Improving management of white mold in soybeans

Michael Wunsch
North Dakota State University Carrington Research Extension Center

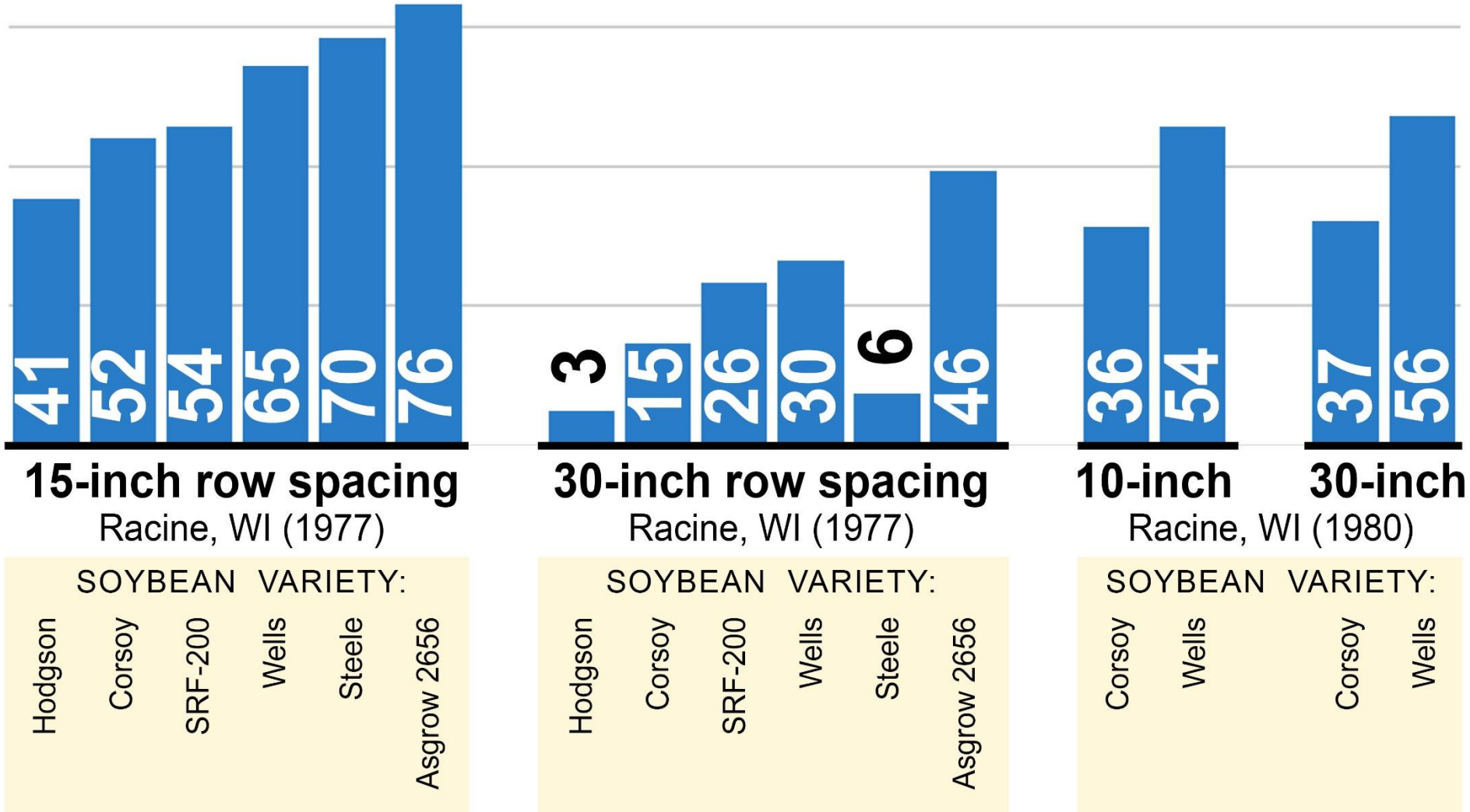
Impact of row spacing on soybean agronomic performance under white mold pressure

Racine, Wisconsin (1977)

White mold incidence (**% of plants;** R7 growth stage)

Seeding rates: 15-inch row: 213,000 seeds/ac 30-inch row: 160,000 seeds/ac

Grau and Radke 1984. Plant Dis. 68(1):56-58.



