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CALIBRATING AND EVALUATING BOOMLESS SPRAY SYSTEMS FOR APPLYING FOREST HERBICIDES

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ABSTRACT.--Describes a testing procedure used to calibrate and evaluate agricultural boomless spray systems. Tests allow the user to obtain dependable and satisfactory results when used in actual forest situations.

KEY WORDS: Ground spraying, conifer release, site preparation.

In the northern Lake States, forest managers use herbicides for many reasons--particularly for site preparation and conifer plantation release. In this region these chemicals are typically applied by helicopters, but because of the need for greater flexibility in applying a variety of herbicides, interest is growing in the use of ground application equipment.

Boom application systems have been utilized for years in farming, but this type of equipment does not adapt well for forestry use because of the standing brush, trees, stumps, slash, and rough terrain encountered. To counteract these problems, an agricultural boomless nozzle spray system has recently been adapted for use in forestry ground applications.

The major difference between the agricultural and forestry uses of the boomless nozzle is that the nozzle is mounted higher for forestry applications (fig. 1) (Spraying Systems Co. 1983). The manufacturer recommends that the nozzle be mounted at 3 feet. In forestry, the nozzle must be higher than that because the target vegetation (i.e., aspen sprouts, raspberry, etc.) is usually much higher than in agricultural applications and is more apt to interfere with the spray. This difference significantly changes the pattern of the spray. The forestry industry has not yet established a standard mounting height. The procedure presented here was developed to quickly and economically calibrate the boomless spray system and to evaluate its spray pattern.

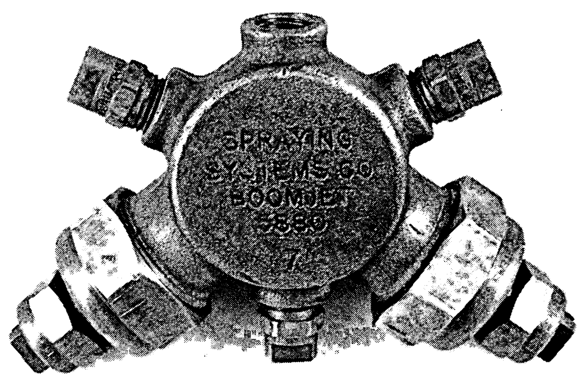

Figure 1.--*Typical boomless nozzle.*

PROCEDURE

The method described was used to calibrate a boomless spray system for use in spraying test strips. This procedure could also be used to calibrate other types of systems with proper adaptation. It utilized a pressure-dependent flow rate control.

For each nozzle test configuration, we obtained the following information: discharge flow rate, discharge pressure, nozzle height above the ground, width of spray pattern, and the distribution of the spray volume within that pattern. All data obtained from the following tests were recorded on a form similar to figure 2. Testing parameters followed those most likely to be used in the field.

To obtain the sprayer output (GPM) at a specific system pressure, we enclosed the spray head in a large plastic bag. The top was wired shut and a hole cut in the lower corner. The sprayer was operated for exactly 1 minute. All discharged water was gathered and measured. The flow test was performed at least three times and then averaged to obtain the discharge flow rate at a specified discharge pressure.

Next the bag was removed and 5-foot-long rain gutters with capped ends were placed on the ground in the spray field parallel with the direction of the sprayer vehicle (fig. 3). The sprayer was then operated for 5 minutes, and we noted the total width of the spray pattern. Because our tests took place on a concrete floor, we could easily see the droplets falling on the wet surface. The water volume collected in each trough was measured and recorded. Plots of the data were made for each test (fig. 4).

After obtaining an adequate spray profile, we examined the droplet particle size. Index cards were placed on the ground at 4-foot spacings, marking each card as to its distance from the center line of the spray rig travel (much like the rain gutters were located). Using a dye in the water, we drove the spray rig along the center line. The average droplet size was measured and then recorded on each card and on a form similar to figure 5. The droplet size is not as critical with the soil-active herbicides as it is with the foliar-active types. Therefore the previously described test was for informational purposes only. Adequate testing and nozzle tip modification may be necessary before the nozzle can be used for the foliar-active types.

