Assessment of Air Stream Speed with Two Nozzle Types as a Tool to Improve Deposition of Fungicide for Control of FHB in Wheat

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OBJECTIVES

To determine most effective air stream speed using two contrasting nozzle types to maximize deposition on the grain spike and improve efficacy of fungicide on hard red spring wheat.

MATERIALS AND METHODS

A field was selected near Esmond, North Dakota that was previously cropped corn. The field was planted to 'Alsen' spring wheat in an east/west direction with an air seeder with tramlines every 80 feet. The study was arranged as a factorial (nozzle type x air stream speed) in a randomized complete block design laid out in four replicated blocks, split into plots 40 x 500 ft. to accommodate one spray boom and the grower's combine straight cut header. Plots were arranged in an east/west direction between tramlines and the plot length measured with a global positioning unit mounted on an all terrain vehicle after all herbicide applications had been completed. The sprayer was a Hardi-Twin (Hardi, Davenport, IA 58206) modified to accommodate the tramlines and to spray one half of the area between the trams, 40 feet width, beginning at the center of the tractor. The sprayer contained a diaphragm type pump and traditional flat fan hydraulic nozzles. The spray nozzles are mounted to direct the spray into the air stream which carried the spray solution to the grain. Before the field trial were completed, the spray booms were equipped with Teejet XR11003 and TT11003 nozzles (Spraying Systems Co, Wheaton, IL 60189)on each boom, respectively and calibrated. The nozzles were directed to spray forward from vertical at the maximum of 30 degrees forward. Both nozzles were calibrated at 40 psi to determine the output of the specific nozzles. The air stream speed was determined by setting the rpm on the fan at 1800, 2400, or 2900. The air stream velocities were about 23, 35 and 50 mph respectively, measured at one-inch from the air stream orifice. This was measured with a 'Kestrel' 2000 wind velocity meter (Niche Retail, Sylvan Lake, MI 48302). The spray drop size measurement application parameters were characterized by mounting two water sensitive papers (WSP) 1" vertically x 30" horizontally" side by side on a piece of flat iron at canopy height and spraying across the WSP. Each combination of the respective factors was measured. Volume median diameter (VMD) of the spray drops formed on the WSP, spray volume, and % area coverage was completed with a WRK 'Droplet Scan analyzer' Cabot, Arkansas.

The fungicide was applied at Feekes growth stage 10.51. The fungicide solution included Folicur (tebuconazole) fungicide 4 fl oz/acre + Induce adjuvant at 0.125% v/v and a food-grade tracer dye (FD & C Blue #1) added at 44grams/acre. Folicur is manufactured by Bayer CropScience and Induce by Helena Chemical Co. Immediately after the fungicide was applied, ten heads were sampled from each plot in each of three locations and placed in 250 ml Erlenmeyer flasks, sealed with a stopper, and placed on ice for transport to the laboratory to measure the relative volume of solution collected for each of the treatments. Barley production recommendations from the North Dakota State University Extension Service for northeast North Dakota were followed.

Eighty ml of 90% ethyl alcohol was added to each flask and shaken for three minutes with a wrist-action mechanical shaker (Burrell Scientific Instruments and Laboratory Supplies, Model BT, Pittsburgh, Pennsylvania 15219). A sub sample of the wash solution was measured with a Jenway spectrophotometer (Jenway, Model 6300, Dunmow, Essex CM6 3LB England) and an absorbance of the tracer dye recorded to determine differences among application parameters. The absorbance reading quantifies differences in the amount of tracer dye deposited on the grain spike (a larger absorbance value is the result of more tracer dye in the solution).
A visual estimation of disease incidence (number of spikes infected) and field severity was made from 20 heads per plot at early dough stage. Field severity rating is the number of FHB infected kernels per head divided by total kernels per individual spike. All plots were harvested with a Caterpillar Lexion combine on 7 August and weighed with a weigh wagon and a grain sample collected. The yield was determined from the grain collected from the harvested plot. The grain sample was cleaned and processed to determine plump, test weight, and protein. A sub sample was ground and analyzed for the toxin deoxynivalenol (DON) by North Dakota State University. Data was analyzed with the general linear model (GLM) in SAS. Least significant differences (LSD) were used to compare means at the 5% probability level.

