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Improving Canopy Coverage by Using Deposition Aids in Low Volume Fungicide Applications in Corn

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Abstract. *Aerial fungicide applications were made at a total volume of 18.9 L/Ha (2 GPA) to corn 2-3 days following tassel emergence. Ten different adjuvant mixes were evaluated to examine their ability to increase deposition into the corn canopy, enhance yields, and control disease.*

Kromecote® papers were placed at three different levels within the corn canopy during the application to evaluate deposition quantity. Cards were scanned using DropletScan™ to determine percent area coverage. Disease and yield comparisons were conducted for all treatments.

Significant differences in coverage among treatments were found in all three collector locations (top, middle, and bottom). Overall, Treatments 4 (Headline with experimental product USEX0108) and 6 (Headline with experimental product USEX0208) tended to provide the best coverage. There were no significant differences found among treatments for yield. However, when compared to the untreated checks, all the treatment yields were significantly better. Low amounts of disease were found both pre and post application, but none of the treatments were significantly better for controlling disease.

Keywords. Application technology, corn, image analysis, aerial, low volume, fungicide, adjuvant, Dropletscan

Introduction

Aircraft are an excellent tool to apply fungicides to crops in mature or semi-mature stages. This is especially true with corn. Many corn fungicide applications are applied at tasseling with timing very critical. Applications by ground equipment may be difficult at this growth stage. Aircraft are well suited to cover large acreages quickly without damaging the crop.

The demand for energy and the higher cash prices has increased the number of acres of corn being grown. Many of these acres reach the treatment stage at about the same time, further increasing the need for swift applications. Application volumes have been reduced to increase application efficiency. When applying at low volumes, such as 18.7 L/ha (2 GPA), coverage and application uniformity are extremely important for efficacy. Therefore, low volumes require that applicators understand and manage droplet spectrums closely. It is also critical that the coverage be attained down into the canopy for best results. In addition, many of these applications may be made when ambient temperatures are 28º C (82º F) or higher. Evaporation is always a consideration with these temperatures.

Adjuvants have been utilized for years to increase coverage, efficacy, and application efficiency. There are many questions among the application community on which adjuvant, or combination of adjuvants, will result in the most efficacious application.

Objectives

The objectives for this study were to evaluate and compare adjuvant treatments when used with low volume aerial applications of fungicide on corn. Adjuvants were evaluated for droplet deposition throughout the crop canopy, yields, and disease control.

Methodology

The study was done in a field location in Western Illinois (Bushnell) on July 19, 2008. An Air Tractor 502 (Air Tractor Inc., Olney, Texas) equipped with a touch screen Air M3 with IntelliFlow® flow control (Hemisphere Air) was used to apply the treatments. USDA ARS spray nozzle models were used to target a droplet spectrum with a volume median size ($D_{V0.5}$) ranging from 275 to 300µ (microns). The application parameters from the models were used to determine the specific nozzle configuration for the airplane. From there a pretest pattern evaluation of the aircraft was completed to determine the effective swath width. The application parameters used are listed in Table 1.

All applications were made at 18.7 L/ha (2 GPA) in a single variety of corn (Midwest Seed Genetics 76865VT3). The application timing was 2-3 days past tassel emergence. The field used was an actual production field. Ten different adjuvant treatments in combination with Headline fungicide (BASF) and an untreated check were replicated three times each in a completely randomized design. Each treatment replication consisted of a single 20 meter (65 foot) swath approximately 300 m (1,000 feet) long. Applications were made parallel to the rows flying from west to east (from 270 to 90 degrees). All the treatments and mixing rates are listed in Table 2. The aircraft was equipped with a rinse and flush system to adequately clean the spray tank between each treatment.

A pre (3 days prior) and post (38 days after) application disease evaluation was taken for each treatment and replication. During the trial, between 3:25 and 6:35 PM, the average temperature and humidity were 29° C (84.2° F) and 65.5%, respectively. Average wind direction was 226.6° with a range from 259 to 200°. The average wind speed was 6.8 km/h (4.2 MPH), ranging from 4.2 to 8.4 km/h (2.6 to 5.2 MPH).

