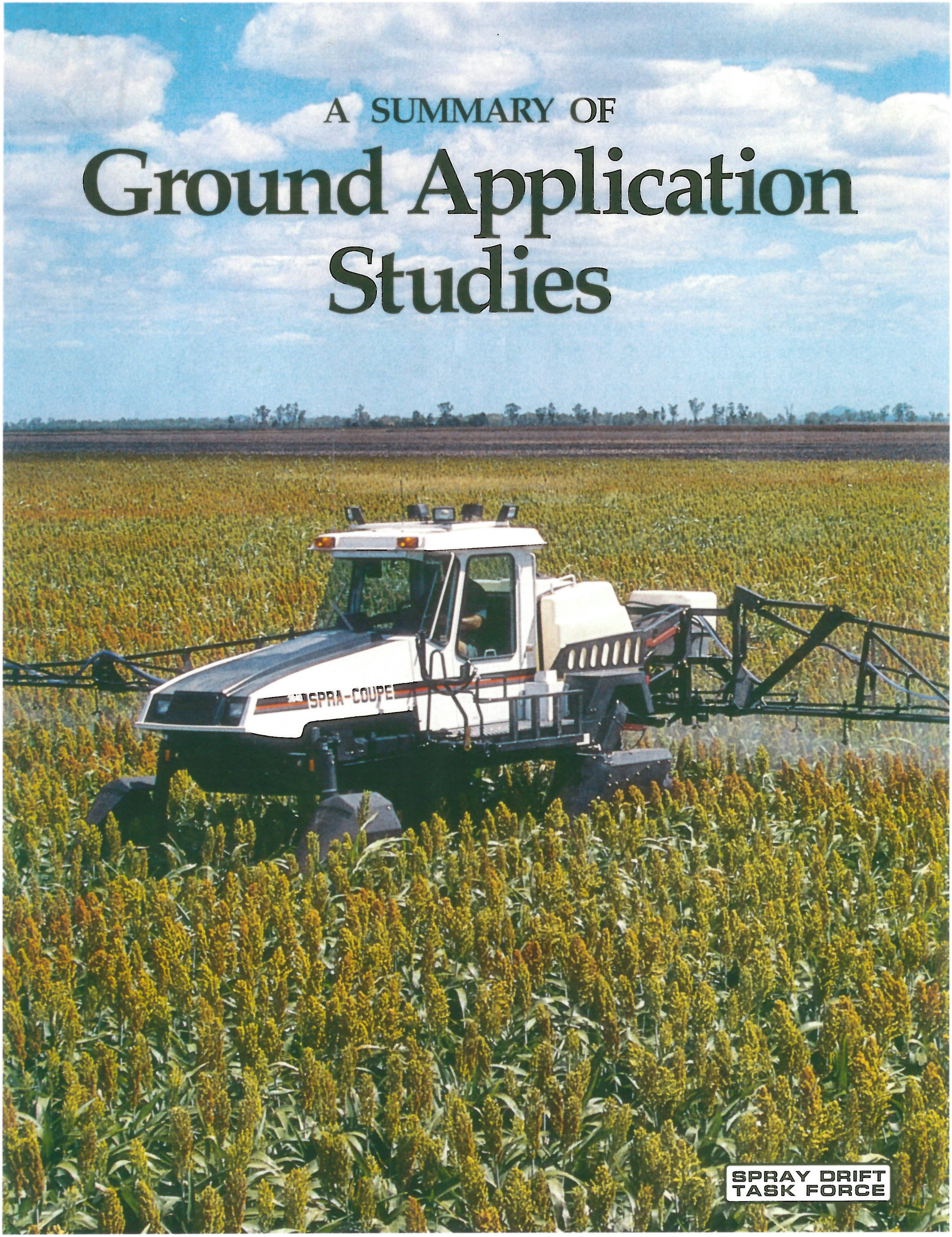
A SUMMARY OF

Ground Application Studies



SPRAY DRIFT TASK FORCE

Introduction

The incidence and impact of spray drift can be minimized by proper equipment selection and setup, and good application technique. Although the Spray Drift Task Force (SDTF) studies were conducted to support product registration, they provide substantial information that can be used to minimize the incidence and impact of spray drift. The purpose of this report is to describe the SDTF ground hydraulic application studies, and to raise the level of understanding about the factors that affect spray drift.

