

A MEANS OF WINNOWING HYDRAULIC NOZZLES TO CONTROL DROPLET DRIFT

K.S. McKinlay

Research Station, Agriculture Canada
Saskatoon, Saskatchewan

R.J. Ford

Member CSAE
Research Station, Agriculture Canada
Saskatoon, Saskatchewan

W.K. Martin

Research Station, Agriculture Canada
Saskatoon, Saskatchewan

INTRODUCTION

The behavior of pesticide sprays is largely determined by droplet size. However, all commercially available spraying equipment produces droplets in a wide range of sizes and the presence of large numbers of small droplets in the spray can cause serious problems due to pesticides drifting out of the target area (1,2). One obvious solution to this problem would be to develop equipment that would produce homogeneous sprays of chosen drop sizes. Sprays of very uniform droplets can be produced by winnowed spinning discs (5, 9). Such devices are extremely useful for research purposes in the laboratory or field but their low flow rates, complexity, and cost make it seem unlikely that they will come into commercial use.

A number of other devices such as the Vibrajel (4), the Microfoil (3), and the vibrating boom (7), reduce drift by producing coarse sprays with reduced numbers of small droplets. Unfortunately, when large drops are used one must either increase the spray volume or accept reduced coverage.

A simpler solution to the drift problem would be to remove the small-drop component from the sprays produced by the ordinary hydraulic nozzles. Roth and Porterfield (8) reported results of preliminary tests in which a counter flow of air was used to remove small drops from the spray produced by a fan-jet nozzle. Similar experiments were carried out by Wiens and Bigsby (10). In both of these instances the movement of the air was directly opposed to the direction of movement of the spray droplets. Using a TeeJet 650067 nozzle at 35 psi (2.5 kg/cm²), Wiens and Bigsby reported that the number of droplets below 100 μ m

were reduced from 20.5 to 7.5% by winnowing.

It was felt that the small drops might be removed more effectively if the winnowing airstream were at right angles to the fan of spray produced by the hydraulic nozzle. In such a system, an air curtain would be produced that could be penetrated by the more energetic large droplets but that would deflect the small droplets into a trap. The present paper reports the performance of such a system.

MATERIALS AND METHODS

The air curtain used in these tests was generated by a 0.234 X 15-cm slit cut in the side of a 5-cm tube maintained at an internal pressure of 5 cm of mercury. A trap consisting of a 25-cm² duct with a 7.5-cm inlet on one side (Figure 1) was located 10 cm from the slit. The lower lip of the trap inlet was tipped up to prevent drips forming and to ensure that all the spray collected ran into the trap. The nozzle to be tested was mounted 15 cm above the air curtain with the spray fan parallel to the trap inlet.

A 2% w/v aqueous solution of Uranine (sodium fluorescein) was supplied to the nozzle at a pressure of 2 kg/cm² from a pressurized reservoir. The spray was turned on and off by a fast-acting valve incorporated in the nozzle body. A pan under the assembly caught the spray so that it could be returned to the reservoir at the conclusion of each test.

Preliminary tests suggested that winnowing efficiency was improved if the air curtain was inclined upwards. With the equipment in use, problems were encountered if the inclination, θ (Figure 1) exceeded approximately 15° so this value was used for all succeeding tests.

The percentage of spray deflected into the trap at any given airflow could be varied by adjusting the horizontal separation between the axis of the spray fan and the lower lip of the trap. Tests showed that apparent elimination of the fine drops was accomplished when 7% of the nozzle output was deflected into the trap with little improvement as the capture rate was increased. Decrease in capture rate below this figure, however, resulted in the escape of considerable numbers of small drops. To leave some margin of safety, it was decided to conduct all subsequent tests with a capture rate of 10% of the nozzle output. The actual volume of liquid being caught was determined by cutting a drain hole in the bottom of the trap and measuring the flow from it after equilibrium had been reached.

The spray droplets were caught on a thin card (Mead Paper Co., Mark I Cover, 6 pt.) coated with a thin layer of gelatin. The relationship between drop diam and stain size for this combination of liquid and collecting surface was estimated by using a spinning disc (5) to produce homogeneous sprays in a wide range of sizes and comparing the diam of the stains produced with the equivalent drop-

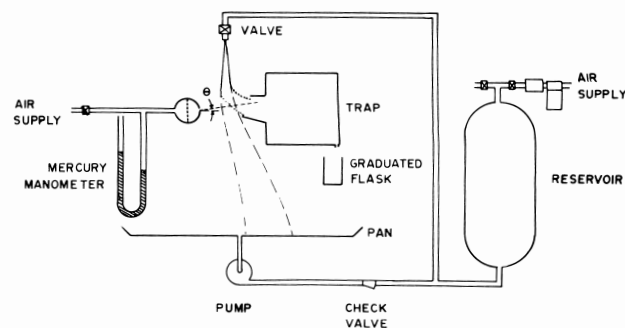


Figure 1. General layout of the winnowing arrangement used for laboratory studies.

Contribution No. 483, Research Station, Agriculture Canada, Saskatoon, Saskatchewan.

