COMPARATIVE EVALUATION OF THREE EXPERIMENTAL DRIFT CONTROL DEVICES

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Comparative studies were carried out to investigate the effectiveness of three spray drift control devices on a boom-type ground sprayer. Two of these, a porous shroud and a power-aspirated winnower, were found to be effective in substantially reducing spray droplet drift.

INTRODUCTION

With the advent of mixed cropping practices and the gradual breaking up of the monoculture conditions which have prevailed in the west, the drifting of fine spray droplets is beginning to have more serious consequences. Many possible solutions have been promulgated, ranging from spray additives to an assortment of different types of spray nozzles, including CDA applicators. This paper compares three devices which can be applied to existing equipment for the reduction of spray drift in applications where drift cannot be tolerated because of proximity to sensitive crops.

The problem of spray drift is not a new one, even though the effects of it were not of concern for many years. Over a period of many years, attempts to reduce drift and confine materials to the treatment area have been made. Some attempts have been mainly operational, to reduce drift without altering the equipment or the spray material in any way. Other approaches have involved the selection of nozzles which will not produce droplets in the drift-prone size ranges, or the modification of the spray solution to discourage the formation of small drops.

Operational approaches amount to using common sense and imply not spraying when winds are excessive; not treating areas immediately upwind of sensitive crops; and not using excessive pressures. The principal difficulty with these recommendations lies in the fact that in many areas such as the prairies, too few hours with calm winds are available for the timely application of chemicals. As a result, farmers too often spray in winds up to 30 km/h.

The simplest hardware approach is the choice of high gallonage nozzles which produce a coarse spray less prone to drifting. In one study of this approach, Page (1961) observed that larger nozzles do produce less drift per gallon emitted than do smaller nozzles. Unfortunately, his data showed that to reduce by 50% the fraction of the spray prone to drifting, the application rate had to be increased by a factor of about 3.5. This increase resulted in a net increase in the actual volume of drifting material of about 75%.

A different approach was represented by the Vibraboom (Morton 1981). In this case, an extremely coarse spray was produced from a perforated pipe operating at low pressure. Although the system appeared to be effective for the purposes claimed, the application rates achieved (160–420 L/ha) made it impractical for field use on the prairies.

For a brief period of time foam nozzles were touted by manufacturers as the cure to drift problems. While they did result in the reduction of drift from chemical applications, their deposit pattern tended to be too coarse to permit good control, particularly of weeds.

Several alternative devices for producing sprays which do not contain large numbers of small drops have been developed. These include the spinning disc (Bals 1975), forced jet stream atomization (Roth and Porterfield 1970), electrostatic atomization (Reimer 1964) and the microfoil (Akesson et al. 1971). Of these, all but the second are commercially available. All attempt to control the breakup of the liquid into relatively uniform droplets of controlled size to reduce or eliminate drift. All are expensive, and some are difficult to adapt to routine field operations.

Attempts to modify sprays by the use of additives have involved particulating agents (Anonymous 1966; Butler et al. 1969), invert emulsions (Akesson et al. 1971; Colthurst et al. 1966), viscosity modifiers (Kaupke and Yates 1966; Stephenson 1971) and wetting agents (Holmsen et al. 1967; Page 1961). Of these, the most effective apparently have been the particulating agents. The invert emulsions produced poor swath patterns; the viscosity modifiers had little effect; and the wetting agents actually increased drift.

EQUIPMENT AND METHODS

Data from unpublished studies carried out by the author suggested that the fine droplets (those under 100 μm) which are particularly prone to drifting could be removed from the spray fan by an air blast perpendicular to the spray fan. The results of these studies indicated that the removal of about 10% by volume of the spray could result in the virtual elimination of the drift-prone fraction of the spray.