The SDTF is a consortium of 38 agricultural chemical companies established in 1990 in response to Environmental Protection Agency (EPA) spray drift data requirements. Data were generated to support the re-registration of approximately 2,000 existing products and the registration of future products from SDTF member companies. The studies were designed and conducted in consultation with scientists at universities, research institutions, and the EPA.

The purpose of the SDTF studies was to quantify primary spray drift from aerial, ground hydraulic, airblast and chemigation applications. Using a common experimental design, more than 300 applications were made in 10 field studies covering a range of application practices for each type of application.

The data generated in the field studies were used to establish quantitative databases which, when accepted by EPA, will be used to conduct environmental risk assessments. These databases are also being used to validate computer models that the EPA can use in lieu of directly accessing the databases. The models will provide a much faster way to estimate drift, and will cover a wider range of application scenarios than tested in the field studies. The models are being jointly developed by the EPA, SDTF, and United States Department of Agriculture (USDA).

Overall, the SDTF studies confirm conventional knowledge on the relative role of the factors that affect spray drift. Droplet size was confirmed to be the most important factor. The studies also confirmed that the active ingredient does not significantly affect spray drift. The physical properties of the spray mixture generally have a small effect relative to the combined effects of equipment parameters, application technique, and the weather. This confirmed that spray drift is primarily a generic phenomenon, and justified use of a common set of databases and models for all products. The SDTF developed an extensive database and model quantifying how the liquid physical properties of the spray mixture affect droplet size.

The SDTF measured primary spray drift, the off-site movement of spray droplets before deposition. It did not cover vapor drift, or any other form of secondary drift (after deposition), because secondary drift is predominantly specific to the active ingredient.

Prior to initiating the studies, the SDTF consulted with technical experts from research institutions around the world and compiled a list of 2,500 drift-related studies from the scientific literature. Because of differing techniques, it was difficult to compare results across the studies. However, the information from these references was useful in developing test protocols that were consistently followed throughout the field studies.

The objective of the ground hydraulic studies was to develop a generic database for evaluating the effects on drift from the range of equipment combinations, atmospheric conditions and pesticide spray mixtures used by applicators.

The information being presented is not an in-depth presentation of all data generated by the SDTF. Use of pesticide products is strictly governed by label instructions. Always read and follow the label directions.

Procedures

Test site location and layout

The site chosen on the High Plains of Texas near Plainview afforded open expanses, up to one-quarter mile downwind from the application area, and a wide range of weather conditions. Wind speeds varied from 5 to 20 mph, air temperatures varied from 44° F to 91° F, and relative humidity varied from 8% to 82%. A control treatment, applied successively with each variable treatment, helped to define affects due to the weather.

Aerial View of Test Site

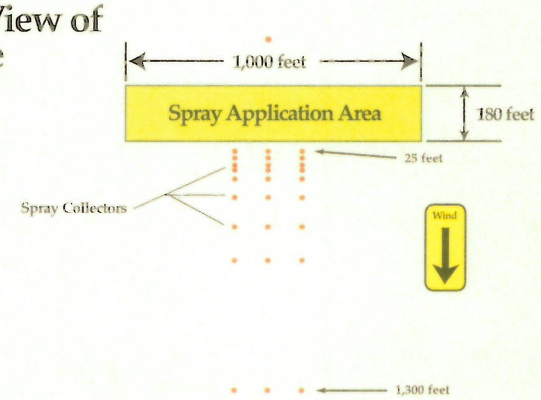


figure 1

The test application area measured 1,000 feet in length and 180 feet in width (figure 1). Four 45-foot wide parallel swaths were sprayed going from left-to-right and right-to-left using a Melroe Spra-Coupe®. Three lines of horizontal alpha-cellulose cards (absorbent material similar to thick blotting paper) were placed on the ground at 9 selected intervals from 25 feet to 1300 feet downwind from the edge of the application area. These collectors simulated the potential exposure of terrestrial and aquatic habitats to drift. A collector was also positioned upwind from the application area to verify that drift only occurs in a downwind direction.

