FIELD TRIALS OF A METHOD FOR REDUCING DRIFT FROM AGRICULTURAL SPRAYERS

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Comparative studies of a field sprayer equipped with a porous shroud for the reduction of drift showed that the device was effective in reducing droplet drift from spraying operations by about 85%. Drift reduction was achieved by capturing droplets as soon as their direction of travel deviated from that of nondrifting droplets.

INTRODUCTION

For many years there has been concern over the loss through drift of herbicides and insecticides from treated fields and the resulting damage to non-target crops, wildlife and people. Many methods, including viscosity modifiers, particulating agents, foaming agents and assorted nozzle types have been tried in attempts to reduce droplet drift from agricultural chemical applications using boom-type ground sprayers. The purpose of this study was to evaluate the drift reduction capabilities of a porous shroud that could be attached to an existing boom-type sprayer.

EQUIPMENT AND PROCEDURES

The study was based on the recovery of dyed spray droplets released by two sprayers, one of which was equipped with a shroud. The two sprayers were operated simultaneously upwind of a sampling array.

Both sprayers were of the dry-boom type, in which nozzles are attached to a frame and connected by piping. Each had a boom 9.14 m in length positioned 720 mm aboveground or above the crop canopy top if one was present. Both sprayers were equipped with 650067 spray nozzles operated at 275 kPa. Nozzle spacings were 457 mm on the test sprayer and 508 mm on the reference sprayer. The reference sprayer was mounted on a swather chassis. The test sprayer was mounted on a truck.

Two types of sampling stations were used for the determination of downwind drift: one a metal stand supporting 12.7-mm-diameter polyethylene spheres at ground level and at a height of 500 mm, the second a fiberglass screen 50 mm wide, 2 m high and having a 1.4-mm pore size supported on a metal frame. The samplers were arranged in seven rows running perpendicular to the spray swath with stations situated 2, 4, 8, 16 and 32 m from the downwind edge of the swath with rows 1 m apart (Fig. 1). Rows 1 and 7 consisted of the screen-type samplers while the polyethylene spheres were put in the remaining five rows.

