



Improving management of white mold in soybeans: 3. Optimizing fungicide spray droplet size

Michael Wunsch, Thomas Miorini, Michael Schaefer, Billy Kraft, Suanne Kallis
NDSU Carrington Research Extension Center
Heidi Eslinger, Kelly Cooper, Seth Nelson NDSU Robert Titus Research Farm, Oakes

RESEARCH FUNDED BY THE **NORTH DAKOTA SOYBEAN COUNCIL**

Droplet size

Cutting droplet diameter in half



=

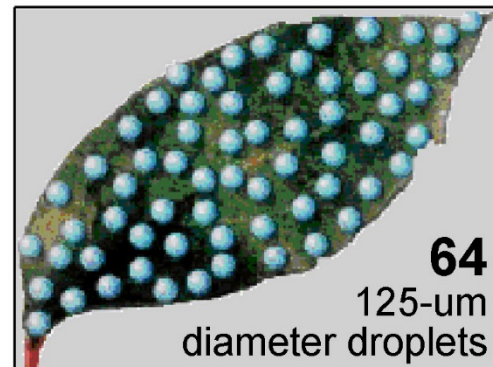
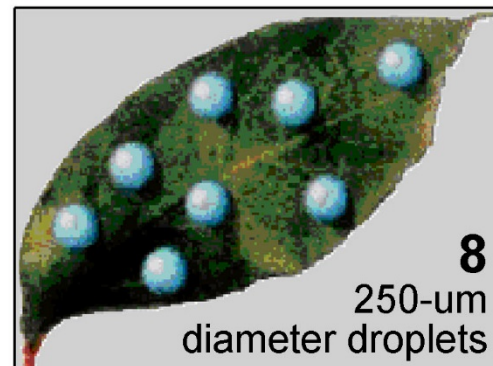
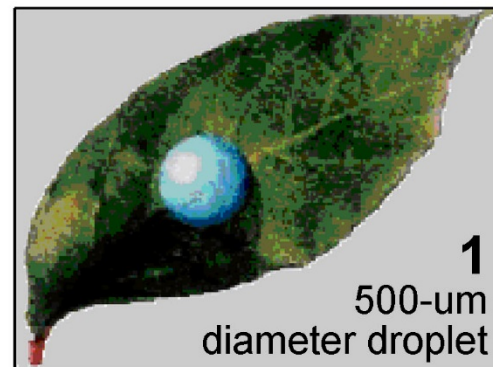
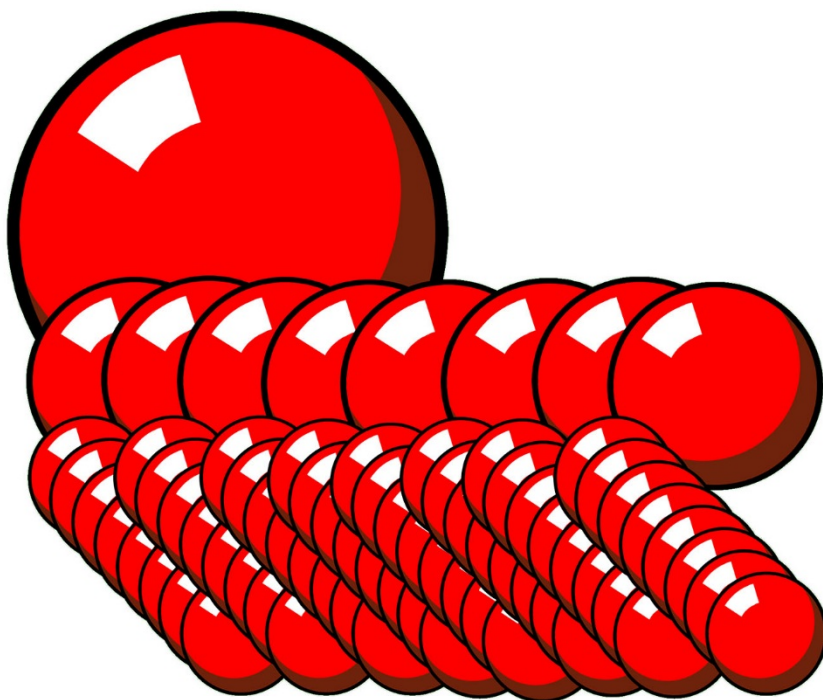
Results in eight times as many droplets



(there is one more droplet in the rear)

Droplet size

0.065 mm³ spray volume =
one 500-um diameter droplet
eight 250-um diameter droplets
sixty-four 125-um diameter droplets