Relating droplet size spectra to drift

All agricultural nozzles produce a range of droplet sizes known as the droplet size spectrum. In order to measure the droplet size spectrum that was applied in each field study treatment (and that represent those produced from commercial applications), the critical application parameters (nozzle type, orifice size, and pressure) were duplicated in an extensive series of atomization tests conducted in a wind tunnel. The controlled conditions of the wind tunnel allowed the droplet size spectrum to be accurately measured using a laser particle measuring instrument.

The volume median diameter (VMD) is commonly used to characterize droplet size spectra. It is the droplet size at which half the spray volume is composed of larger droplets and half is composed of smaller droplets. Although VMD is useful for characterizing the entire droplet spectrum, it is not the best indicator of drift potential.

A more useful measure for evaluating drift potential is the percentage of spray volume consisting of droplets less than 141 microns in diameter. This value was selected because of the characteristics of the particle-measuring instrument, and because it is close to 150 microns which is commonly considered a point below which droplets are more prone to drift.

The cut-off point of 141, or 150 microns, has been established as a guide to indicate which droplet sizes are most prone to drift. However, it is important to recognize that drift doesn't start and stop at 141 microns. Drift potential continually increases as droplets get smaller than 141 microns, and continually decreases as droplets get bigger.

The wind tunnel atomization tests verified that a broad range of droplet size spectra was applied in the field study treatments. This information was critical to understanding the differences in spray drift that were measured for each field study treatment.

The SDTF atomization studies also verified that the physical properties of the spray mixture have only a minimal affect on the droplet size spectrum from ground hydraulic nozzles relative to the effects of nozzle parameters. Any small differences in droplet size due to differences in physical properties would not be expected to significantly affect drift.

Test application variables

Nozzle type, orifice size and spray pressure are equipment factors that affect the droplet size spectrum for ground hydraulic sprayers. These factors were varied in the SDTF studies to provide a range of droplet size spectra similar to those used by applicators in the field (table 1).

- *8010LP* flat fan nozzle at 20 pounds per square inch (psi) pressure produced the coarsest droplet spectrum. It represented high-volume custom sprayers such as those used for turf and right-of-way applications.

- *8004LP* flat fan nozzle at 20 psi pressure produced a finer droplet spectrum than the 8010LP nozzles, but a coarser droplet spectrum than the 8004 at 40 psi. The 8004LP is a low pressure equivalent of the 8004, thus any difference in droplet size is due primarily to the lower pressure.

Nozzle	Pressure (psi)	VMD (microns)	Volume < 141 microns (%)
8010LP	20	762	1
8004LP	20	486	2
8004	40	341	7
TX6	55	175	26

