


Improving management of white mold in soybeans and dry beans: Optimizing fungicide application methods

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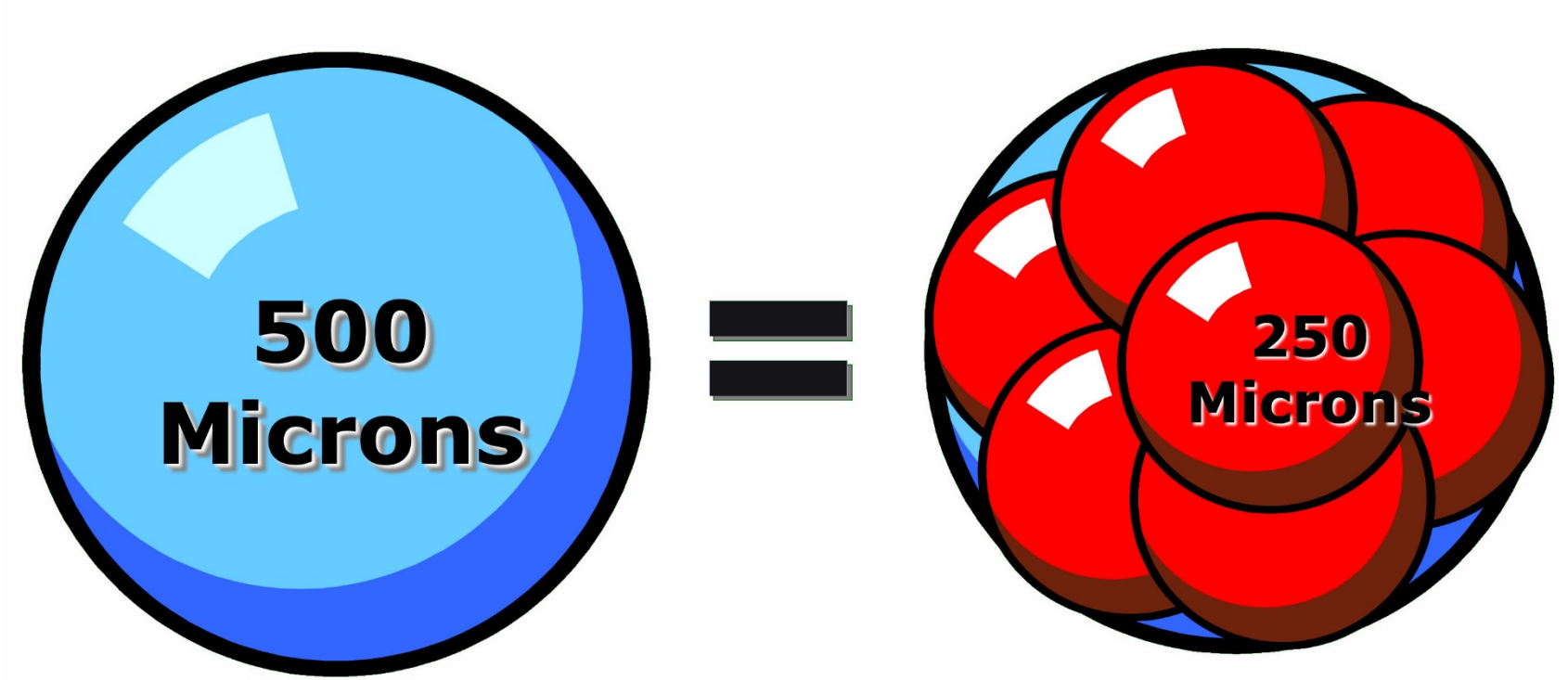
Spray droplet size

Cutting droplet diameter in half

Results in **eight times as many droplets**



(there is one more droplet in the rear)

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

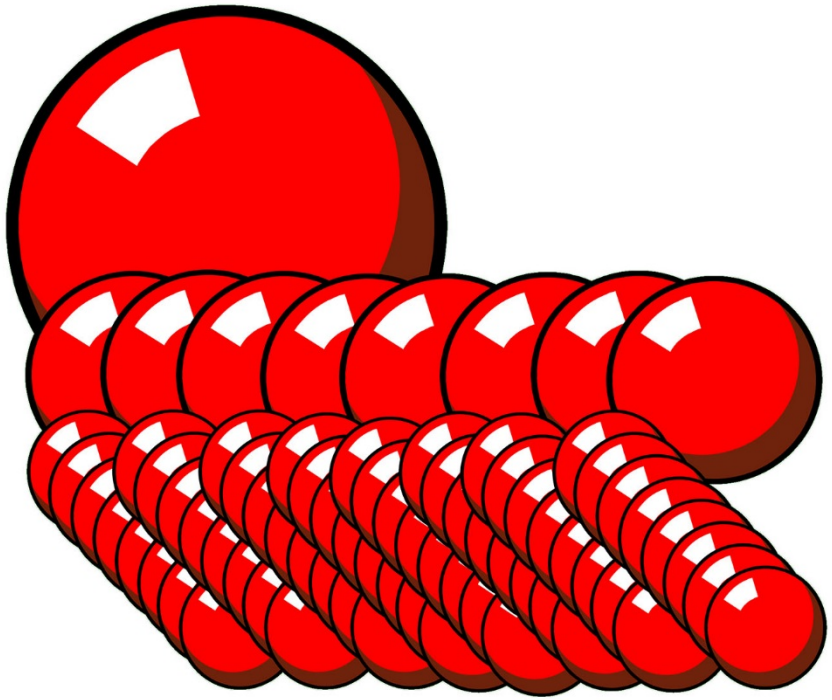
Spray droplet size

0.065 mm^3 spray volume =

one 500-um diameter droplet

eight 250-um diameter droplets

sixty-four 125-um diameter droplets



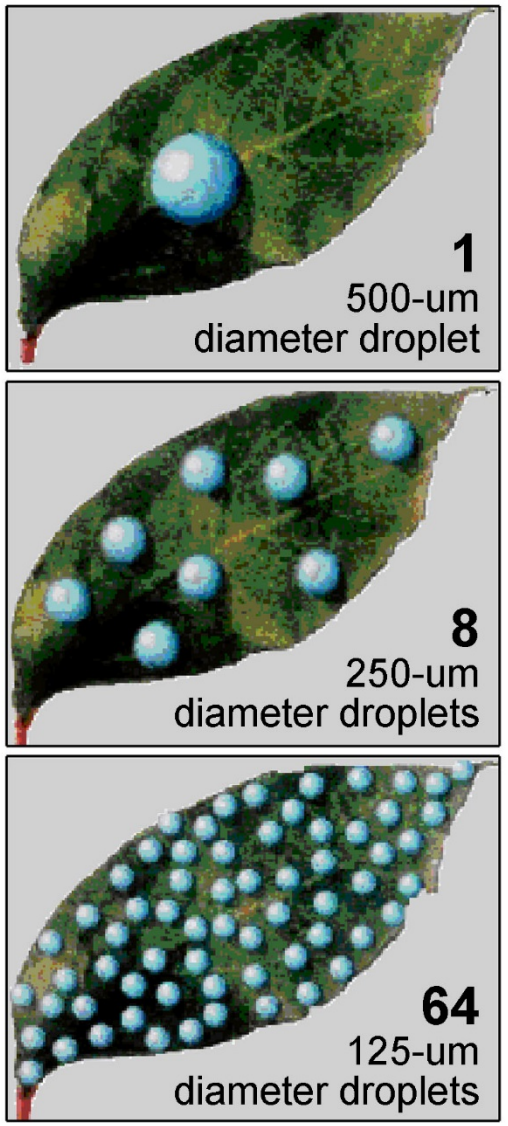
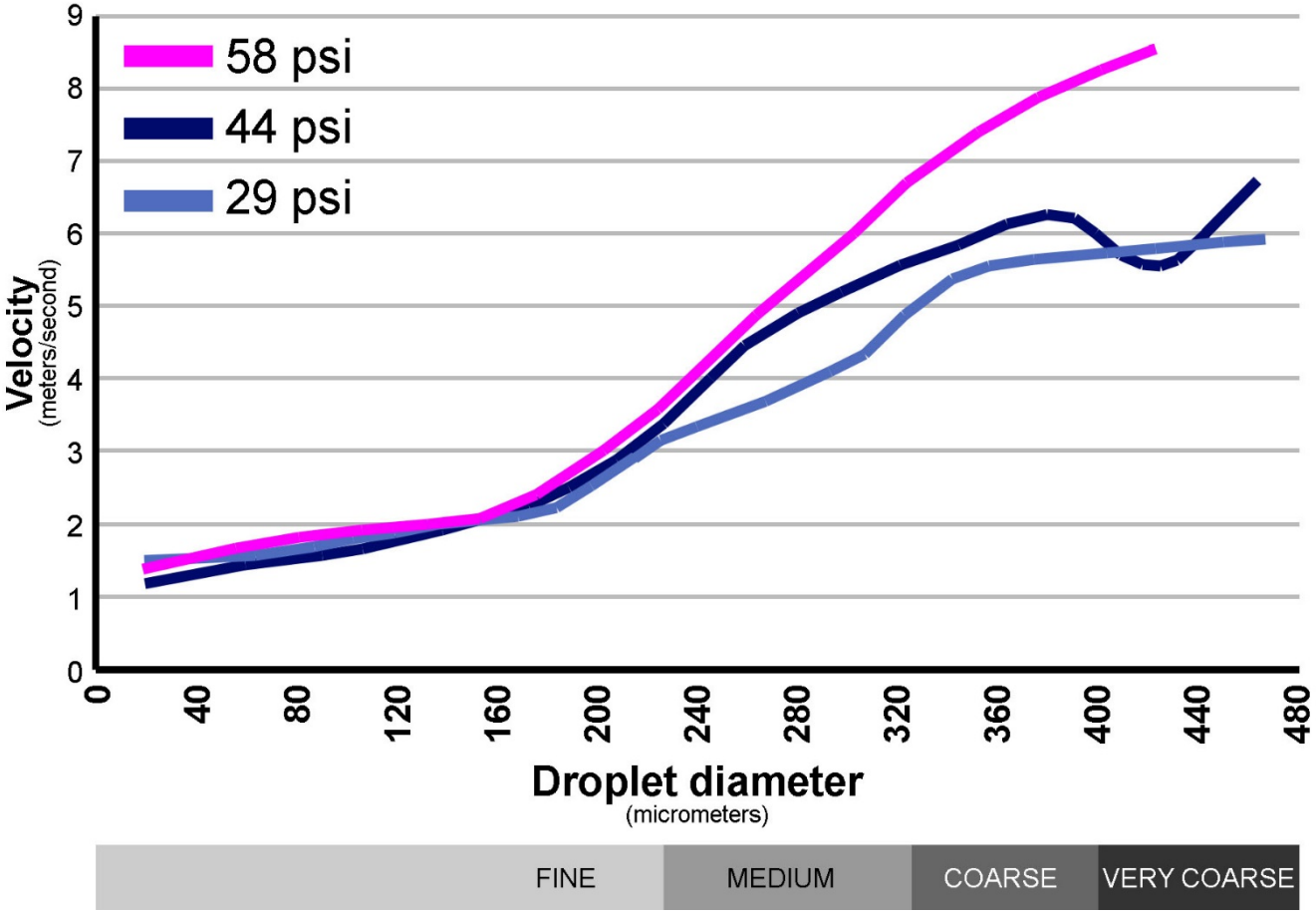


Image adapted from a presentation by Bob Wolf (Kansas State Univ.); Bobby Grisso and Pat Hipkins (Virginia Tech Univ.); and Tom Reed (TeeJet)

Spray droplet size

… but larger droplets have greater velocity, drift less.

Increased velocity and reduced drift improves canopy penetration.