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Racine, Wisconsin (1977)

Soybean Yield (bushels/acre; 13% moisture)

Seeding rates: 15-inch row: 213,000 seeds/ac
30-inch row: 160,000 seeds/ac

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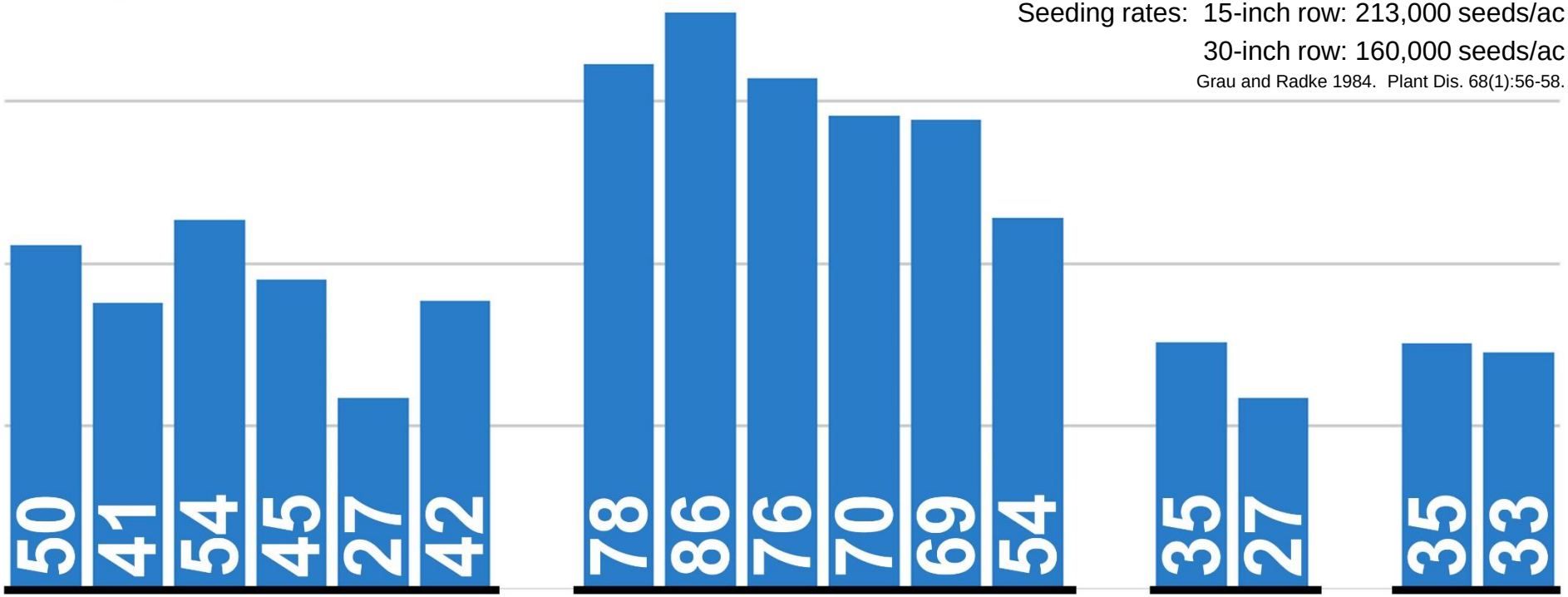


15-inch row spacing
Racine, WI (1977)

SOYBEAN VARIETY:
Hodgson
Corsoy
SRF-200
Wells
Steele
Asgrow 2656

30-inch row spacing
Racine, WI (1977)