RESULTS

The VMD measured with water sensitive paper describes the relative drop size of the spray deposits from each of the nozzles. Half of the spray volume is in drops larger than this size in microns and half of the spray volume is in drops smaller than this value. The XR11003 nozzles had a smaller VMD than the TT11003 nozzle. Increasing air speed increased the VMD by spreading the drop over a larger area. Adding air as a spray solution carrier increased the area of coverage on the cards and increasing air stream speed increased area of coverage further.

Deposition (Absorbance) on the grain heads were the same with both nozzles when no air was used to assist in deposition. The XR11003 nozzle deposited more tracer dye than the TT11003 nozzle. The 2900 rpm air stream speed was statistically the same as no air but greater than the 1800 and 2400 air stream speed when averaged across both nozzle types indicating a benefit to the high speed air stream.

A characterization of the nozzles (F025_110) supplied with the Hardi-Twin and operating parameters traditionally used by the grower, indicated a reduction in VMD when nozzle pressure was increased and a large reduction in coverage of the cards when nozzle pressure was 90 psi. This indicates that the sprayer may provide better consistency of fungicide application due to increased deposition on the wheat head when operated with lower nozzle pressure and increased air stream speed.

The growing season was very dry during flowering and no measurable disease developed. Only the disease levels on the untreated plots were assessed, FHB incidence and field severity were found to be 6.3 and 0.5 percent, respectively. There were no differences among treatments in yield, test weight, plump, or deoxynivalenol concentration.

Acknowledgement

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Figure 1: Volume Median Diameter (VMD) drop size produced using XR11003 and TT11003 nozzles at varying spray air delivery speeds.

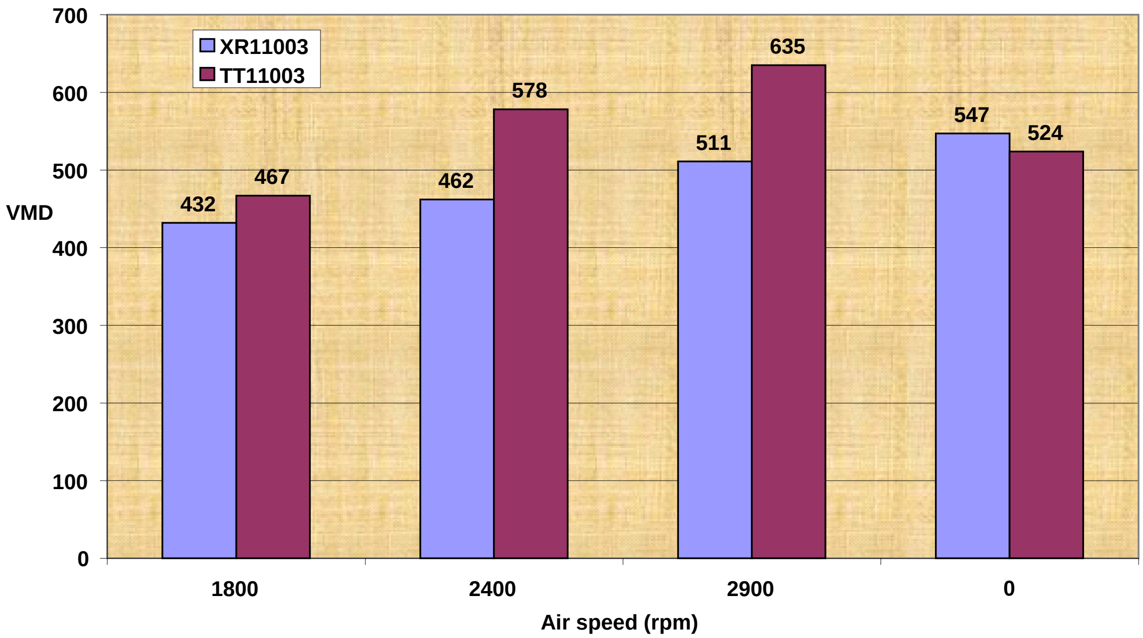


Figure 2: Estimated spray volume in GPA using XR11003 and TT11003 nozzles with varying spray air delivery speeds.