RECEIVED FOR PUBLICATION JUNE 26, 1972

10. Wens, E.H. and F.W. Bigsby. 1971. Winnowing as a means of removing small droplets from a spray pattern. *Can. Agr. Eng.* 13(1): 13-18.

9. Smith, D.B., E.C. Burt and F.C. Bencil. 1970. Design of a spinning disc, droplet separator and the determination of the size and density of droplets deposited on cotton foliage. *Trans. Amer. Soc. Agr. Eng.* 13(5): 664-668.

8. Roth, L.O. and J.G. Portfield. 1970. Spray drop size control. *Trans. Amer. Soc. Agr. Eng.* 13(6): 779-81, 784.

7. Reimer, C.A. 1964. Evaluation of a vibrating boom sprayer for drift control. *Down Earth* 20(1): 3-6.

6. May, K.R. 1950. Measurement of airborne droplets by the magnesium oxide method. *J. Sci. Instr.* 42: 500-501.

5. McKimay, K.S. and G.S. Glen. 1971. A shrouded spinning disc for the production of homogeneous sprays. *Can. Agr. Eng.* 13(1): 19-22.

4. Lake, J.R. 1970. Spray formation from vibrating jets. *Brit. Crop. Prot. Council. Monogr. No. 2.*

3. Kirch, J.H., J.E. Waldrum and P.W. Bishop. 1969. The microfoil - an aerial device for controlling drift from conventional spry. *Proc. 23rd N.E. Weed Control Conf.*

2. Coursee, R.J. 1959a. Investigations on spray drift. I. The small drop component of sprays. *J. Agr. Eng. Res.* 4: 144-152.

1. Coursee, R.J. 1959b. Investigations on spray drift. II. The occurrence of drift. *J. Agr. Eng. Res.* 4: 229-242.

REFERENCES

It was found that a suitable air curtain and trap arrangement would reduce the percentages of drops below 100 microns from 60 to 4 or 5 percent by number.

Percent by number	Percent by volume			
	(size range μm)			
Under 128	128	285	392	433
Under 285	128	285	392	433
Under 392	128	285	392	433
Under 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433
Over 433	128	285	392	433

TABLE I DROP SPECTRA OF TEEJET 6501 AND 650067 WITH AND WITHOUT WINNOWING

The ordinary hydraulic spray nozzle produces droplets in a wide range of sizes including many below 100 microns that

SUMMARY

The ordinary hydraulic spray nozzle produces droplets in a wide range of sizes including many below 100 microns that

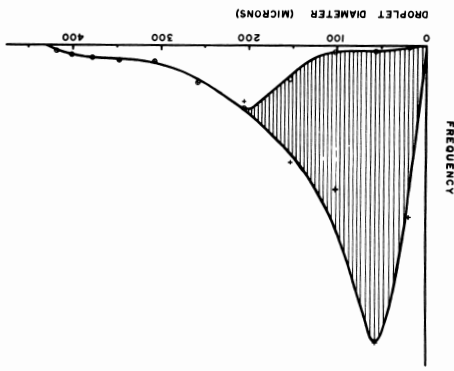


Figure 2. Droplet-size frequency distributions for the Teejet 6501 nozzle with and without winnowing.

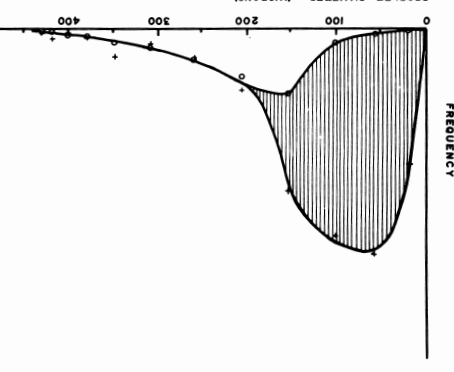


Figure 3. Droplet-size frequency distributions for the Teejet 650067 nozzle with and without winnowing.

These results suggest that, by follow-

winnowing a stream was used, these percentages fell to 5.6 and 9.5%. The ordinary hydraulic spray nozzle produces droplets in a wide range of sizes including many below 100 microns that

The operating conditions described above had been set up by trial and error so that 10% of the spray, by volume, would be carried into the trap as fine droplets by the winnowing air. The removal of this relatively small proportion of the spray had a very marked effect on the droplet spectrum of the spray that was released. The number median diameter for the Teejet 650067 nozzles were 80 and 90 μm , respectively, without winnowing and rose to 240 and 212 μm with winnowing.

RESULTS AND DISCUSSION

The drop spectra for the Teejet nozzles are shown in Table I, and adjusted droplet-size distribution curves for the Teejet 6501 and 650067, with and without winnowing, are shown in Figures 2 and 3, respectively. These curves have been scaled so that the top ends of the droplet-size spectra, unaffected by winnowing, fit the same portion of the curve of the unwinnowed spectrum. In this way, it is possible to demonstrate the proportion of finer drops, by number, removed by winnowing (shaded area).

let diam as measured on magnesium oxide plates (6).