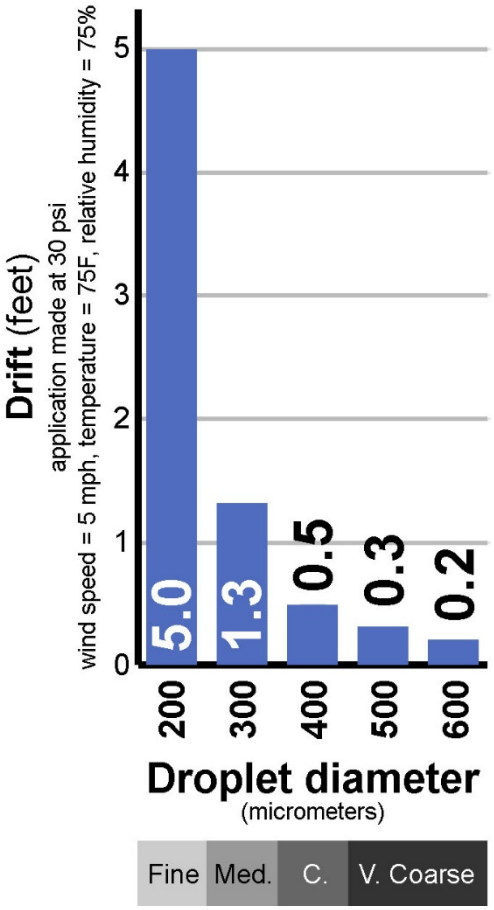


Image adapted from a presentation by Bob Wolf (Kansas State Univ.); Bobby Grisso and Pat Hipkins (Virginia Tech Univ.); and Tom Reed (TeeJet)

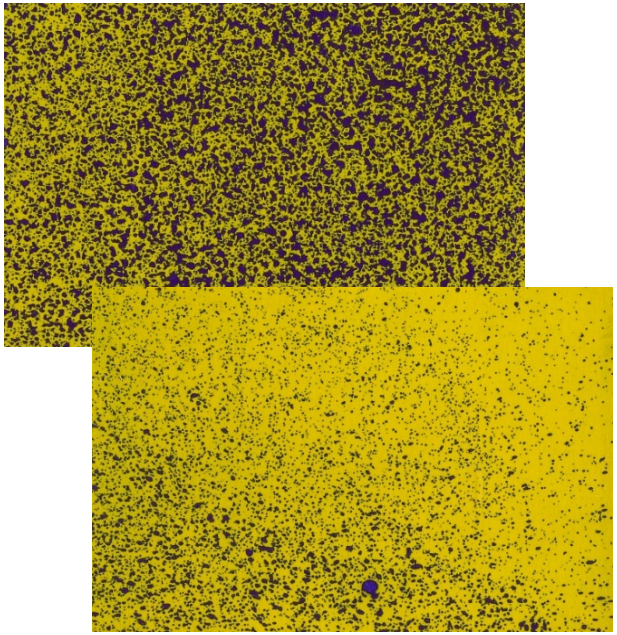
Experimental methods

- **Spraying Systems TeeJet extended-range flat-fan nozzles**
- **Tractor-mounted sprayer**
- **Constant driving speed** (6.7 mph), **spray volume** (15 gal/ac)
- **Pulse-width modulation system** (Capstan AG)
- **Pulse width calibrated and confirmed** by quantifying spray nozzle output

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

Experimental methods

Spray cards were utilized to confirm that pulse width calibration was correct and that spray volume was consistent across treatments.



	July 13 ProSeed 'XT60-40' Peterson '17X09N' Dairyland 'DSR-0904'	July 16 Peterson '18X06N'
temperature:	86-87˚F	71-74˚F
relative humidity:	37-42%	43-49%
wind:	1-2 mph	6-8 mph
XR8003 50 psi FINE DROPLETS	19	20
XR8004 40 psi MEDIUM-FINE DROPLETS	18	20
XR8006 40 psi MEDIUM DROPLETS	19	16
XR8008 35 psi MEDIUM-COARSE DROPLETS	18	16
XR8010 30 psi COARSE DROPLETS	20	15
P>F:	0.9162	0.3446
CV:	24.6	24.1

Experimental methods

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

XR TeeJet® (XR)

	PSI						
	15	20	25	30	40	50	60
XR8001	F	F	F	F	F	F	F
XR80015	M	F	F	F	F	F	F
XR8002	M	M	F	F	F	F	F
XR80025	M	M	F	F	F	F	F
XR8003	M	M	M	F	F	F	F
XR80035	M	M	M	M	M	F	F
XR8004	C	M	M	M	M	F	F
XR8005	C	C	M	M	M	M	F
XR8006	C	C	C	M	M	M	M
XR8008	VC	VC	C	C	M	M	M
XR8010	XC	VC	VC	C	C	C	C
XR8015	XC	XC	VC	VC	VC	C	C

Experimental methods

XR8003 50 psi
FINE DROPLETS

XR8004 40 psi
MEDIUM-FINE DROPLETS

XR8006 40 psi
MEDIUM DROPLETS

XR8008 35 psi
MEDIUM-COARSE DROPLETS

XR8010 30 psi
COARSE DROPLETS

XR TeeJet® (XR)

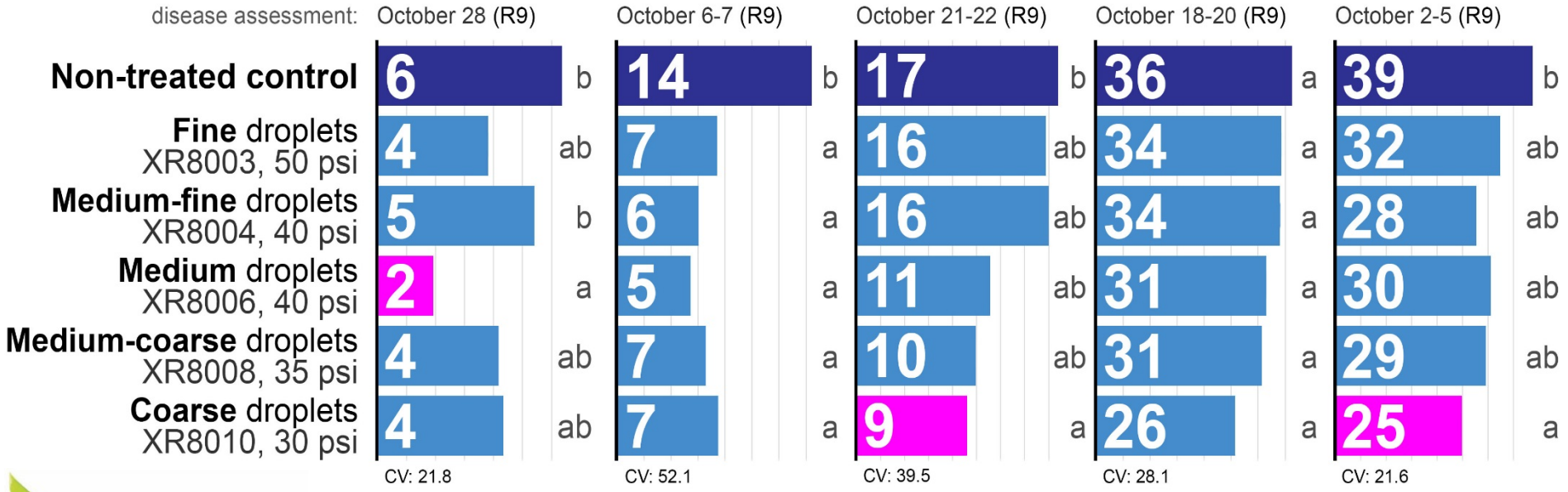
	PSI						
	15	20	25	30	40	50	60
XR8003	M	M	M	F	F	F	F
XR8004	C	M	M	M	M	F	F
XR8006	C	C	C	M	M	M	M
XR8008	VC	VC	C	C	M	M	M
XR8010	XC	VC	VC	C	C	C	C

OPTIMIZING FUNGICIDE DEPOSITION WITHIN SOYBEAN CANOPIES

Impact of spray droplet size – SOYBEANS (2018)

	Carrington, ND	Carrington, ND	Carrington, ND	Carrington, ND	Oakes, ND
variety (**maturity rating**):	ProSeed 'XT60-40' **(0.4)**	Peterson '18X06N' **(0.6)**	Dairyland 'DSR-0904' **(0.9)**	Peterson '17X09N' **(0.9)**	Pioneer 'P11A95X' **(1.1)**
fungicide application date, growth stage:	**July 13** 100% R2	**July 16** 80% R2, 20% R3	**July 13** 100% R2	**July 13** 100% R2	**July 12** 80% R2, 20% R3
Canopy closure at fungicide application:	Canopy closure: **75-90%**	Canopy closure: **80-95%**	Canopy closure: **90-95%**	Canopy closure: **90-95%**	Canopy closure: **97-100%**

White mold severity index (% of canopy diseased)



North Dakota Soybean Council
Our World Is Growing.

NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

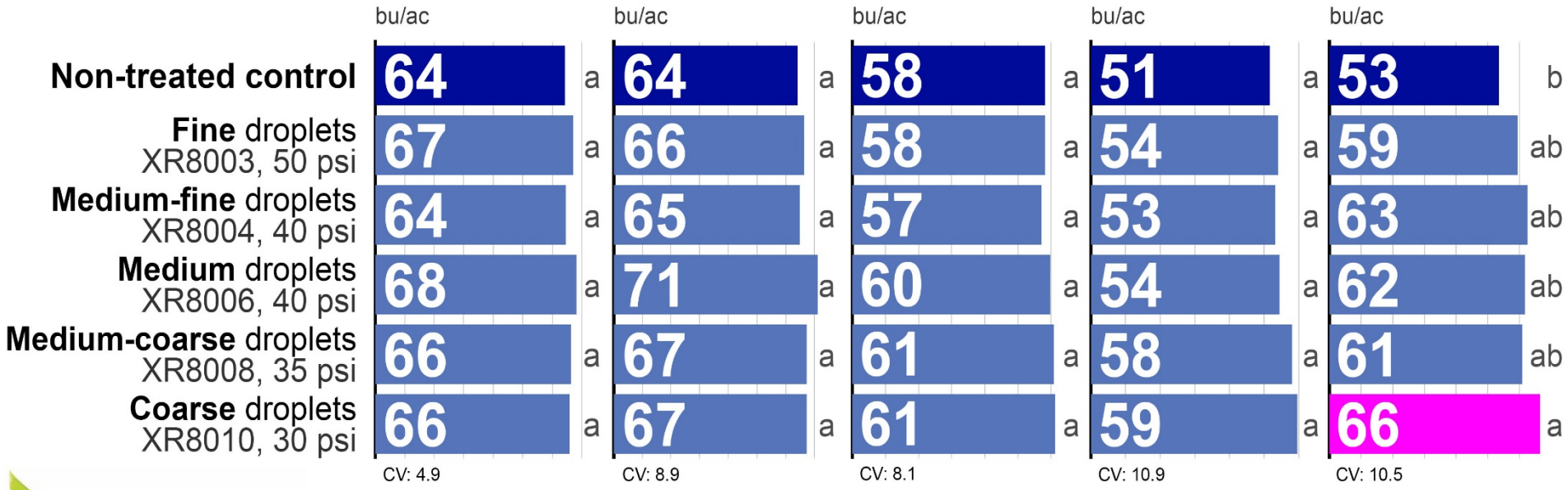
Fungicide: Endura at 5.5 oz/ac
Spray volume: 15 gal/ac **Driving speed:** 6.7 mph

Soybean row spacing: 21 inches

Impact of spray droplet size – SOYBEANS (2018)

	Carrington, ND	Carrington, ND	Carrington, ND	Carrington, ND	Oakes, ND
variety (**maturity rating**):	ProSeed 'XT60-40' **(0.4)**	Peterson '18X06N' **(0.6)**	Dairyland 'DSR-0904' **(0.9)**	Peterson '17X09N' **(0.9)**	Pioneer 'P11A95X' **(1.1)**
fungicide application date, growth stage:	**July 13** 100% R2	**July 16** 80% R2, 20% R3	**July 13** 100% R2	**July 13** 100% R2	**July 12** 80% R2, 20% R3
Canopy closure at fungicide application:	Canopy closure: **75-90%**	Canopy closure: **80-95%**	Canopy closure: **90-95%**	Canopy closure: **90-95%**	Canopy closure: **97-100%**

Soybean yield (13% moisture)



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NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Fungicide: Endura at 5.5 oz/ac
Spray volume: 15 gal/ac **Driving speed:** 6.7 mph

Soybean row spacing: 21 inches

Impact of spray droplet size – SOYBEANS (2017)