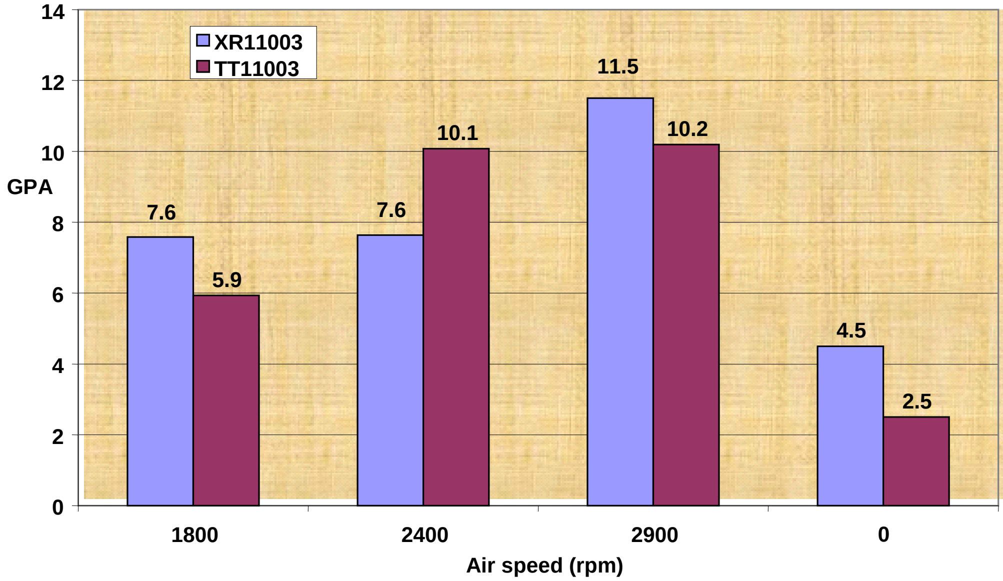


Figure 3: Relative percent area of water sensitive paper coverage using XR11003 and TT11003 nozzles with varying spray air delivery speeds.

