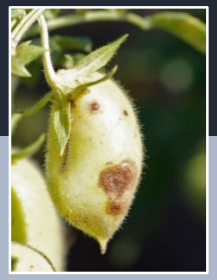
Optimizing fungicide spray droplet size for improved management of Ascochyta blight of chickpeas



Michael Wunsch, Jesse Hafner, Suanne Kallis, Billy Kraft and Thomas Miorini
NDSU Carrington Research Extension Center

Research funded by the
Northern Pulse Growers Association
and the **North Dakota Crop Protection Product Harmonization Board and Registration Board**

Northern Pulse Growers Association

Droplet size

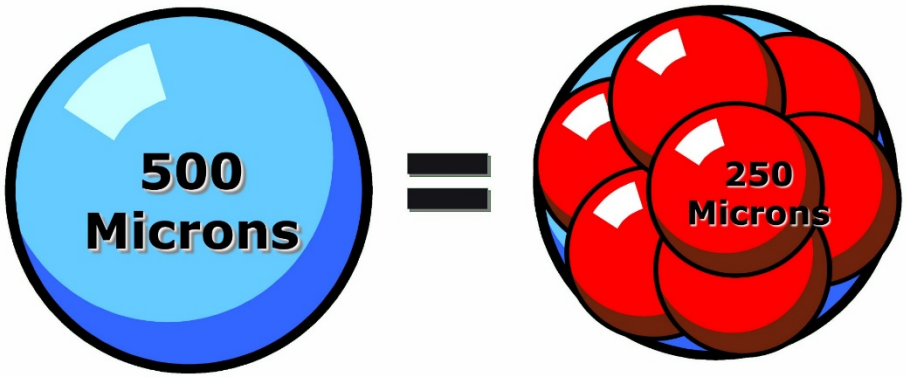
Reducing droplet size increases spray coverage.

Modern systemic fungicides exhibit only limited systemic movement – limited upward movement from the point where the fungicide was deposited and movement from the upper to the lower surface of the leaf. Older contact fungicide have no systemic movement.

Due to the limited systemic movement by fungicides within plants, fine to medium spray droplets that optimize fungicide coverage to the upper canopy are generally recommended for fungicides.

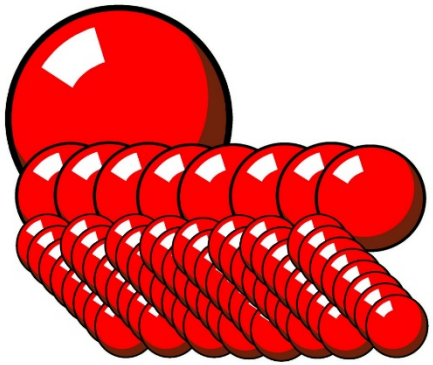
Cutting droplet diameter in half

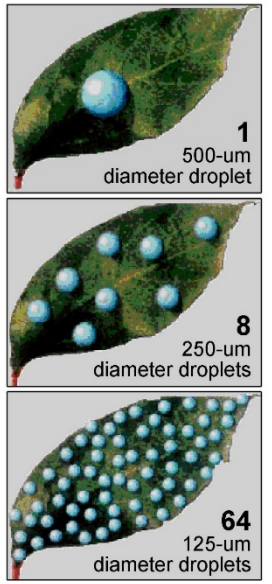
Results in **eight times as many droplets**



(there is one more droplet in the rear)

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





Images adapted from a presentation by Bob Wolf (Kansas State Univ.); Bobby Grisso and Pat Hipkins (Virginia Tech Univ.); and Tom Reed (TeeJet)

Droplet size

... But reducing droplet size reduces droplet velocity and increases the risk of drift.

Because fine droplets lack the velocity to penetrate dense canopies, medium or even coarse droplets (depending on canopy height and density) may optimize disease control when targeting a disease that develops in the interior of a dense canopy.

