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Effects of Spray Solution On Fungicide Application in Corn

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Abstract. *Aerial fungicide applications were made at a total volume of 28 L/Ha (3 GPA) to diseased corn. The predominant disease was gray leaf spot. Treatments of different headline formulations and combinations were compared to a competitive fungicide 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 and the untreated checks.

Significant differences in coverage among treatments were found in all three collector locations (top, middle, and bottom). Treatments had little effect on the droplet spectra. Disease control varied by treatment, timing, and field location. Damage from the disease worsened over time as percent control became less. Yield differences were minimal.

Keywords. Application technology, corn, image analysis, aerial, low volume, fungicide, disease, adjuvant, Dropletscan, deposition, coverage, water sensitive paper, kromekote paper

Introduction

In recent years there has been a major focus on the application of fungicides for improved crop health. Airplanes are typically used to apply fungicides to crops, especially corn since many corn fungicide applications are applied at tasseling with timing very critical. Many of these acres reach the treatment stage at about the same time, further increasing the need for swift applications. Aircraft are well suited to cover large acreages quickly without damaging the crop. Application volumes have been reduced to increase application efficiency. When applying at low volumes 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. Adjuvants have been utilized for years to increase coverage, efficacy, and application efficiency. Often times, studies of this type are completed without the presence of disease, so determining application affects is hard to ascertain. There are many questions among the application community on which fungicide, adjuvant, or combination of fungicides and adjuvants, will result in the most efficacious application.

Objectives

The objective of this study was to determine the ability of Headline formulations alone and Headline plus a triazole fungicide for ability to improve coverage throughout the corn canopy and to control established diseases and increase yields via plant health in corn.

Methodology

The study was done in a field location in Western Kansas (Meade) on July 28, 2009. An Air Tractor 401(Air Tractor Inc., Olney, Texas) equipped with GPS was used to apply the treatments. The aircraft was equipped with a drop boom with 38 CP (CP Products, Inc., Mesa, Arizona) nozzles (29 - .078 and 9 - .125) with 5 degrees deflection. The spraying pressure was at 248 kPa (36 psi). The AT 401 flew at a ground speed of 193 km/h (120 MPH). The pilot was instructed to use an application height of 3 - 3.7 m (10-12 feet). Based on USDA droplet prediction models using the above parameters, the Dv0.1, Dv0.5, and Dv0.9 were calculated at 207, 388, and 719 microns respectively for the .078 orifice and 214, 389, and 746 microns respectively for the .125 orifice. The droplet spectra classification, based on the ASABE Standard S572, was determined to be medium for both.

All applications were made at 28 L/ha (3 GPA) on an irrigated circle of corn of approximately 180 acres. The application timing was 2-3 days past tassel emergence. Four different fungicide treatments and three untreated checks made up the experiment. Each treatment consisted of 20 meter (67 feet) spray swaths for the entire width of the circle. The treatments were applied perpendicular to the corn rows. An expanded flight pattern was used beginning at the center of each plot until approximately 25 acres were sprayed. The application direction alternated between 180 and 360°. All the treatments and mixing rates are listed in Table 1. The aircraft was equipped with a rinse and flush system to adequately clean the spray tank between each treatment.

Three post application disease evaluations were taken for each treatment and check. During the trial, between 9:45 AM and 12:20 PM, the average temperature and humidity was 26.2° C (79.2° F) and 51.6%, respectively. Average wind direction was 286.9° with an average crosswind of 73.1°. The average wind speed was 7.9 km/h (4.9 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 of each aerial swath/treatment on ten corn plants, 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. There were two replications per treatment. Each KKP was paper clipped 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. DropletScan® (WRK of Arkansas, Lonoke, AR; and WRK of Oklahoma, Stillwater, OK; Devore Systems, Inc., Manhattan, KS), 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 (Vision Pink, GarrCo Products Inc., Converse, IN) was mixed in each treatment to provide the contrast needed by the scanner. The percent area coverage was calculated separately for each individual card.

Treatment areas were harvested as a part of the whole field using a conventional combine with GPS technology and yield monitor to acquire the yield and moisture data. Yield data for each treatment was then extracted and analyzed using APEX Farm Management Software. The yields reported represent the entire area (approximately 25 acres) for each treatment and check. All yields were corrected to 15.5% moisture or Number 2 corn.

Results and Discussion

The objective of this study was to determine the ability of Headline formulations alone and Headline plus a triazole fungicide for ability to improve coverage throughout the corn canopy and to control established diseases and increase yields via plant health in corn.