Carrington, ND (2017) Peterson '17X09N' soybean (0.9 maturity)

Fungicides applied twice: R2 + R3 growth stages (11 days apart)

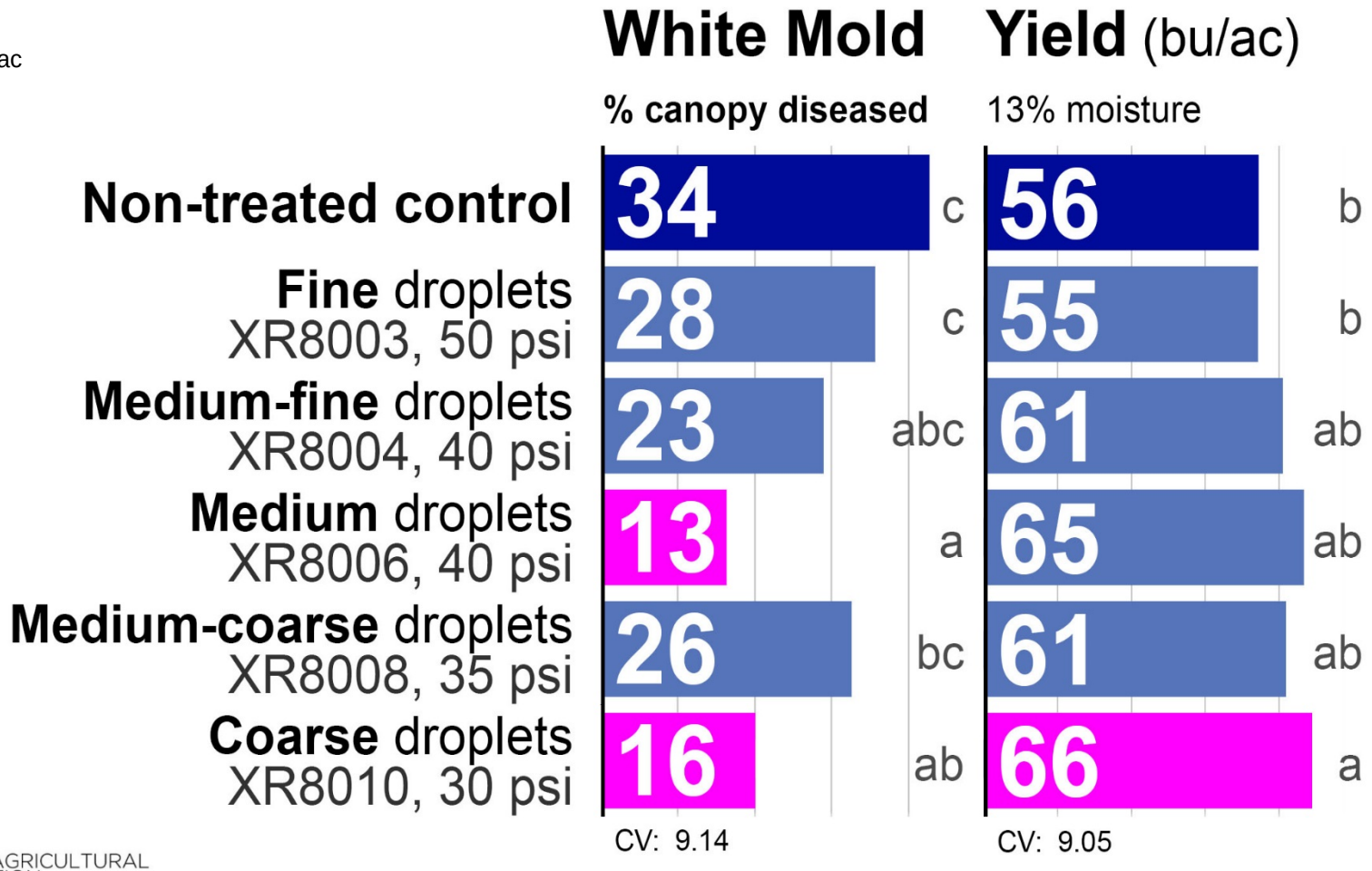
21-inch row spacing

Spray volume: 15 gal/ac
Driving speed: 6.7 mph

Fungicide: Endura, 5.5 oz/ac

Fungicide application 1:
R2 growth stage,
90-95% canopy closure

Fungicide application 2:
R3 growth stage
100% canopy closure
11 days after application 1



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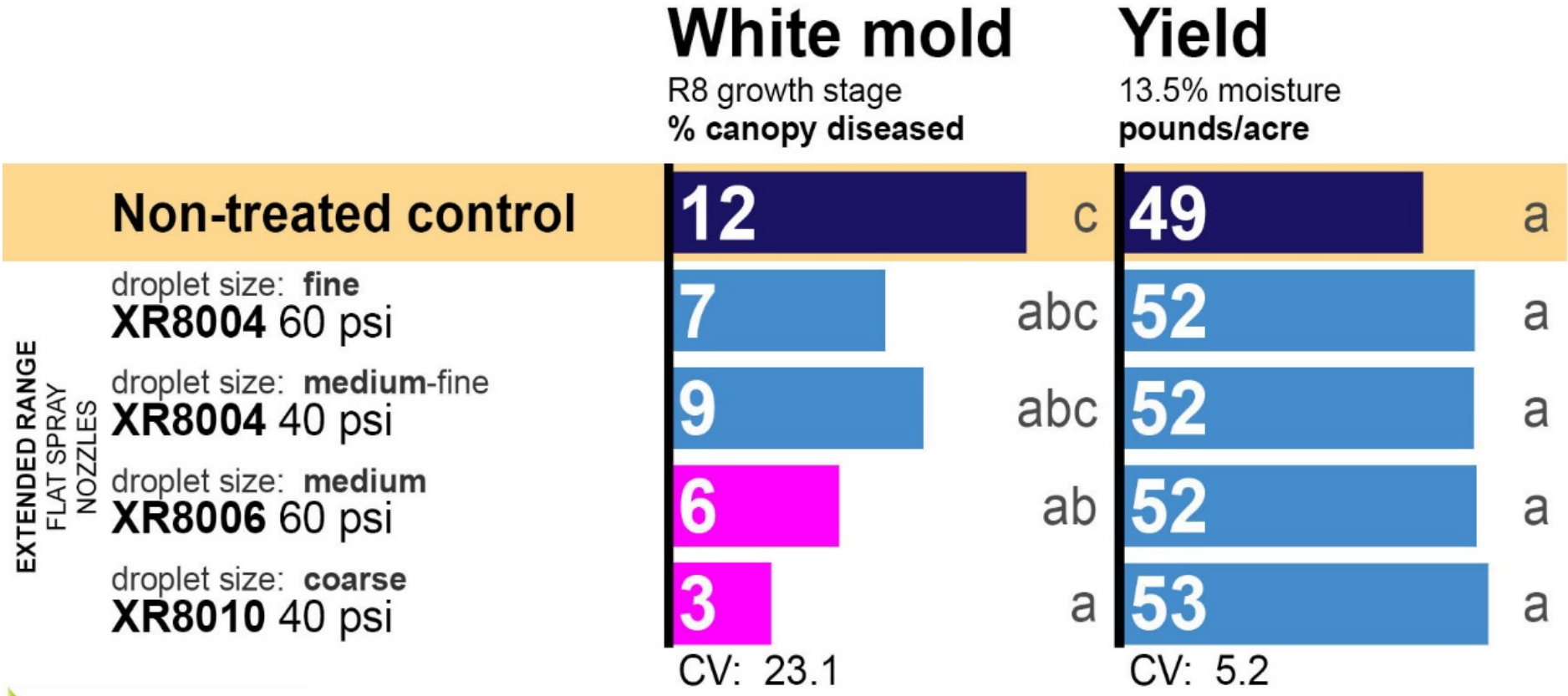
NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Impact of spray droplet size – SOYBEANS (2017)

Carrington, ND (2017)

Dairyland 'DSR-0619' soybean (0.6 maturity)

21-inch row spacing



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NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Spray volume: 15 gal/ac **Driving speed:** 4.0 mph

Fungicide: Endura at 5.5 oz/ac

Application timing: 80% of plants at R2, 20% of plants at R3 growth stage
Canopy closure (average) = 92%

Impact of spray droplet size

(1) Soybeans with an open canopy:

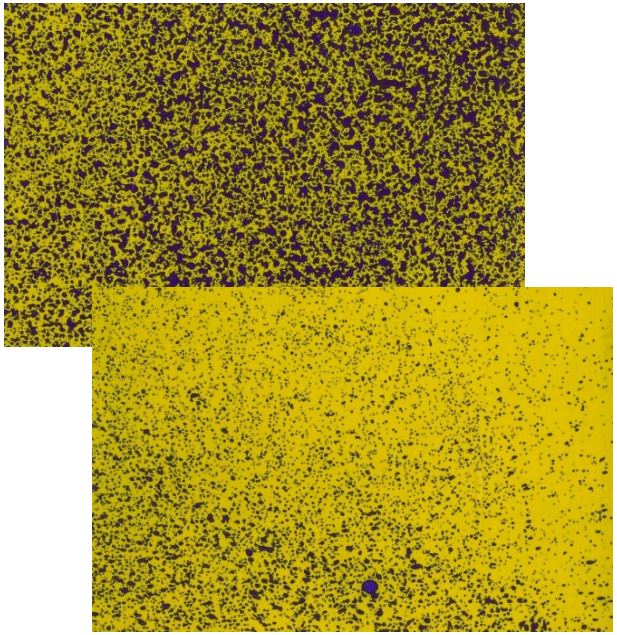
When canopy closure averaged <90% at fungicide application timing (R2 growth stage),
white mold control and soybean yield under white mold pressure were maximized when fungicides were applied with a **medium spray droplet size**.

(2) Soybeans at or near canopy closure:

When canopy closure averaged 95-100% at fungicide application timing,
white mold control and soybean yield under white mold pressure were maximized when fungicides were applied with a **coarse spray droplet size**.

Experimental methods

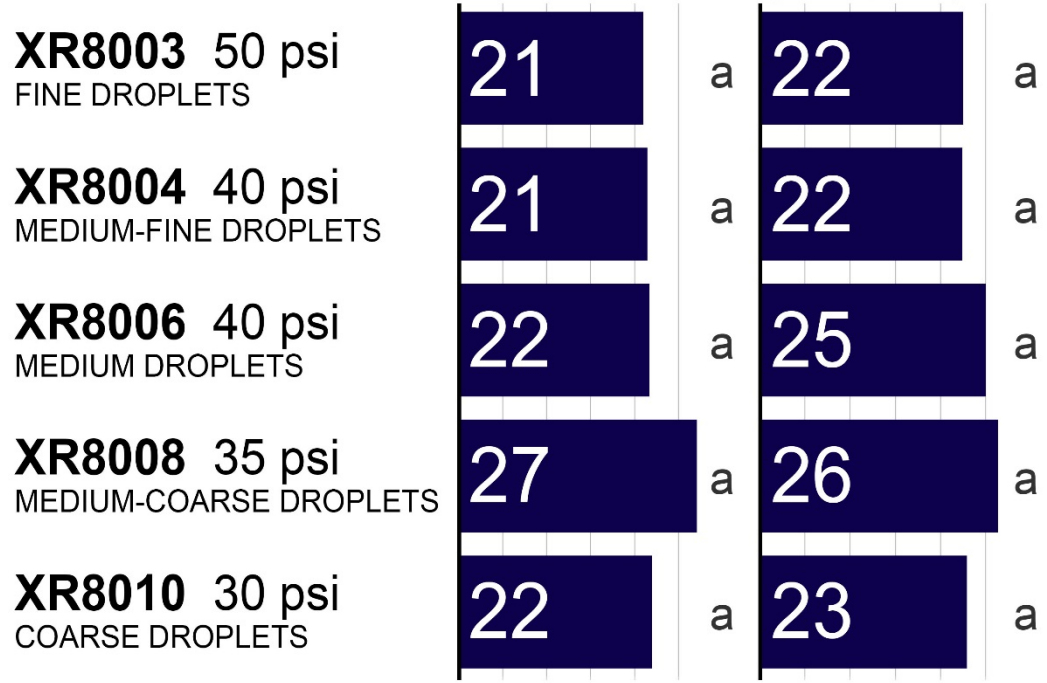
Spray cards were utilized to confirm that pulse width calibration was correct and that spray volume was consistent across treatments.