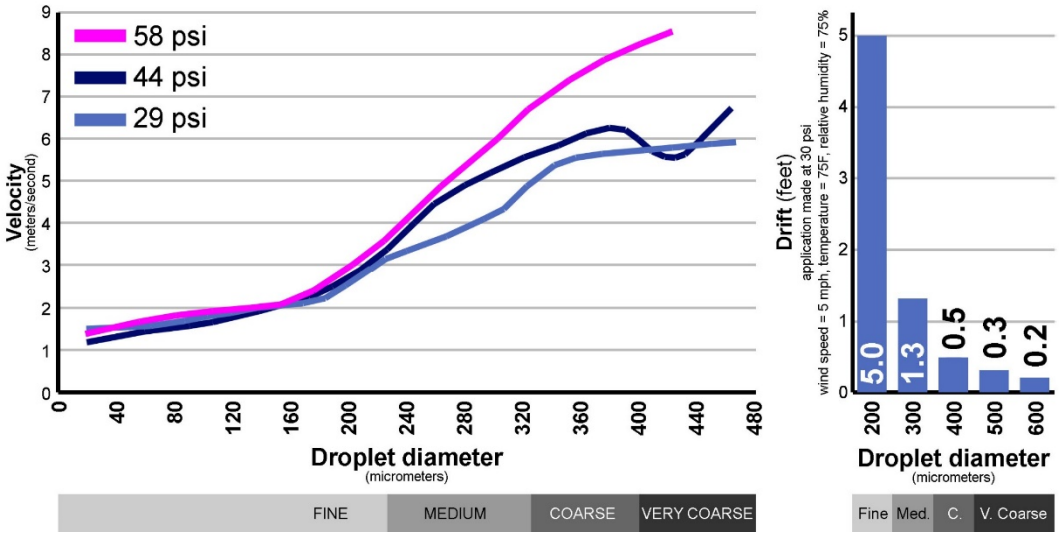


Image adapted from a presentation by Bob Wolf (Kansas State Univ.); Bobby Grisso and Pat Hipkins (Virginia Tech Univ.); and Tom Reed (TeeJet)

What fungicide droplet size is optimal for chickpeas?

Ascochyta blight of chickpeas is a splash-dispersed disease that spreads when raindrops hit pathogen fruiting structures within diseased lesions. Because the most severe raindrop-facilitated spread would be expected in the upper canopy, theory suggests that applying fungicides with fine droplets will optimize management of Ascochyta blight.

Fine droplets optimize fungicide coverage to the upper canopy.

Methods

Applications were made with a 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 Carrington in 2019.

Methods

Studies were conducted with nozzles from two manufacturers.

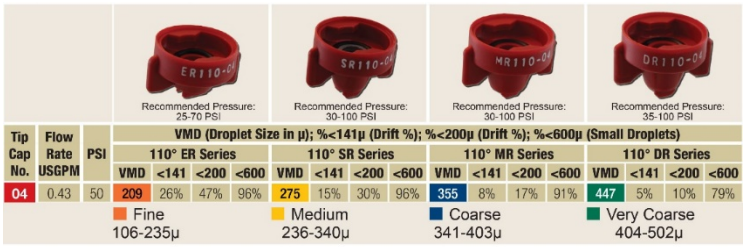
The droplet size spectrum considered to be “fine” vs. “medium” vs. “coarse” can differ by manufacturer. Testing was conducted with nozzles from different manufacturers to confirm that the results were not specific to a specific nozzle manufacturer.