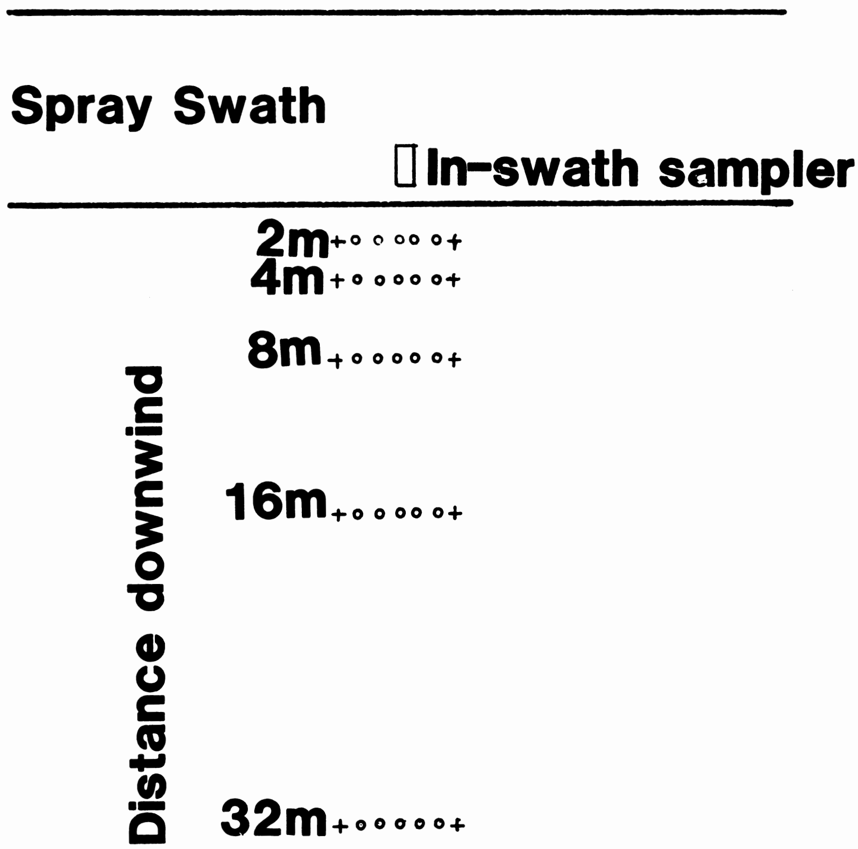

Figure 1. Experimental field layout used. +, screen sampler; ○, spherical sampler.

Since two sprayers were to be used simultaneously in the tests, it was necessary to know whether their outputs per metre of travel were the same and, if not, to have some basis for correcting the drift deposits obtained. To accomplish this a second array of 12.7-mm spheres was placed in the spray swath. This array consisted of 100 spheres mounted in four rows at right angles to the direction of travel of the sprayer. The spheres were mounted at ground level with a 25-mm spacing between spheres in both directions.

Both sprayers were loaded with water containing fluorescent dye as follows: in the reference sprayer rhodamine WT 1% wt/vol and in the test sprayer sodium fluorescein 1% wt/vol. When the wind conditions were suitable (approximately 16 km/h perpendicular to the swath), both sprayers were driven past the sampling layout at a speed of 6.5 km/h with the test boom following the reference boom at a distance of approximately 10 m. Both sprayers were operated at the same pressure — 275 kPa at the nozzle — and were

TABLE I. PERCENT REDUCTION IN DRIFT FROM A SHROUDED BOOM SPRAYER RELATIVE TO AN UNSHROUDED SPRAYER OVER BOTH BARE GROUND AND A CROP CANOPY

Distance downwind (m)	Sampler type†	Height (cm)	% drift reduction	
			Bare ground‡	With plant canopy
2	SPH	0	88	91
2	SPH	50	86	90
2	SCR	0–200	84	85
4	SPH	0	94	90
4	SPH	50	85	88
4	SCR	0–200	84	84
8	SPH	0	80	69
8	SPH	50	82	84
8	SCR	0–200	87	86
16	SPH	0	87	93
16	SPH	50	82	84
16	SCR	0–200	84	87
32	SPH	0	86	82
32	SPH	50	87	90
32	SCR	0–200	78	86

†SPH = spherical target, SCR = fiberglass screen target.
‡ = average of two tests.

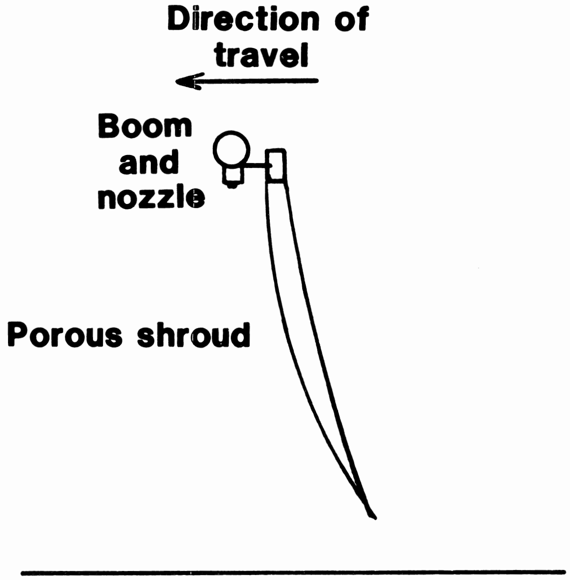

Figure 2. End view of spray boom with curved porous shroud attached.

turned on at a point 10 m before the start of the sampling array and off at a point the same distance beyond the last row of samplers.

