Performance of Spray Drift Adjuvants

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Abstract: *Numerous drift reduction adjuvants and spray deposition aids are available to aerial applicators. Since there are no product labeling or efficacy regulations for these adjuvants, applicators must rely on experience or information in the technical literature for evaluating their performance. Twelve new drift control adjuvants were selected for atomization studies in a wind tunnel to document their performance as applicable to aerial application. The adjuvants were mixed in a blank emulsifiable concentrate tank mix at their maximum recommended label rate for aerial application. Atomization data were collected with a laser spectrometer on the first and eighth passes through a gear pump. The eighth pass simulates the effect of shear breakdown and loss of effectiveness of the adjuvant from bypass and recirculation in the spray tank during application. Most of the adjuvants move the droplet spectra classification from Fine to Medium. The most effective adjuvant moved the droplet spectra classification from Fine to Coarse. This performance information will aid aerial applicators in selecting drift reduction adjuvants.*

Introduction

Spray droplet size has long been recognized as the most important variable that aerial applicators can influence to mitigate spray drift from the application site. Sprays with Coarse droplet spectra drift less than sprays with Fine droplet spectra, but applicators must also consider the droplet size needed for optimum efficacy of the applied material. Spray nozzle selection is the first factor for aerial applicators to consider in determining spray droplet size or spectrum. Secondary considerations are those operational factors that influence atomization such as nozzle angle or deflection relative to the airstream, aircraft speed, and spray pressure. An auxiliary factor often considered for drift reduction by aerial applicators, after nozzle selection and operation, is spray drift adjuvants. Water soluble synthetic polymers were the dominant components of most of the adjuvants that were first designed and marketed for spray drift control. These materials were generally effective in increasing spray droplet size and 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. There is only limited information on aerial performance of the newer drift reduction adjuvants.

Spray drift became a concern with the introduction and use of phenoxy herbicides, and drift continues as an industry issue with enhanced concerns about environmental trespass, threatened and endangered species, and associated regulatory actions.

The American Society of Agricultural Engineers (ASAE) developed a standard for classifying agricultural sprays into droplet size categories (DSC) ranging from Very Fine (VF) through Fine (F), Medium (M), Coarse (C), Very Coarse (VC), to Extremely Course (XC). The ASAE standard will be used in the USA for classifying agricultural sprays on product labels and in regulatory actions. DSC values are a part of current scientific and regulatory nomenclature for agricultural sprays and are consequently a part of this presentation on performance of spray drift adjuvants.

Objective

The objective of this study was to determine the effectiveness – based on increased droplet size, reduction of fine droplet content, and resistance to pump shear degradation – of some of the recently-introduced drift reduction adjuvants for typical aerial spray applications.

Materials and Methods

Previous research indicated that inadequate amounts of drift reduction adjuvants in the spray mix could result in increased incidence of driftable fine droplets, so the maximum recommended label rate for aerial application for each product was used in the spray mixes in this study. A blank emulsifiable concentrate (EC) product mixed with tap water was used as the spray mix for testing each spray drift reduction adjuvant. The spray mix was made up of 90 percent tap water and 10 percent EC blank plus the recommended maximum label rate of the respective adjuvant for aerial application. The EC blank was made up of 92 percent w/w Aromatic 150 (ExxonMobil Corporation, Houston, Texas), 1.6 percent w/w Toximul 3454F (Stephan Company, Northfield, Illinois) and 6.4 percent w/w Toximul 3453F (Stephan Company, Northfield, Illinois). This EC blank spray mix was considered reasonable because many pesticides are formulated as emulsifiable concentrates. Drift reduction adjuvants and EC blank components were obtained from product manufacturers and commercial sources for the study. Spray mixes were prepared according to manufacturer's directions for each drift reduction adjuvant. The EC blank was added in the mixing sequence specified by the adjuvant label for addition of the pesticide.