NOZZLE CALIBRATION
MOBILE SPRAYING
SPRAY TEST SET UP

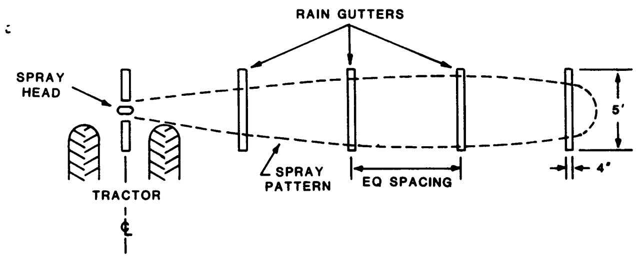

Figure 3.--*Experimental setup for boomless nozzle distribution test.*

SPRAY NOZZLE TRIAL TEST

TEST NO. 1a

NOZZLE TYPE: 5880-3/4-2TO C06

DATE 12 May 83

#1/4VV-1506

6733-0C06

HY1/4VVL-9502

NOZZLE TIP NUMBERS

FLOW TEST

TEST PRESSURE (PSI)	TRIAL 1 (GAL/MIN)	TRIAL 2 (GAL/MIN)	TRIAL 3 (GAL/MIN)	AVERAGE (GAL/MIN)
20	1.95	1.8	2.25	2.0

DISTRIBUTION TEST

NOZZLE HEIGHT (FT): 7 SPRAY WIDTH (FT): 44

DISTANCE FROM NOZZLE (FT)	VOLUME COLLECTED (ML)
0	180
4	340
8	470
12	330
16	290
20	140

Figure 2.--*Form for spray trial test.*

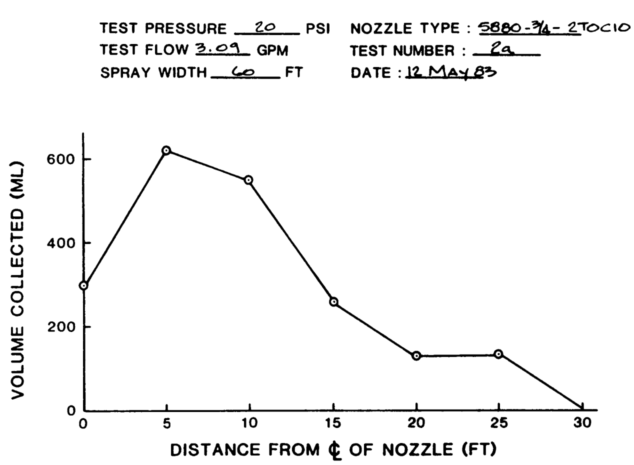

Figure 4.--*Plot of a single spray pattern.*

SPRAY NOZZLE DROPLET SIZE TEST

TEST PRESSURE 20 PSI — NOZZLE TYPE 5880-¾-2TOC06

TEST FLOW 2.0 GPM — TEST NO. 1d

SPRAY WIDTH 44 FT — DATE 12 May 83

AVERAGE DROPLET SIZE (MICRONS)	DISTANCE FROM SPRAY NOZZLE (FT)
250	0
500	4
1000	8
3000	12
5000	16
10,000	20

Figure 5.--*Form for droplet size test.*

RESULTS

Ten tests were conducted using the above procedure --seven with standard boom jet nozzle and tip combinations as provided by the manufacturer and three with modified nozzle and tip configurations. The seven tests utilizing the factory nozzles showed a wide variation in the spray distribution which we feel can be attributed to the difference between the recommended and actual nozzle mounting height. In the last three tests, nozzle tips were interchanged to obtain a somewhat flatter distribution curve (fig. 6). The tip configuration used to obtain that distribution for the modified 5880-¾ nozzle consisted of two H¼-U-0520HE (upper tips), one H¼-VVL-9506 (lower tip), and two 6733-OC6 (main tips).

DISCUSSION

To provide satisfactory results, ground application systems must be dependable. The first step in achieving this objective is to calibrate and evaluate the intended spray system. Application rates can be calculated using conventional formulas and information on flow rates, swath width, and rig speed. Known application rates provide better results and lower costs.