table 1

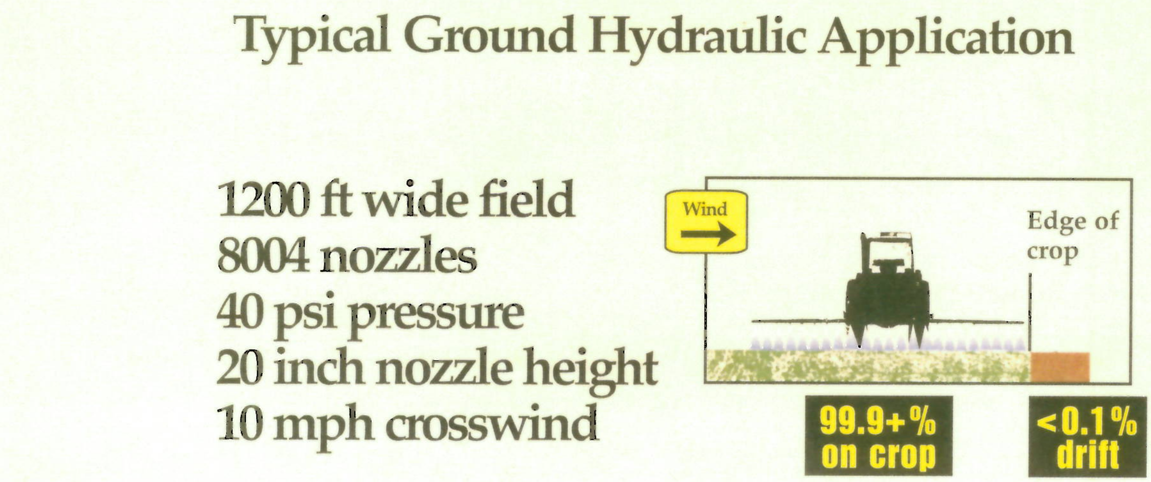


figure 2

• ***8004*** flat fan nozzle at 40 psi pressure produced a finer droplet spectrum than the 8004LP, but a coarser spectrum than the TX6. It is widely used for agricultural applications.

• ***TX6*** hollow cone nozzle at 55 psi pressure produced the finest droplet spectrum. These nozzles are commonly used to enhance penetration of insecticides and fungicides into a crop canopy. The TX6 also represents the fine droplet spectra from low volume applications.

Spray boom heights of 20 inches (typical for most agricultural applications) and 50 inches (the greatest height that could be attained with the Melroe Spra-Coupe) were evaluated for every nozzle except the 8004LP. Applications at speeds of 5 mph and 15 mph were evaluated, but are not discussed further since they were found to have no significant effect on drift.

Findings

Typical drift levels from ground hydraulic applications

The goal of ground applicators is to protect crops from diseases, insects, and weeds while keeping drift as close to zero as possible. The SDTF studies show that drift can be kept very low by using good application procedures.

Based on data generated by the SDTF, in a typical full field ground hydraulic application, more than 99.9 percent of the applied active ingredient stays on the field and less than one tenth of one percent drifts (figure 2). A typical application was defined as a 1200-foot wide, 20-swath field (suggested by the EPA), using 8004 flat fan nozzles at 40 psi, a 20-inch nozzle height, and a 10 mph crosswind.

Although ground hydraulic applications typically consist of a 1200-foot wide application area, using fields of this size was not practical. Instead, a four-swath (180 feet wide) application area was used in the field studies. This design generated data that represented drift from a 20-swath field, since most drift originates from the farthest downwind swaths.

Because the application area was smaller than is typical for commercial applications, and because most drift comes from the outer swaths of the field, the percentage of the active ingredient leaving the field in the SDTF studies was slightly higher than the typical full field application, but was still only about 0.5% (figure 3). This percentage of drift is artificially high due to the relative size of the application areas. The 0.5% drift is calculated from the average of 24 applications of the control treatment. The SDTF control application differed from the typical application only in the size of the application area.

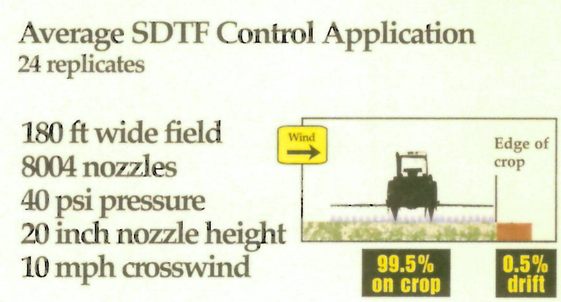


figure 3

Figure 4 shows how the 0.5% of the control treatment that left the field deposited downwind. The amount of material that deposited on the ground decreased rapidly with distance. Ground deposition was measured out to one quarter mile downwind, but data are only presented for the first 300 feet to better illustrate the differences in drift between treatments. At 300 feet, the amount of ground deposition was already extremely low. Ground deposition measurements began 25 feet downwind, which represents a reasonable distance from the edge of a crop to the effective edge of a field where drift would begin to be of concern.