Percent Area Coverage

The various treatments were compared for ability to improve coverage throughout the corn canopy. Figure 1 provides the results from the in-canopy measurements for the bottom, middle, and top collectors for the four treatments and are expressed in percent area coverage (PAC). The total coverage for each treatment is also included.

Treatment 3 was better for bottom, middle, top, and total coverage at 0.7, 1.6, 2.3, and 4.7 PAC respectively. Treatment 1 was next with 0.5, 1.1, 1.6, and 3.2 PAC for bottom, middle, top, and total respectively. Treatment 5 was next for top and total coverage measured (0.6 and 0.9 PAC), but Treatment 7 ended up with more coverage in the bottom and middle collection areas (0.2 and 0.3 PAC) when compared to Treatment 5 (Figure 1). Canopy density ratings would indicate that the structure and thickness of the corn in Treatments 5 and 7 presented more challenges to penetrate the canopy. The density ratings were based on a scale of 1-10 with 10 being the densest. The density ratings were measured at 7, 8, 10+, and 9 for Treatments 1, 3, 5, and 7 respectively. The height of the corn canopy was also likely a factor in limiting droplet penetration. The measured heights for corn plants in each treatment were 100, 98, 120, and 102 inches for Treatments 1, 3, 5, and 7 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 5 provided the highest amount of coverage at 3.53 PAC followed by Treatment 7 (2.81 PAC), Treatment 3 (2.73 PAC), and Treatment 1 (2.58 PAC)

(Figure 2). The droplet size for the open canopy treatments was measured and is reported as volume median diameter (VMD). Very small differences were found for the VMD's with the four treatments. The range was from 361 – 337 microns with Treatment 3 being the largest and Treatment 7 the smallest (Table 3).

Yield and Efficacy

Yield data is reported in Figure 4 and is expressed as Number 2 bushels per acre corrected to 15.5% moisture. Yields for the four treatments ranged from 259 to 273 Bu/ac. The top yield was reported with Treatment 5 and the lowest yield was reported with Treatment 3. Yields for the three checks were 261 bu/ac for the west check, 269 bu/ac for the center check, and 270 bu/ac for the east check.

Three disease ratings were taken post application (8/14, 9/4, 9/23). The primary disease was identified as gray leaf spot. Disease ratings were taken from the ear leaf, and three leaf areas above and below the ear leaf representing seven leaves per assessment. The numbers reported represent an average of the seven leaves. During the first evaluation period the disease control ratings were 92.9% for Treatment 7, 92.1% for Treatment 3, 90.0% for Treatment 5, and 80.7% for Treatment 1. During the second rating Treatment 1 had 88.6% control; Treatment 3, 87.1%; Treatment 5, 58.6%, and Treatment 7, 40%. For the last rating Treatment 1 had 72.1% control, Treatments 3 and 7 each had 54.3% control, and Treatment 5 had 48.6% control (Figure 4).

At the same time the disease ratings were taken a disease damage rating was assessed to the check strips. During the first rating period, the west check strip was assessed with 32.9% damage, the center check strip had 11.45% damage, and the east check strip had 20.0% damage. The damage had increased by the time of the second rating. On Sept. 4 the west check had 88.6% damage, the center had 67.1%, and the east had 25.0%. For the last rating the west was assessed at 68.6% damage, the center had 88.6%, and the east had increased to 97.1%. Disease severity appeared to increase over the rating period (Figure 5).

With more damage late on the east side of the field it would appear that the percent control was poorer on that side of the field later when compared to the west side. Control based on location and timing effects can further be assessed with a closer evaluation of the data. By averaging control across the three evaluation periods by treatment, Treatment 1 had the overall highest control at 81% which was closely followed by Treatment 3 at 78%. Treatment 5 was next at 62% with Treatment 7 providing the lowest control in this study at 62%. The average damage across all three check strips was 56%.

Conclusions

A study was conducted to determine the ability of Headline formulations alone and Headline plus a triazole fungicide for ability to improve coverage throughout the corn canopy and to control established diseases and increase yields via plant health in 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. Differences were found in percent area coverage comparisons among treatments at all three collector levels. In the canopy bottom, Treatments 3 and 1 provided the highest coverage, while Treatments 5 and 7 had the lowest PAC. In the middle canopy, Treatments 3 provided the greatest coverage and Treatment 5 had the lowest PAC. In the upper canopy location, Treatment 3 had the highest coverage, while Treatment 7 had the poorest top canopy coverage. When summing for all three collectors (top, middle, bottom) in all comparisons, Treatments 3 provided the best total coverage followed by Treatment 1. Treatments 5 and 7 were measured

with much less total coverage. The treatments had little effect on droplet size.

