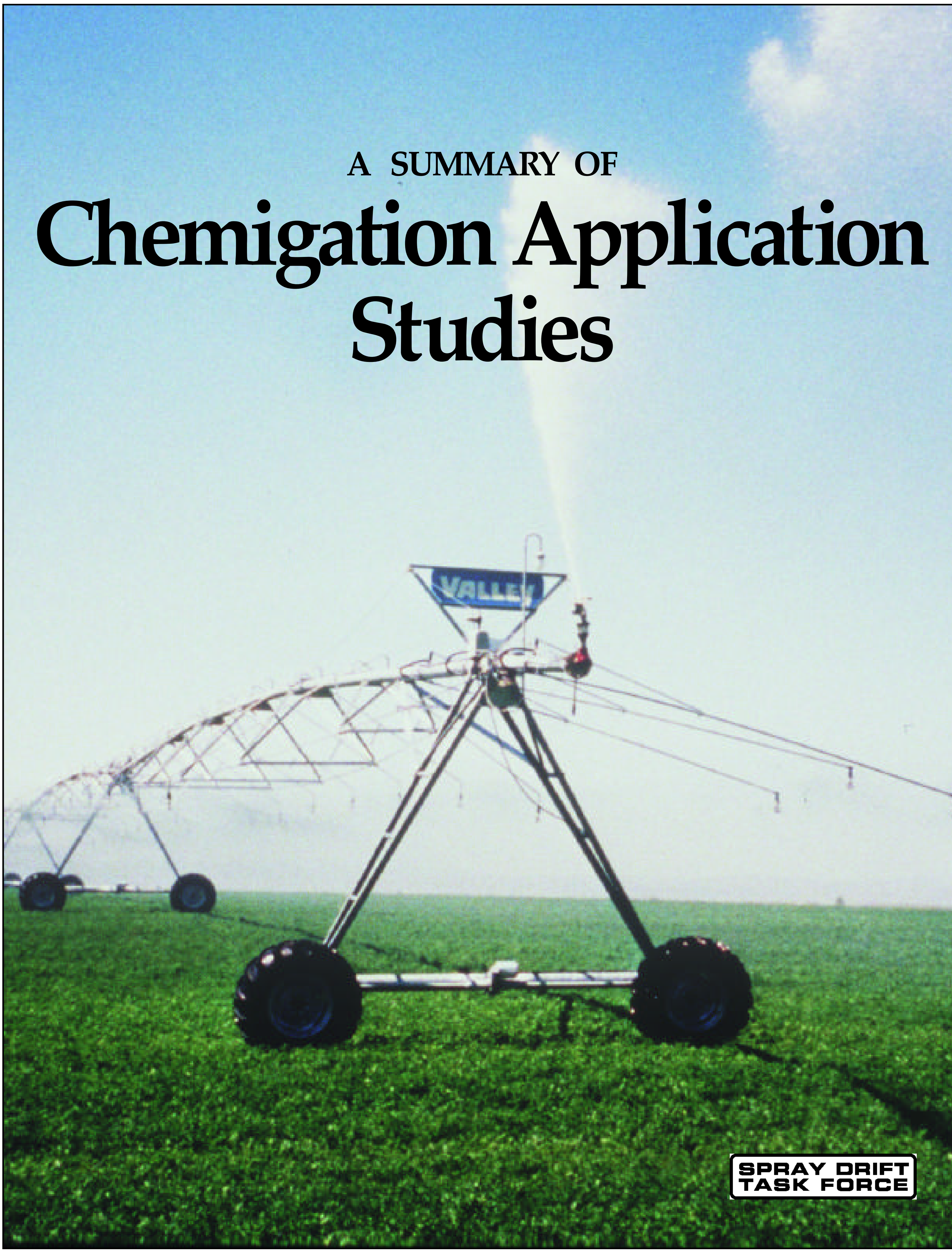
A SUMMARY OF

Chemigation 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 chemigation 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 EPAcan 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. 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 chemigation studies was to develop a database for evaluating the effects on drift from low and high pressure irrigation systems, with and without end guns, over a range of atmospheric conditions.

