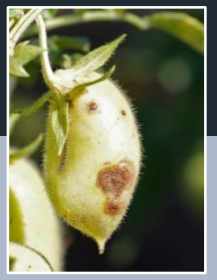
Optimizing fungicide spray droplet size for improved management of Ascochyta blight of chickpeas



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Droplet size

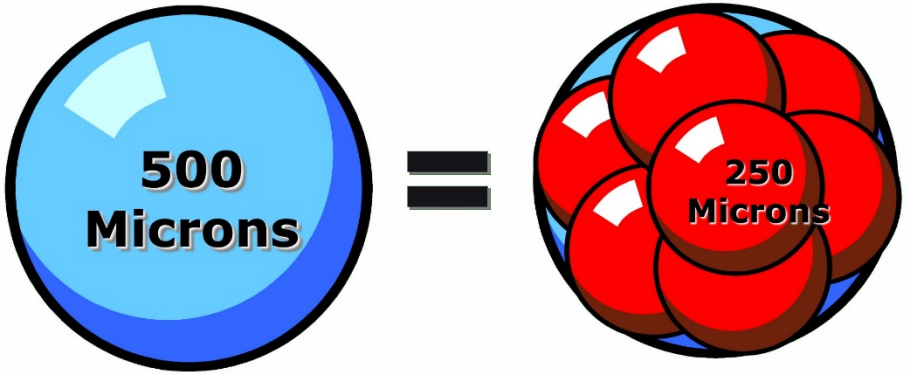
Reducing droplet size increases spray coverage.

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.

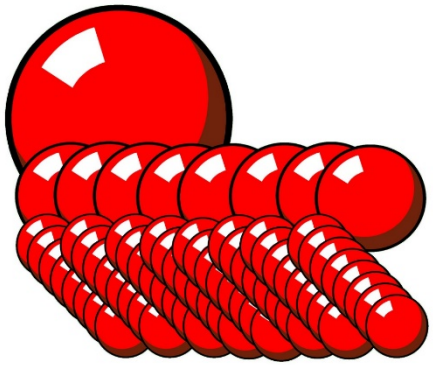
Cutting droplet diameter in half

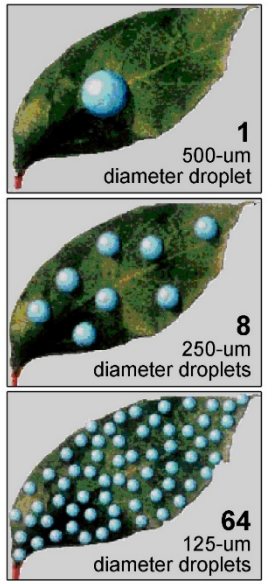
Results in **eight times as many droplets**



(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.

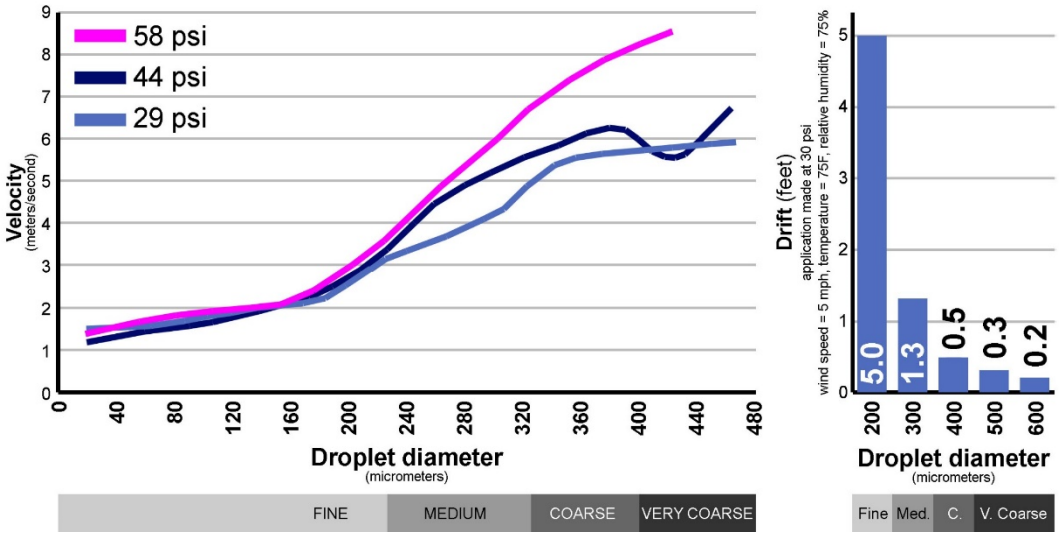


Image adapted from a presentation by Bob Wolf (Kansas State Univ.); Bobby Grisso and Pat Hipkins (Virginia Tech Univ.); and Tom Reed (TeeJet)

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 2019, **10.5 mph** in 2020.

Methods

Studies were conducted with nozzles from two manufacturers.

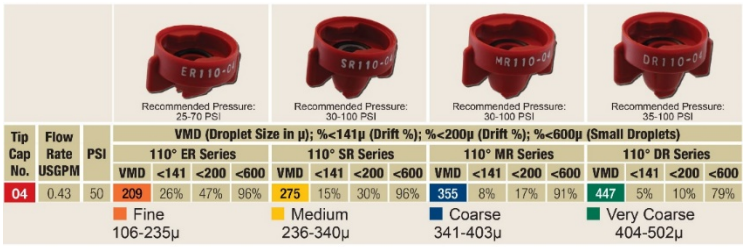
The droplet size spectrum considered to be “fine” vs. “medium” vs. “coarse” can differ by manufacturer. Testing was conducted with nozzles from different manufacturers to confirm that the results were not specific to a specific nozzle manufacturer.