There were small differences in yield among the treatments and checks. The highest yields were located on the east side of the field which is where the lowest amounts of coverage in the canopy were measured. That side of the field was also reported with the best early control, but was measured with much less control in the later evaluations. Based on the check strips, the east side of the filed had the lowest disease damage in the two early ratings.

When conducting field experiments of this magnitude many complicating factors may confound interpreting the results. The researchers believe that the canopy density and structure may have been the determining factor on amount of coverage measured in the lower canopies. Several agronomic factors across the field may also have influenced some of the findings.

Acknowledgements

The researchers would like to express a special appreciation to the aircraft owner and pilot, Craig Stratton; BASF for donations of product, time, and funds; and the land owner and farmer whose efforts made this research project successful. I would also like to thank Elly Blasi for her help in laying out the plot and placing the collectors in the field.

Table 1 - Treatments and application rate.

Treatment #	Treatment[1]		Rate/Acre
1	Headline EC + water + Vision Pink[2]	COC	6 oz + 16 oz
2	Untreated check		
3	Headline SC + water + Vision Pink[2]	COC	6 oz + 16 oz
4	Untreated Check		
5	Headline SC + Caramba + water + Vision Pink[2]	X	5.8 oz + 6.1 oz
6	Untreated check		
7	Quilt + water + Vision Pink[2]	COC	14 oz + 16 oz

[1]All treatments were applied at 28 L/Ha (3 GPA) using tap water.
[2]Vision Pink added at 1 quart (16 oz) per 50 gallons of water.

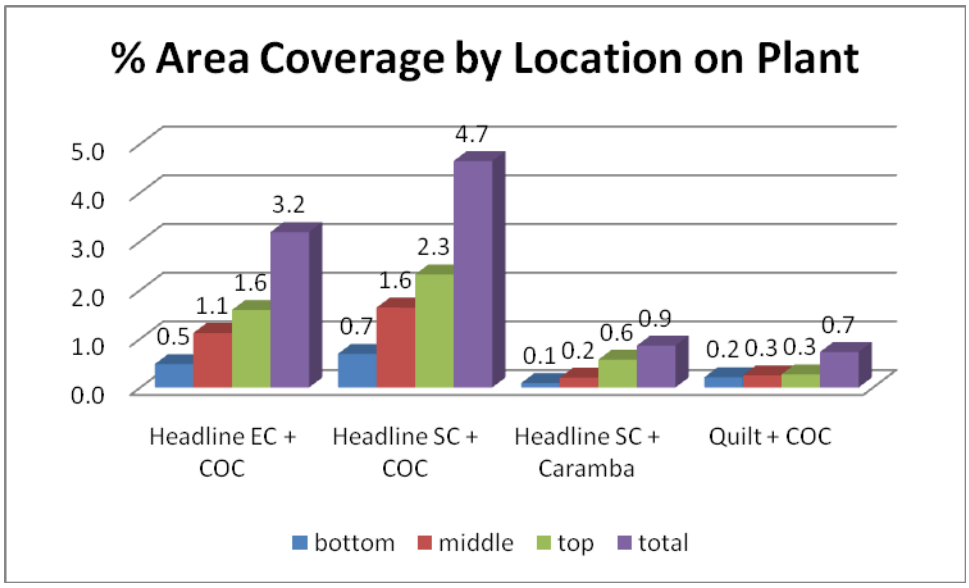

Figure 1. Means for percent area coverage for bottom, middle, and top, collectors with total coverage.