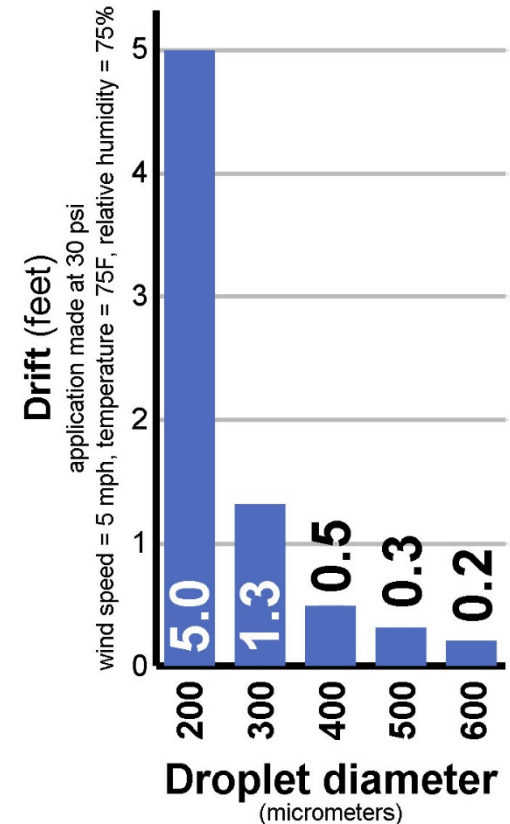
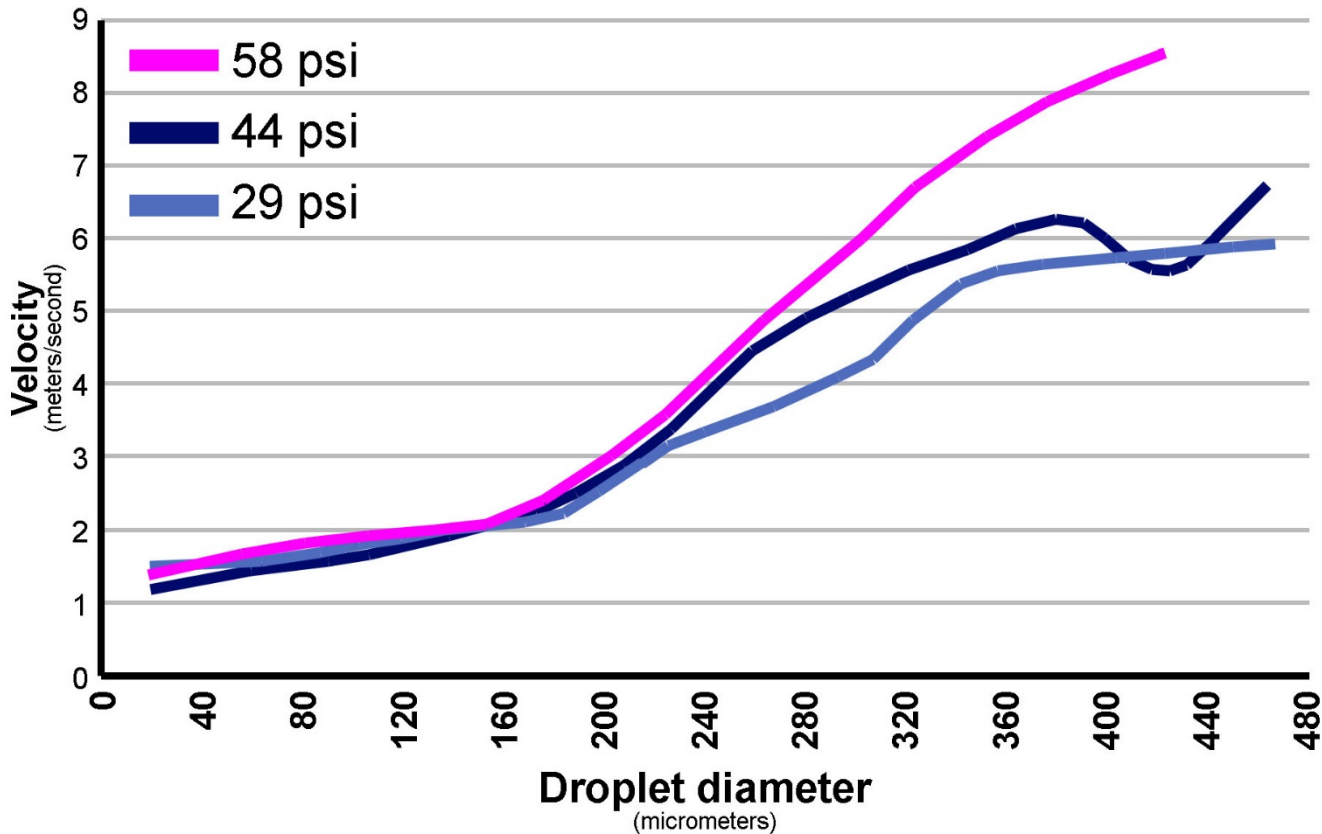


OPTIMIZING FUNGICIDE DEPOSITION WITHIN A CROP CANOPY

Droplet size

... but larger droplets have greater velocity, drift less.