	July 18 pinto, navy, black and kidney beans	**August 1** navy, black and kidney beans
temperature:	73-80˚F	60-63˚F
relative humidity:	55-64%	58-70%
wind:	4-7 mph	8-10 mph

Percent spray coverage

SPRAY CARDS placed at height of crop canopy



P>F:	0.0848	0.8088
CV:	7.3	23.1

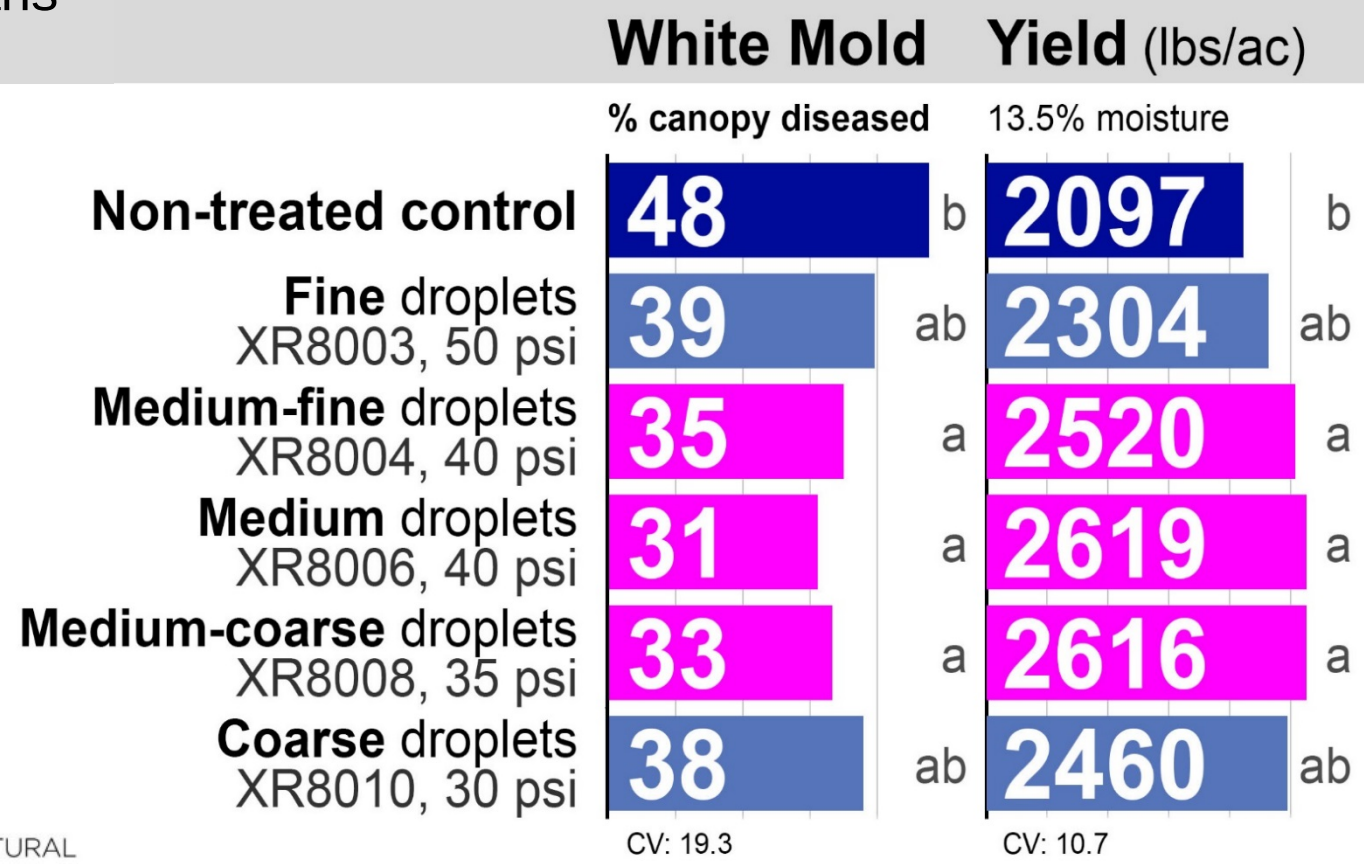
Impact of spray droplet size – NAVY BEANS

Carrington, ND (2018)

'Avalanche' navy beans

21-inch row spacing

TWO FUNGICIDE APPLICATIONS



NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Spray volume: 15 gal/ac **Driving speed:** 6.7 mph

First fungicide application (July 18):
Endura 70WG 8 oz/ac

Full bloom, average pod length 2 in. (max. 3.5 in.)
canopy closure = 90-98%, canopy height = 19-24 in.
73-80˚F, 4-7 mph wind, 55-64% relative humidity

Second fungicide application (Aug. 1):
Topsin 4.5FL 40 fl oz/ac

Full bloom, average 21 full-length pods/plant
canopy closure = 100%, canopy height = 13-19 inches
60-63˚F, 8-10 mph wind, 58-70% relative humidity

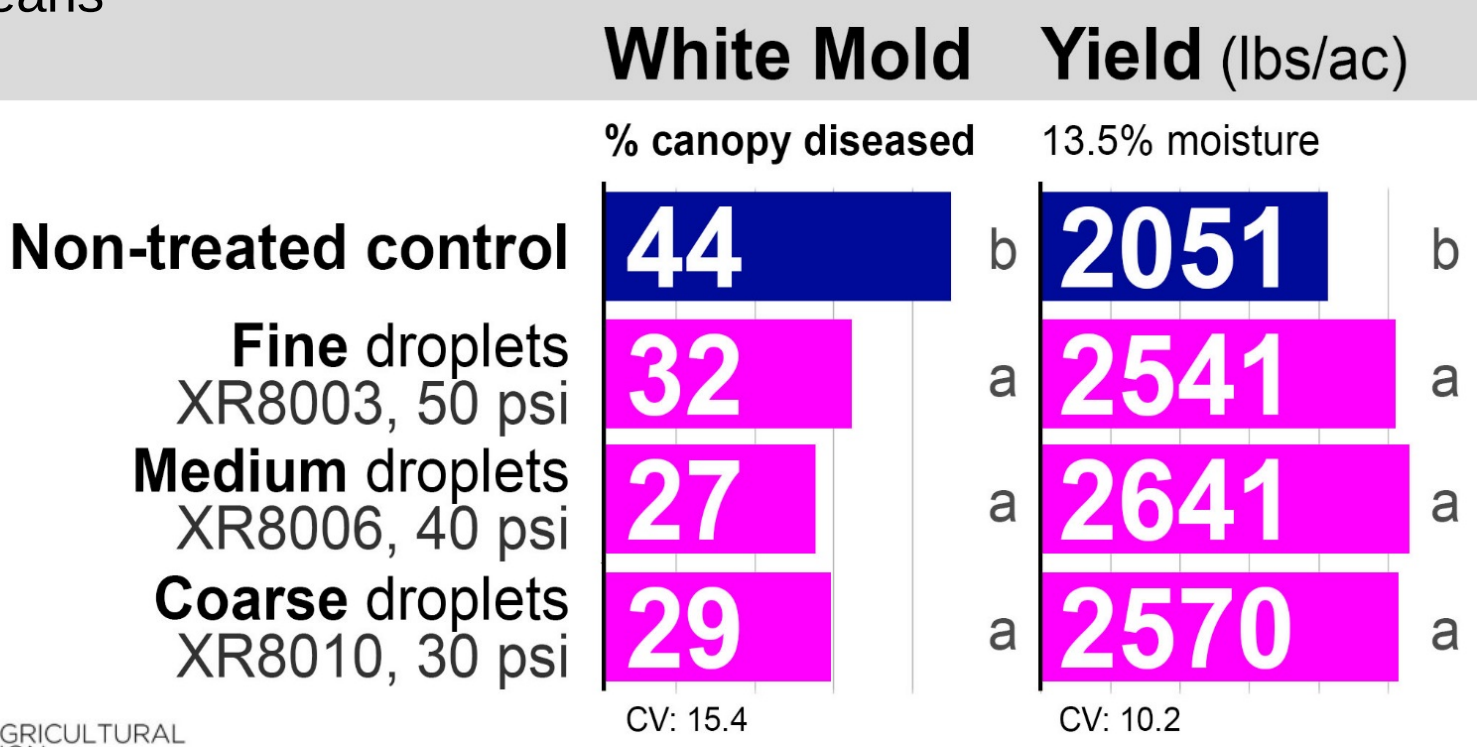
Impact of spray droplet size – BLACK BEANS

Carrington, ND (2018)

'Eclipse' black beans

21-inch row spacing

TWO FUNGICIDE APPLICATIONS



NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Spray volume: 15 gal/ac **Driving speed:** 6.7 mph

First fungicide application (July 18):

Endura 70WG 8 oz/ac

Full bloom, average pod length 2.5 in. (max. 4.0 in.)
canopy closure = 75-85%, canopy height = 16-23 in.
73-80˚F, 4-7 mph wind, 55-64% relative humidity

Second fungicide application (Aug. 1):

Topsin 4.5FL 40 fl oz/ac

Full bloom, average 13 full-length pods/plant
canopy closure = 100%, canopy height = 17-20 inches
60-63˚F, 8-10 mph wind, 58-70% relative humidity

Impact of spray droplet size

Black beans and **navy beans:**

White mold control and
black and navy bean yield under white mold pressure
were maximized when fungicides were applied with
a **medium spray droplet size**.

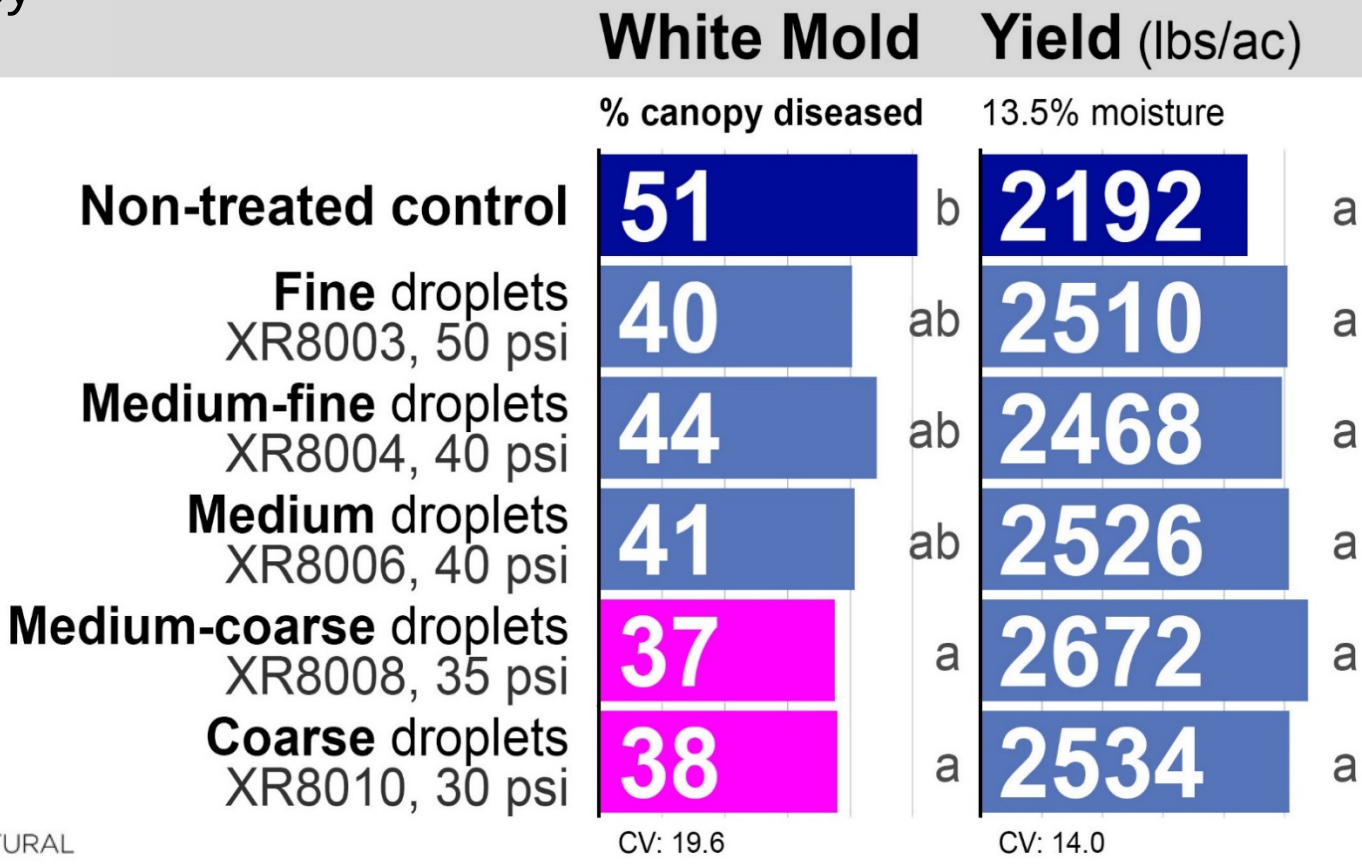
Impact of spray droplet size – KIDNEY BEANS

