A METHOD FOR THE COMPARATIVE EVALUATION OF DRIFT ABATEMENT TECHNIQUES FOR GROUND SERVICES

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A method is described for evaluating drift control techniques, using a stationary sprayer and a very small air sampling layout. Drift samples as large as necessary may be taken, and many of the variables associated with the use of a moving sprayer are removed.

INTRODUCTION

With the ever-increasing concern for environmental pollution and risk to adjacent crops, it is becoming more obvious that action is necessary to reduce droplet drift from spray applications of agricultural chemicals. To this end, numerous companies within the agricultural chemical and equipment fields, as well as companies in other areas, have marketed a wide array of additives and equipment.

Each of these remedies for droplet drift has appeared on the market accompanied by claims that they can eliminate or markedly reduce spray drift. Unfortunately, the author's experience with these claims has led him to think that they may be, in some cases, somewhat over-optimistic, based more on a belief in what 'ought' to work rather than on sound testing and evaluation.

That this is the case should not prove surprising. The methods currently in use for carrying out this kind of test tend to be cumbersome, involving large quantities of labor and equipment. The tests must be carried out under field conditions in most cases, since suitable wind tunnels are exceedingly scarce, and in most cases their owners are likely to be reluctant to have their tunnels sprayed with agricultural chemicals (which may be toxic or corrosive or both) or tracer dyes. This necessity for field testing places an additional restriction on test programs; they can only be carried out when the weather is suitable.

Under these conditions, and bearing in mind the present lack of governmental supervision, it is inevitable that products will appear on the market without sufficient preliminary testing to determine whether or not they are capable of doing what is claimed for them. The purpose of this paper is to suggest a means of evaluating drift control measures for ground equipment with a minimum investment in equipment and labor.

REVIEW OF CURRENT METHODS

Studies of droplet drift from spraying operations have been carried out for many years. The extensive use of aircraft for spraying in the United States has resulted in a considerable amount of work being done on the measurement and abatement of drift from this type of agricultural chemical application. In addition, there have been a number of studies made of the drift from ground sprayers and of various methods of reducing such drift.

In virtually all of these studies, the tests have been carried out by moving the sprayer past a stationary sampling layout arranged on the downwind side of the spray swath. In most cases the sampling array is quite extensive, extending a considerable distance downwind to provide information on the distance travelled by the drift.

The nature of the samplers used varies considerably. The simplest approach used is the bioassay method (Holmsen et al. 1967; Reimer 1964) in which sensitive plants are set out in the sampling area, then graded at some later time to determine the effect of any drift which may have occurred. This is a useful technique where estimates of damage to be expected on specified targets are required or where comparisons between two spray applications are to be carried out. However, it has two drawbacks. One of these is the necessity of holding the plants under standardized conditions for a period of time following the trial. This requires either greenhouse space or, preferably, growth chambers. The second possible drawback is that it is not capable of measuring quantitatively the amount of drift occurring, determining only the biological effect of the drift. Thus, the method is not usable in attempts to achieve a mass balance for agricultural chemical applications.

The alternative approach involves the use of mechanical air samplers of various types. The most elementary type of sampler is the flat collecting plate on which drifting material precipitates (Colthurst et al. 1966; Kaupke and Yates 1966; Yates 1966). The plates may be constructed of paper, mylar or acrylic plastic. They may be located at the ground surface or at any height above the surface.

Other studies (Maybank 1969; Yates 1966) rely on aspirated air samples which either cause airborne particles to impact on collecting plates or retain the material on filter elements. These provide much more reliable data than do simple flat plates which are highly sensitive to air movement. However, they involve the use of portable vacuum pumps and power supplies. For a reasonably sized layout, this requires a substantial capital investment and a large expenditure in labor to set up the sampling array. If the wind should shift prior to the completion of a series of tests, the entire layout must be picked up and moved, a tiresome task at best.

METHODS

In each of the foregoing methods, the spray rig was moved past a stationary sampling array. As a result, each collector received a very small sample which was subject to random variations whose magnitude may be of the same order as the sample itself. These variations make it difficult to extract usable information unless large numbers of sampling points are used. This necessarily increases the cost in terms of equipment and time.