Increased velocity and reduced drift improves canopy penetration.







FINE MEDIUM COARSE VERY COARSE

Fine Med. C. V. Coarse

Experimental Methods

1. WILGER nozzles

Spray droplet size estimates were based on information provided by the manufacturer.

																		
			Recommended Pressure: 25-70 PSI				Recommended Pressure: 30-100 PSI				Recommended Pressure: 30-100 PSI				Recommended Pressure: 35-100 PSI			
Tip Cap No.	Flow Rate USGPM	PSI	VMD (Droplet Size in μ); %<141 μ (Drift %); %<200 μ (Drift %); %<600 μ (Small Droplets)															
			110° ER Series				110° SR Series				110° MR Series				110° DR Series			
			VMD	<141	<200	<600	VMD	<141	<200	<600	VMD	<141	<200	<600	VMD	<141	<200	<600
04	0.43	50	209	26%	47%	96%	275	15%	30%	96%	355	8%	17%	91%	447	5%	10%	79%
			■ Fine 106-235 μ				■ Medium 236-340 μ				■ Coarse 341-403 μ				■ Very Coarse 404-502 μ			

ER110-04

50 psi

FINE
DROPLETS

SR110-04

50 psi

MEDIUM
DROPLETS

MR110-04

50 psi

COARSE
DROPLETS

DR110-04

50 psi

VERY COARSE
DROPLETS

Experimental Methods

2. TEEJET nozzles

Spray droplet size estimates were based on information provided by the manufacturer.

XR TeeJet® (XR)

	PSI						
	15	20	25	30	40	50	60

XR11004 50 psi
FINE DROPLETS

XR11004	M	M	M	M	M	F	F
----------------	---	---	---	---	---	---	---

XR11005 40 psi
MEDIUM-FINE DROPLETS

XR11005	M	M	M	M	M	F	F
----------------	---	---	---	---	---	---	---

XR11006 35 psi
MEDIUM DROPLETS

XR11006	C	M	M	M	M	M	F
----------------	---	---	---	---	---	---	---

XR11008 40 psi
MEDIUM-COARSE DROPLETS

XR11008	C	C	C	C	M	M	M
----------------	---	---	---	---	---	---	---

XR11010 30 psi
COARSE DROPLETS

XR11010	VC	C	C	C	M	M	M
----------------	----	---	---	---	---	---	---

Initial Calibration

The initial calibration was conducted with water.



Spot-On sprayer
calibrator model SC-1

Innoquest, Inc.;
Woodstock, IL

Objectives:

- 1. Nozzle selection:** Tips with output deviating from advertised specifications discarded
- 2. Initial identification of pulse width** needed to deliver 15 gal/ac spray volume at 8.9 mph driving speed

Final Calibration

The final calibration was conducted with fungicide in the field immediately before application.

Objectives:

- 1. Ensure a precise spray volume of 15 gal/ac.** Manual adjustments to pulse width were made as needed.
- 2. Confirm that all nozzles are operating correctly –** consistent output across all nozzles; no plugs.

Applications

Tractor-mounted sprayer equipped with a pulse-width modulation system from Capstan AG.

Spray volume: 15 gal/ac Pulse width manually calibrated to maintain a constant spray volume across tips differing in output.

Driving speed: 8.9 mph in all studies conducted in 2019. In studies conducted in 2018, driving speed was 6.7 mph.



Study design, data collection

Row spacing: 21 inches (three rows per plot)

Seeding rate: 165,000 pure live seeds/ac

Replicates: 6, 9, 10 or 12 replicates (Wilger nozzles)
9, 11, 12 or 13 replicates (TeeJet nozzles)

A large number of replicates was utilized due to the inherent spatial variability of white mold and the need to differentiate small treatment differences.

Plot size: 5 ft x 25 ft at planting, 5 ft x average 19 ft at harvest (Carrington), average 16 ft at harvest (Oakes)

Disease assessments: Every plant in the two rows farthest from the sprayer within each plot was individually assessed for white mold severity (%) at soybean maturity.