SOYBEAN VARIETY:
Hodgson
Corsoy
SRF-200
Wells
Steele
Asgrow 2656

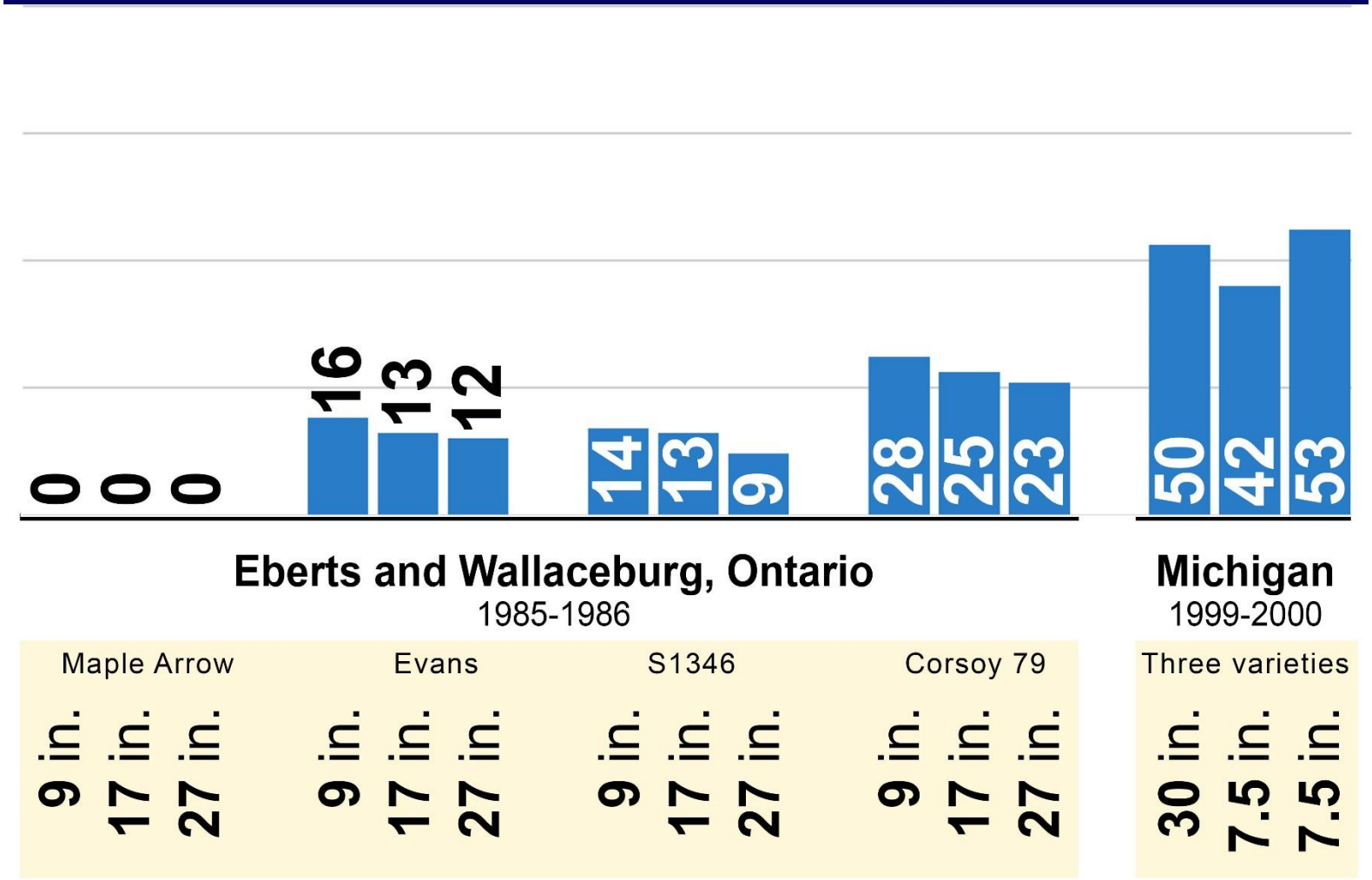
10-inch **30-inch**
Racine, WI (1980)

SOYBEAN VARIETY:
Corsoy
Wells
Corsoy
Wells

Impact of row spacing on soybean agronomic performance under white mold pressure

Eberts and Wallaceburg, Ontario (1985-1986) **Ingham County, Michigan** (1999-2000)

White mold incidence (**% of plants;** R7 growth stage)



Ontario - Seeding rates: 9-inch row: 264,000 seeds/ac 18-inch row: 180,000 seeds/ac 27-inch row: 147,000 seeds/ac

Buzzell et al. 1993. Can. J. Plant Sci. 73:1169-1175

Michigan - Seeding rates: 30-inch row: 174,000 seeds/ac 7.5-inch row: 174,000 and 224,000 seeds/ac

Lee et al. 2005. Weed Technology 19:580-588.