A wind tunnel consisting of an engine driven centrifugal fan fitted with a converging duct and internal flow straighteners was used to generate a high-speed airstream. An aircraft boom section placed in the airstream and fitted with a CP-03 nozzle, orifice size of 0.078, deflector angle of 30°, spray pressure of 30 psi, and airspeed of 140 mph were used for all tests. A PMS laser spectrometer and data acquisition system were used to image and size 12,000-18,000 spray droplets in four horizontal atomization scans of the probe through the spray plume for three replications of each adjuvant test condition. The laser scanning position was 2.5 ft downstream from the spray nozzle. The by-pass from the gear pump during an atomization test was directed to a second tank so there would be no uncontrolled recirculation through the pump. The remaining spray mix was then passed through the gear pump to the second tank and then back and forth to accumulate 7 passes through the pump. The atomization scans were then repeated on the eighth pass of the spray mix through the pump. Atomization scans were made on the water and EC blank spray mix (without addition of drift reduction adjuvant) to serve as a basis or standard for determining the relative effectiveness of the respective drift reduction adjuvants. Statistical analyses were completed on the atomization parameters.

Results and Discussion

Spray Droplet Size

The parameters typically used to characterize droplet size of agricultural sprays are Volume Median Diameter (DV0.5) which is the droplet size at which 50 percent of the spray volume is in smaller droplets, and Relative Span (RS) which is a relative measure of the range of the mid 80 percent of the spray spectrum. Most of the drift reduction adjuvants increased each of the droplet size parameters to different levels as noted by the parameter significance levels in table 1. Corral Poly provided significantly larger droplet size spectra than the other drift control adjuvants; Control was second best relative to increasing spray droplet size parameters. Corral Poly and Control are liquid formulations of polyvinyl polymers. Border EG 250, Cell-U-Wett, and StrikeZone PPS were the three next-best adjuvants for increasing spray droplet size parameters; these three drift reduction adjuvants are dry formulations of synthetic or natural polymers. In-Place, Intac Plus, and Valid were ineffective in changing the spray droplet size properties of the EC blank spray mix.

Relative Span of the EC Blank spray mix was low in this study. Corral Poly and Control had the highest Relative Spans measured in this study, but the values were only slightly above 1.0, indicating that the drift control adjuvants were reasonably effective in moving the spray droplet size spectrum upscale without excessively widening Relative Span.

Spray droplet size parameters for most of the drift reduction adjuvants decreased significantly after undergoing shear stresses from eight passes through the gear pump, but the two products reflecting better spray spectrum properties for drift mitigation were better after eight passes than the next best products were on the first pass through the gear pump. It is interesting to note that droplet size parameters for four of the five dry formulated adjuvants – Array, Border EG 250, Cell-U-Wett, and StrikeZone PPS – did not degrade from eight passes through the gear pump.

Spray Drift Mitigation

The percentage of the spray volume in droplets less than 200 µm diameter (%<200µm) is a general indicator of the spray drift propensity of a given spray droplet spectrum. The %<200µm was reduced from 12.4 percent with the EC blank alone to relatively low single digit values, except for the adjuvants – In-Place, Intac Plus, and Valid, which were previously noted as ineffective in influencing the spray drift properties of the spray mix. Corral Poly provided significantly lower percentages of driftable fine droplets (%<200µm) than the other adjuvants; Control was second best relative to these same parameters. Both of these adjuvants are liquid formulations of polyvinyl polymers; however, the three next-best adjuvants relative to these same parameters – Border EG 250, Cell-U-Wett, and StrikeZone PPS – are all dry formulations of synthetic or natural polymers.

Droplet Spectra Classification

The Droplet Spectra Class-ification (DSC) for the EC blank spray mix was Fine. Array, Border EG 250, Cell-U-Wett, Control, Corral Poly, and StrikeZone PPS increased the DSC to at least Medium for both the first and eighth passes through the pump. Direct increased DSC to Medium for the first pass through the pump, but the DSC was degraded to Fine on the eighth pass through the pump. Corral Poly increased DSC to Coarse for the first pass through the pump, but DSC was degraded to Medium on the eighth pass through the pump. Airex DC and SanAg 41-A changed the spray drift atomization properties of the EC blank spray mix, but not enough to increase DSC from the Fine category to a Medium category.