- *An average of 212 plants were individually assessed in each plot (Carrington)*
- *An average of 97 plants were individually assessed in each plot (Oakes).*
- *White mold severity was calculated for each plot by averaging the disease severity ratings taken across all plants in the plot.*

Impact of droplet size, TeeJet nozzles – soybeans

Canopy open when fungicides applied

	Location YEAR soybean variety:	Oakes 2019 Dairyland 'DSR-1120'	Oakes 2019 Peterson '18X11N'	Carrington 2018 ProSeed 'XT60-40'	Carrington 2018 Peterson '18X06N'
Canopy Closure	Average:	70%	73%	82.5%	87.5%
	Range:	60-85%	60-85%	75-90%	80-95%
White mold severity index (% of canopy diseased)					

Study locations: Oakes & Carrington, ND

Years: 2018, 2019

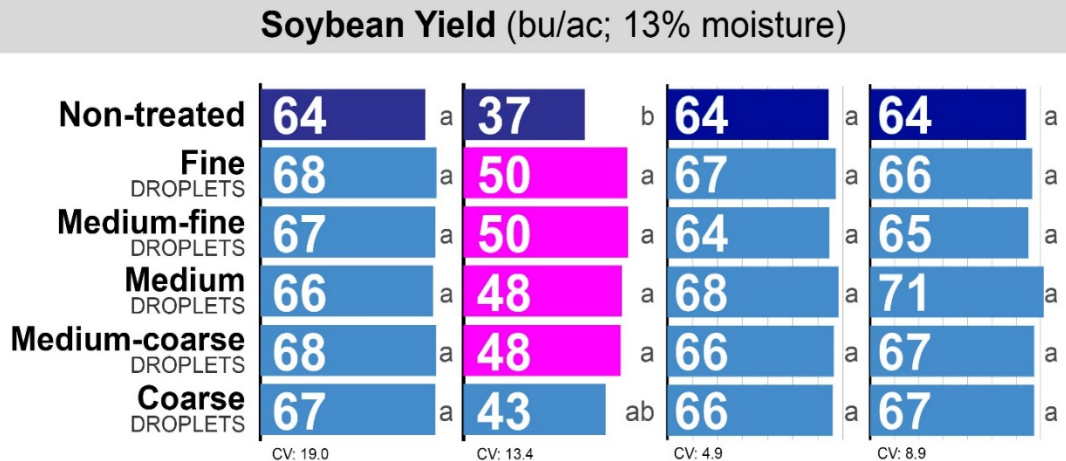
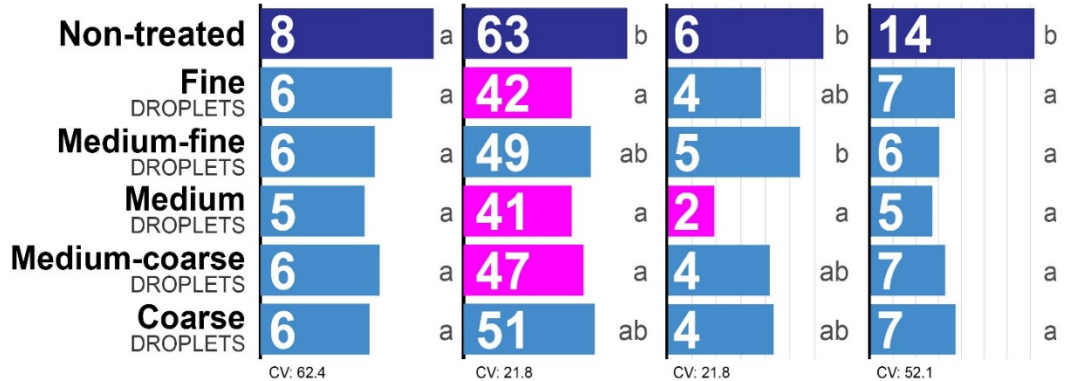
Fungicide: Endura 70WG (5.5 oz/ac), 100% of plants at the R2 growth stage

Row spacing: 21 inches **Seeding rate:** 165,000 pure live seeds/ac

Spray volume: 15 gal/ac **Driving speed:** 8.9 mph (2019); 6.7 mph (2018)

Nozzles (2018): XR8003, 50 psi (fine); XR8004, 40 psi (medium-fine); XR8006, 40 psi (medium); XR8008, 35 psi (medium-coarse); XR8010, 30 psi (coarse)

Nozzles (2019): XR11004, 50 psi (fine); XR11005, 40 psi (medium-fine); XR11006, 35 psi (medium); XR11008, 40 psi (medium-coarse); XR11010, 30 psi (coarse)



Impact of droplet size, TeeJet nozzles – soybeans

Canopy near closure when fungicides applied

Study location:

Carrington, ND

Years: 2017, 2018, 2019

Fungicide: Endura 70WG
(5.5 oz/ac), 100% of plants at the R2 growth stage

Row spacing: 21 inches

Seeding rate: 165,000 pure live seeds/ac

Spray volume: 15 gal/ac

Driving speed: 8.9 mph

(2019); 6.7 mph (2018); 4.0 mph (2017)

