THE EFFECT OF SPRAY MIX ADJUVANTS ON SPRAY DRIFT

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Abstract


Numerous drift reduction adjuvants and spray deposition aids are available to applicators of crop production and protection chemicals. Performance of many of the newly introduced drift control adjuvants has not been well documented for ground application. Tree drift control adjuvants were selected for drift studies in ar assisted applications. Deposition and downwind drift in a vineyard canopy were collected on Filter papers for measurement and analysis. The deposition was highly correlated to the drift distance and treatments or adjuvants. Treatment and distance had significant effects on deposition. The filter papers detected essentially no droplet depositions beyond the 24 m. All the treatments had similar deposition values from 6th and 9th m. The results will aid applicators in selecting drift reduction agents to meet the drift mitigation criterion for a given application.

Key words: air assited, spray, drift, adjuvant, deposit

Introduction

Spray drift from the application of pesticides has been recognized as a concern for the environment. Even though a better understanding of the variables associated with spray drift exists, it is still a challenging and complex research topic. Environmental variables, equipment design issues, many application parameters, and numerous interactions make it difficult to completely understand drift related issues (Smith et al., 2000; Wolf et al., 2005). Spray droplet size has long been recognized as the most important variable that applicators can influence to mitigate spray drift from the application site (Bird et al., 1996; Anon., 1997). Sprays with coarse droplet spectra drift less than sprays with fine droplet spectra, but applicators must also consider droplet size for optimum efficacy of the applied material. Spray nozzle selection is an important factor for spraying to consider in determining spray droplet size or spectrum. Other factors are deflector angle, sprayer speed and spray pressure (Celen, 2008; Celen et al., 2008). The auxiliary factor often considered for drift reduction by aerial applicators, after nozzle selection and operation, is spray mix additives or adjuvants. Materials added to aerial spray tank mixes that alter the physical properties of the spray mixture affect the droplet size spectrum (Hoffmann et al., 2003).

By the 1960s, manufacturers already had produced thousands of different adjuvants, for both industrial and agricultural purposes. Today, the agricultural and horticultural industries are being overwhelmed by adjuvant choices. Spray application is perhaps the weakest link in the chain of events a pesticide follows through

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its development process. Some researchers claim that up to 70 percent of the effectiveness of a pesticide depends on the effectiveness of the spray application. Adjuvants can minimize or eliminate many spray application problems associated with pesticide stability, solubility, incompatibility, suspension, foaming, drift, evaporation, volatilization, degradation, adherence, penetration, surface tension, and coverage. Adjuvants are designed to perform specific functions, including wetting, spreading, sticking, reducing evaporation, reducing volatilization, buffering, emulsifying, dispersing, reducing spray drift, and reducing foaming. No single adjuvant can perform all these functions, but different compatible adjuvants often can be combined to perform multiple functions simultaneously (Hock, 1998).

There are many types of spray adjuvants with classifications such as surfactants, spreaders, stickers, deposition aids, activators, humectants, antifoamers, wetting agents, and drift reduction agents. Soaps and oils of various types were some of the materials first used as spray adjuvants, but products designed and formulated for specific purposes have been available for several years. Spray drift became a significant issue with the introduction and use of phenoxy herbicides and the associated off-target damage to sensitive vegetation. Spray drift continues as an industry issue with enhanced concerns about environmental trespass, threatened and endangered species, and associated regulatory actions (Mulkey, 2001).

Water soluble synthetic polymers were the dominant components of most of the adjuvants that were first designed and marketed for spray drift control (Bouse et al., 1988). These materials were generally effective in increasing the average spray droplet size and sometimes, but not always, in reducing the content of fine droplets that are more prone to drift from the application site. More recently, natural and other polymers, often formulated as dry materials have been marketed for spray drift reduction. Guler et al. (2006) did laboratory study and found both nonionic colloidal and polyvinyl polymer drift retardants reduced the drift potential compared to the spray carrier containing water only. There is limited technical literature on aerial performance of the newer drift reduction adjuvants (Hewitt, 2003; Kirk, 2003; Wolf et al., 2002, 2003, 2005), since much of the previous research has focused on ground application systems.

Adjuvants are the best tools to control the physical and chemical properties of sprays and improve pesticide performance. The value of adjuvants is now recognised with all pesticide types and their use will increase, especially with insecticides and fungicides. Successful products will be easy to use and cost effective. Adjuvant technology is rapidly evolving and their future depends on the resolution of several apparent dichotomies (Green, 2000).