Carrington, ND (2018)

'Rosie' light-red kidney

21-inch row spacing

TWO FUNGICIDE APPLICATIONS



NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Spray volume: 15 gal/ac **Driving speed:** 6.7 mph

First fungicide application (July 18):
Endura 70WG 8 oz/ac

Full bloom, average pod length 2.5 in. (max. 4.0 in.)
canopy closure = 65-75%, canopy height = 19.5 in.
73-78˚F, 4-7 mph wind, 55-64% relative humidity

Second fungicide application (Aug. 1):
Topsin 4.5FL 40 fl oz/ac

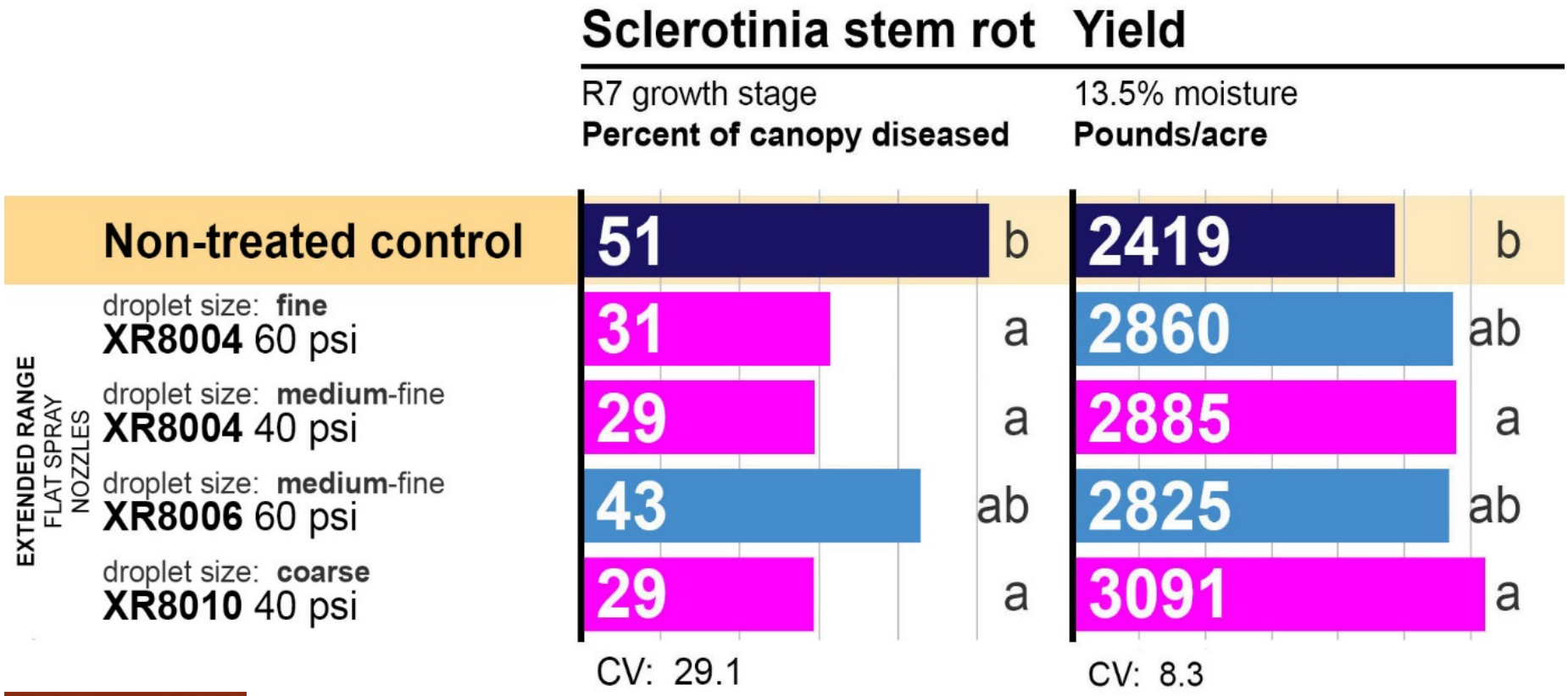
Full bloom, average 12 full-length pods/plant
canopy closure = 100%, canopy height = 19 inches
60-63˚F, 8-10 mph wind, 58-70% relative humidity

Impact of spray droplet size – KIDNEY BEANS

Carrington, ND (2017)

‘Rosie’ light-red kidney

21-inch row spacing



Spray volume: 15 gal/ac **Driving speed:** 4.0 mph

Fungicide application #1: Topsin 4.5FL 30 fl oz/ac
(July 10, 10-20% of plants with an open blossom, 30-40% canopy closure)

Fungicide application #2: Endura 70WG 8 oz/ac (July 20)

NORTHARVEST BEANS

NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Impact of spray droplet size

Kidney beans:

White mold control and
kidney bean yield under white mold pressure
were maximized when fungicides were applied with
a **medium-coarse to coarse spray droplet size**.

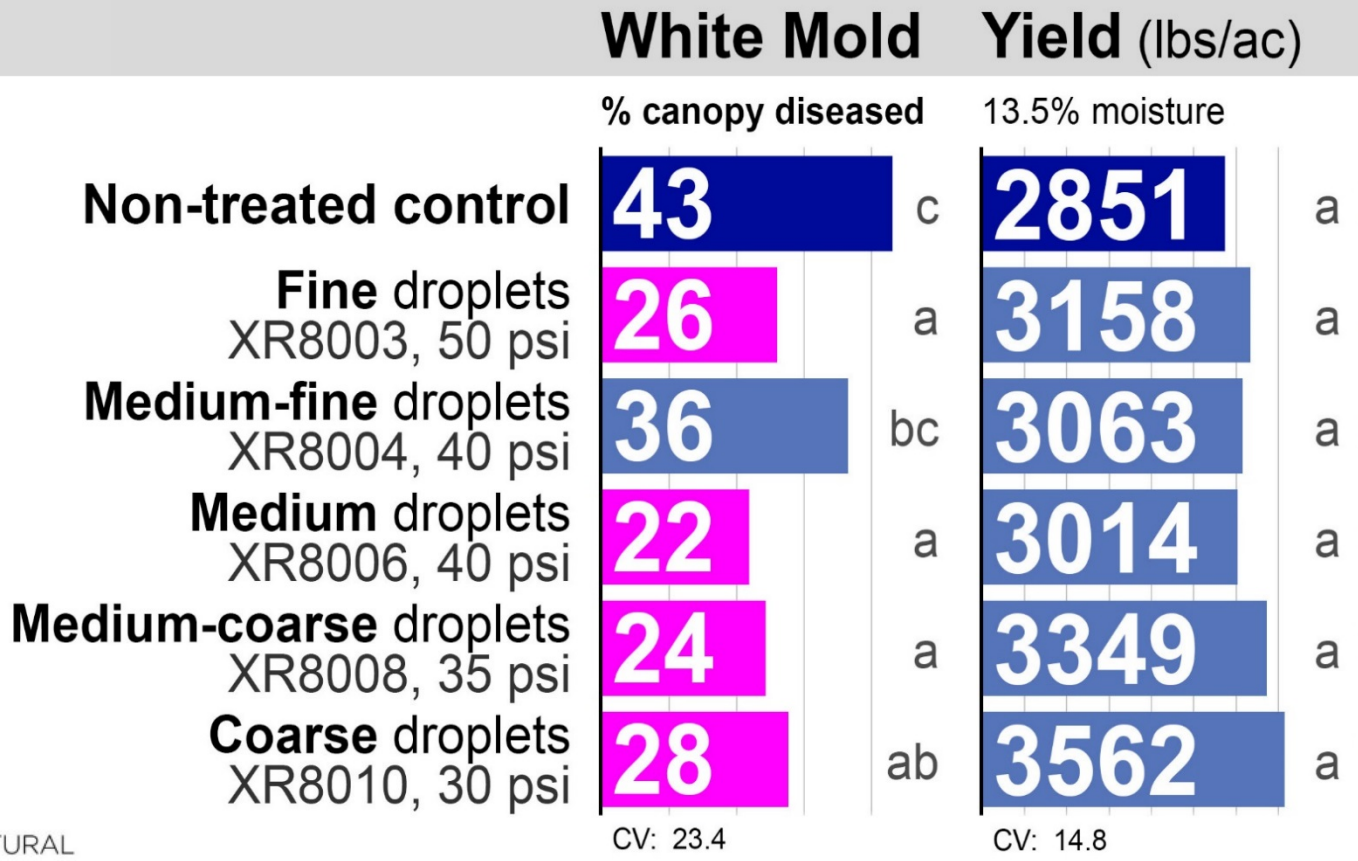
Impact of spray droplet size – PINTO BEANS

Carrington, ND (2018)

'Palomino' pinto

21-inch row spacing

TWO FUNGICIDE APPLICATIONS



NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Spray volume: 15 gal/ac **Driving speed:** 6.7 mph

First fungicide application (July 5):
Topsin 4.5FL 40 fl oz/ac

100% plants with an open blossom, pin-pods
canopy closure = 75-80%, canopy height = 19 inches
69-70˚F, 3-5 mph wind, 62-66% relative humidity

Second fungicide application (July 18):
Endura 70WG 8 oz/ac

Full bloom, average pod length = 3 in. (max. = 5 in.)
canopy closure = 92-98%, canopy height = 19 inches
73-80˚F, 4-7 mph wind, 55-64% relative humidity