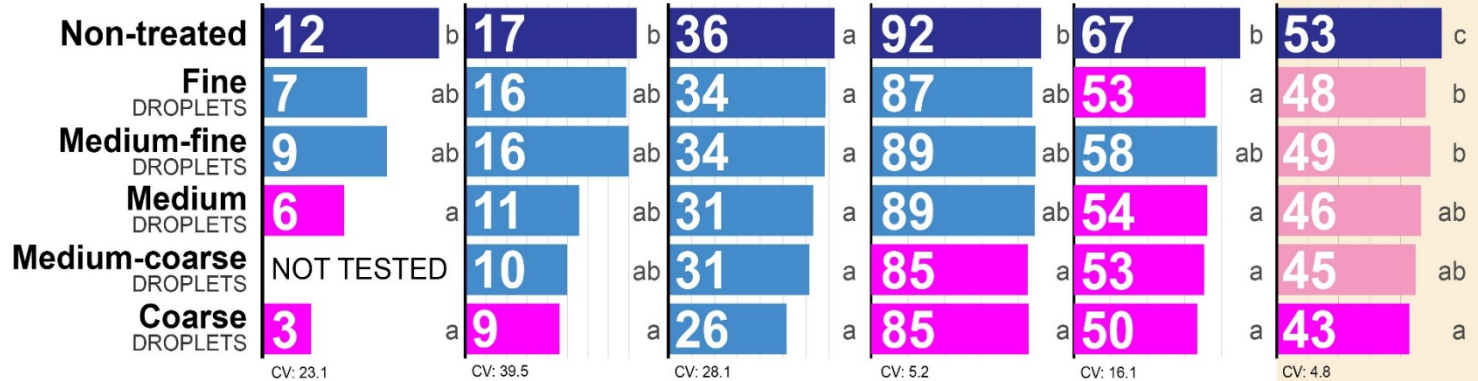
Nozzles (2018): XR8003, 50 psi (fine); XR8004, 40 psi (medium-fine); XR8006, 40 psi (medium); XR8008, 35 psi (medium-coarse); XR8010, 30 psi (coarse)

Nozzles (2019): XR11004, 50 psi (fine); XR11005, 40 psi (medium-fine); XR11006, 35 psi (medium); XR11008, 40 psi (medium-coarse); XR11010, 30 psi (coarse)

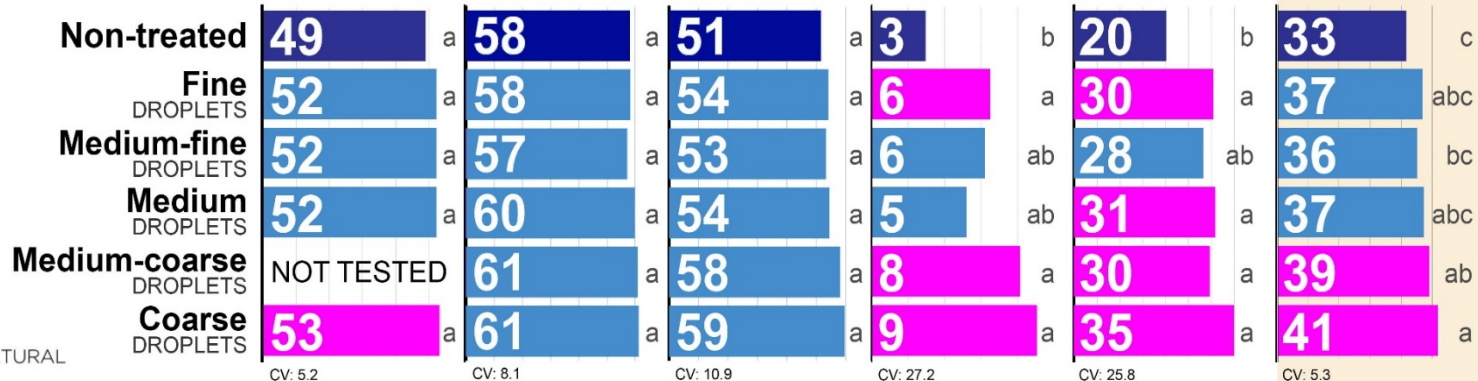


	Location	Carrington	Carrington	Carrington	Carrington	Carrington	COMBINED ANALYSIS
	YEAR	2017	2018	2018	2019	2019	Four varieties
	soybean variety:	Dairyland 'DSR-0619'	Dairyland 'DSR-0904'	Peterson '17X09N'	Peterson '17X09N'	Dairyland 'DSR-0418'	
Canopy Closure	Average:	92%	92.5%	92.5%	94.9%	95.9%	92.5-95.8%
	Range:	75-97%	90-95%	90-95%	80-100%	90-100%	canopy closure (average, studies with all five droplet size treatments)

White mold severity index (% of canopy diseased)