The aim of this study was to measure the effect of different spray adjuvants on the downwind deposition.

Materials and Methods

All tests were conducted in 2008 on a vineyard trained to spur-pruned cordon with 3.0 m row spacing and distance between plants of 1.5 m. Cordon height was 1.2 m. The measurements were taken at July vine growth stages.

A total four tests were conducted with the average canopy characteristics from three plants at nine locations measured at the time of each tests are shown in Table 1.

The deposition and downwind movement of applied material released from the air assisted sprayer were measured. Sampling stations were placed perpendicular to rows. Sprayer was driven perpendicular to the wind (Figure 1). There were three sampling lines (A-B-C) for each distance. Lines were located 3rd m, 6th m, 9th m, 15th m and 24th m. At each line filter papers were placed at different height (a: 35, b: 70, c: 110 and d: 175 cm).

The air assisted sprayer used for the trials was a pre-industrial version of the one developed at the Viticultural Research Institute of Tekirdag. It was a double-row, mounted type, machine with a spraying section composed of a 400 L polythene tank, membrane pump, and constant pressure regulator. The sprayer was attached to a 55 kW tractor, and the
forward speed was a constant 6 km h\(^{-1}\) in all the field trials. Spray application treatments used TXVK-8 Hollow cone spray tips (Spraying systems Co.) set to the number 10 and 75 degree deflection. All tests were made using a tractor operated 6 km/h and a spray pressure of 3 bar. Each treatment was replicated three times over a vineyard canopy with each replication consisting of one spray pass with the right way on the downwind side.

Three adjuvants were used in this study (Table 2). The spray solution consisted of water, EC blank formulation, fluorescent dye (2 g/lt) and a spray adjuvant. The Tartrazine was used as tracer to measure the deposition and downwind movement of the spray during the tests (Celen et al., 2008). For each spray treatment, sprayer was loaded with 400 liter of spray containing 80 g of dye. Tank mixture consisted of 90% water.

### Table 1
The average canopy characteristics from three plants at sampling lines

<table>
<thead>
<tr>
<th>Location, cm</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>15</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max plant height, cm</td>
<td>180</td>
<td>178</td>
<td>185</td>
<td>183</td>
<td>177</td>
<td>180</td>
</tr>
<tr>
<td>Max plant width, cm</td>
<td>59</td>
<td>69</td>
<td>61</td>
<td>76</td>
<td>64</td>
<td>62</td>
</tr>
</tbody>
</table>

### Table 2
Three Adjuvants were used in this study (www.herbicide-adjuvants.com)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Product name</th>
<th>Company</th>
<th>Adjuvant category</th>
<th>Principal functioning agents</th>
<th>Use range, g/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Extra point</td>
<td>Big rivers Agri supply</td>
<td>Deposition (Drift control) and/or retention agent plus ammonium sulfate and defoamer and buffering agent or acidifier and nitrogen source</td>
<td>Ammonium sulfate, HPG polymer, dimethylpolysiloxane</td>
<td>2.9-5.9</td>
</tr>
<tr>
<td>T2</td>
<td>Drift guard</td>
<td>Rosen’s, Inc.</td>
<td>Deposition (Drift control) and/or retention agent plus ammonium sulfate and defoamer and buffering agent or acidifier and nitrogen source and water conditioning agents</td>
<td>Proprietary blend of diammonium sulfate, rheologic modifying polymer and antifoam agent</td>
<td>10.8-16.8</td>
</tr>
<tr>
<td>T3</td>
<td>Amsurf</td>
<td>United Suppliers Inc</td>
<td>Surfactant plus Nitrogen Source</td>
<td>Premixed AMS, nonionic surfactant, and antifoaming agent</td>
<td>23.4</td>
</tr>
</tbody>
</table>
After each treatment replication, sufficient time was allowed for the spray material to move downwind and the material deposited on the filters to dry (approximately 5 min).

Each exposed filter (7.6 cm²) was placed in a labelled plastik box, stored and transported to the laboratory for quantification. The filter papers were exposed to sunlight for less than 15 min following an application; therefore, no appriciable degradation of the fluorescent dye would be expected. 20 ml of ethanol was pipetted into each box, the bags were agitiated and 6 mL of the effluent was poured into a cuvette. The cuvettes were then placed into a spectrophotometer (SHIMADZU co., 1208 Model UV-VIS) with an excitation wavelength of 400 nm. Fluoremetric readings were converted to μg of dye cm⁻².

