure of the degree of variation among all of the spray deposits sampled. A desirable goal is to apply pesticides so that the CV for the field deposits on soil, grass, or weed surfaces is 15 percent or less.

Table 1 shows that a CV of 15 percent indicates the maximum spray deposit is 56 percent larger (i.e., max/min ratio = 1.56) than the minimum deposit, or the maximum and minimum deposits would be about 28 percent greater than and less than the average deposit, respectively.

Much of the quantified, field research data available indicates the CV values are typically between 20 and 25 percent, with some CV values being more than 100 percent for cluster or off-center nozzles.

A CV value of 25 percent indicates (Table 1) the maximum and minimum deposits are 59 percent above and below the average deposit. Such variation in pesticide deposits is unacceptable because these over- or under-dosage situations are inefficient and ineffective for controlling pests.

Hydraulic Boom-type Sprays

Several field studies have been conducted to quantify spray deposits while using new spray nozzles and calibrated equipment, and operating over relatively smooth terrain (i.e., no holes, hills, or ditches in test areas).

The types of hydraulic nozzles evaluated include regular flat fans (8002 VS, 8004 VS, LF-4-65°, and LF-8-80°), Twin Jet flat fans (TJ 8002 and TJ 8004), Extended Range flat fans (XR 8002 and XR 8004), Raindrop cone nozzles (RA-15, RA-20, and RA-30), and flooding fan nozzles (TK-10, D-10-NY, D-15-NY, and D-20-NY). Spraying Systems Company manufactured the TJ, XR, VS, and TK nozzles. Delavan Corporation manufactured all other nozzles. All nozzles were made of brass or nylon (NY) or had hardened stainless steel inserts.

Based on 100 field tests replicated three times, only 29 treatments produced average across-the-swatch CVs of 15 percent or less (Table 2).
There are many other possible combinations of nozzle types and sizes, boom heights, spacings, and pressures that were not tested and may or may not produce acceptably uniform spray deposits.

The Raindrop nozzle produces a hollow-cone-type spray pattern and should not be operated at a 0-degree tilt angle (i.e., liquid directed straight down) because it is almost impossible to properly overlap such patterns. Operate the Raindrop nozzles at a tile angle between 45 and 60 degrees (i.e., down and to the rear at 45–60 degrees). The flooding tips usually produce the most uniform deposits when set at tilt angles between 0 and 60 degrees.

Boom heights of 36–48 inches usually are best even though the D-10-NY nozzles (Table 2) at a 60-degree tilt angle and a boom height of 60 inches produced relatively uniform deposits. Regular flat fan tips normally will produce the most uniform deposits at boom heights of 6–8 inches higher than those recommended by the manufacturer.

Figure 1 (LF-4-65° nozzles, 20 psi, 20-inch spacing) illustrates this point because the manufacturer's recommended nozzle height is 21–23 inches for a 65-degree fan angle. Notice that, as the boom height was increased, the spray deposits became more uniform (i.e., smaller CV values). But don't raise the boom more than necessary (depending on the fan angles of the nozzles) because spray drift increases dramatically with increasing nozzle heights (i.e., doubling nozzle height increases drift deposits about four times).

Table 1. Relationship between coefficients of variation (CV), ratio of maximum/minimum swath deposits, and approximate deviations above and below average deposit.

CV (%)	Ratio of maximum/ minimum swath deposits	Extreme deposits relative to average deposit (%)
0	1.00	±0
10	1.32	±16
15	1.56	±28
20	1.84	±42
25	2.17	±59
30	2.57	±79
40	3.53	±127

Rotary Disc Boom Sprays

A few quantitative field tests have been conducted with rotary atomizers. These devices produce patterns similar to those of the larger hollow-cone-type nozzles. Typical CV values for such operating conditions (2,000 or 5,000 rpm) range from 20 to 26 percent (refer to Table 1). Operate these atomizers with the disc angled 15–30 percent above the horizontal plane to obtain the most uniform deposits possible while minimizing drift problems.

Off-center Nozzles

Do not use off-center nozzles for regular broadcast application in pastures or row crop fields. Use these nozzles only for spraying areas that can be approached only from one side (ditches, brush-covered fence rows, road rights-of-way) and other areas where conventional booms are impractical.