Soybean Yield (bu/ac; 13% moisture)



Impact of droplet size, TeeJet nozzles – soybeans

Canopy at closure when fungicides applied

Study locations:

Carrington and Oakes, ND

Years: 2018, 2019

Fungicide: Endura

70WG (5.5 oz/ac), 100% of plants at the R2 growth stage

Row spacing: 21 inches

Seeding rate: 165,000

pure live seeds/ac

Spray volume: 15 gal/ac

Driving speed: 8.9 mph (2019); 6.7 mph (2018)

Nozzles (2018): XR8003, 50 psi (fine); XR8004, 40 psi (medium-fine); XR8006, 40 psi (medium); XR8008, 35 psi (medium-coarse); XR8010, 30 psi (coarse)

Nozzles (2019):

XR11004, 50 psi (fine);

XR11005, 40 psi

(medium-fine);

XR11006, 35 psi

(medium); XR11008, 40

psi (medium-coarse);

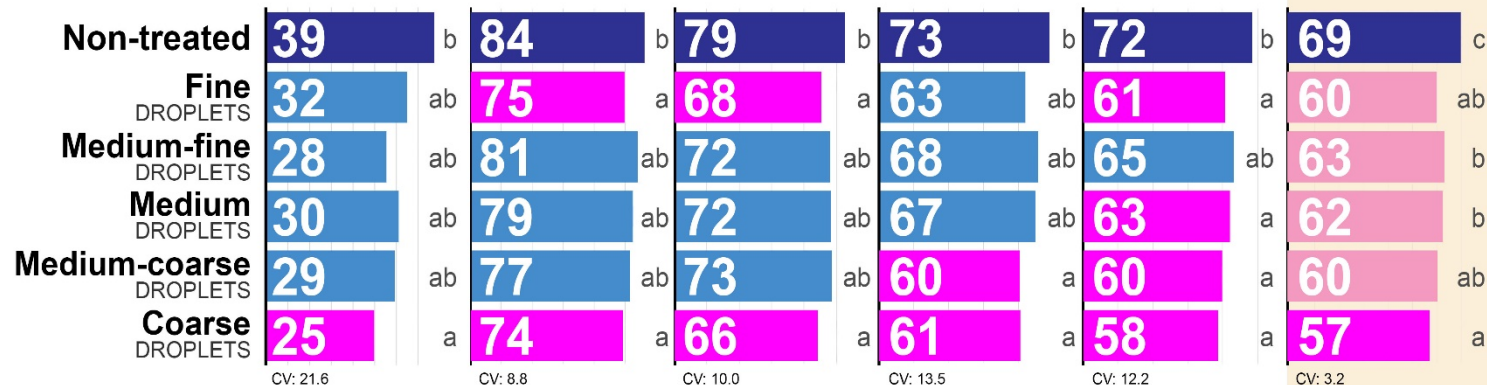
XR11010, 30 psi (coarse)



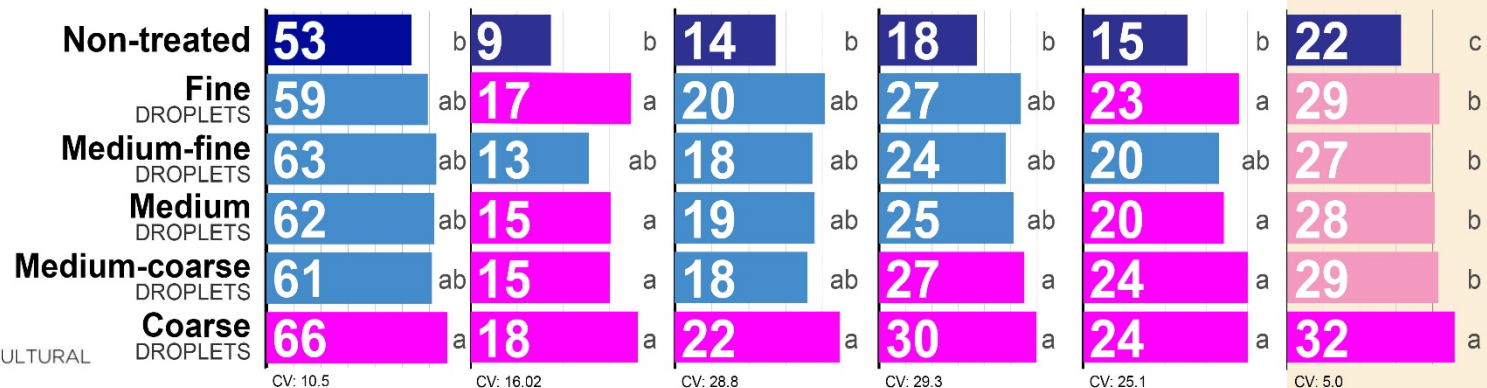
Location	Oakes	Carrington	Carrington	Carrington	Carrington	COMBINED ANALYSIS
YEAR	2018	2019	2019	2019	2019	
soybean variety:	Pioneer 'P11A95X'	Peterson '14R09N'	Peterson '18X07N'	Dairyland 'DSR-0807'	Peterson '18X06N'	Five varieties

