Hard Red Spring Wheat (*Triticum aestivum* 'Knudson')
Fusarium head blight; *Fusarium graminearum*
Stagonospora blotch; *Stagonospora nodorum*
Tan spot; P*yrenophora. tritci-repentis*

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'Knudson' Hard Red Spring Wheat Response to JAU 6476 Fungicide Rate, Spray Systems, and Boom Height above Crop Canopy, 2004

The Bayer CropScience experimental fungicide JAU 6476, prothioconazole, has shown improved efficacy in the control of Fusarium head blight (FHB) on durum and hard red spring wheat (HRSW) and reductions in deoxynivalenol levels compared to most of the labeled fungicides on small grains. The fungicide's effects on disease reduction and deoxynivalenol concentrations are very linear with dosage on HRSW making the properties of the fungicide favorable for research to compare spray application technologies. Due to variations in the landscape, size of the spray units, and travel speed operators typically are required to operate booms in configurations less than optimal to maximize spray deposition. This creates additional problems with the mechanics of the delivery of the spray solution to the target. There has been a general consensus among researchers that failures in the control of fungicide to effectively control FHB are related to the failure of the operator and the machine to properly deliver the fungicide to the target.

A study was conducted to compare JAU 6476 dosages; 0.25x (1.4 fl oz/A) and 0.75x (4.3 fl oz/A) applied with an air delivery/rotary atomizer (**Proptec™**) and a hydraulic delivery/hydraulic nozzles (Conventional) type spray system. The conventional system was equipped with either a single row of Spraying Systems™ Twin-Jet 8002 nozzles (**Conventional Down**), or a double row of nozzles angled 30º downward from horizontal and oriented forward and backward (**Conventional F+B**). A third factor included **contrasting boom configurations** in a randomized complete block design trial arranged as a 2 x 3 x 2 factorial (rates x sprayers x configurations) with 6 replicates. The Proptec configuration is unit delivery oriented backward from direction of travel system and was angled 50º downward from horizontal (**recommended**) or oriented vertically down (**not recommended)**. The Conventional Down configuration dispersed the spray solutions 17-19 inches above the canopy (recommended) or 40-44 inches above canopy (not recommended). The Conventional F + B configuration dispersed solutions 10 inches above canopy (recommended) or 36 inches above canopy (not recommended). An untreated treatment was included in the study but not included in the analysis. The study site was previously cropped soybean. The area was seeded May 6 with a drill with disks space 6 inches apart. The area was divided to plots 20 ft. wide by 50 ft. long. The air delivery system had spray delivery units spaced 48 inches apart and the hydraulic delivery system had nozzles spaced 20 inches apart. The nozzles were Spraying Systems XR8001. The conventional systems are typical of two in use by producers for applying fungicide. A major difference in the three systems is the drop size. The air delivery system can deliver a much smaller drop size containing most of the movement of the small drops to the target. The drop size from the air delivery system would be classified as very fine and the hydraulic delivery fine. Each system was calibrated to deliver 10 GPA at a 6 mph tractor travel speed. Recommended production practices for Northeast North Dakota by North Dakota State University Extension were followed. Wheat grains colonized by *F. graminearum* were hand broadcast on 15 Jun on individual plots at 3.5 oz per plot to increase chance of infection to Fusarium head blight. The tractor traveled on the left half of the plot area. This area also provided border to reduce off target drift between treatment areas. Differences in spike coverage between treatments were measured by using water sensitive cards (WSP). Water sensitive cards were placed back to back on stands and oriented vertically both in the direction of travel and perpendicular to the direction of travel and horizontally at spike height in two spots with each configuration. Two additional configurations with the Proptec were included in non plot areas of the trial to gather additional coverage data. The WRK DropletScan system was used to determine the drop size from deposits on the water sensitive paper and coverage from each of the configurations. Grain spikes were sampled after fungicide application, bagged, and frozen for JAU 6476 residue and metabolite analysis by Bayer CropScience. The sample, approximately one lb, was comprised of an equal quantity of spikes from two configurations of the Proptec and one configuration of the conventional F + B. A visual estimation was made from 20 samples per plot on 10 August to estimate the incidence (number of spikes infected) and field severity (number of FHB infected kernels per head divided by total kernels per individual spike) in each plot. Severity of leaf diseases was based on visual estimate of the percent leaf infection from five leaves per plot. A flag leaf sample was one leaf and a head sample was one spike. Each plot was harvested with a Hege plot combine after removal of the front and rear 10 feet of crop from the plot to remove areas where spray drift may have occurred. The grain sample was cleaned and processed for yield, test weight, protein, and deoxynivalenol determination. 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 and Discussion