All spheres and screens were immediately collected and placed in polyethylene containers protected from the sun until they were analyzed. The spheres were washed in 10 mL of distilled water and the screens in 100 mL of distilled water. The washings were analyzed for both fluorescein and rhodamine by means of a Turner 111 fluorometer which was calibrated against samples of the spray solution from each of the two spray tanks.

The mean deposits on the in-swath spheres were used as a basis for the normalization of the deposits of each dye on the downwind targets. This removed the effects of different nozzle spacings on the two sprayers as well as any difference in delivery rates from the nozzles on the two machines.

At each distance downwind from the swath, the deposit per unit output on each type of target for each of the two dyes were compared and the percent reduction of the fluorescein relative to the rhodamine was calculated.

Differences in mean percent reductions for the two types of samplers and five downwind sampling locations were tested for significance using a *t* test.

RESULTS

The results of the calculations from three tests of the shroud are shown in Table I. Percent reductions over bare soil are the average of two tests with a wind velocity of approximately 16 km/h perpendicular to the direction of travel of the sprayers. A single trial was carried out under essentially the same weather conditions, but with a crop canopy ranging in height from 150 to 200 mm. In each case, the figures shown represent averaged data from all samplers of a given type at that location.

Statistical analysis indicated that there were no significant differences between samplers within any test or between tests in terms of drift reduction at the 80% confidence level. Accordingly, all the values obtained for drift reduction were averaged. This resulted in a value of 85.5% for the magnitude of drift reduction by this device.

DISCUSSION

Earlier tests (Ford 1984) had been carried out with a porous shroud consisting of a single thickness of plastic screen which encompassed the spray boom. In an attempt to increase the efficiency of this shroud, two changes were made to it. First, the screening was removed from the front face of the shroud and added to the rear face. This increased the air flow through the spray while the doubling of the screen at the rear reduced the porosity of the screen to drifting spray droplets.

Second, the rear face of the shroud was changed from a flat plane to a section of a parabola with the convex surface facing the nozzles. This shape was chosen as it allowed the shroud to parallel the approximate path of the main body of the spray. The modified shroud was mounted on the spray boom 50 mm behind the spray nozzles (Fig. 2).

Although the actual distance from the screen to the sprayer is not critical, the screen must be mounted close to the spray. In one field trial, the screen was mounted approximately 500 mm behind the boom, but in this position was ineffective in reducing drift. There are two reasons for this which involve changes in the effective porosity of the screen and the creation of alternative pathways for drifting droplets as the screen-to-nozzle spacing increases.

The mechanism by which the effective porosity of the screen changes can be seen by looking at the trajectory of droplets smaller than 100 μm diameter, which are prone to drifting. As a result of their lower terminal velocity, they will tend to be accelerated towards the rear of the spray by the motion of the air relative to the moving spray boom. This results in their eventual separation from the main body of the spray, at which time they are said to be drifting.

As these droplets leave the spray, their trajectory forms a relatively small angle with the trajectory of the remaining droplets. As the separation increases and the drifting droplets continue to accelerate to the velocity of the air relative to the boom this angle continues to increase until, in the limit, it reaches 90°. If the screen is placed at this point, the effective porosity will closely approximate its true porosity, i.e., the ratio of the total open area of the mesh to the overall screen area.

If, however, the screen is placed in close proximity to the spray so that the trajectory of the drifting droplets is still almost parallel to the screen, the horizontal filaments in the screen which are at right angles to the path of the droplets will appear to be spaced much more closely when viewed from a direction parallel to the trajectory of the drifting droplets. This reduces the effective porosity of the