To capture the droplet information, Kromekote® papers (KKP) used as collectors were placed in the center ten rows of each aerial swath/treatment on ten corn plants, one plant per each of the ten rows, at three different plant heights; top corn leaf, ear leaf, and the leaf three collars below ear leaf (30 papers). All KKP were placed at 30 cm (12 inches) from the main stalk for each treatment replication. Each KKP was stapled on the top surface of the leaf and randomly positioned based on the leaf orientation. In addition, an open canopy collection was taken for each treatment to evaluate coverage for a no canopy effect. The open canopy collections were made by the airplane making a single pass in an open area over ten KKP that were evenly spaced at 1 m (3 foot) intervals under the center of the swath.

After field spraying was completed and ample drying time allowed for, the Kromekote® papers from each repetition of each treatment were collected and placed in pre-labeled manila envelopes. These data envelopes were used to organize and store the KKP until analysis was completed. All staples were removed before the analysis was done.

DropletScan™, a software program utilizing a high resolution color scanner to digitize the images on the Kromekote® papers, was used to analyze each paper. A red dye was mixed in each treatment to provide the contrast needed by the scanner. The percent area coverage was calculated separately for each individual card.

Yields were taken from the center rows of each treatment over a distance of approximately 300 m (1,000 feet). Each treatment repetition was harvested using a conventional combine with GPS technology and yield monitor to extract the yield and moisture data. Field scale-weighed loads were used as a calibration check for the yield monitor to assure accuracy. All yields were corrected to 15.5% moisture or Number 2 corn.

Coverage data was analyzed using a SAS Proc Mixed (SAS Institute, Cary, NC, 2007) analysis with treatment as the independent variable. A separate analysis was done for each of the three heights; top, middle, and bottom with treatment as the fixed effect and replication and individual card nested within replication as random effects. Pairwise differences of least squares means were calculated for each combination of treatments with alpha set at 0.05. Yield and disease data were analyzed with analyses of variance (ANOVA) with treatment as the independent variable and Fisher's LSD used to compare means with alpha set at 0.05.

Results and Discussion

Percent Area Coverage

One main objective of this study was to compare the various adjuvant treatments for ability to improve coverage throughout the corn canopy. Figures 1-3 provide the results from the in-canopy measurements for the bottom, middle, and top collectors for all treatments and are expressed in percent area coverage (PAC).

Treatment 6 (0.525 PAC) was significantly better for bottom coverage than six of the other treatments. Treatment 2 (0.517 PAC) had significantly greater coverage in the bottom part of the canopy than five of the other treatments. After treatments 6 and 2, treatments 4 (0.355 PAC) and 1 (0.345 PAC) had the next highest coverage in the bottom of the canopy. Treatments 10 and 3 had the poorest lower canopy coverage at 0.180 PAC (Figure 1).

In the middle (ear leaf) part of the canopy, treatment 4 (0.800 PAC) had a significantly greater coverage than seven of the other treatments and treatment 6 (0.703 PAC) had a significantly greater coverage than four of the other treatments. Treatment 3 (0.542 PAC) had the third highest coverage, which was significantly greater than one of the other treatments. Treatment 9 had the poorest middle canopy coverage at 0.240 PAC (Figure 2).

Treatments 7 (0.855 PAC), 4 (0.847 PAC), 5 (0.786 PAC), and 10 (0.730 PAC) were significantly better for coverage in the top of the corn canopy than Treatment 1. Treatment 1 had the poorest top canopy coverage at 0.234 PAC (Figure 3).

As shown in Figures 1-3, the top of the canopy tended to accumulate the highest amount of coverage while the middle and lower canopy resulted in reduced amounts. This would be the expected trend; however, in a few cases the results for some of the treatments were mixed when compared across collector locations. As an example, Treatment 6 had its greatest coverage in the middle canopy location (0.703 PAC) and was similar in the bottom and top (0.523 and 0.525 PAC), respectively.