A scale of Relative Drift is used in this and all subsequent graphs to facilitate comparisons among treatments. Since the control treatment will be used as a standard of comparison, it was set to 1.0 at 25 feet. For an application of one pound of active ingredient per acre, this represents only 0.08 ounce per acre deposited on the ground at 25 feet. A Relative Drift value of 0.5 indicates that one-half as much was deposited. A value of 2.0 indicates that twice as much was deposited. In subsequent graphs the deposition profile for the control treatment is shown in red in order to facilitate comparisons.

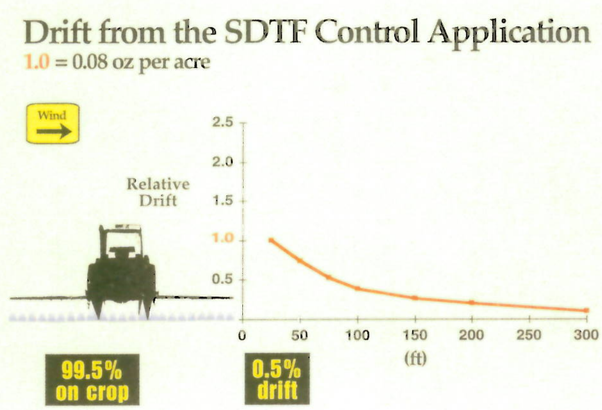


figure 4

How droplet size affects drift

The effect of droplet size on downwind ground deposition is illustrated in figure 5. Ground deposition from all four nozzles at the 20-inch boom height was

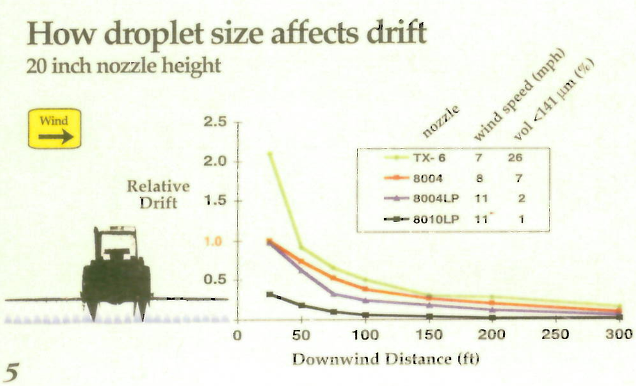


figure 5

low. As expected, there was a strong correlation between the volume less than 141 microns, and drift. In 7 mph to 8 mph winds, drift from the TX6 nozzle was greater than from the 8004 nozzle. In 11 mph winds, drift from the 8004LP nozzle was greater than from the 8010LP nozzles. Even though the wind speed was lower, drift was greater from the TX6 and 8004 than from the 8004LP and 8010LP nozzles. The largest difference in drift was between the TX6 and the other nozzles. This corresponded to the difference in the volume of droplets less than 141 microns.

How droplet size and wind speed affect drift

Wind speed significantly increased drift only for the TX6 nozzle, which produced the finest droplet spectrum (figure 6). For nozzles producing coarser droplet spectra (illustrated by the 8004LP), there was essentially no difference in drift between 8 mph and 16 mph winds.

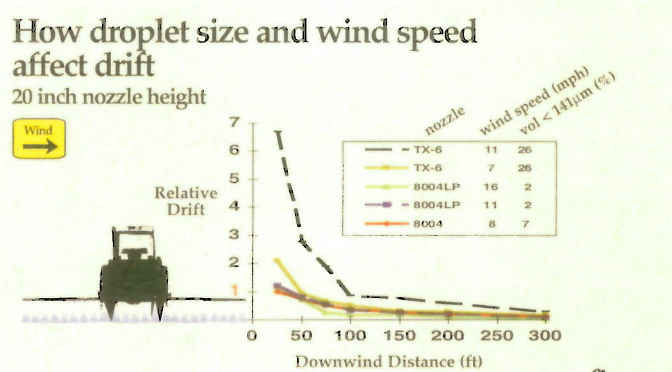


figure 6

In the scientific literature, there are correlations between wind speed and drift for ground hydraulic sprayers. However, except for the TX6 nozzle, the SDTF studies found no correlation between wind speed and drift. This apparent discrepancy is probably due to differences in the distance at which ground deposition measurements began. In the literature, correlations are usually based on drift from 0 feet to 25 feet downwind, where most of the drift occurs. In the SDTF studies, downwind deposition measurements began at 25 feet from the edge of the application area.