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 chemigation studies were conducted in central Washington state near Moses Lake. A center-pivot sprinkler irrigation system with a 623-foot radius covering 28 acres was used in all the field studies (figure 1).

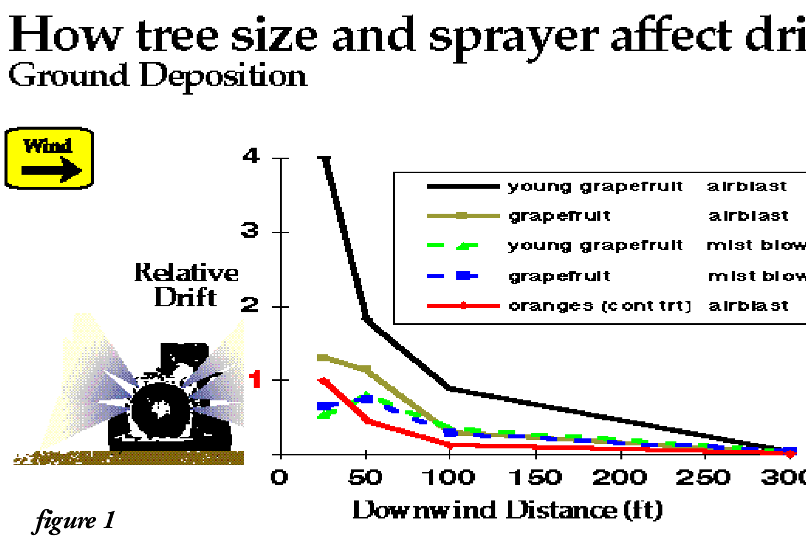


figure 1

For each treatment, the downwind quarter of the circle was irrigated during a 90-minute span, at an application rate of 0.1 acre inches of water. The quarter-circle application area was representative of the whole circle, since drift from the remainder of the circle would be negligible due to the distance from the downwind collectors.

When an end gun was operated as part of the system, the radius of the irrigated area increased to 655 feet (36 acres). The system was configured so that applications typical of high and low pressure systems could be made, with or without an end gun. Acritical difference between the systems was that the spray release height for the high pressure system and the end guns was 12 feet, compared to only 5 feet in the low pressure system.

Horizontal alpha-cellulose cards (absorbent material similar to thick blotting paper) were placed on the ground at nine selected intervals from 50 feet to 1,000 feet downwind from the edge of the application area (figure 1). These collectors simulated the potential exposure of terrestrial and aquatic habitats to drift. One collector was also positioned directly upwind from the center pivot to verify that drift only occurs in a downwind direction.

Relating droplet size spectra to drift

All irrigation nozzles produce a range of droplet sizes known as the droplet size spectrum. In order to measure the droplet size spectrum applied in the field study treatments, the impact sprinkler heads and rotary spinners used in the field studies were tested in a large, specially designed facility. The controlled conditions of the facility allowed the droplet size spectra to be accurately measured using a laser particle measuring instrument. It was not possible to measure the droplet size spectrum from the end gun, but it appeared to be coarser than that measured from the impact sprinklers of the high pressure system.

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.

Test application variables

The field studies consisted of four treatments: a high pressure system and a low pressure system, both with and without an end gun (table 1). The high pressure system was operated at 70 pounds per square inch (psi) with impact sprinklers located on top of the irrigation pipe, approximately 12 feet above the ground. The low pressure system was operated at 20 psi, with rotary spinners located approximately 5 feet above the ground.

Test Application Variables

	System Type*	
	High Pressure	Low Pressure
Pressure:	70 psi	20 psi
Sprinkler height:	12 feet	5 feet
Sprinkler type:	impact	rotary spinner
Volume <141 microns:	0.33%	1.3%
Volume Median Diameter: (VMD)	3,008 µm	1,690 µm

*With and without an end gun

table 1

Findings

Typical drift levels from chemigation

Based on data generated by the SDTF, in a typical chemigation application (160 acre field, high pressure system with end gun, 5 mph wind), more than 99% of the applied active ingredient stays on the field, and less than one percent drifts (figure 2).
In the SDTF studies it was not practical to apply to an entire 160 acre field due to the potential for changes in