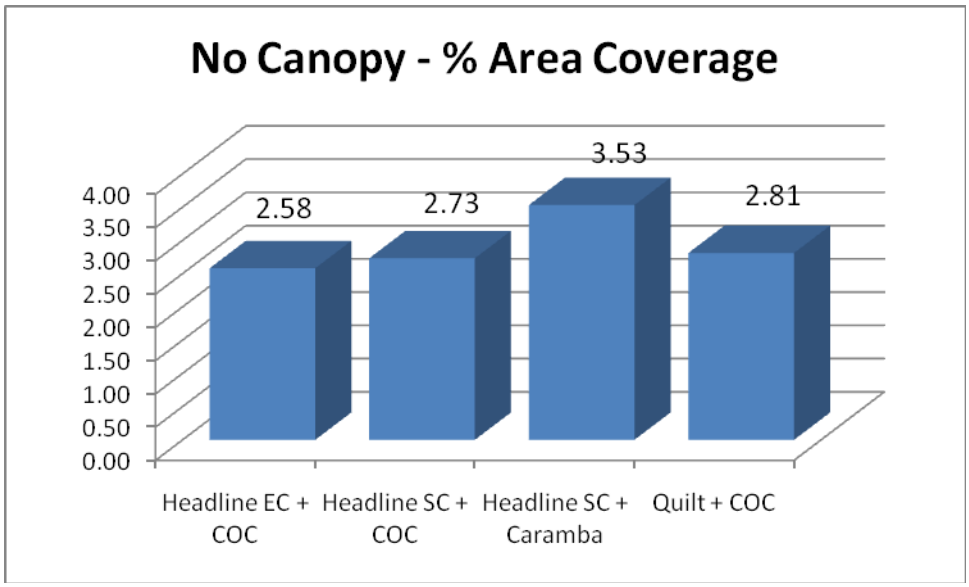

Figure 2. Percent area coverage for all treatments with no canopy (not replicated).

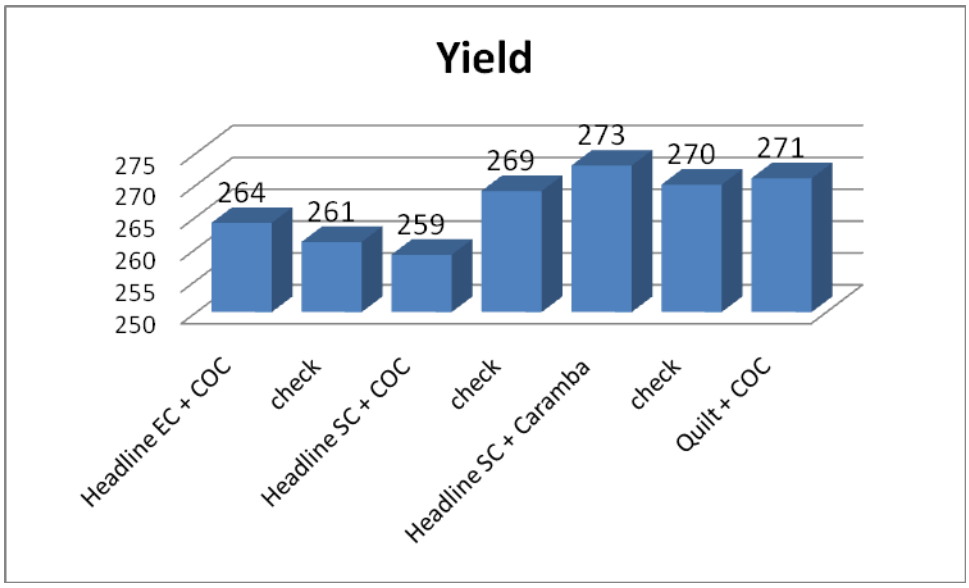

Figure 3. Yield for each treatment. Based on entire plot average.

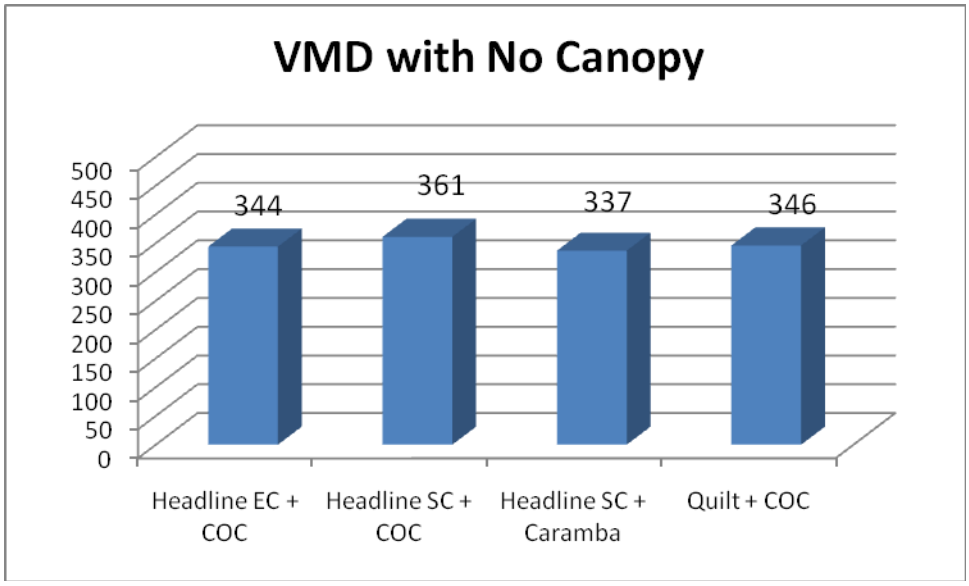

Figure 4. Droplet size for each treatment measured in an open canopy.