How nozzle height affects drift

Regardless of the droplet size spectrum, ground deposition from the 50-inch boom height was always greater than from the 20-inch height. The effect of nozzle height is illustrated for the coarsest (8010LP) and finest (TX6) droplet size spectrum in figures 7 and 8, respectively . Although drift was higher with the 50 inch boom height for both nozzles, the difference was much greater for the TX6, and was evident at greater distances downwind. This was due to the much finer droplet size spectrum compared to the 8010LP nozzle. At 25 feet downwind, the TX6 nozzle at 50 inches resulted in almost three times higher deposition than at 20 inches. This was approximately seven times higher deposition than the control treatment. These results illustrate the need to keep all nozzles, particularly those producing fine droplet spectra, at the lowest possible height that provides uniform coverage.

How nozzle height affects drift

8010LP nozzle

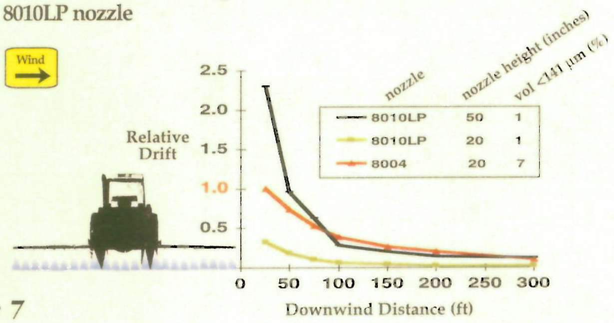


figure 7

How nozzle height affects drift

TX-6 nozzle

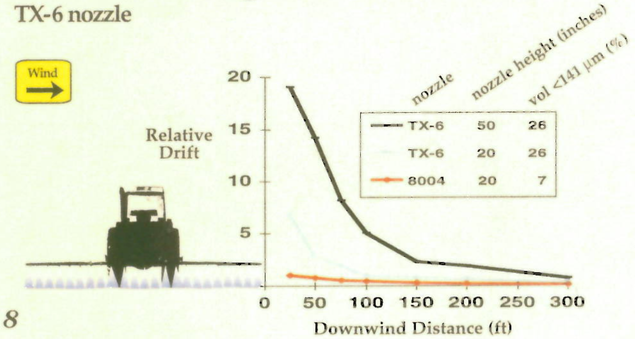


figure 8

Conclusions

The results from the SDTF studies confirm conventional knowledge concerning the role of factors that affect spray drift. In many cases the studies quantified what was already known qualitatively. As expected, droplet size was shown to be the most important factor affecting drift from ground applications. Logically, the results also confirm that drift only occurs downwind. Waiting until the wind is blowing away from sensitive areas is an effective application practice. Although drift cannot be eliminated totally with current technology, there are many ways to minimize drift to levels approaching zero. The SDTF studies confirm that when good application practices are followed, all but a small percentage of the spray is deposited on target.

Drift levels can be minimized by:

a. Applying the coarsest droplet size spectrum that provides sufficient coverage and pest control.

b. Using the lowest nozzle height that provides uniform coverage.

c. Applying pesticides when wind speeds are low and consistent in direction.

When accepted by the EPA, the SDTF model and databases will be used by the agricultural chemical industry and the EPA in environmental risk assessments. Even though active ingredients do not differ in drift potential, they can differ in the potential to cause adverse environmental effects. Since drift cannot be completely eliminated with current technology, the SDTF databases and models will be used to determine if the drift from each agricultural product is low enough to avoid harmful environmental effects. When drift cannot be reduced to low enough levels through altering equipment set up and application techniques, buffer zones may be imposed to protect sensitive areas downwind of applications.

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