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

(1) WILGER

Combo-Jet flat-fan nozzles

ER110-04, 50 psi – fine droplets
SR110-04, 50 psi – medium droplets
MR110-04, 50 psi – coarse droplets



Tip Cap No.	Flow Rate USGPM	PSI	VMD (Droplet Size in µ); %<141µ (Drift %); %<200µ (Drift %); %<600µ (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 106-235µ				Medium 236-340µ				Coarse 341-403µ				Very Coarse 404-502µ			

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

(2) TEEJET

Extended-range flat-fan nozzles

XR11004, 50 psi – fine droplets
XR11005, 50 psi – medium-fine droplets
XR11006, 35 psi – medium droplets
XR11008, 40 psi – medium-coarse droplets

	PSI						
	15	20	25	30	40	50	60
XR11004	M	M	M	M	M	F	F
XR11005	M	M	M	M	M	F	F
XR11006	C	M	M	M	M	M	F
XR11008	C	C	C	C	M	M	M
XR11010	VC	C	C	C	M	M	M

XR11004 50 psi FINE DROPLETS

XR11005 40 psi MEDIUM-FINE DROPLETS

XR11006 35 psi MEDIUM DROPLETS

XR11008 40 psi MEDIUM-COARSE DROPLETS

XR11010 30 psi COARSE DROPLETS

Methods

The initial calibration was conducted with water.

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

Spot-On sprayer calibrator model SC-1 (Innoquest, Inc.; Woodstock, IL)

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.

Methods

To ensure rigorous results, a large number of experimental replicates was utilized.

All studies conducted in Carrington in 2019 were conducted with seven replicates, and other studies were conducted with six replicates.

Row spacing: 7.5 inches (seven rows per plot)

Seeding rate: 4.5 pure live seed/square foot

Plot size: In the tractor-applied studies conducted in Carrington in 2019, fungicide treatments were applied to 60-foot-long plots consisting of 30-foot lengths of each of two varieties ('CDC Leader' and 'CDC Frontier').

Experimental design: Randomized complete block with split-plot arrangement (main factor = fungicide, sub-factor = droplet size).

Disease assessments:

- Initial disease assessments (during mid-bloom) were conducted by estimating the percent of the canopy diseased in each of four locations per variety per plot.
- Final disease assessments (when chickpeas were senescing) were conducted by assessing the incidence of pods with Ascochyta lesions. In each of four locations per variety per plot, all of the pods on 2 to 4 plants were evaluated for Ascochyta lesions (average 348 pods evaluated per plot).

OPTIMIZING FUNGICIDE SPRAY DROPLET SIZE

TeeJet nozzles

Applying fungicides with fine droplets minimized Ascochyta blight and maximized chickpea yield.

Fine droplets optimized Ascochyta management across both fungicides tested and both chickpea varieties evaluated.