Foliar and head disease levels were low in 2004 in HRSW due to the cold temperatures throughout the growing season. The untreated plot means had FHB incidence, field severity, foliar disease severity, and deoxynivalenol concentrations of 27%, 1%, 38%, and 0.6% respectively so the treated plot data was not recorded for diseases. The Conventional F+B had greater yields than the other spray systems (Table 1) and an interaction was determined in yield by spray system, height, and spray rate (Figure 1). There were no differences in test weight or proteins although test weight values were indicative of losses one would see in a moderate to heavy disease epidemic season. A frost on August 20 may have been the cause. Drop size and area covered as determined from the WSP are reported in Table 2 and Table 3.

Conventional F+B nozzles showed similar advantage in yield over Conventional Down as has previously been reported. Although the Twinjet nozzle offers some convenience to growers they did not produce an equal yield to conventional F + B even with low levels of disease. Volume median diameters (VMD) were larger with the twinjet configuration but not as consistent from front to back. The wind direction generally determines which side of the spike receives the most coverage when the wind speed is greater than the velocity of the spray. Generally the back side only receives very fine deposits and very little coverage as indicated by the card data. The Conventional F +B nozzles provided the most consistent coverage when comparing the recommended boom height compared to a greater boom height. The very fine drops produced by the Proptec apparently did not have enough mass to remove them from the air stream and deposit on the spike. Adjustment will be discussed for future trials. The residue determinations from Bayer CropScience showed 7522.8 ppb with the Conventional F+B at recommended height, 1554.9 ppb with the Proptec oriented down, and 1052.9 ppb with the Proptec oriented 50º downward. The actual fungicide deposits show some of the limitations with using card coverage to determine fungicide deposition and suggest other methodology for accurate coverage qualification and quantification. The residue analysis is the preferred method but costs limit the use of the technology. The other factor was that the very fine drop size formed by the Proptec creates other deposition problems for the wheat spike as a target that will need to be addressed in the future.

A careful review of Figure 1 begs the question, “Why the significant differences in yield that are minimally related to the individual control parameters of system, rate, or height”? Field observations imply it may be the effect of wind. Past research has show that the angle the spray drops inters the top of the canopy strongly influences the deposition efficiency. A wheat head presents a much larger target from the side that it does top. Thus a spray system with F&B nozzles usually provides better disease control that straight down nozzles when operated at the correct height in low wind and low ground speed conditions. But as wind speed approaches 10 miles per hour, the wind starts to change the trajectory of the spray droplets. If an XR8001 or a Twin-Jet 8002 nozzle is 36” above the canopy the angle of spray droplets entry into the canopy is almost totally controlled by the wind. No wind results in nearly a vertical entry angle and as the wind speed raises the angle of entry increases and deposition efficiency improves as does the risks associated with spray drift. At the Landon Research Station during the early July spray window for FHB, the winds are rarely nor are they consistent throughout the daylight hours. Wind velocities of 10 mph or more are common.

A similar observation can be made about how ground speed affects the angle of droplet entry into the wheat canopy. As ground speed exceeds 10 mph the spray droplets from straight down nozzles enter the canopy at an angle similar to spray from forward tilted nozzles at low ground speed. The Proptec™ sprayer spraying is an “air carrier” system designed to provide uniform spray coverage through a heavy fruit canopy. Additional effort is needed to reduce the “air carrier” wind velocity and decrease the angle of entry so as to not carry the spray droplets past the wheat heads and into the low leaf canopy.

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Table 1. Yield, Test Weight, Protein by Spray System, Relative Spray Boom Height and Fungicide Rate, 2004.

Spray System and Configuration	Relative Spray Boom Height	Fungicide Rate [z]	Yield (bu/A)	Test Weight (lb/bu)	Protein (%)
Untreated			55.1	56.7	12.6
Conventional Down			55.9	56	12.8
Conventional F + B			59.4	57.7	12.8
Proptec			54.7	56.7	13.0
	Recommended		57.2	56.8	12.9
	Not Recommended		56.2	56.7	12.8
		0.25x	56.0	56.7	12.8
		0.75x	57.3	56.9	12.9
Spray System	*P*=.05		3.0	NS	NS
Height			NS	NS	NS
Rate			NS	NS	NS
System*Height			NS	NS	NS
System*Rate			NS	NS	NS
Height*Rate			NS	NS	NS
System*Height*Rate			5.9	NS	NS
% C.V.			9	3	2

[z] JAU 6476 (480 SC) applied with Induce Adjuvant at 0.125% v/v/A.