On the basis of this information, a winnowing device was constructed which could be attached to a standard boom-type sprayer. This winnower (Fig. 1) consisted of a series of slit-shaped air jets, located one in front of each nozzle on the boom, and a porous screen immediately behind the boom. Air was supplied under pressure by a hydraulically-driven blower mounted on the spray vehicle. A solid shroud behind the screen prevented any tailwind from blowing through the screen and counteracting the air blast from the air slits. At the same time, it directed the air flow from the screen downwards, to aid the droplets to reach the ground more quickly.

That portion of the spray which was caught on the screen was allowed to coalesce and drip to the ground in large drops. The rationale for not collecting this material was that the volume involved was small and the problems involved in its recovery (including the removal of dust and other debris washed from the screen) too great to be worth the trouble.

For the sake of comparison, two other devices were also constructed. One was a solid shroud made from polyethylene film; the other a gauze shroud of the same dimensions, constructed from plastic

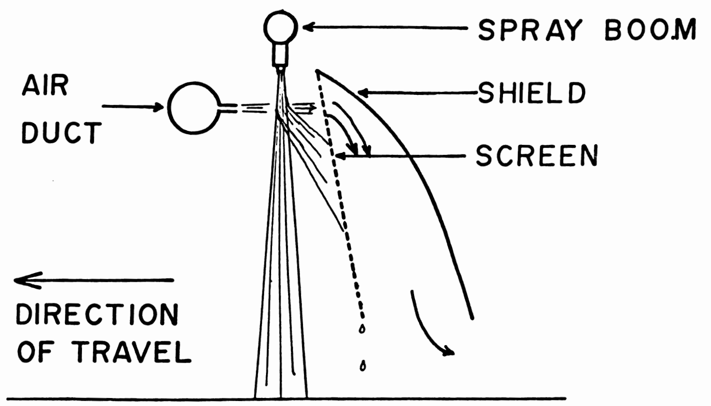

Figure 1. Simplified end view of powered winnower showing air flow and deflection of fine droplets onto screen.

screening. The construction of these two shrouds is shown in Fig. 2.

TEST PROCEDURES

The method used in these tests was that described by Ford (1976) and consisted of a series of static paired comparisons. Seven paired comparisons were used; standard boom vs. standard boom, power winnower vs. standard boom, gauze shroud vs. standard boom, solid shroud vs. standard boom, power winnower vs. gauze shroud, power winnower vs. solid shroud and solid shroud vs. gauze shroud. One of the comparisons may require some explanation. Number 1 (standard boom vs. standard boom) was required to ensure that both sides of the sprayer were producing equal drift.

All tests were carried out with Spraying Systems 650067 nozzles operated at a pressure of 275 kPa and a boom height of 1.0 m. The spray was tagged with sodium fluorescein (1% wt/vol.). Two 1-min runs were carried out for each comparison. Drift was collected in air samplers located 5 m downwind from the midpoint of each spray boom at heights of 0.5 and 1.0 m, using filters with a 1.2-μm pore size and a flow rate of approximately 20 L/min. The actual flow rate through each sampler was determined prior to each test. The wind speed was determined at 1-min intervals during the tests at an elevation of 2.0 m.

The air samplers were removed immediately after each test and put in a box sheltered from the sun to prevent the photodecomposition of the fluorescent dye. The filters were then washed in 20 mL of distilled water buffered with dibasic sodium phosphate (pH 9 approx.) and the dye concentration was determined with a Turner 111 fluorometer.

The concentration (microlitres of dye solution per cubic metre of air) of the aerosol produced by each boom was determined at each sampling location from the dye concentrations measured by the fluorometer and the observed flow rates through the samplers.

Comparison 1 (Table I) indicated that the right side of the sprayer was producing 35% more drift than was the left side at the locations of the samplers. Accordingly, all drift values relating to that side of the sprayer were divided by 1.35 to compensate for the increased output of drifting particles.

The remaining comparisons were treated by dividing the concentration of the drift from the right boom by the concentration of that from the left boom after the above correction was made.