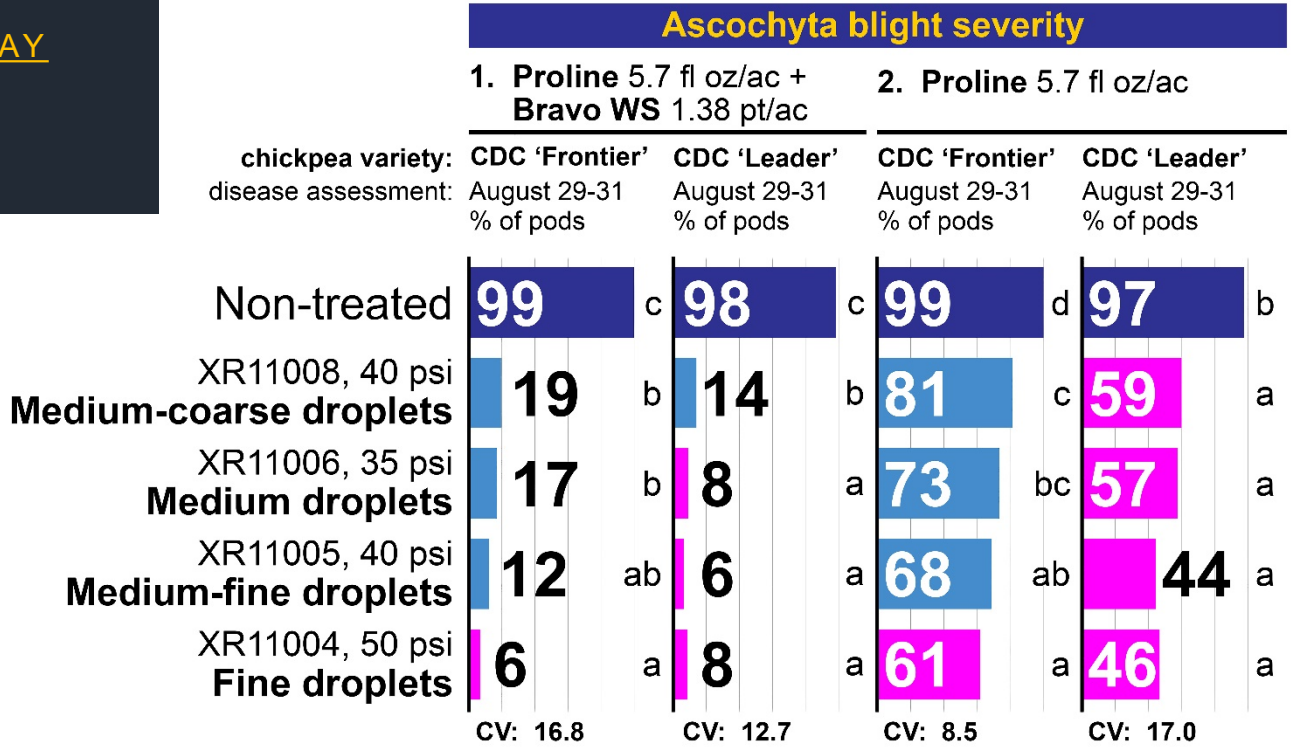
Carrington, ND (2019)

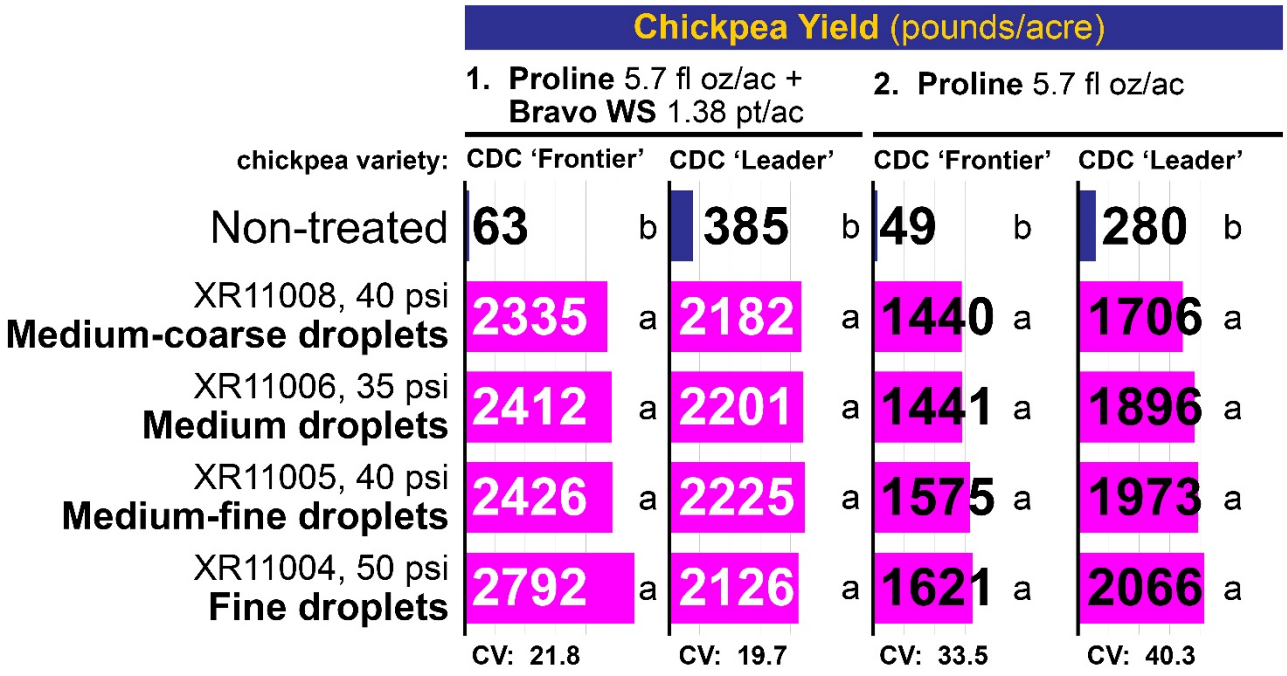
Fungicides were applied with a tractor-mounted R&D sprayer equipped with a pulse-width modulation system. Driving speed = 8.9 mph. Spray volume = 15 gal/ac. Pulse width was modified as needed to maintain constant spray volume across tips differing in output.