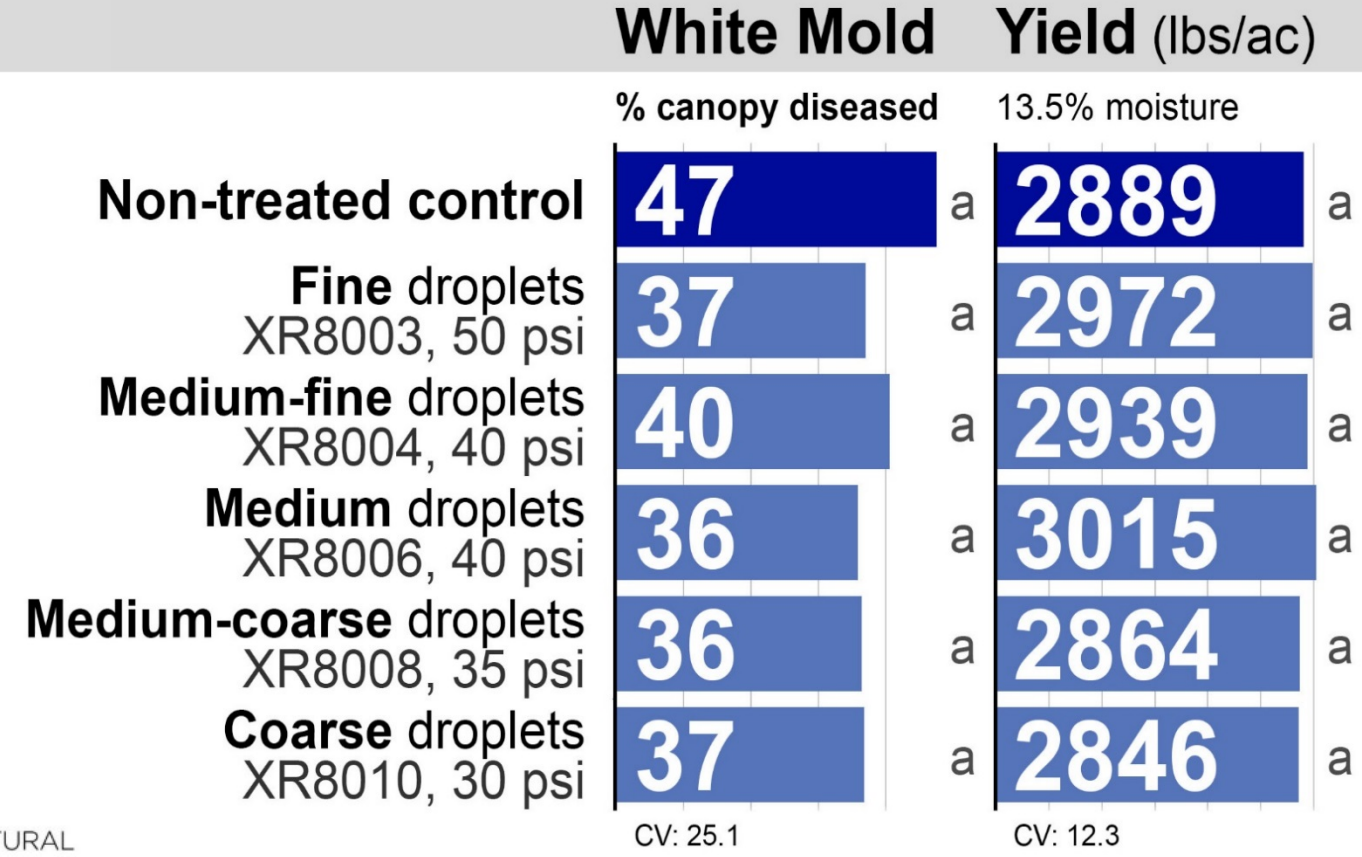
Impact of spray droplet size – PINTO BEANS

Carrington, ND (2018)

'Palomino' pinto

21-inch row spacing

ONE FUNGICIDE APPLICATION



NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Spray volume: 15 gal/ac **Driving speed:** 6.7 mph

Fungicide application (July 5):

Topsin 4.5FL 40 fl oz/ac

100% plants with an open blossom, pin-pods

canopy closure = 75-80%, canopy height = 19 inches

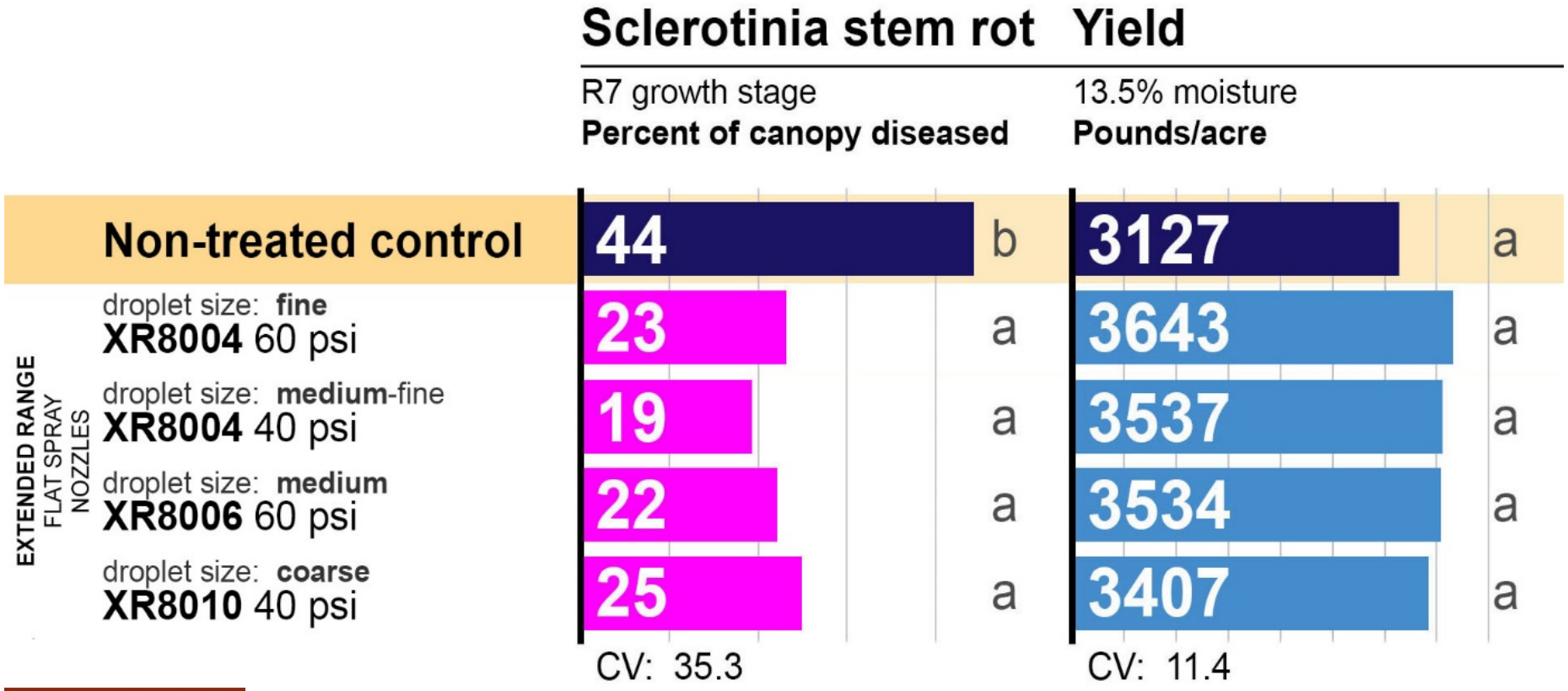
69-70˚F, 3-5 mph wind, 62-66% relative humidity

Impact of spray droplet size – PINTO BEANS

Carrington, ND (2017)

'Palomino' pinto

21-inch row spacing



Spray volume: 15 gal/ac **Driving speed:** 4.0 mph

Fungicide application #1: Topsin 4.5FL 30 fl oz/ac
(July 10, 10-15% of plants with an open blossom, 70-82% canopy closure)

Fungicide application #2: Endura 70WG 8 oz/ac (July 20)

NORTHARVEST BEANS

NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Impact of spray droplet size

Pinto beans:

Studies evaluating the impact of spray droplet size on white mold control and
pinto bean yield under white mold pressure
have been inconclusive.

Drop nozzles - methods

- **‘360’ Undercover drop nozzles** (360 Yield Center)
- **Constant driving speed** (3.8 mph), **spray volume** (15 gal/ac)
- **Drop nozzles centered between 21-inch rows**

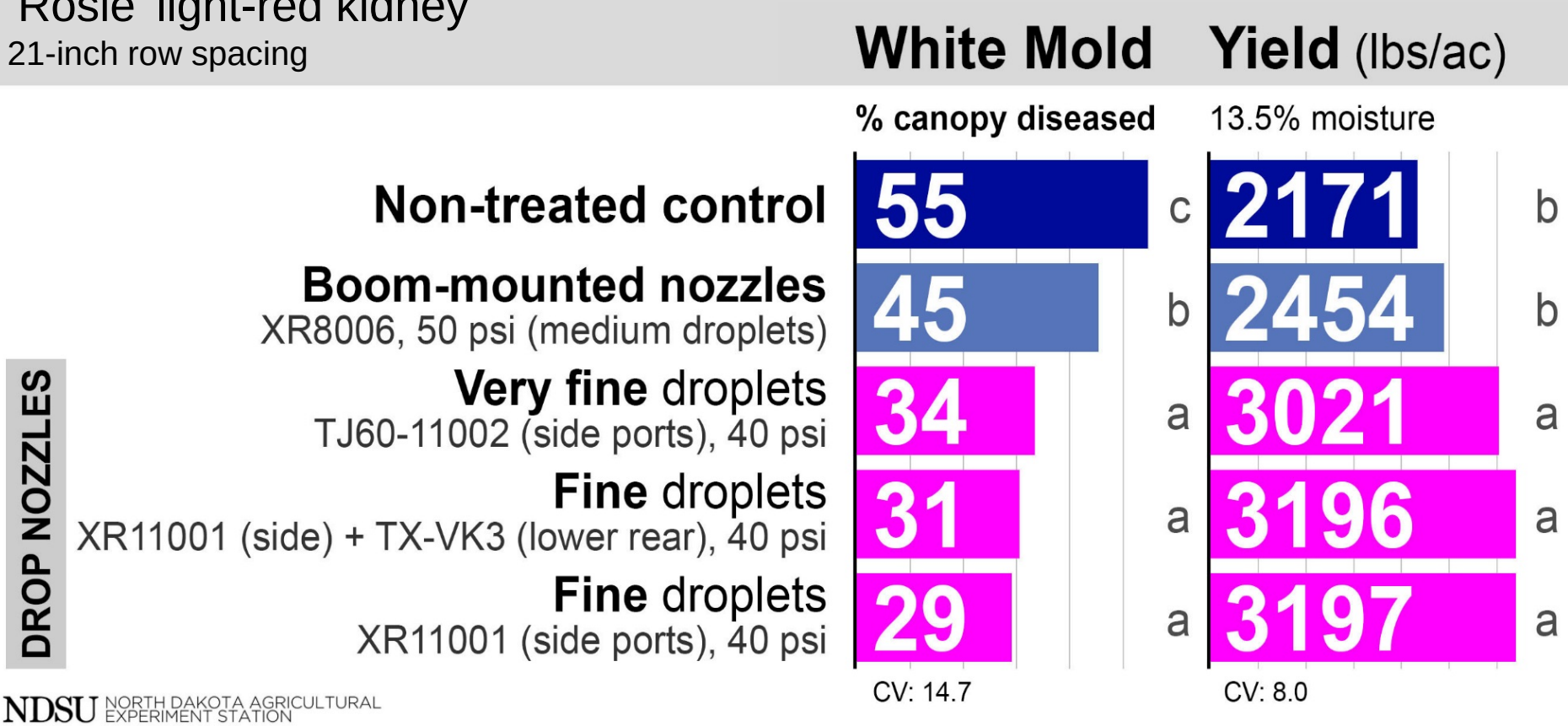
Applications were made with a tractor-mounted boom equipped with a pulse-width modulation system (Capstan AG). Pulse width was calibrated and confirmed by measuring nozzle output. Spraying Systems TeeJet spray nozzles were used.