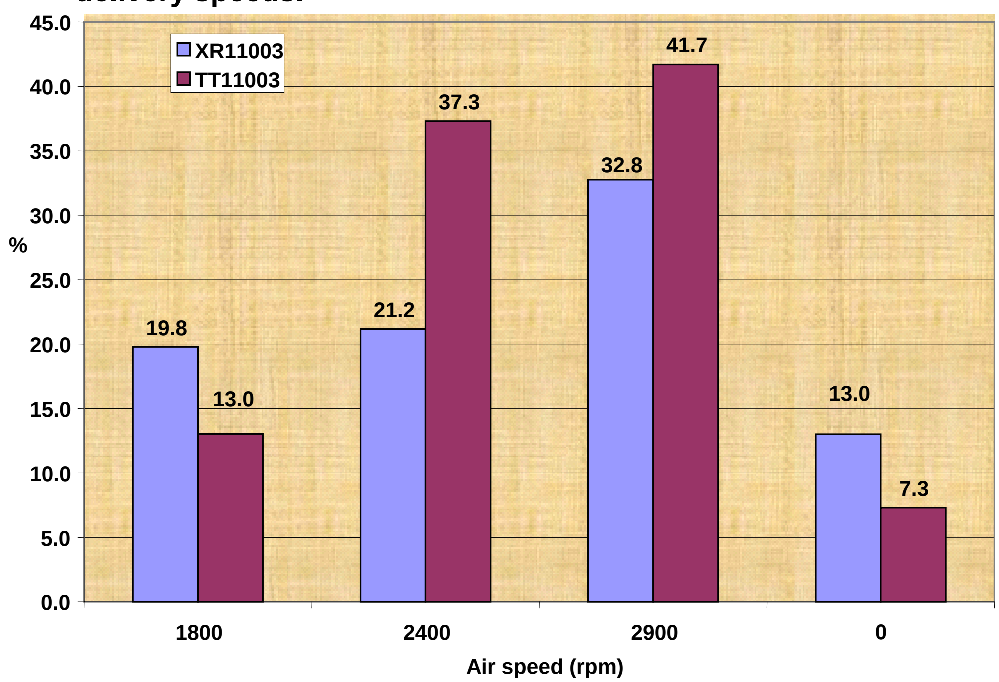


Figure 4: Relative deposition of spray on wheat heads using XR11003 and TT11003 nozzles in varying spray air delivery streams.

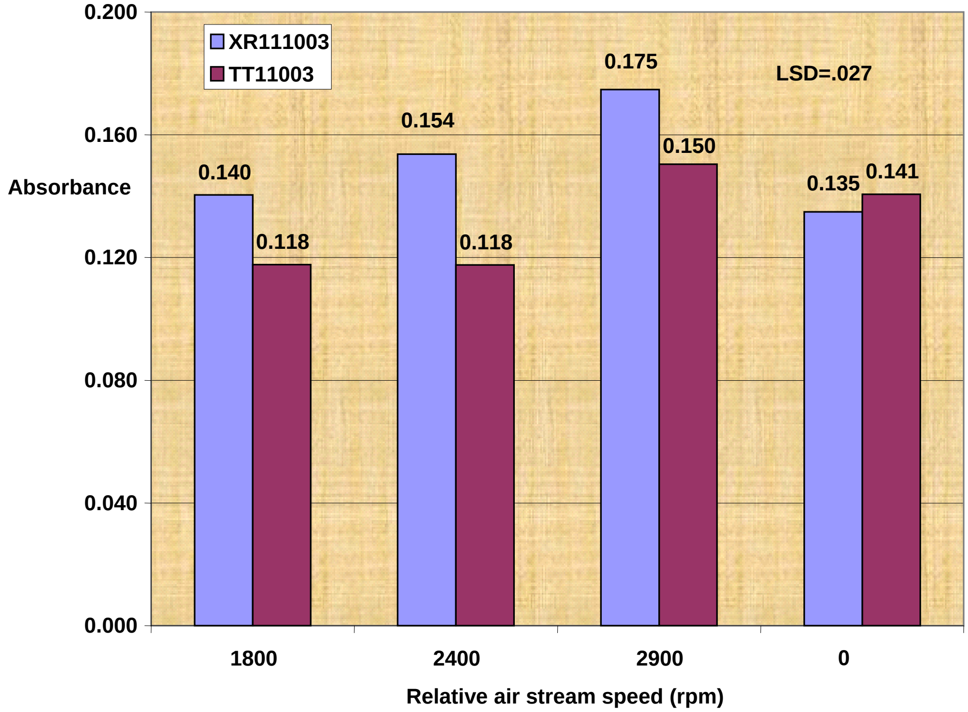


Figure 5: Volume Median Diameter (VMD) drop size measured with water sensitive paper using Hardi FO25_110 nozzles at varying pressures and spray air delivery speeds.