Five fungicide applications were made 10-14 days apart from first appearance of disease symptoms (shortly before bloom) until early senescence. The last fungicide application was conducted on August 8.

Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comparison procedure).

The non-ionic surfactant 'Preference' (alkylphenol ethoxylate, sodium salts of soya fatty acids, isopropyl alcohol, 89.5%; Winfield United, River Falls, WI) was applied at 0.25% (v/v) with all fungicide applications.





OPTIMIZING FUNGICIDE SPRAY DROPLET SIZE

Wilger nozzles

Applying fungicides with fine droplets minimized Ascochyta blight and maximized chickpea yield.

Fine droplets optimized Ascochyta management across both fungicides and both chickpea varieties evaluated.

Carrington, ND (2019)

Fungicides were applied with a tractor-mounted R&D sprayer equipped with a pulse-width modulation system. Driving speed = 8.9 mph. Spray volume = 15 gal/ac. Wilger manufactures tips that differ in droplet size while maintaining constant output, and all applications were made with 100% pulse width.

Five fungicide applications were made 10-14 days apar from first appearance of disease symptoms (shortly before bloom) until early senescence. The last fungicide application was conducted on August 8.

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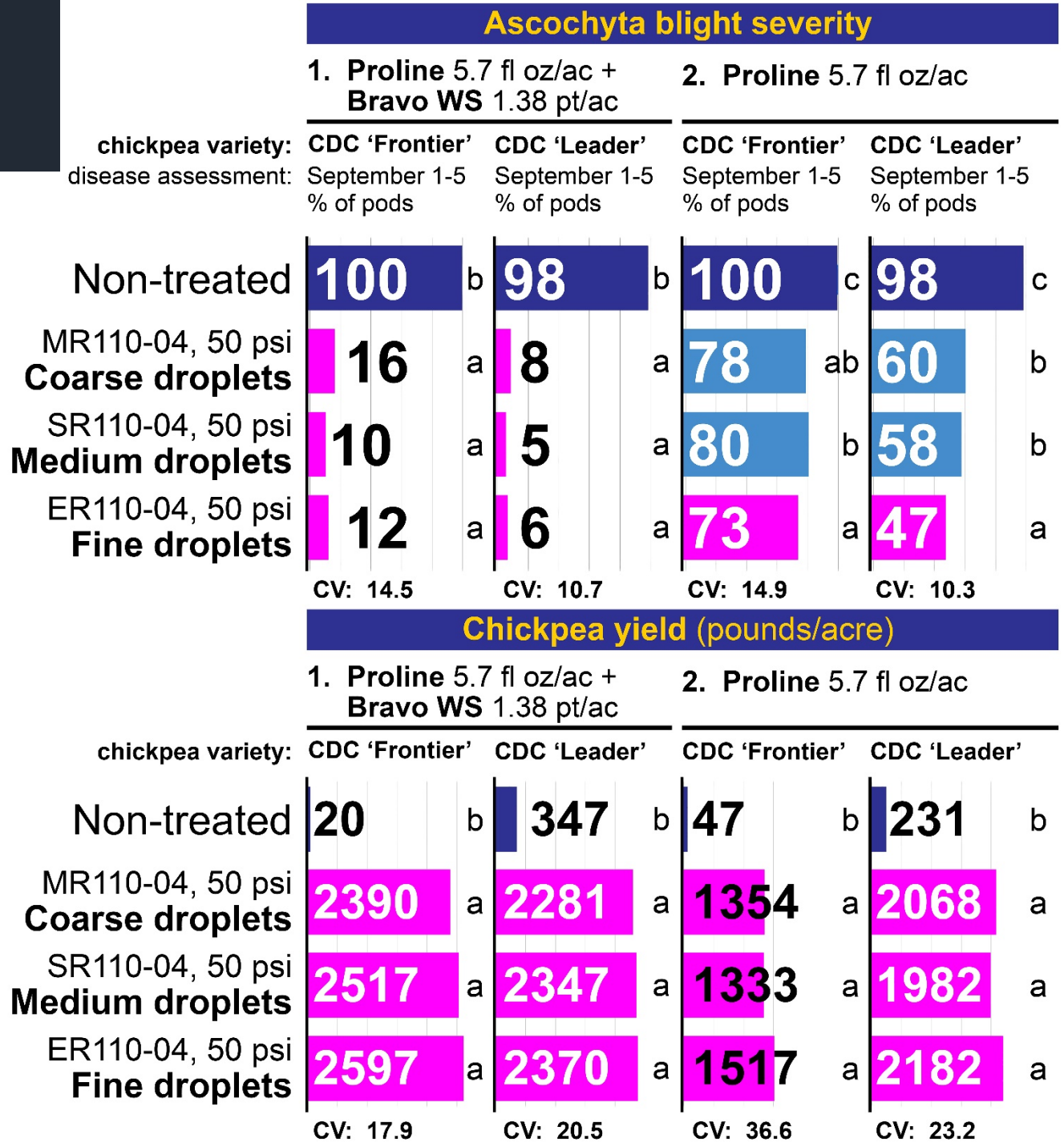

Preliminary study, 2018: TeeJet TurboTee nozzles

Applying fungicides with fine droplets minimized Ascochyta blight and maximized chickpea yield when Proline was tank-mixed with Bravo WS.

No response to droplet size was observed when Proline was applied alone.

Caution: This was an initial study with an unrealistic driving speed (3.6 mph).

Carrington, ND (2018)
'CDC Frontier' chickpeas

Fungicides were applied with a tractor-mounted R&D sprayer equipped with a pulse-width modulation system. Driving speed = 3.6 mph. Spray volume = 15 gal/ac. Pulse width was modified as needed to maintain constant spray volume across tips differing in output.

Five fungicide applications were made 10-14 days apart from first appearance of disease symptoms (shortly before bloom) until early senescence.