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	SR110-04	MR110-04	DR110-04
50 psi	50 psi	50 psi	50 psi
FINE DROPLETS	MEDIUM DROPLETS	COARSE DROPLETS	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 50 psi FINE DROPLETS	M	M	M	M	M	F	F
XR11005 40 psi MEDIUM-FINE DROPLETS	M	M	M	M	M	F	F
XR11006 35 psi MEDIUM DROPLETS	C	M	M	M	M	M	F
XR11008 40 psi MEDIUM-COARSE DROPLETS	C	C	C	C	M	M	M
XR11010 30 psi COARSE DROPLETS	VC	C	C	C	M	M	M

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.

Studies were conducted with six to eight 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).

IMPACT OF FUNGICIDE SPRAY DROPLET SIZE: **TEEJET** AND **WILGER NOZZLES**

Ascochyta management in **chickpeas**

Fungicide #1: **Proline** (5.7 fl oz/ac)

The droplet size optimizing performance of Proline was contingent on canopy characteristics.

chickpea variety:	CDC **Leader**	CDC **Frontier**	CDC **Orion**	CDC **Leader**
year that study was conducted:	2019	2019	2020	2020
growth stage when disease developed:	**late vegetative growth**	**late vegetative growth**	**full bloom, early pod-fill**	**full bloom, early pod-fill**

TEEJET nozzles

ASCOCHYTA SEVERITY (0-100)

Non-treated control	49	b	55	c	52	b	44	b
Fine droplets	12	a	20	a	27	a	18	a
Medium-fine droplets	14	a	27	ab	21	a	17	a
Medium droplets	17	a	31	b	21	a	18	a
Medium-coarse droplets	16	a	33	b	26	a	17	a
	CV: 19.0		CV: 7.5		CV: 22.4		CV: 27.9	

CHICKPEA **YIELD** (pounds/acre)

Non-treated control	280	b	49	b	537	b	1008	b
Fine droplets	2066	a	1621	a	2130	a	2135	a
Medium-fine droplets	1973	a	1575	a	2319	a	2200	a
Medium droplets	1896	a	1441	a	2247	a	2197	a
Medium-coarse droplets	1706	a	1440	a	1854	a	2599	a
	CV: 40.3		CV: 33.5		CV: 32.1		CV: 32.0	

WILGER nozzles

ASCOCHYTA SEVERITY (0-100)

Non-treated control	51	b	58	b	32	b	22	b
Fine droplets	13	a	22	a	11	a	7	a
Medium droplets	14	a	23	a	8	a	6	a
Coarse droplets	15	a	24	a	12	a	8	a
	CV: 7.8		CV: 8.4		CV: 19.8		CV: 27.5	

CHICKPEA **YIELD** (pounds/acre)

Non-treated control	231	b	47	b	606	b	983	b
Fine droplets	2182	a	1517	a	2331	a	2058	a
Medium droplets	1982	a	1333	a	2272	a	2277	a
Coarse droplets	2068	a	1354	a	2469	a	2371	a
	CV: 23.2		CV: 36.6		CV: 25.2		CV: 33.8	

Wilger Combo-Jet flat-fan nozzles. FINE DROPLETS: ER110-04, 50 psi (2019); ER110-05, 60 psi (2020); MEDIUM: SR110-04, 50 psi (2019); SR110-05, 60 psi (2020); COARSE: MR110-04, 50 psi (2019); MR110-05, 60 psi (2020). **TeeJet XR flat-fan nozzles.** FINE: XR11004, 50 psi (2019), XR11005, 60 psi (2020); MEDIUM-FINE: XR11005, 40 psi (2019), XR11006, 50 psi (2020); MEDIUM: XR11006, 35 psi (2019, 2020); MEDIUM-COARSE: XR11008, 40 psi (2019, 2020). **Spray volume:** 15 gal/ac **Driving speed:** 8.9 mph (2019), 10.5 mph (2020)

IMPACT OF FUNGICIDE SPRAY DROPLET SIZE: **TEEJET** AND **WILGER NOZZLES**

Ascochyta management in **chickpeas**

Fungicide #2: **Proline** (5.7 fl oz/ac) **+ Bravo WS** (1.38 pt/ac)

Fine droplets (TeeJet) or fine to medium droplets (Wilger) optimized fungicide performance

Wilger Combo-Jet flat-fan nozzles. FINE DROPLETS: ER110-04, 50 psi (2019); ER110-05, 60 psi (2020); MEDIUM: SR110-04, 50 psi (2019); SR110-05, 60 psi (2020); COARSE: MR110-04, 50 psi (2019); MR110-05, 60 psi (2020). **TeeJet XR flat-fan nozzles.** FINE: XR11004, 50 psi (2019), XR11005, 60 psi (2020); MEDIUM-FINE: XR11005, 40 psi (2019), XR11006, 50 psi (2020); MEDIUM: XR11006, 35 psi (2019, 2020); MEDIUM-COARSE: XR11008, 40 psi (2019, 2020). **Spray volume:** 15 gal/ac **Driving speed:** 8.9 mph (2019), 10.5 mph (2020)

Optimizing fungicide spray droplet size

Chickpeas

TeeJet and Wilger Nozzles

For modern locally systemic fungicides, calibrating fungicide droplet size relative to canopy characteristics may maximize fungicide performance (Ascochyta control, chickpea yield).

For contact fungicides or tank-mixes with contact fungicides, fine droplets (TeeJet) or fine to medium droplets (Wilger) may maximize fungicide performance irrespective of canopy characteristics.

The droplet size spectrum considered to be “medium”, “coarse”, “very coarse”, etc. may be different for Wilger vs. TeeJet.

Quantification of droplet size spectrums will be conducted in 2021.

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Thank you!

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