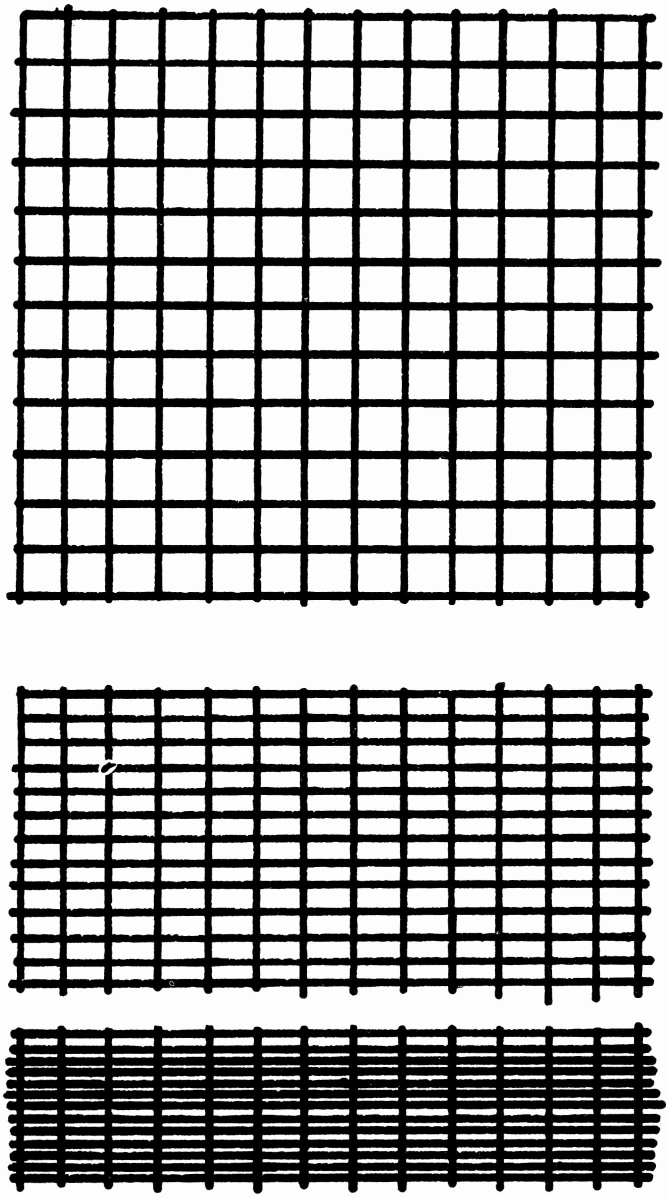

Figure 3. Perpendicular and oblique views of screen showing changes in effective porosity to droplets as the angle of approach changes from 90° to 15°.

screen to zero in the limit (Fig. 3).

Since the direction of the airflow is relatively unchanged between these two extreme positions, the porosity of the screen to the air is also unchanged. Accordingly, the shroud is more effective in capturing droplets from the air which passes through it when it is placed close to the main body of the spray.

A second problem can arise if the screen is placed too far from the spray boom. Since the porosity of the screen is less than one (generally about 0.5) the screen will offer some resistance to air flow. Hence, there will be a tendency for the air to flow around the screen, leaving a relatively stagnant area immediately in front of the screen. If the spray is released into the air stream ahead of this relatively stagnant area, the drifting droplets will, to a large extent, be carried around the screen, thereby avoiding capture. If the spray boom is located well within the stagnant area, there is little chance of this happening.

The material captured by the shroud was allowed to drain from the shroud and drip onto the ground with no attempt being made to recover it. Preliminary tests had indicated that the driftable portion of the spray amounted to no more than 10% by volume of the total spray. It was felt that the cost and inconvenience involved in trying to recover and clean the material for re-use would be prohibitive. Since the captured material falls in a few large drops within the swath, it is likely to have little effect, and so must still be considered as lost material from a pest control point of view.

CONCLUSION

The results of these comparisons show that a porous shroud was able to reduce spray droplet drift from agricultural chemical applications employing standard farm sprayers under moderate wind conditions by approximately 85% provided that the shroud was located immediately behind the spray nozzles.

REFERENCE

FORD, R.J. 1984. Comparative evaluation of three drift control devices. Can. Agric. Eng. 26: 97–99.