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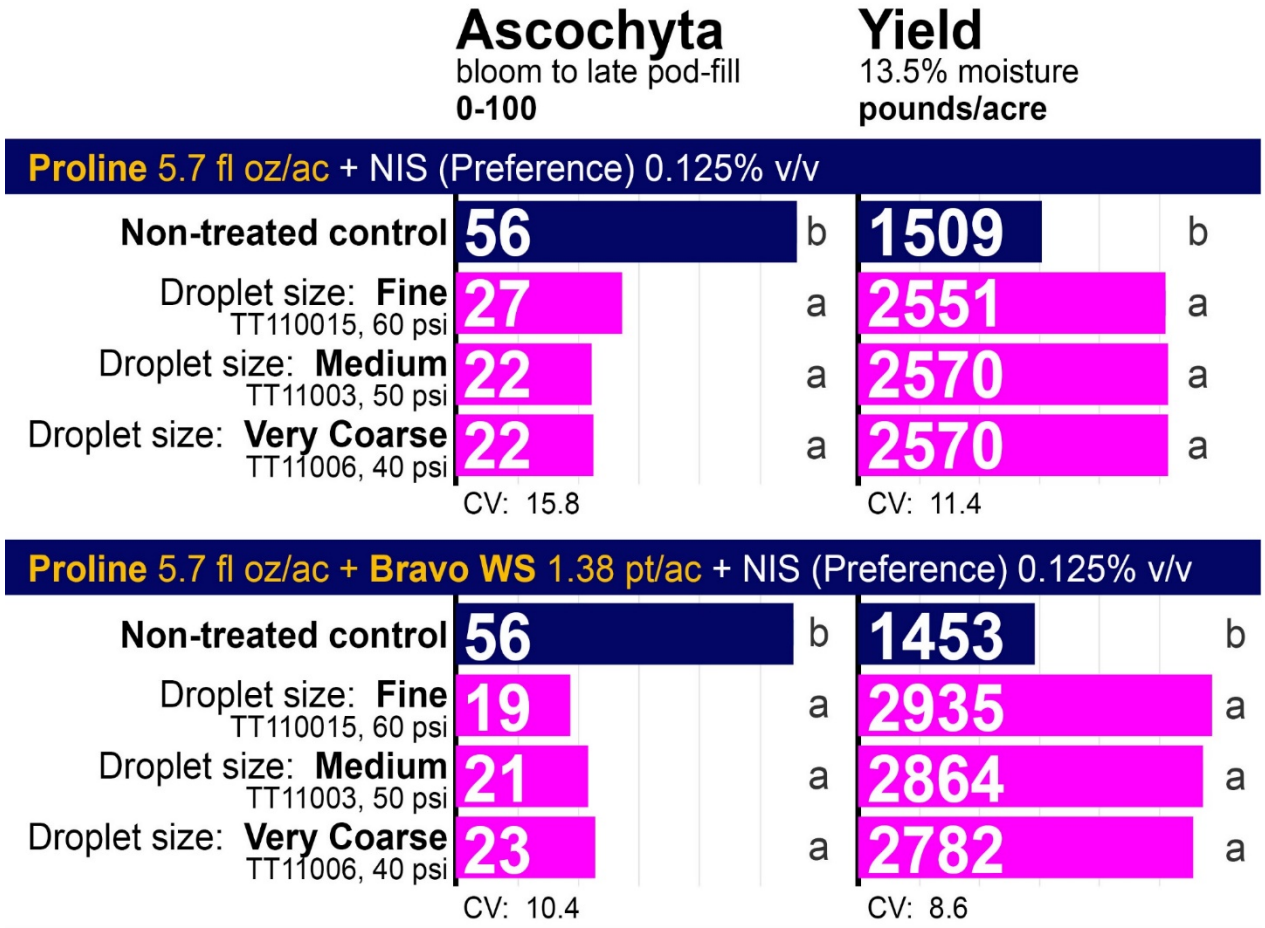

Conclusions

Preliminary results from an ongoing research project

Fine droplets optimized fungicide performance against Ascochyta blight in chickpeas, minimizing disease and maximizing chickpea yield.

The response to droplet size on was consistent across nozzle manufacturers, fungicides and chickpea varieties.

Response to applying fungicides with fine rather than coarse droplets: Applying fungicides with fine droplets (vs. coarse or medium-coarse) conferred average yield gains of 151 lbs/ac for Proline and 143 lbs/ac for Proline + Bravo WeatherStik.

Response to applying fungicides with fine rather than medium droplets: Applying fungicides with fine droplets (vs. medium) conferred average yield gains of 132 lbs/ac for Proline and 78 lbs/ac for Proline + Bravo WeatherStik.

The return on investment to optimizing spray droplet size is very high.
The cost of optimizing spray droplet size is nearly zero – just the price of outfitting the boom with appropriate nozzles and utilizing an appropriate application pressure.

Thank you!

Research funded by:
Northern Pulse Growers Association
North Dakota Crop Protection Product Harmonization Board & Registration Board