Canopy Closure	Average:	98.5%	98.7%	98.9%	99.6%	99.6%	98.5-99.6%
	Range:	97-100%	98-100%	97-100%	98-100%	99-100%	canopy closure (average)

White mold severity index (% of canopy diseased)



Soybean Yield (bu/ac; 13% moisture)



Conclusions from field trials conducted in 2017-2019

Preliminary results from an ongoing research project

Soybeans – TeeJet nozzles:

Applying fungicides with **coarse droplets** optimized white mold management in soybeans when the soybean canopy was at or near closure (92-100% average canopy closure).

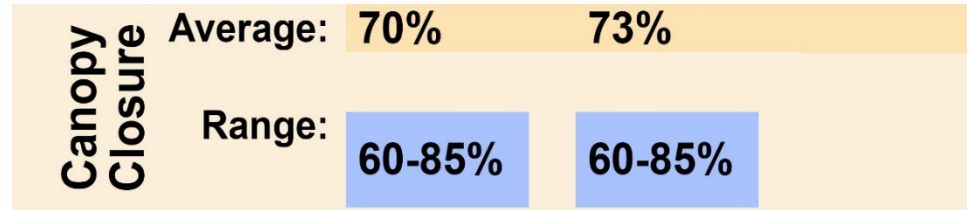
Applying fungicides with **fine to medium droplets** optimized white mold management in soybeans when the soybean canopy was open (70-88% average canopy closure).



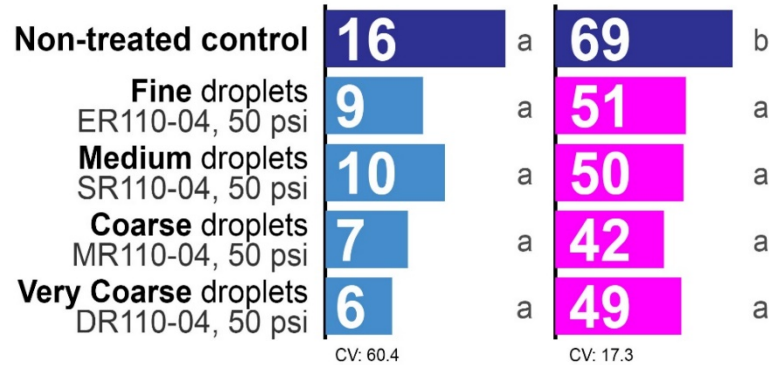
Impact of droplet size, Wilger nozzles – soybeans

Canopy open when fungicides applied

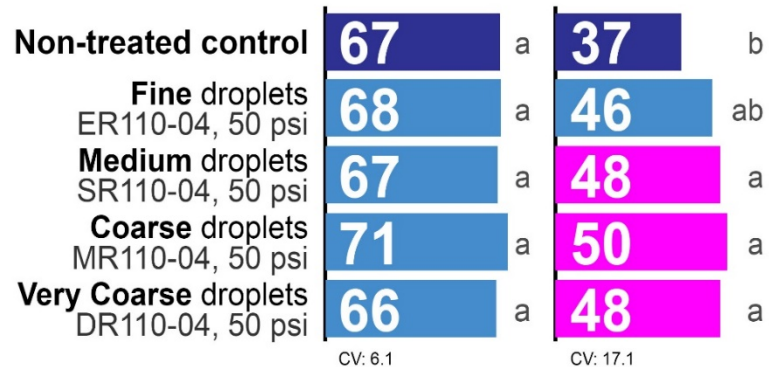
Location Oakes **Oakes**
YEAR 2019 2019
 soybean variety: Dairyland 'DSR-1120' Peterson '18X11N'



White mold severity index (% of canopy diseased)



Soybean Yield (bu/ac; 13% moisture)



Study location: Oakes, ND
Year: 2019
Fungicide: Endura 70WG (5.5 oz/ac), 100% of plants at the R2 growth stage
Row spacing: 21 inches
Seeding rate: 165,000 pure live seeds/ac
Spray volume: 15 gal/ac
Driving speed: 8.9 mph (2019)