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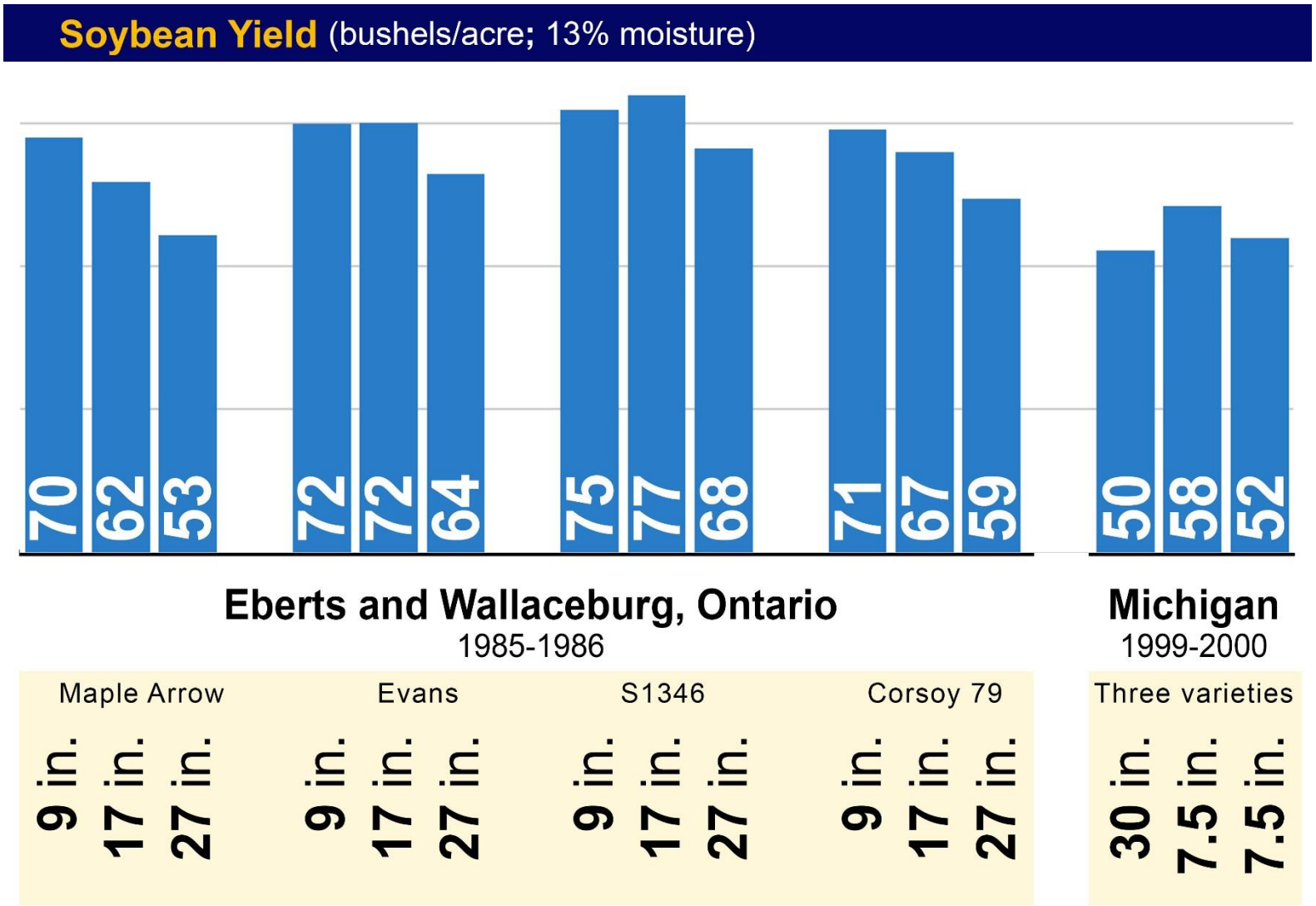