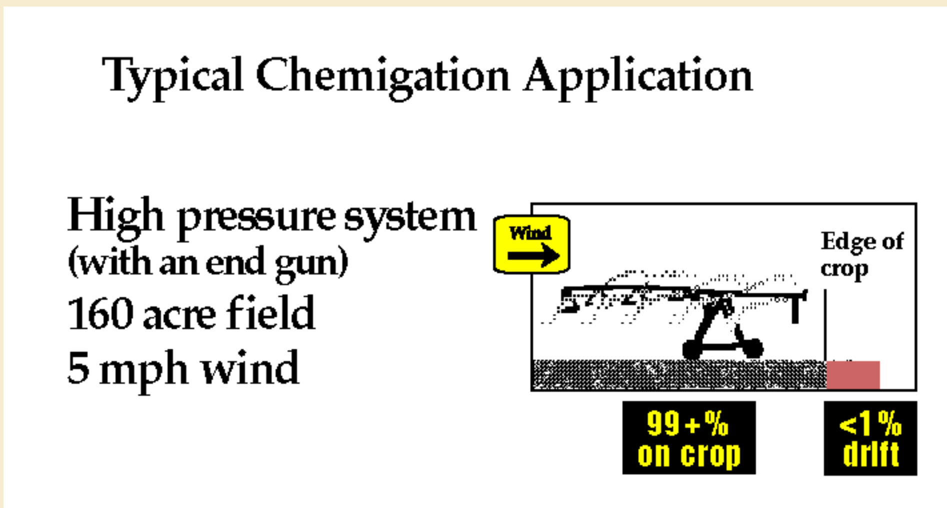


figure 2

wind speed and direction during the time required for the irrigation system to travel a full circle. It was also not necessary because virtually all of the drift comes from the outside edge of the downwind portion of the circle. Therefore, applications were made only to the downwind quarter of the circle covering a 40 acre field.

Because the application area was smaller than a typical field, and because most of the drift comes from the outside edge of the downwind quarter of the irrigated circle, the percent of the active ingredient leaving the field is artificially high. Therefore, for the control treatment, the percent of the total active ingredient applied that drifted was approximately 2% rather than less than 1% for a typical application (figure 3). The only difference between the typical and control applications was the size of the application area (160 acres versus 40 acres). The high pressure system with end gun, 40 acre field, and 5 mph wind was chosen as the control because it represented an intermediate level of drift relative to the other SDTF treatments. It is used as a standard for comparison throughout this report.

Figure 4 shows how the 2% of the applied active ingredient that left the field in the SDTF control

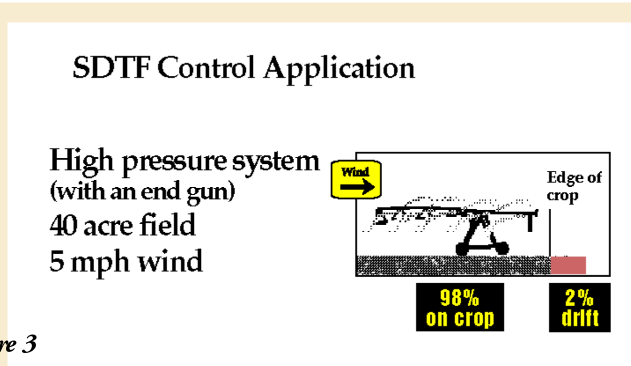


figure 3

application deposited downwind. The amount of ground deposition decreased rapidly with distance and was already approaching zero at 150 feet downwind. Drift was measured up to 1000 feet 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 50 feet

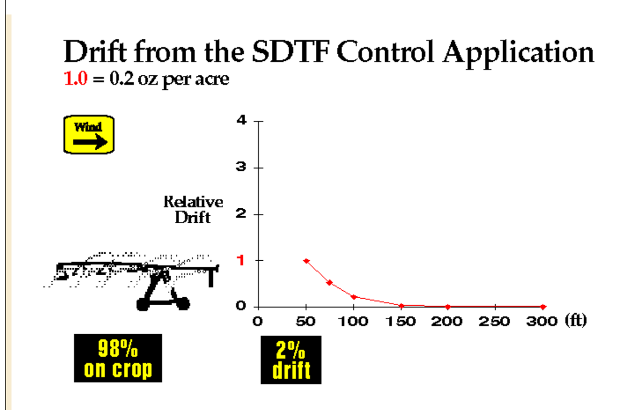


figure 4

downwind from the end of the irrigation system. This distance was necessary to allow for normal variation in the size of the wetted circle inherent to impact sprinkler systems (without the effects of wind). The 50-foot distance ensured that only drift was being measured.