The small size of the samples presents a further problem in that the detection of drift is more likely to be limited by the sensitivity of the detector used in the analysis of the samples. This could be remedied by making multiple runs past the sampling array to increase the size of the samples, and to some extent, average out the variability in the deposit. However, this would increase the time required for each test and, as a result, reduce further the number of occasions necessary for the experiment.
Figure 1. Experimental layout for comparative tests.

on which the weather conditions would remain sufficiently constant to give meaningful results.

The method used by the author attempts to overcome these problems by leaving the sprayer stationary in front of a small sampling array for the duration of the test. Two identical sets of collectors are employed in the array so that both an unmodified spray and a test spray embodying mechanical modifications or employing additives may be tested side by side in the field under identical meteorological conditions.

A typical set-up used to study the effect of mechanical alterations is shown in Fig. 1. In this case, the modified spray and standard spray were located at opposite ends of the same sprayer, so that both were automatically operated under identical conditions.

The samplers (millipore field monitors with 0.8-μm filters) were located 5 m downwind of the spray boom. This spacing was chosen on the basis of the assumption that any material still airborne this distance downwind from the nozzle would likely remain airborne for a considerable distance. Sampling heights were 0.5 m and 1.0 m. Aspirated air samplers were used rather than sedimentation or passive impaction collectors because of the difficulty of collecting the dried remains of the finer drops which are generally 25 μm or less in diameter.

Wind speeds were monitored by a rotating cup anemometer located 2 m above ground. Wind direction was checked by observing the drift plume to ensure that it did not miss the samplers at any time during the test. If this happened, the test was discarded.

Test duration is set so that when the air sampler filters are washed in water (10 ml is the minimum amount used in these tests), the resultant solutions are well in excess of the limit of detectability for the dye and detector in use. For the system used by the author (sodium fluorescein 10 g/4.5 liters and a Turner III fluorometer), tests of 1-min duration have provided adequate sensitivity.

This method does not determine the absolute amount of material drifting away but determines instead the amount of drift produced by the spray under test relative to the amount produced by a standard spray under identical conditions.

If it is desired to determine the total amount of drift leaching the area as a percentage of the amount of material emitted by the sprayer, a much denser sampling array would be required than has been used to date. However, since the goal of such testing is more likely to be the determination of percent reduction in drift, it does not seem that the added expense would be justified.

DISCUSSION

This method has a number of distinct advantages over other techniques which would tend to encourage its use by researchers who do not have the resources to make use of more traditional drift sampling techniques. It also has some disadvantages which might limit its usefulness in certain instances.

The advantages are fairly obvious. The investment in equipment is relatively small. The author's sampling layout was assembled for less than $500.00. Man-power requirements are minimal. Two workers can carry out comparisons at a rate of from 3 to 12 an hour, depending on the nature of changes to be made between tests. Because of the simplicity of the layout, it can be turned ready to compensate for changes in wind direction during a long series of comparisons. Since the duration of individual tests can be varied at will, samples can be made as large as necessary to suit available analytical equipment.

There are, in addition, certain limitations to the method. Since the sprayer is stationary during the test period, the spray boom will not be subjected to random accelerations which could be expected in normal use, and which may affect the performance of the spray. A second limitation is that the method is obviously incapable of being used in the evaluation of aircraft applications. A third limitation is that this test method will not show the effects on the spray deposit pattern of additives or other modifications to the spray. Although consideration of the deposit pattern may not, at first, appear germane to a drift study, it cannot be completely ignored since a modification which controls drift at the expense of coverage can hardly be considered feasible. Finally, because of the simplicity of the sampling array used by the author, the total amount of material drifting could not be determined with any degree of accuracy. However, this problem could likely be solved, if necessary, by the use of more samplers in a small but dense array.

CONCLUSIONS

The method described, of sampling drift from stationary ground sprayers by a small sampling array, has enabled the author to carry out comparative drift studies which would have been impossible using standard methods in consideration of time and cost of labor and equipment. The method should provide manufacturers and others with a rapid and inexpensive method for the screening of drift-reducing additives and modifications to ground spraying equipment.