The similarity of DSC's for the different spray drift adjuvants and significant differences in spray droplet size and spray drift mitigation parameters for the different spray drift adjuvants reflects on the very broad nature of the DSC categories. It further indicates that applicators can benefit in spray drift mitigation by appropriate attention to other atomization parameters in addition to guidelines such as DSC that may be specified on product labels.

Table 1. Spray spectrum parameters for twelve drift reduction adjuvants in an EC blank spray mix as compared to the EC blank spray mix with no drift reduction adjuvant.

Adjuvant	Adjuvant Rate in the Spray Mix	Number of Passes Through the Pump	DV0.5 [a][b]	RS [a][b]	%<200µm [a][b]	DSC [a]
EC Blank			278 k	0.69 f	12.4 c	F
Airex DC	2 oz / gal	1	338 h	0.86 bc	5.3 gh	F
		8	329 ij	0.83 cd	6.0 fg	F
Array [c]	14 lb / 100 gal	1	357 g	0.84 bcd	5.0 hi	M
		8	355 g	0.88 bc	4.9 hij	M
Border EG 250 [c]	10 oz / 100 gal	1	403 d	0.92 b	3.5 m	M
		8	392 e	0.89 bc	3.7 lm	M
Cell-U-Wett [c]	1.5 lb / 100 gal	1	369 f	0.90 bc	4.6 ijk	M
		8	376 f	0.87 bc	4.3 ijklm	M
Control	8 oz / 100 gal	1	463 c	1.03 a	2.6 n	M
		8	409 d	0.89 bc	3.5 m	M
Corral Poly	8 oz / 100 gal	1	529 a	1.08 a	1.5 o	C
		8	484 b	1.01 a	1.9 no	M
Direct	4 oz / 100 gal	1	368 f	0.84 bcd	4.0 klm	M
		8	344 h	0.77 de	4.8 hijkl	F
In-Place	1 part /4 parts chemical	1	249 m	0.69 f	21.8 a	F
		8	258 l	0.69 f	18.3 b	F
Intac Plus	3 oz / acre	1	276 k	0.71 ef	13.1 c	F
		8	276 k	0.69 f	12.6 c	F
SanAg 41-A [c]	5 oz / 100 gal	1	336 hi	0.87 bc	6.2 f	F
		8	327 j	0.85 bcd	7.0 e	F
StrikeZone PPS [c]	12 lb / 100 gal	1	371 f	0.90 bc	4.5 ijkl	M
		8	388 e	0.89 bc	4.1 jklm	M
Valid	16 oz / 100 gal	1	281 k	0.70 ef	11.6 d	F
		8	279 k	0.68 f	12.4 c	F

[a] DV0.5 = droplet size as volume median diameter; RS = relative span; %<200µm = a measure of the driftable fraction of the spray; DSC = droplet spectra classification. (Definitions are from ASAE Standards.)
[b] Parameter values by column with the same letters or groups of letters are not significantly different at 0.05 level of Duncan's New Multiple Range Test.
[c] Dry formulation.

Summary

Drift of agricultural sprays is important to aerial applicators because of potential damage to off-target sites and possible associated litigation. Spray mix adjuvants are marketed for reducing spray drift. The primary effect of these adjuvants is increasing spray droplet size and reducing the driftable fine component of the spray spectrum, which are the primary factors influencing spray drift. Simulated agricultural sprays were atomized in a wind tunnel with drift reduction adjuvants in the spray mix at rates and conditions typical of aerial spray application. The effectiveness of the adjuvants in increasing spray droplet size is different for different adjuvants. Based on these wind tunnel studies with the EC blank spray mix, the drift retardant adjuvants in this study – except for In-Place, Intac Plus, and Valid – should provide a measure of spray drift mitigation in commercial use. The measure of drift mitigation attained with drift reduction adjuvants is a matter that applicators can balance or optimize based on adjuvant performance and economics to achieve drift mitigation goals for a given application.

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