Ascale of Relative Drift is used in this and all subsequent graphs to facilitate comparisons among treatments. Since the SDTF control treatment will be used as a standard of comparison, it was set to 1.0 at 50 feet. For an application of one pound of active ingredient per acre, this represents 0.2 ounce per acre deposited on the ground at 50 feet. ARelative Drift value of 0.5 indicates that one-half as much was deposited. Avalue of 2.0 indicates twice as much was deposited. In subsequent graphs, the deposition profile for the control treatment is shown in red in order to facilitate comparisons.

How droplet size affects drift

The VMD was 1690 microns for the rotary spinner nozzles on the low pressure system, and was 3008 microns for the impact sprinklers on the high pressure system (table 1). The volume of droplets less than 141 microns was 1.3% for the low pressure spinners, and 0.33% for the high pressure sprinklers. Although there was a significant difference between these droplet spectra, the volume of small, drift prone droplets was too low for either system to have a measurable affect on drift.

How sprinkler height affected drift

In 9 mph to 11 mph winds, with no end gun, drift levels were higher from the high pressure sprinklers at 12 feet than from the low pressure spinners at 5 feet (figure 5). When wind speeds were 2 mph to 3 mph, drift levels from both systems were very low, and were not significantly different.

With end guns, drift levels from the high-pressure system (sprinklers at 12 feet) were only slightly higher than from the low pressure system (rotary spinners at 5 feet) in 9 mph winds (figure 6). In 5 mph to 6 mph winds, there was virtually no difference in drift between the two systems. This is because most of the drift came from the end gun which was located at 12 feet on both systems. Higher droplet trajectories and spray velocities leaving the impact sprinklers and end guns may also have

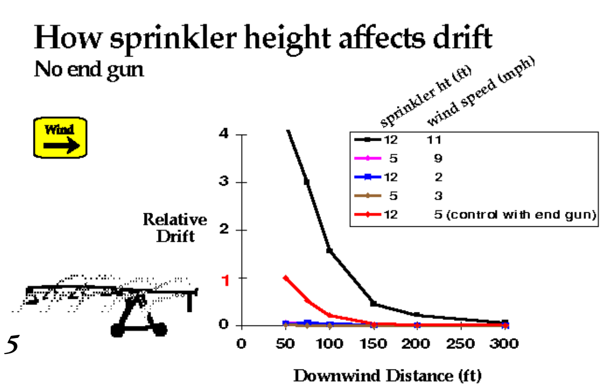


figure 5

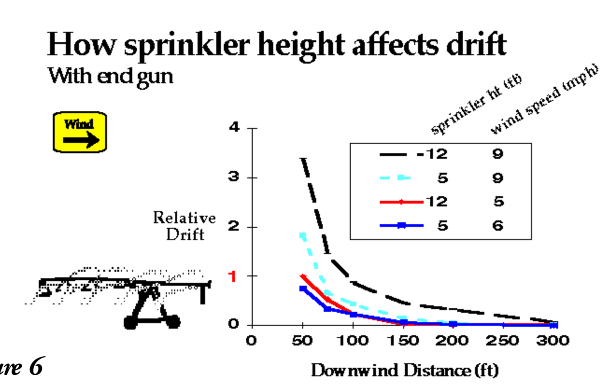


figure 6

contributed to the greater drift levels.

How end guns affect drift

In the high pressure system, which produced the most drift, the addition of an end gun increased drift only slightly (figure 7). Since droplets were already released at 12 feet, the addition of the end gun had only a relatively small additive affect. The addition of an end gun had a much greater effect for the low pressure system because it increased the release height to 12 feet at the outside of the circle from where the majority of drifting droplets originated.