Drop nozzles – kidney beans

Carrington, ND (2018)

'Rosie' light-red kidney

21-inch row spacing



NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Spray volume: 15 gal/ac **Driving speed:** 3.8 mph

First fungicide application (July 18):
Endura 70WG 8 oz/ac

Full bloom, average pod length 1.5 in. (max. 4.0 in.)
canopy closure = 75-90%, canopy height = 19.5 in.
78-80˚F, 6-8 mph wind, 69-73% relative humidity

Second fungicide application (Aug. 1):
Topsin 4.5FL 40 fl oz/ac

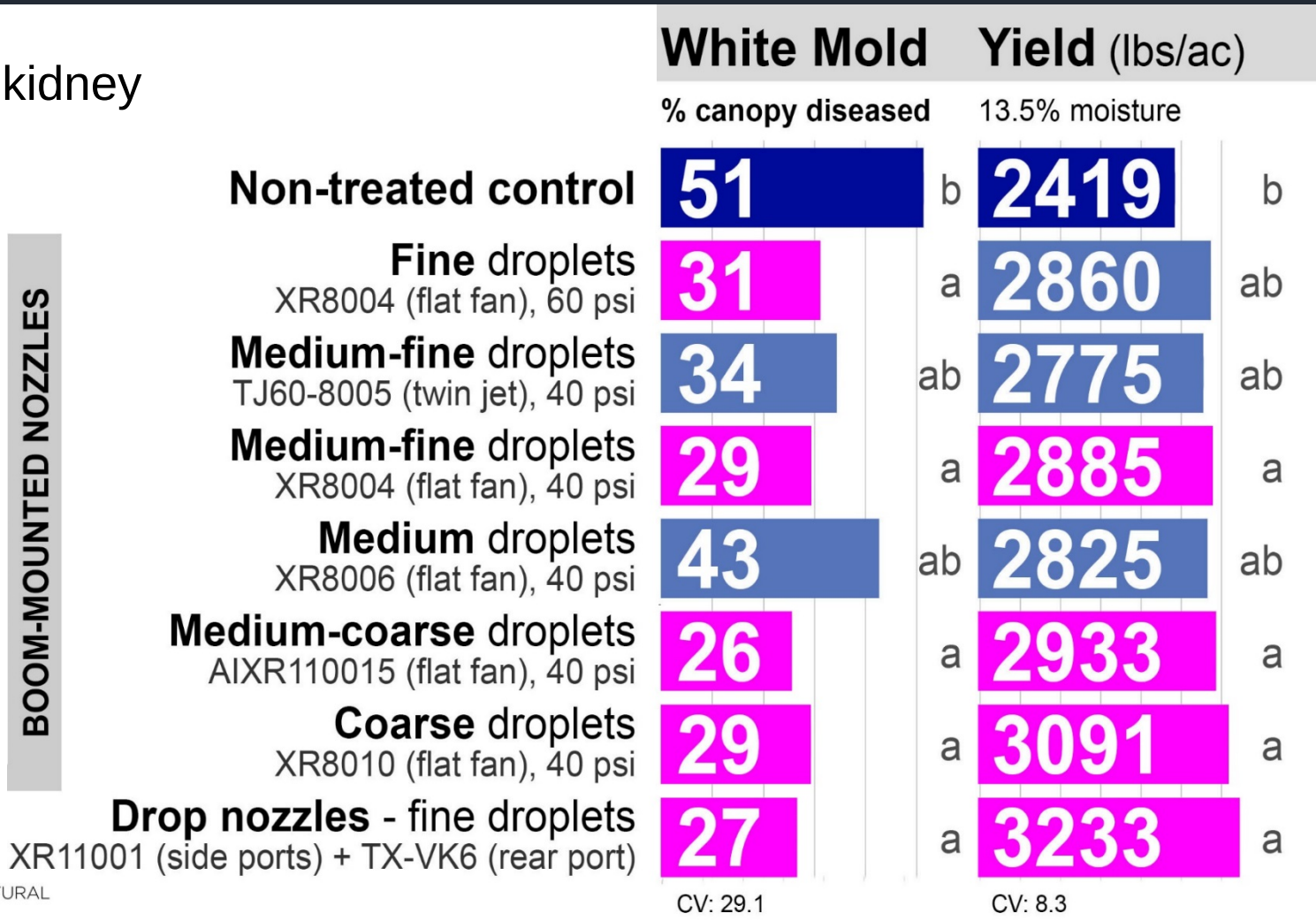
Full bloom, average 12 full-length pods/plant
canopy closure = 100%, canopy height = 19 inches
65˚F, 3-6 mph wind, 54-55% relative humidity

Drop nozzles – kidney beans

Carrington, ND (2017)

'Rosie' light-red kidney

21-inch row spacing



NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Spray volume: 15 gal/ac

Driving speed: 4 mph

except AIXR nozzles (3.2 mph)

First fungicide application (July 10)

Topsin 4.5FL 30 fl oz/ac

10-20% of plants with an open blossom, no pods

canopy closure = 30-40%, canopy height = 6-12 in.

78-83˚F, 6-9 mph wind, 41-49% relative humidity

Second fungicide application (July 20)

Endura 70WG 8.0 oz/ac

75-86˚F, 7-9 mph wind, 53-65% relative humidity

Sclerotinia management in soybeans – Carrington and Oakes, ND (2017, 2018)

Applying fungicides with drop nozzles improved white mold control when fungicides were applied to soybean canopies at or near closure

21-inch row spacing

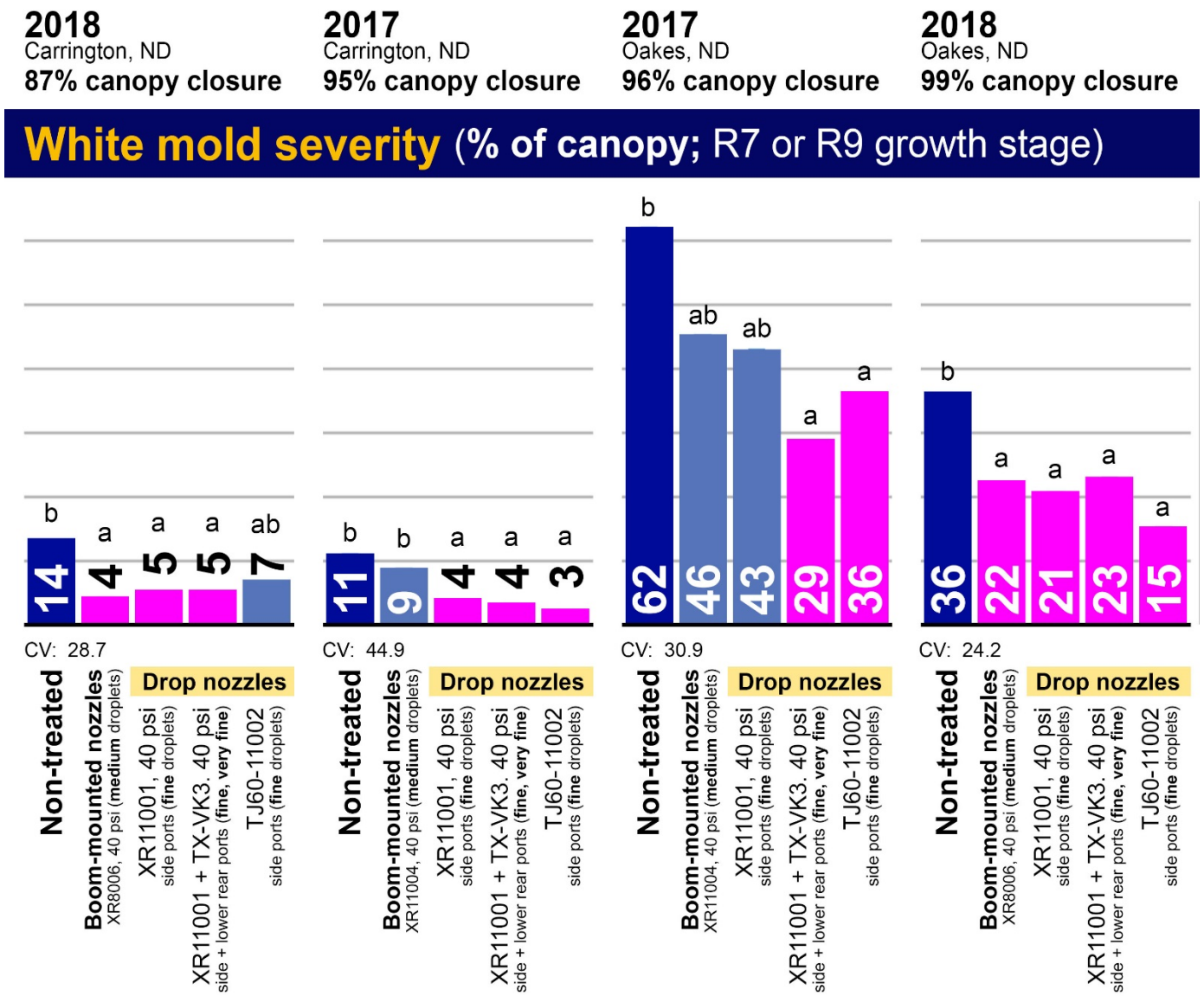
Spray volume: 15 gal/ac

Fungicide: Endura, 5.5 oz/ac

Application timing:
Full R2 growth stage

Driving speed, boom mounted nozzles:
6.7 mph

Driving speed, drop nozzles:
3.8 mph



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NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Sclerotinia management in soybeans – field trials conducted in Carrington and Oakes, ND (2017, 2018)

Applying fungicides with drop nozzles improved soybean yield under white mold pressure when applied to soybean canopies at or near closure

21-inch row spacing

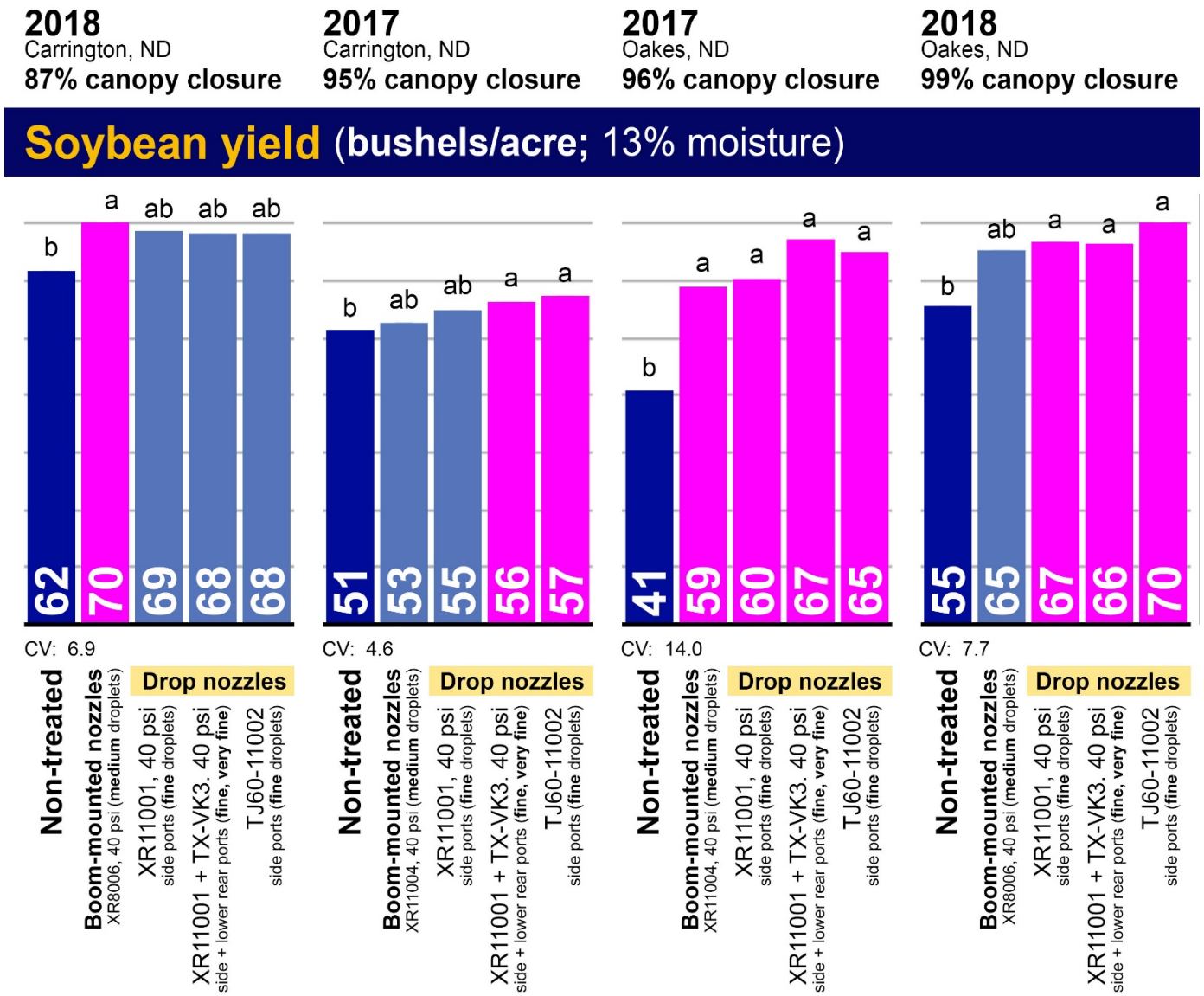
Spray volume: 15 gal/ac

Fungicide: Endura, 5.5 oz/ac

Application timing:
Full R2 growth stage

Driving speed, boom mounted nozzles:
6.7 mph

Driving speed, drop nozzles:
3.8 mph



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NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Sclerotinia management in soybeans – field trials conducted in Carrington and Oakes, ND (2018)