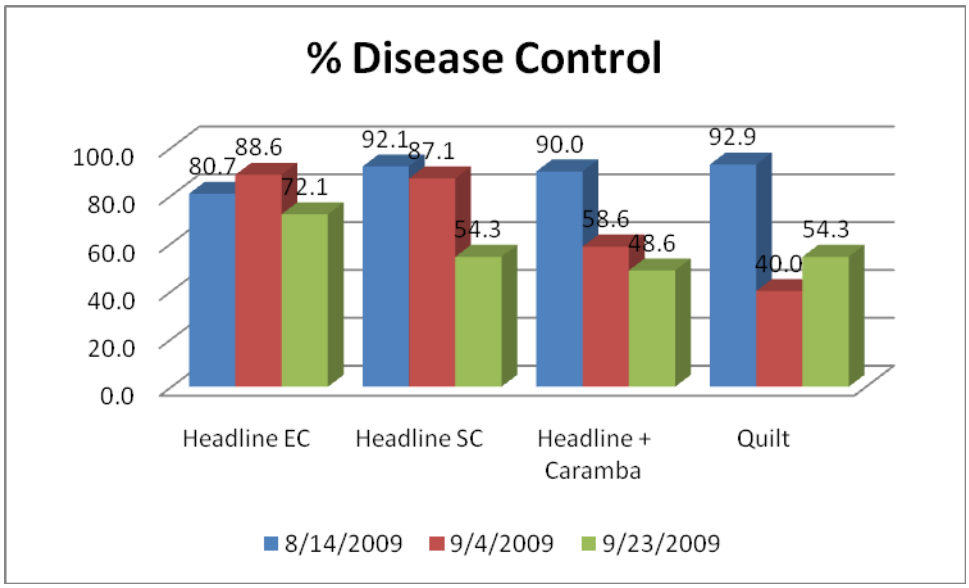

Figure 5. Percent disease control by treatment with timing.

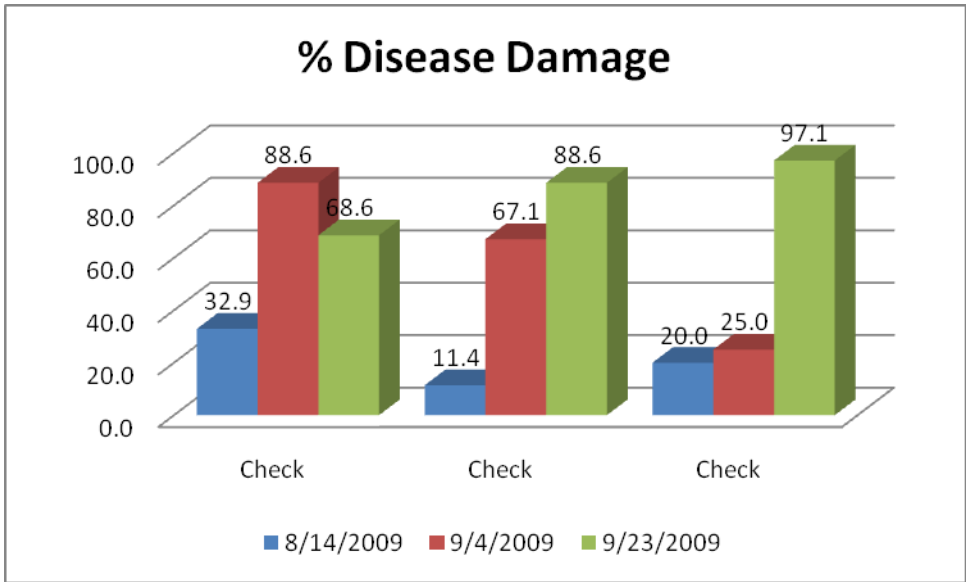

Figure 6. Percent disease damage in checks with timing.