Evaluation of Fungicide for Control of Fusarium Head Blight with Aerial Application Technology

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Introduction

Fusarium head blight (FHB) has been a major problem for cereal grain producers during the past decade. To combat this disease, growers have applied fungicide by both aerial and ground application. About 50% of the small grains acreage sprayed with fungicide in the Dakota-Minnesota region of the Great Plains is applied with spray planes. Aerial application has several advantages over ground application. The planes travel at speeds greater than 100 mph so large acreages can be sprayed in relatively short periods of time, the planes can make applications when surface conditions do not permit use of ground application equipment, and there is less damage to the crop due to tracking. Most aerial applications are applied at 3 to 7 GPA depending on the fungicide label. Applicators use a variety of nozzle types. Most applicators adjust spray solution deflectors to discharge perpendicular to the air stream when applying fungicide. Spray discharge angles perpendicular to the air stream create a smaller drop size than nozzles angled parallel to or close to air stream. Faster travel speeds will decrease drop size and increasing liquid operating pressure will increase drop size. Spray volumes can be increased by increasing orifice size or by adding additional orifices along the spray boom. Aerial application spray drop size is determined by orifice size, nozzle orientation to the air stream, operating pressure and flying speed.

Materials and Methods

An aerial application study was conducted near Esmond, North Dakota in 2006 to evaluate fungicide application for control of FHB on ‘Tradition’ cultivar barley. A site was selected on the Bill and Louie Arnold farm. The study team included Bill Arnold, farm operator, Dakota Aviation, Don Hutson-owner/pilot, Dakota Aviation, Grafton, ND, Vern Hofman and Scott Halley-North Dakota State University, Extension Engineer and Crop Protection Scientist, respectively. Several additional summer staff completed the team. The study was designed as a randomized complete block with four replicates. The plots were 150 ft wide (three application passes) by 450 to 850 ft long. Plots in blocks for replicate one and two were north/south and replicates three and four east/west. The treatments included Folicur 3.6 F (tebuconazole) fungicide (Bayer CropScience manufacturer) at 4 fl oz/acre applied with spray volumes of 3 or 7 GPA applied with a fine and a ‘small’ medium size drop and one volume of 5 GPA applied with a ‘small’ medium size drop (the 5 GPA treatment is a typical application standard of commercial aerial applicators). The applications were applied to heading barley (greater than 50% of main stem heads fully extended from the boot). The fungicide was applied with a fixed-wing Cessna Ag Truck aircraft equipped with CP-03 nozzles flying at 125 mph with an operating pressure of 40 psi. The different spray volumes were obtained by changing orifice size across the spray boom and the drop size adjustment was made by using the 30 or 90 degree deflector, large and smaller drop size, respectively. The treatments were applied on 30 June between 10:00 a.m. to 2:00 pm after the dew had dried from the plants. Wind conditions were WNW at speeds of 8.5 to

10.4 mph. This is a typical wind speed for the region at this time of year. The fungicide was applied with Induce adjuvant (Helena Chemical Co.) at 0.125% v/v and F D&C Blue #1 dye added at 44 grams per acre. The dye is a food grade type used in coloring food products. Water sensitive cards were placed on stands at grain head height in the center of each plot in replicate one. The most commonly used method to evaluate spray technology is the use of water and oil sensitive paper (WSP Spraying Systems Co. ®, Wheaton, Illinois 60189). Cards, 26 x76 mm, were placed at grain head height on stands (Panneton, 2002). One card was placed horizontal (Wolf and Caldwell, 2004). Applied stain size was determined with WRK DropletScan system (WRK, Cabot, Arkansas 72023) and presented as volume median diameter (VMD) which indicates that ½ of the spray volume is in drops smaller than this drop size and ½ of the spray volume is in drops larger than this size. The area of coverage is presented as percent of the card area analyzed.