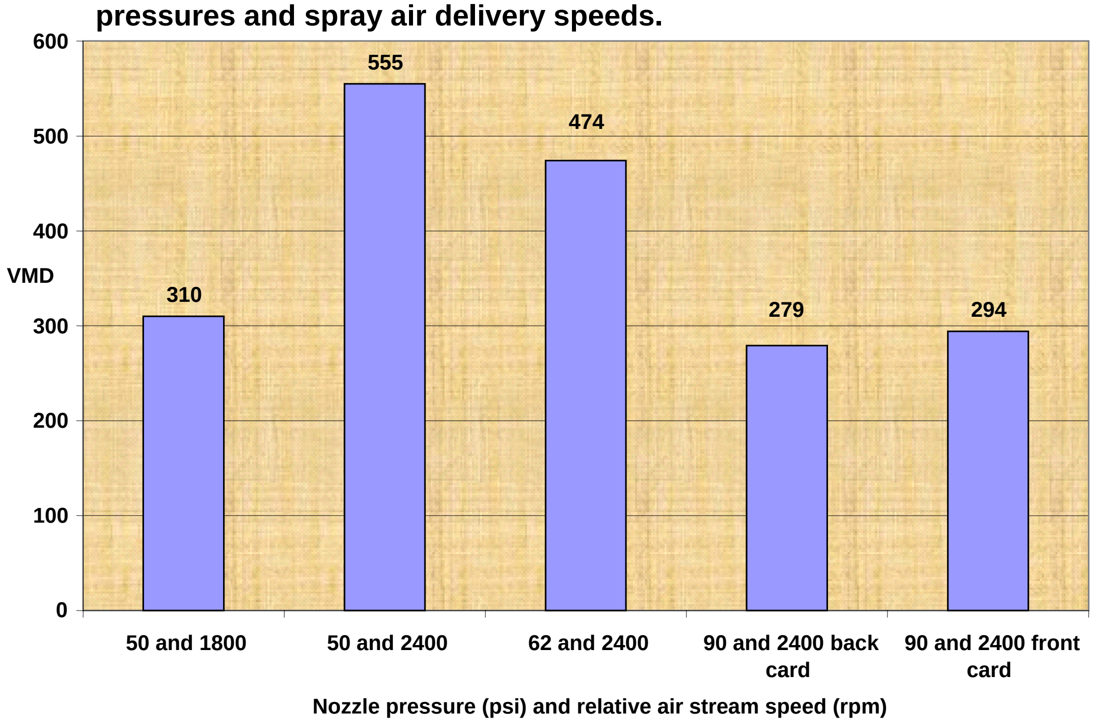


Figure 6: Estimated GPA measured on water sensitive paper using Hardi FO25_110 nozzles at various operating pressures and spray air delivery speeds.