Table 2. Drop Size on Water Sensitive Paper by Spray System, Relative Spray Boom Height and Fungicide Rate, 2004.

			Cards Drop Size			
Spray System	Boom Configuration	Horizontal VMD	back VMD	front VMD	right VMD	left VMD
Twinjet	Recommended	664	343	423	396	290
	High	298	136	378	299	153
Conventional F+B	Recommended	575	200	325	236	202
	High	572	189	272	337	205
Proptec	Down	265	149	137	137	137
	30º	396	410	115	146	198
	50º	209	170	119	147	183
	70º	246	145	139	131	152
LSD		324	NS	96	117	NS
% CV		34	40	17	22	46

Table 3. Coverage on Water Sensitive Paper by Spray System, Relative Spray Boom Height and Fungicide Rate, 2004.

			Cards Coverage				
Spray System	Boom Configuration	Horizontal %	back %	front %	right %	left %	mean %
Twinjet	Recommended	58	7	37	20	17	20
	High	15	<1	11	5	3	5
Conventional F+B	Recommended	50	1	19	4	4	7
	High	49	1	17	14	3	9
Proptec	Down	18	7	3	3	3	4
	30º	28	40	<1	4	11	14
	50º	43	9	<1	2	9	5
	70º	18	3	2.4	2	4	3
LSD		60	73	31	72	103	6
% CV		NS	15	8	11	NS	28

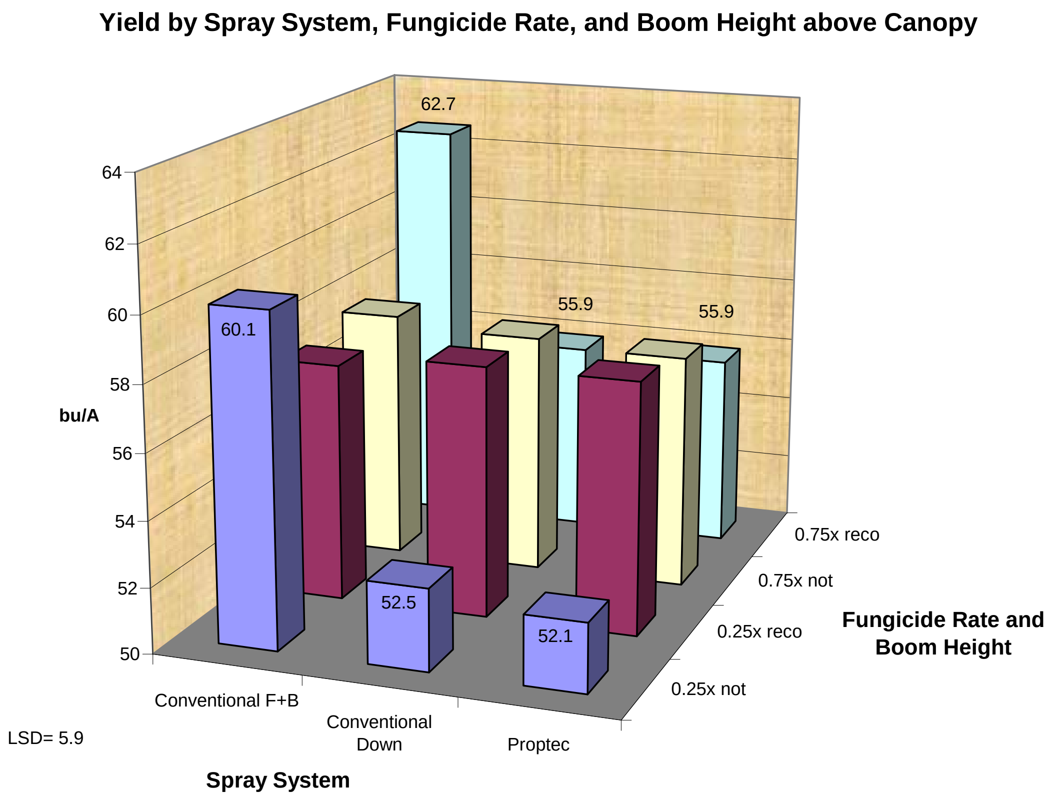

Figure 1. Yield by Spray System, Fungicide Rate and Boom Height, 2004.