Meteorological data were monitored through the study using a LUTRON AM-4202 and a TESTO 605-H1 temperature and relative humidity probe mounted in a shield. They were mounted on a stand and set 2 m above top of canopy. They were located approximately 20 m downwind of the tractor line. Data was collected averaged based on a 15 min time period corresponding to 5 min prior to application and 5 min following application.

All statistical analyses were performed using SPSS statistical programme. Treatment means in 3-6-9-15-25 m for deposition, as measured were separated by LSD Test (α=0.05)

**Results and Discussion**

Meteorological values and Leaf area index (LAI) are presented in Table 3.

<table>
<thead>
<tr>
<th>Trial date (2008)</th>
<th>19 July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature, °C</td>
<td>25</td>
</tr>
<tr>
<td>Relative humidity, %</td>
<td>69</td>
</tr>
<tr>
<td>Wind speed, m s⁻¹</td>
<td>2.1</td>
</tr>
<tr>
<td>Leaf area index, m² m⁻²</td>
<td>0.78</td>
</tr>
</tbody>
</table>

The filter papers detected essentially no droplet depositions beyond the 24 m (Figure 2). Treatments 2 had the least deposition 15th m. Treatment 3 resulted in the greatest downwind deposition, followed by treatments 1. All the treatments had similar deposition values from 6th and 9th m.

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**Table 3**

**Vineyard characteristics and environmental conditions**

<table>
<thead>
<tr>
<th>Temperature, °C</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative humidity, %</td>
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</tr>
<tr>
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<td>Leaf area index, m² m⁻²</td>
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</tr>
</tbody>
</table>

**Fig. 2. The deposition values at 0-3-6-9-15-24 m and different heights (a-b-c-d)**
The deposition values by height by treatment from the first plant row are shown in Figure 2. The values decreased as height increased. Treatment 2 resulted in highest deposition on ground on first row. Treatment 1 resulted in lowest deposition at 175 cm on first row.

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![Graph: Deposition values by height by treatment from the first plant row]

**Fig. 3.** The deposition values by height by treatment from the first plant row

The deposition generally decreased as distance downwind from the spray increased. Means separation results from LSD values for deposition are calculated. LSD test results showed that Treatment (LSD 1.16) and distance (LSD 4.021) effects on deposition were highly significant. The mean deposition was 10.669, 10.484 and 12.244 microg cm\(^{-2}\) for treatment 1-3, respectively. Treatment 1 and 2 had similar deposition values. Treatment 3 resulted in the greatest deposition followed Treatment 1 and 2. All the Treatments had similar deposition values on the different heights (LSD 4.925). Effect of distance had similar deposition values on different distances, except for 9 m, 15 m and 24 m (LSD 4.021). There are greatest depositions (34.709 microg cm\(^{-2}\)) on first row. The deposition decreased as distance increased on the other rows.

**Conclusions**

Adjuvants are quietly helping to revolutionise the pesticide business as the best tools for users to improve application and achieve more cost-effective, better targeted, and more environmentally acceptable pest control. Selecting adjuvants is important factor to alter the performance of sprayer. First step on reducing drift is proper sprayer and operation. Additional adjuvant is needed for good coverage. Too much surfactant may permit runoff or loss of deposit rather than increasing good coverage.

Treatment and distance had significant effects on deposition. Lan et al. (2008) reported similar results. The filter papers detected essentially no droplet depositions beyond the 24 m. Treatments 2 had the least deposition 15th m. Treatment 3 resulted in the greatest downwind deposition, followed by treatments 1. All the treatments had similar deposition values from 6th and 9th m. Treatment 2 resulted in highest deposition on ground on first row. Treatment 1 resulted in lowest deposition at 175 cm on first row.

The results will aid applicators in selecting drift reduction agents to meet the drift mitigation criterion for a given application.

**References**

Anon, 1997. A summary of aerial application studies. Spray Drift Task Force. For more information contact David R. Johnson at Stewart Agricultural Research Services, Inc., P.O. Box 509, Macon, Missouri 63552.


Received May, 14, 2009; accepted for printing, December, 2, 2009.