Impact of application method and application frequency on fungicide efficacy

Soybean row spacing:
21 inches

Carrington, ND (2018)

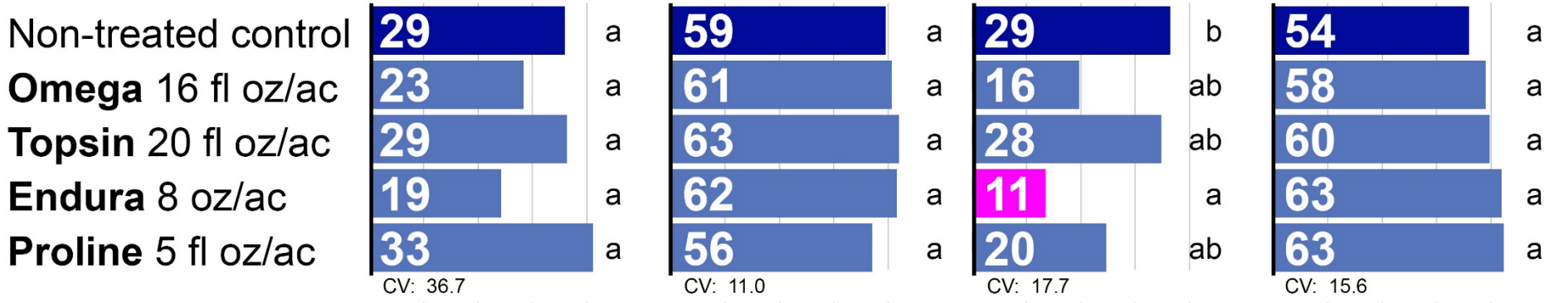
Peterson Farms '17X09N' (0.9 maturity)

Oakes, ND (2018)

Pioneer 'P11A95X' (1.1 maturity)

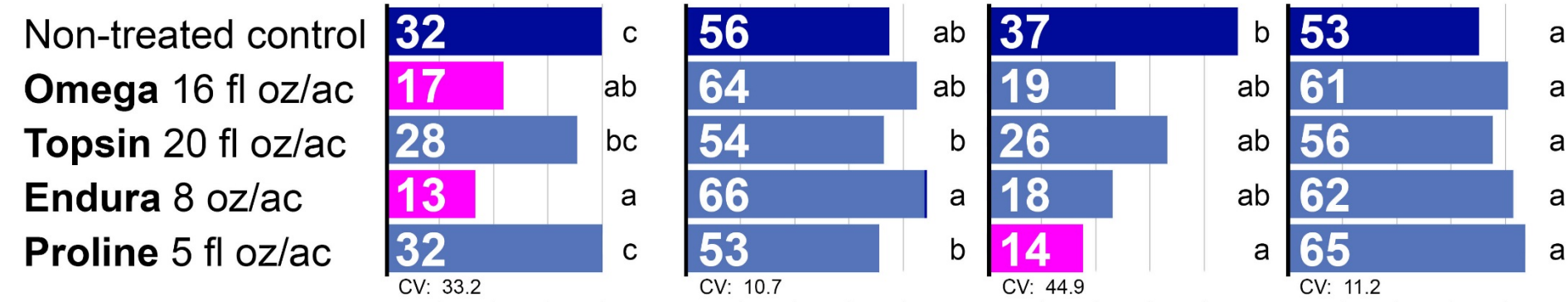
BOOM-MOUNTED NOZZLES: **One fungicide application** (R2 growth stage)

XR8006 flat-fan nozzles, 40 psi (medium droplets) spray volume = 15 gal/ac driving speed = 6.7 mph



BOOM-MOUNTED NOZZLES: **Two fungicide applications** (R2 + R3 growth stages)

XR8006 flat-fan nozzles, 40 psi (medium droplets) spray vol. = 15 gal/ac driving speed = 6.7 mph applications 11 days apart



Sclerotinia management in soybeans – field trials conducted in Carrington and Oakes, ND (2018)

Impact of application method and application frequency on fungicide efficacy

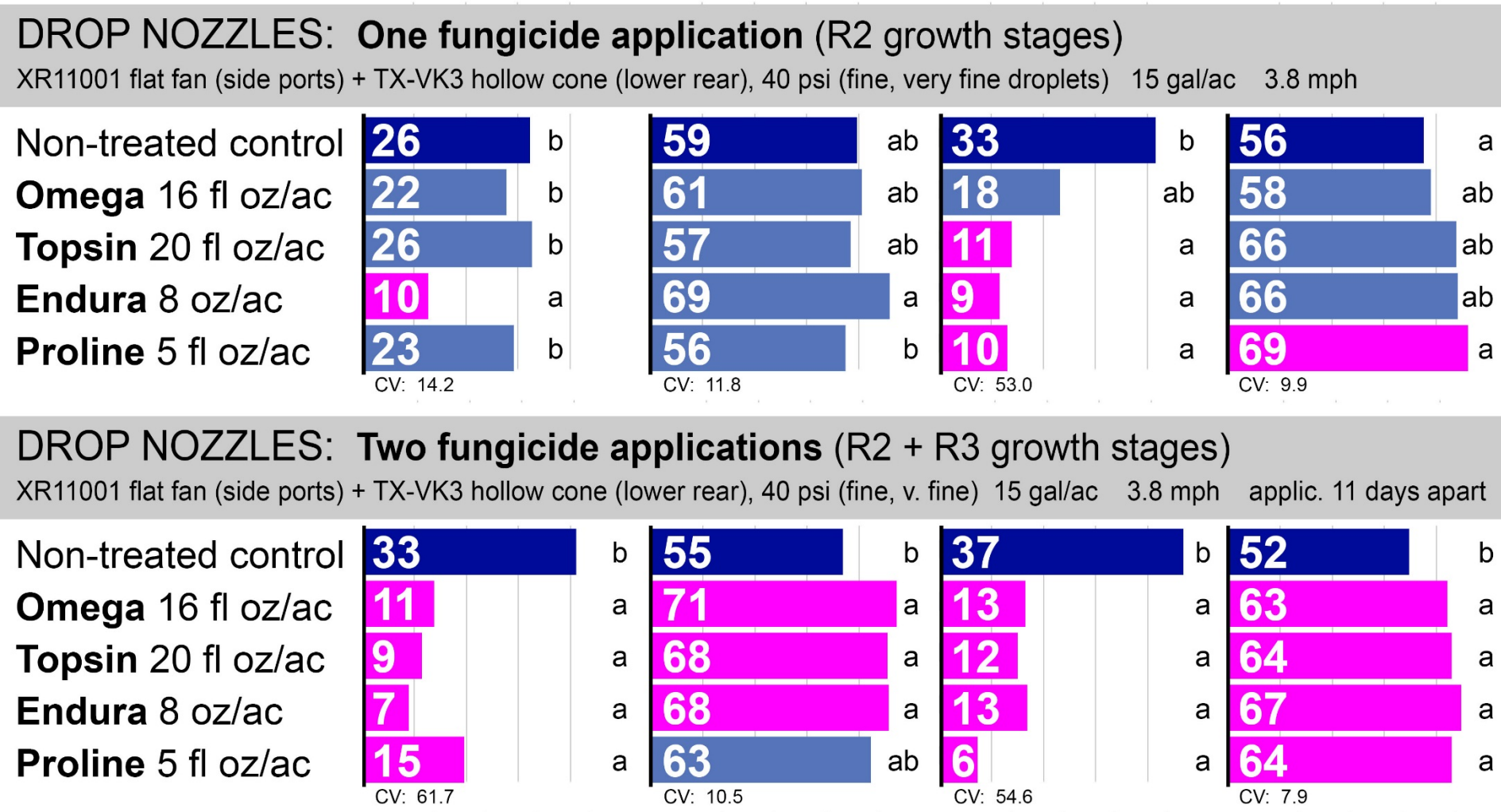
Soybean row spacing:
21 inches

Carrington, ND (2018)

Peterson Farms '17X09N' (0.9 maturity)

Oakes, ND (2018)

Pioneer 'P11A95X' (1.1 maturity)



‘360 Undercover’ drop nozzles (360 Yield Center; Morton, IL)

(1) When to use the ‘360 Undercover’ drop nozzle:

Drop nozzles are most likely to improve fungicide performance when the **soybean canopy is at or near closure**

Drop nozzles may facilitate **more consistent fungicide performance**, providing opportunities to use a cheaper product

(2) Drop nozzle setup:

Use wide-angle (110-degree) nozzles on side ports
Multi-directional sprays within the canopy are likely optimal

110˚ twin-jet nozzles on side ports or
110˚ twin-jet or flat-fan nozzles on side ports + 80˚ hollow-cone on lower rear port

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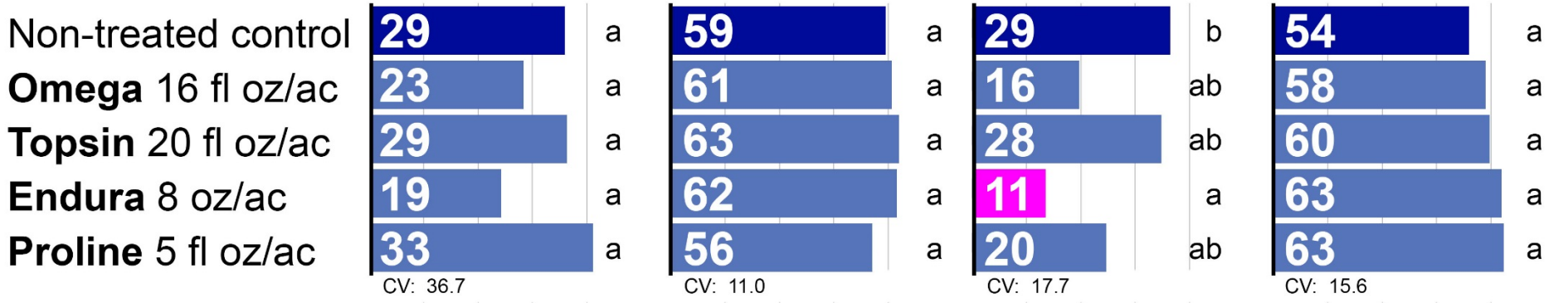

BOOM-MOUNTED NOZZLES: **Two fungicide applications** (R2 + R3 growth stages)

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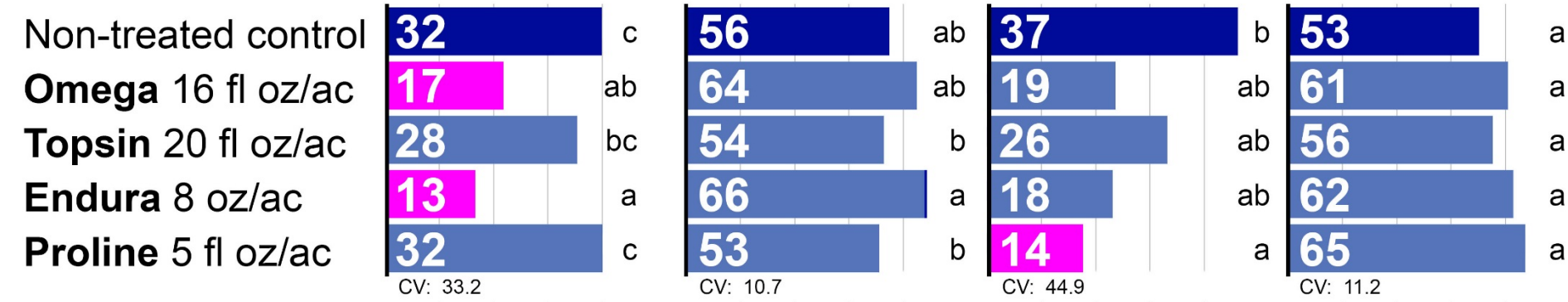




Thank You!

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North Dakota Crop Protection Product Registration and Harmonization Board

NORTHARVEST BEANS

North Dakota Soybean Council
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