Coverage data in an open canopy was measured to learn the effects of the various tank mix solutions on coverage without a canopy effect. The no canopy coverage comparisons without any replications show that Treatments 3 and 10 provided the highest amount of coverage at 3.92 and 3.85 PAC, respectively. Treatments 1 and 9 were measured with the lowest amount of coverage at 1.20 and 0.83 PAC respectively. All the other treatments ranged from 3.24 to 2.16 PAC (Figure 4).

Yield and Efficacy

Yield data is reported in Figure 5 and is expressed as Number 2 bushels per acre and has been corrected to 15.5% moisture. There were no significant differences in yield among all treatments. Yields for the ten treatments ranged from 266.3 to 259.4 Bu/ac. However, there was a significant difference for all treatment yields when compared to the untreated check (244.5 Bu/ac). The average yield of the ten treatments was 263.1 Bu/ac, thus there is a difference of 18.6 Bu/ac between the treatment average and the untreated check.

Disease ratings were taken pre and post application. The pre application measurement (3 days prior) indicated that disease severity was less than 5 percent with the primary disease listed as common rust with some anthracnose reported on the lower leaves. Several weeks post application (38 days) the primary disease was again common rust with some gray leaf spot. There were no significant differences in disease severity reported among treatments or the untreated check post application. The range in disease severity, expressed as percent ear leaf, was from 11.2% for the untreated check to 5.0% for Treatment 4 (Figure 6).

Conclusions

A study was conducted to determine the influence of tank mix additives on leaf coverage, yield, and disease control while making low volume aerial fungicide applications on corn. Coverage comparisons were made utilizing Kromekote® paper at collectors located at top, middle, and bottom positions in the corn canopy and DropletScan™ software to measure the deposition. Significant differences were found in percent area coverage comparisons among treatments at all three collector levels. In the canopy bottom, Treatments 6, 2, 4, and 1 provided the highest coverage, while Treatments 10 and 3 had the lowest PAC. In the middle canopy, Treatments 4, 6, and 3 provided the greatest coverage. Treatment 9 had the lowest PAC among all treatments in the middle canopy. In the upper canopy location, Treatments 7, 4, 5, and 10 had the highest coverage, while Treatment 1 had the poorest top canopy coverage. When summing for all three collectors (top, middle, bottom) in all comparisons, Treatments 4, 6, and 2 tended to provide the best total coverage.

There were no significant differences in yield among the treatments, but when compared to the untreated check all treatments had a significantly higher yield. Even though low amounts of disease were found, there were no significant differences reported in severity of disease found among the ten treatments and the untreated check.

Acknowledgements

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Table 1. Aircraft, application parameters, and applicator details.

Aircraft	Airspeed	Nozzle	Orifice	Deflection Angle	
AT 502	150	CP 11TT	12	8	
Pressure	**VMD**	**Span**	**Number of Nozzles**	**Swath Width**	**Application Height**
40	288	1.1	38	65	12
Company	**Owner**	**Location**	**Pilot**	**Cooperators**	**Field Location**
Curless Flying Service	Harley Curless	Astoria, IL	Cary Latham	Ken & Dan Wolf	Bushnell, IL

Table 2 - Treatments and application rate for all locations.

Treatment #	Treatment[1]		Rate/Acre	Water Amount
1	Headline 6 oz/acre + water	Premium COC[2]	16 oz	234 oz
2	Headline 6 oz/acre + water	Between[2]	8 oz	242 oz
3	Headline 6 oz/acre + water	Downdraft[2]	4 oz	246 oz
4	Headline 6 oz/acre + water	USEX0108[2]	4 oz	246 oz
5	Headline 6 oz/acre + water	USEX0108[2]	8 oz	242 oz
6	Headline 6 oz/acre + water	USEX0208[2]	4 oz	246 oz
7	Headline 6 oz/acre + water	USEX0208[2]	8 oz	242 oz
8	Headline 6 oz/acre + water	USEX0308[2]	4 oz	246 oz
9	Headline 6 oz/acre + water	USEX0308[2]	8 oz	242 oz
10	Headline 6 oz/acre + SRN-28	Between[2]	8 oz	Water 114 oz SRN-28 128 oz
11	Check-no spray			

[1]All treatments were applied at 18.9 L/Ha (2 GPA) using tap water and Garrco Vision Pink dye at 0.5%.