Three 50 ft spray passes were made side by side (150 ft.) on each plot. All data were collected from the center of the plot. Additionally, three samples of ten heads were collected at 3 points across the center swath and placed in glass Erlenmeyer flasks for determination of head coverage of the spray solution. The collected heads were stored on ice until they could be measured for dye coverage. The spray coverage of the heads was determined by washing the dye from the heads by wrist action shaking for three minutes with 80 ml of 90% ethyl alcohol and determining the absorbance with a Jenway spectrophotometer (model 6300). Differences among treatments were determined by a visual assessment of FHB and foliar disease at mid dough growth stage by assessing twenty heads per plot and determining the incidence of the disease (present or not) and the severity of the individual head. The summation of the incidence times the severity of the twenty heads gave a field severity per plot. Foliar disease differences were determined by estimating the infected area on five leaves at two locations. The field was harvested on 5 August. One pass of the combine was made through the center of each plot with a Caterpillar Lexion combine with a straight cut header. The grain from the harvested area of each plot was measured with a weigh wagon and a sub sample saved to determine yield, test weight, protein, plump and deoxynivalenol (DON) from the processed grain sample. Data were analyzed with the general linear model (GLM) in SAS. Fisher’s protected least significant differences (LSD) were used to compare means at the 5% probability level.

Results and Discussion

The environmental conditions were in contrast in 2006 compared to 2005 when a duplicate trial was conducted. The crop in 2005 was devastated with FHB. In 2006 low relative humidity levels and little precipitation kept both FHB and foliar diseases from causing an economic loss. The limited available soil water also limited yields and reduced test weight and plump to levels so that malting barley standards were not met. No differences were determined among yield, test weight, protein and absorbance. Plump was increased 10% with a 3 GPA spray volume. The benefit was a result of increased amount of fungicide active ingredient collected on the spike with the larger fungicide concentration of the spray solution. Some fungicides extend the growing period of the plant before senescence and it is the authors’ perspective that this may have occurred. A trend was established showing greater deposition with the finer type drop size. The awns of the barley are efficient collectors of fine drops and also spores. This trend is different from a typical application with ground equipment where a drop size of 300 to 350 microns will deposit in greater quantities than a fine drop size. The ASABE standard S-572 drop sizes for the two applications should have been about 240 and 300 microns. The WSP card showed a larger stain size than the reported limits of the technology. The differences show a drop size difference of about 50 microns between the two stain sizes and show one of the limitations of using WSP and field spray applications. The untreated in each replicate was not included in the statistical analysis because of the lack of fit with the factorial arrangement used to compare the mean volumes and drop sizes but is presented as a reference to overall fungicide efficacy.

References

http://apmru.usda.gov/downloads/AERIAL%20SPRAY%20NOZZLE%20MODEL%20TABLES%202004.html

Panneton, B. 2002. Image analysis of water-sensitive cards for spray coverage experiments. ASAE Applied Engineering in Agriculture. 18(2):179-182

Wolf, T.M., and B.C. Caldwell. 2004. Evaluation of double spray deposits on vertical targets. Aspects of Applied Biology 71:99-106.

Table 1. Yield, Test Weight, Plump, Protein, and Head Coverage (Absorbance) by Spray Volume and Drop Size Esmond 2006.

Spray Volume	Drop Size	Yield (bu/ac)	Test Weight (lb/bu)	Plump (%)	Protein (%)	Absorbance
untreated		66.3	45.1	48.9	11.8	0.057
Spray volume averaged across drop sizes						
3		62.0	45.8	58.3	11.8	0.255
7		64.8	45.4	52.8	12.7	0.263
LSD $_{(0.05)}$		NS	NS	5.3	NS	NS
Drop size averaged across spray volumes						
	Fine	62.3	45.6	55.3	11.9	0.289
	Medium	66.6	45.6	55.9	11.9	0.229
3	Fine	58.5	46.0	58.6	11.8	0.286
	Medium	65.4	45.5	58.0	11.9	0.225
7	Fine	61.9	45.2	51.9	12.1	0.292
	Medium	67.7	45.6	53.8	12.0	0.235
Sources of variation						
Rep		0.0474	<0.0001	0.0019	0.1765	0.0431
Volume		0.8153	0.1592	0.0430	0.3871	0.8911
Drop Size		0.2256	0.8025	0.7976	0.9459	0.3390
Vol*Drop		0.6634	0.1146	0.6099	0.5453	0.9735
%C.V.		10	1	9	3	45

Table 2. Volume Median Diameter (VMD), GPA, and Coverage determined Spray Solution Collected on Horizontal Placed Water Sensitive Cards, Esmond 2006.

Spray Volume	Drop Size	VMD	GPA	Coverage (%)
3	Fine	360	4.2	10.1
3	Medium	404	2.0	4.7
5	Medium	370	4.9	12.0
7	Fine	401	7.5	17.8
7	Medium	451	4.7	11.9
Untreated		200	0.07	0.2