How wind speed affects drift

In the high pressure system, with or without an end

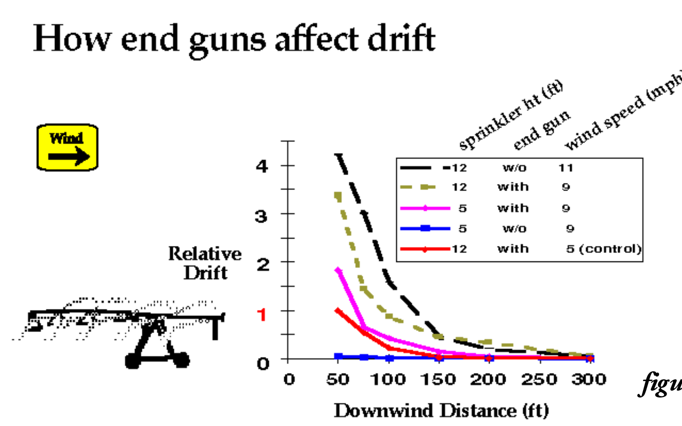


figure 7

gun, there was a direct correlation between wind speed and drift. Ground deposition decreased as wind speeds dropped from 11 mph to 2 mph (figure 8).

In the low pressure system, wind speed only affected drift when there was an end gun (12-foot release height). With no end gun, all droplets were released at

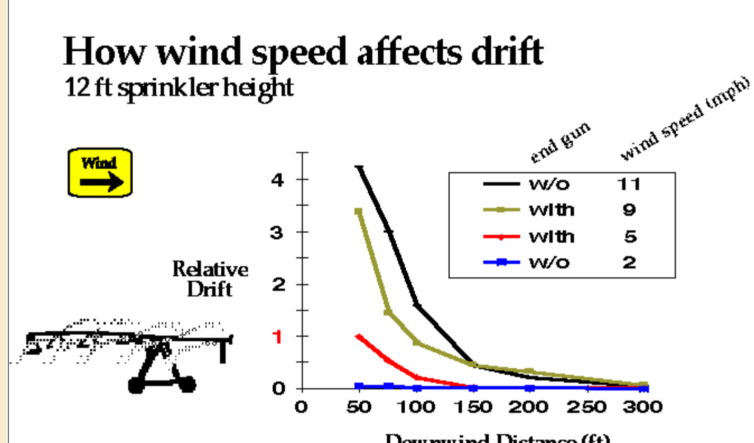


figure 8

How wind speed affects drift

5 ft sprinkler height

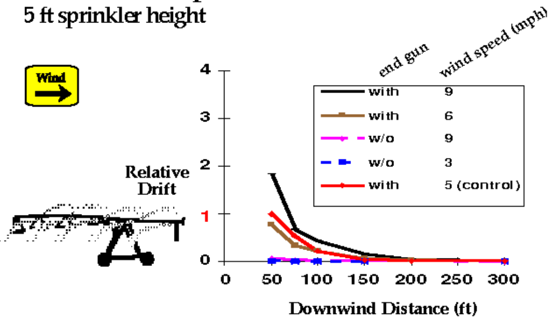


figure 9

the 5-foot height and drift levels were very low, with no significant differences in downwind deposition between 3 mph and 9 mph winds (figure 9).

Conclusions

The level of drift from chemigation is very low because center pivot irrigation systems produce a very low level of small, drift-prone droplets (<141 microns). Drift from the high pressure system was greater than from the low pressure system primarily because of the higher release height of the droplets. The addition of an end gun to the high pressure system did not have a large additive affect on drift because droplets were already being released at 12 feet. However, addition of an end gun to the low pressure system substantially increased drift, bringing it to levels approaching the high pressure system. Wind speeds between 2 mph and 12 mph only had a significant affect on drift when droplets were released at 12 feet from the sprinklers of the high pressure system, or from an end gun. Under the range of wind speeds experienced in this study, the lowest levels of drift were measured from the low pressure system without end guns.

When accepted by the EPA, the SDTF model and databases will be used by the agricultural chemical industry and the EPAin 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 database 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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For more information contact David Johnson at Stewart Agricultural Research Services, Inc., P.O. Box 509, Macon, Missouri 63552. (816) 762-4240 or fax (816) 762-4295. (Area code changes to 660 after 11-97)