[2]Deposition aid materials and suggested mix rates were provided by United Suppliers, Inc. Treatments 4 through 9 are experimental products.

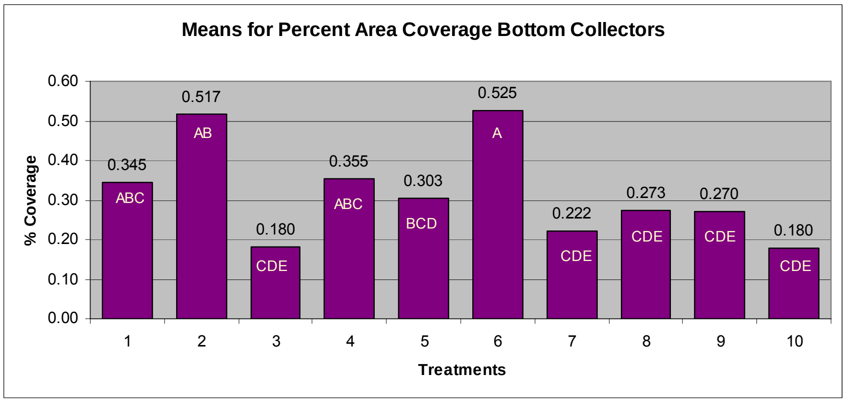

Figure 1. Means for percent area coverage for bottom collectors. Means with the same letter are not significantly different.

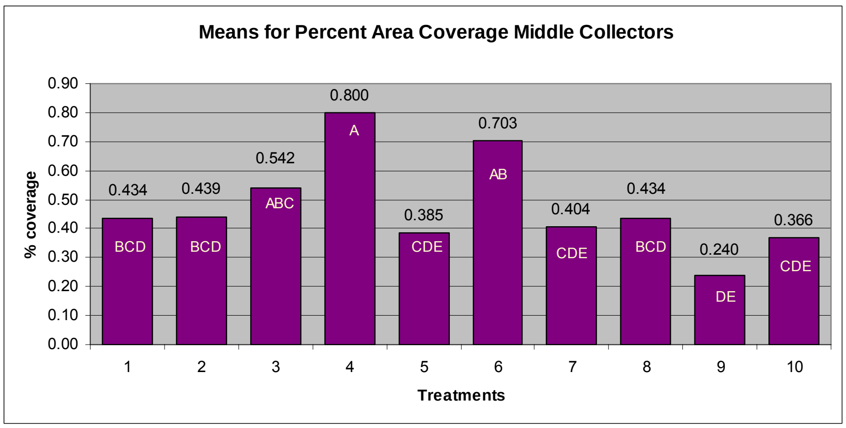

Figure 2. Means for percent area coverage for middle collectors. Means with the same letter are not significantly different.

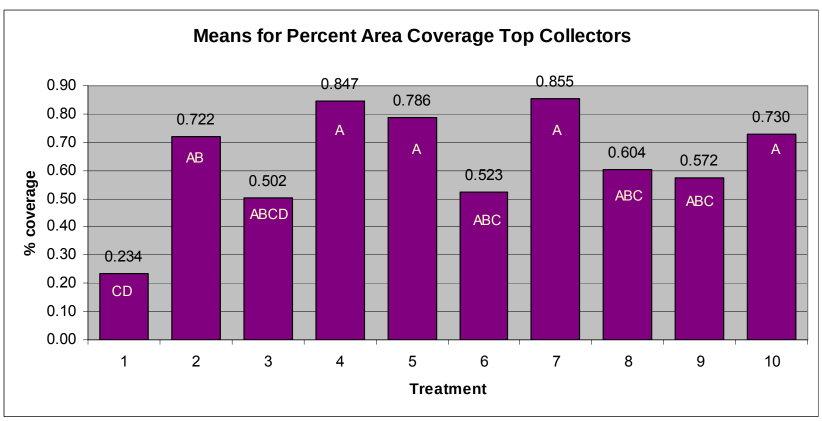

Figure 3. Means for percent area coverage for the top collectors. Means with the same letter are not significantly different.