The velocity and direction of the wind have a strong influence on the location and magnitude of deposits from off-center nozzles (Figure 2). As indicated by the curves in Figure 2, it is nearly impossible to obtain reasonably uniform deposits with the off-center nozzles. CV values for these types of nozzles typically range from 30 to 70 percent.

Table 2. Nozzle types, sizes, and operating conditions that have produced CV values of ≤ 20 percent during quantified research studies.

Type and size	Pressure (psi)	Height (in)	Spacing (in)	Tilt angle (°)	CV (%)
Flooding Fan					
TK-10	15	36	40	15	13
TK-10	15	36	40	45	15
TK-10	15	36	40	75	17
TK-10	15	48	40	15	15
TK-10	15	60	40	15	19
D-10-NY	26	36	40	60	12
D-10-NY	26	48	40	15	15
D-10-NY	26	48	40	60	12
D-10-NY	26	60	40	60	15
D-15-NY	11	36	40	15	18
D-15-NY	11	48	40	15	16
Flat Fan					
TJ 8004	30	18	20	0	12.7
TJ 8004	40	18	20	0	11.2
TJ 8004	40	24*	20	0	10.4
XR 8002	30	24*	20	0	14.3
XR 8004	30	18	20	0	9.5
XR 8004	40	18	20	0	13.5
XR 8004	30	24*	20	0	10.0
XR 8004	40	24*	20	0	12.4
8002 VS	40	18	20	0	11.6
8002 VS	40	24*	20	0	13.0
8004 VS	30	18	20	0	13.0
8004 VS	30	24*	20	0	13.0
8004 VS	40	24*	20	0	12.6
LF-4-65°	20	28.5*	20	0	15.0
LF-8-80°	30	18	20	0	19.0
LF-8-80°	30	36*	20	0	14.0
TJ 8004	40	18	20	45	12.5
XR 8004	40	18	20	45	10.3
8002 VS	30	18	20	45	13.2
8004 VS	30	18	20	45	13.3
8004 VS	40	18	20	45	11.4
LF-8-80°	30	18	20	45	15.0
Raindrop					
RA-15	30	23	40	45	13

*Heights recommended for 65° and 80° flat fan nozzles are 17–19 and 21–23 inches, respectively. Increasing boom height substantially increases spray drift.

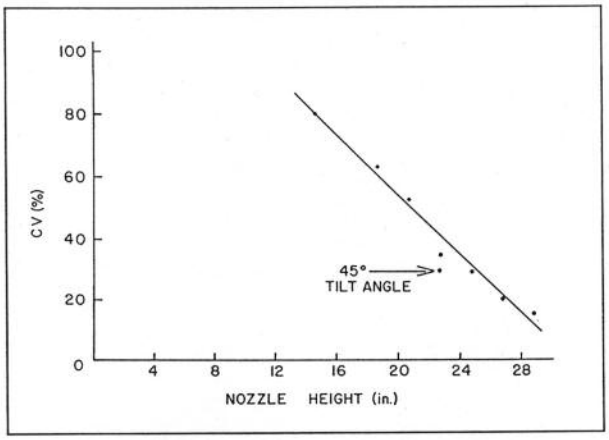


Figure 1. Coefficient of variation versus nozzle height for a boom equipped with pressure range of LF-4-65° nozzles, 20 psi, 20-inch spacing, and 0-degree tilt angle (except for one test at 45 degrees).

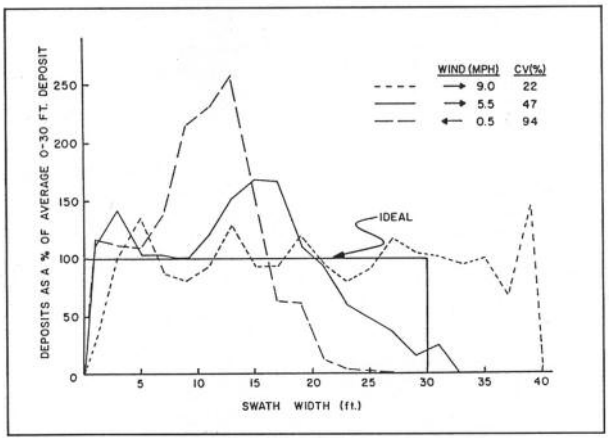


Figure 2. Variation in spray deposits versus swath width for three wind velocity and direction conditions when using off-center nozzles.

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