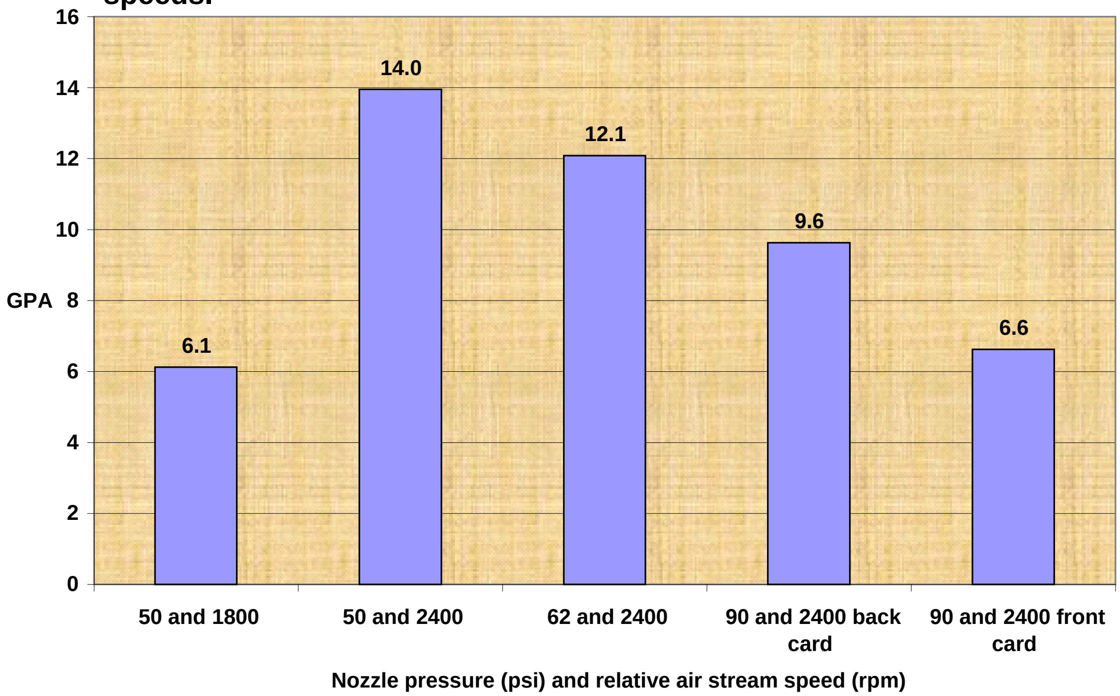
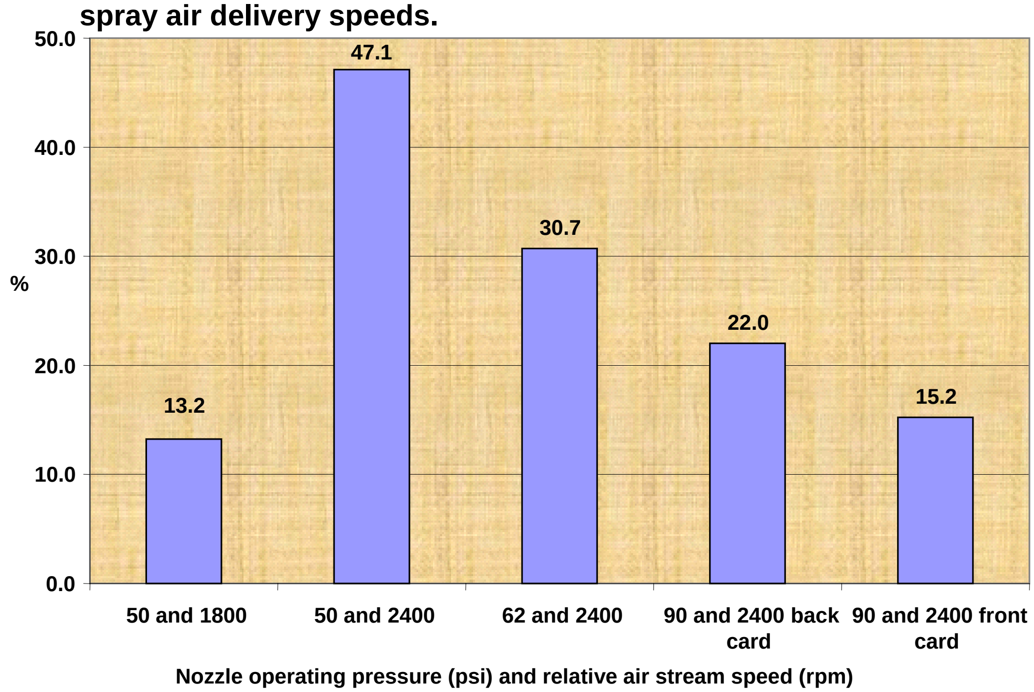


Figure 7: Estimated Percent (%) area of coverage on water sensitive paper using Hardi FO25_110 nozzles at varying operating pressures and spray air delivery speeds.



Sources of Variation	**Nozzle or Air Stream Speed**	**Absorbance**	**Yield** (bu/a)	**Test Weight** (lb/bu)	**Protein** (%)
Nozzle		0.0444	0.1438	0.0867	0.1075
Air Stream Speed		0.0771	0.9207	0.6719	0.6693
Noz*Air		0.4275	0.7027	0.6749	0.8804
%C.V.		18	8	1	3
Nozzles averaged across air stream speeds					
	XR11003	.151	30.3	58.0	15.8
	TT11003	.132	28.8	57.4	16.1
LSD $_{(0.05)}$		.02	NS	00.6[Z]	NS
Air stream speeds averaged across nozzles					
	Fast	.163	29.0	57.4	16.1
	Medium	.136	29.5	57.7	16.0
	Slow	.129	29.2	57.7	15.8
	None	.138	29.7	57.9	15.9
LSD $_{(0.05)}$		.03[Z]	NS	NS	NS

[Z] Significant at 0.10 level.