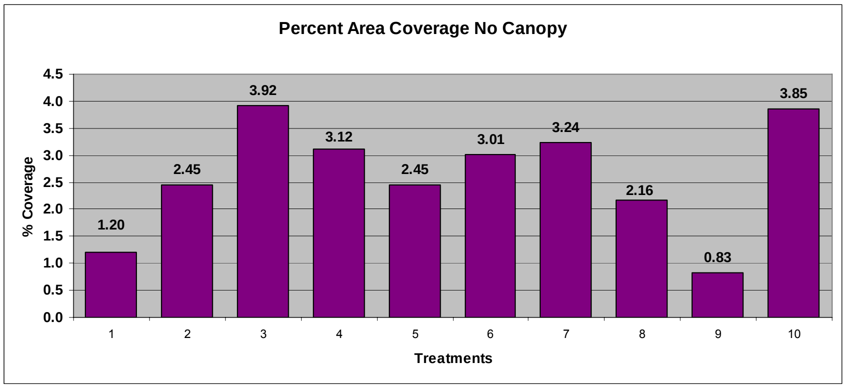

Figure 4. Percent area coverage for all treatments with no canopy (not replicated).

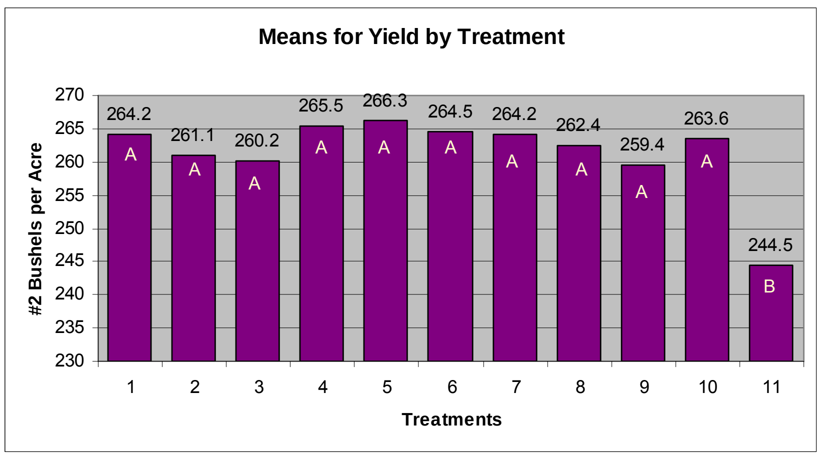

Figure 5. Means for yield for each treatment. Means with the same letter are not significantly different.

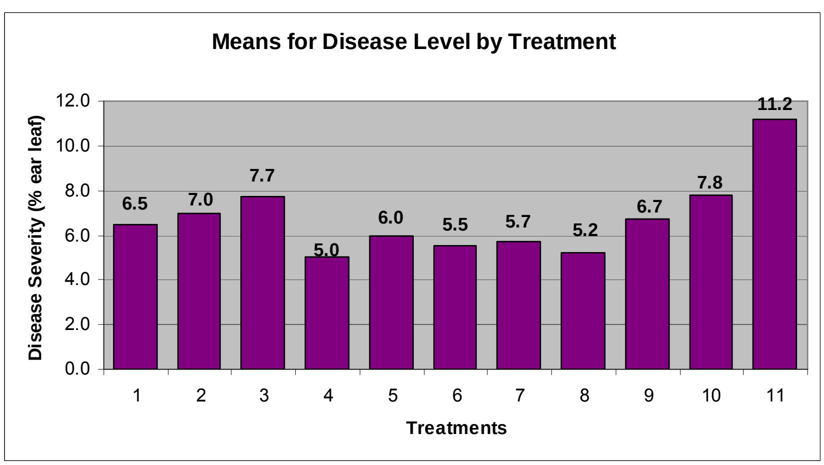

Figure 6. Means for post treatment disease severity by treatment.