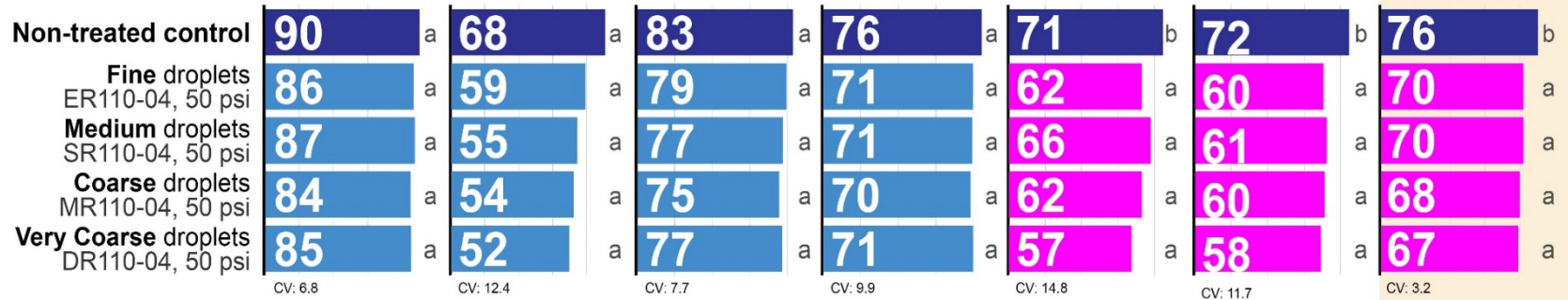


Impact of droplet size, Wilger nozzles – soybeans

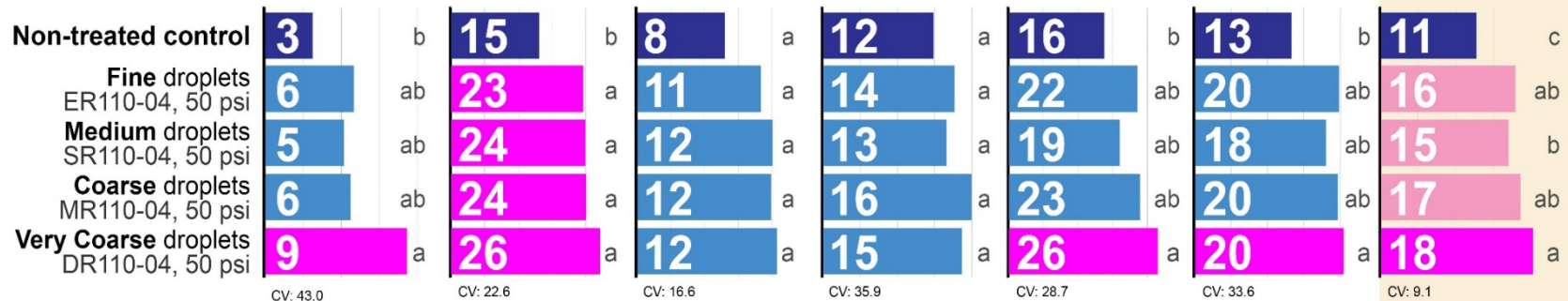
Canopy at or near closure when fungicides applied

	Location YEAR soybean variety:	Carrington 2019 Peterson '17X09N'	Carrington 2019 Dairyland 'DSR-0418'	Carrington 2019 Peterson '14R09N'	Carrington 2019 Peterson '18X07N'	Carrington 2019 Dairyland 'DSR-0807'	Carrington 2019 Peterson '18X06N'	COMBINED ANALYSIS
Canopy Closure	Average:	94.9%	95.9%	98.7%	98.9%	99.6%	99.6%	98.5-99.6%
	Range:	80-100%	90-100%	98-100%	97-100%	98-100%	99-100%	Average across six varieties

White mold severity index (% of canopy diseased)



Soybean Yield (bu/ac; 13% moisture)



Study location: Carrington, ND **Year:** 2019

Fungicide: Endura 70WG (5.5 oz/ac), 100% of plants at the R2 growth stage

Row spacing: 21 inches **Seeding rate:** 165,000 pure live seeds/ac

Spray volume: 15 gal/ac **Driving speed:** 8.9 mph



Conclusions from field trials conducted in 2017-2019

Preliminary results from an ongoing research project

Soybeans – Wilger nozzles:

Applying fungicides with **very coarse droplets** optimized white mold management in soybeans when the soybean canopy was at or near closure (95-100% average canopy closure).

Applying fungicides with **coarse droplets** optimized white mold management in soybeans when the soybean canopy was open (70-73% average canopy closure).

It is unclear whether the droplet spectrum considered to be “medium”, “coarse”, “very coarse”, etc. is the same/different for Wilger vs. TeeJet.

Applying with very coarse droplets may not be optimal for TeeJet nozzles.





Thank You!

Research funding:
North Dakota Soybean Council



NDSU NORTH DAKOTA AGRICULTURAL
EXPERIMENT STATION