Our procedure is a quick, inexpensive way to determine nozzle output and to evaluate spray patterns for uniformity. The use of nozzles as provided by the manufacturer may give undesirable results, particularly

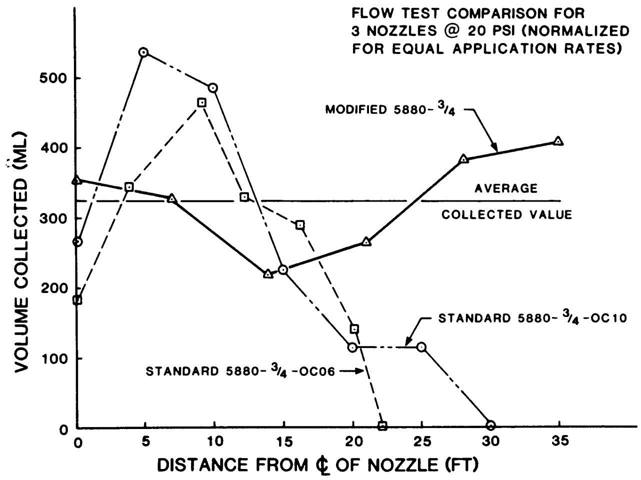

Figure 6.--*Modified nozzle pattern comparisons.*

when used in a manner other than as recommended. Large variations in the spray distribution, as experienced in our first seven tests, would apply too little herbicide in some areas and too much in others. The varying dosages would eventually show up as streaks or bands in the treated area. To eliminate the banded areas, managers may increase the application rates, overdosing a major portion of the sprayed area and increasing the application costs.

As an example, consider the distribution test shown in figure 4. Suppose a similar test using the same flow rate of 3.09 GPM and a spray width of 60 feet gives good results in a field trial and an evenly distributed spray pattern of 330 ml, which is an average of the collected amounts shown in figure 4. To obtain similar results from the configuration for the test system, the volumes collected in the zone 15 to 30 feet away from the sprayer need to be increased by approximately 200 ml or 150 percent more than that now obtained. To do this, the flow rate needs to be increased to 7¾ GPM. In the 5- to 10-foot zone, which is already being overdosed by an average of 75 percent, the rate becomes almost 4.4 times that which is necessary. The overall effects of the poor flow pattern system are increased chemical (50 to 100 percent) and water costs, slower production rates, and inadequate results. The use of improper chemical rates can cause lasting injury to nontarget vegetation.

As previously mentioned, foliar-active herbicides require greater control over the chemical droplet size than do the soil-active types. For this reason, modifying the nozzle tips to obtain an even distribution pattern is not an end in itself. Consideration must be given to the maximum desired droplet size in order to obtain the desired results. To reduce the particle sizes at the outer reaches of the spray pattern, smaller capacity tips would probably have to be installed at the two tip locations. Although we did not examine this configuration in our testing, we felt that the modification would reduce not only the droplet size but also the spray distribution in this area. If used in a commercial application where side-by-side strips are applied, these reductions may not be a deterrent to the spraying system because the patterns could be overlapped enough to provide for the proper distribution density.

Chemical application mistakes can be costly. A study done by Nebraska agricultural engineers found two out of three pesticide applicators were making significant application errors--the result of inaccurate calibration, incorrect mixing, worn equipment, and equipment failure (Reichenberger 1980). These mistakes, causing both over- and under-application, were costing farmers $2 to $12 per acre in added chemical expense, potential crop damage, and threatened weed competition. The same could happen in forest applications.

In these preliminary tests, we used water alone for practical reasons. When the sprayer system is in actual field use, addition of the herbicide and other additives will decrease the flow rate and narrow the spray pattern. The pattern should be observed, and mix usage over a predetermined course and quantities mixed should be adjusted to obtain the proper rates.

CONCLUSIONS

In developing a spray system for use with soil-active chemicals in single-strip application methods, the evenly distributed spray pattern is of prime importance. But in actual operational spraying, where several side-by-side swaths are required to cover a site, a flat top center with tapered edges is a better pattern because it allows some leeway between adjacent swaths when the tractor operator cannot maintain absolutely straight parallel courses at a constant distance apart.

The method discussed allows the applicator to evaluate a spray system's performance and determine what adjustments and modifications are necessary to obtain the required results.

We do not know if foliar-active chemicals can be applied satisfactorily with a boomless sprayer nozzle configuration. Because of the inherent design of the boomless nozzle spray tips, the droplet size cannot be controlled without significantly changing the spray pattern.

LITERATURE CITED

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