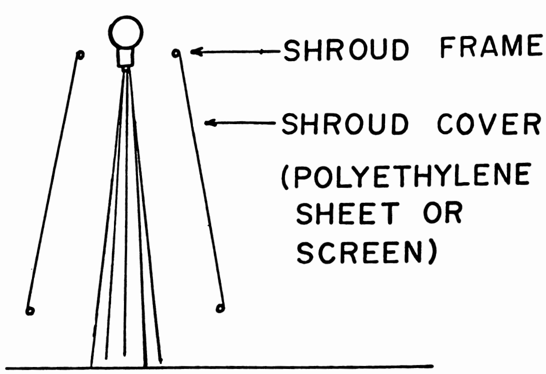

Figure 2. End view of passive shrouds used for comparisons.

TABLE I. RELATIVE DRIFT AND DRIFT REDUCTION FOR STANDARD AND MODIFIED SPRAY BOOMS AT A DISTANCE OF 5 m

Test	Comparison		Drift relative to left boom at†		Percent change in drift at	
no.	Left boom	Right boom	0.5 m	1.0 m	0.5 m	1.0 m
1	Control	Control	1.35	1.35		
2	Control	Power winnower	0.036	0.087	−96.4	−91.3
3	Control	Gauze shroud	0.184	0.564	−81.6	−43.6
4	Control	Solid shroud	0.365	1.56	−63.5	+56.0
5	Gauze shroud	Power winnower	0.222	0.128	−77.8	−81.2
6	Solid shroud	Power winnower	0.117	0.114	−88.3	−88.6
7	Gauze shroud	Solid shroud	1.33	1.34	+33.0	+34.0

†Values shown for relative drift for Test 1 are raw data. The corresponding values for the other tests have been divided by 1.35 to correct for an apparently higher drift from the right boom.

RESULTS AND DISCUSSION

Table I summarizes the results of this investigation. The reason for the 35% difference in drift between the right and left booms is not known. The most likely reason is difference between individual spray tips. The last two columns of Table I show the amount of drift captured from each drift control device relative to the reference boom as well as the other control devices and the percentage reduction in drift at sampling heights of 0.5 and 1.0 m.

In tests 2, 3 and 4, in which comparisons are being made between drift control devices and the unmodified boom, the percent reduction in drift is higher in each case at 0.5 m than it is at 1.0 m.

In the first two cases, the smallest droplets, which are more likely to escape from the drift control devices and have very low falling velocities, probably would not have reached the lower air samplers. This would have resulted in an apparent improvement in drift control at that point. The larger droplets within the drift-prone portion of the spray which would have passed the lower sampling points were captured more efficiently by the devices under test.

The apparent increase in drift noted at the 1.0-m height with the solid shroud requires a different explanation. In this case, the problem arises from the design of the shroud itself and is one that may be encountered with other shrouded booms. The top of the shroud was not closed over the top of the spray boom (Fig. 2). Under windy conditions, the difference in wind velocity between the top of the shroud and the bottom (because of the steep wind velocity gradient near ground level) was sufficient to induce an upward flow of air through the shroud. This air flow winnowed the fines from the spray and released them with an upward velocity at the top of the shroud, at a level considerably higher than that which they would have left the spray had there been no shroud.

These results indicate that the power-aspirated winnower, with a drift reduction of about 95%, was substantially more efficient than either of the other two devices. However, its cost was greater, making it less desirable.

The solid shroud's performance was so poor in comparison to the other two that it will receive no further consideration except to point out that it represents an excellent example of how not to design a shroud.

The gauze shroud, with a drift reduction of up to 80%, was less efficient than the power-aspirated winnower. Even so, its performance was sufficiently good relative to its cost to warrant further effort in improving its efficiency.

CONCLUSION

The initial purpose of this study was to test the effectiveness of a power-aspirated winnowing device for the control of spray drift. This device functioned as well as expected. A second device, created solely for the sake of comparison, consisting of a porous shroud suspended from the boom, also functioned well. This shroud was much less expensive than the powered winnower, and could be a practicable drift control device for addition to a field sprayer.

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