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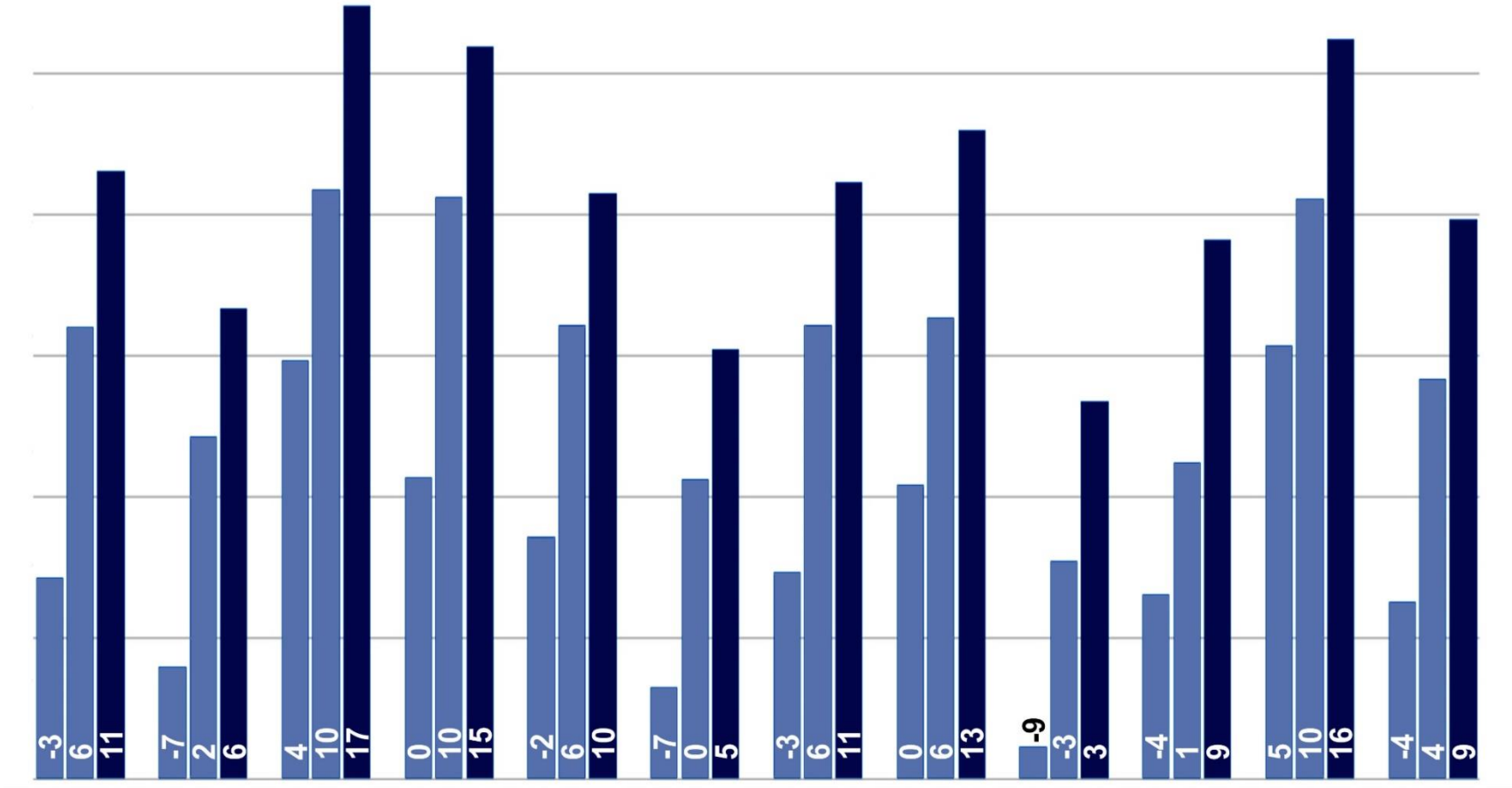
Impact of seeding rate on soybean agronomic performance under white mold pressure

Oakes, ND (2015-2017) Combined analysis across three seeding rates: 132,000; 165,000; and 198,000 viable seeds/ac

Canopy closure (days before or after bloom initiation - 90% of plants at R1)



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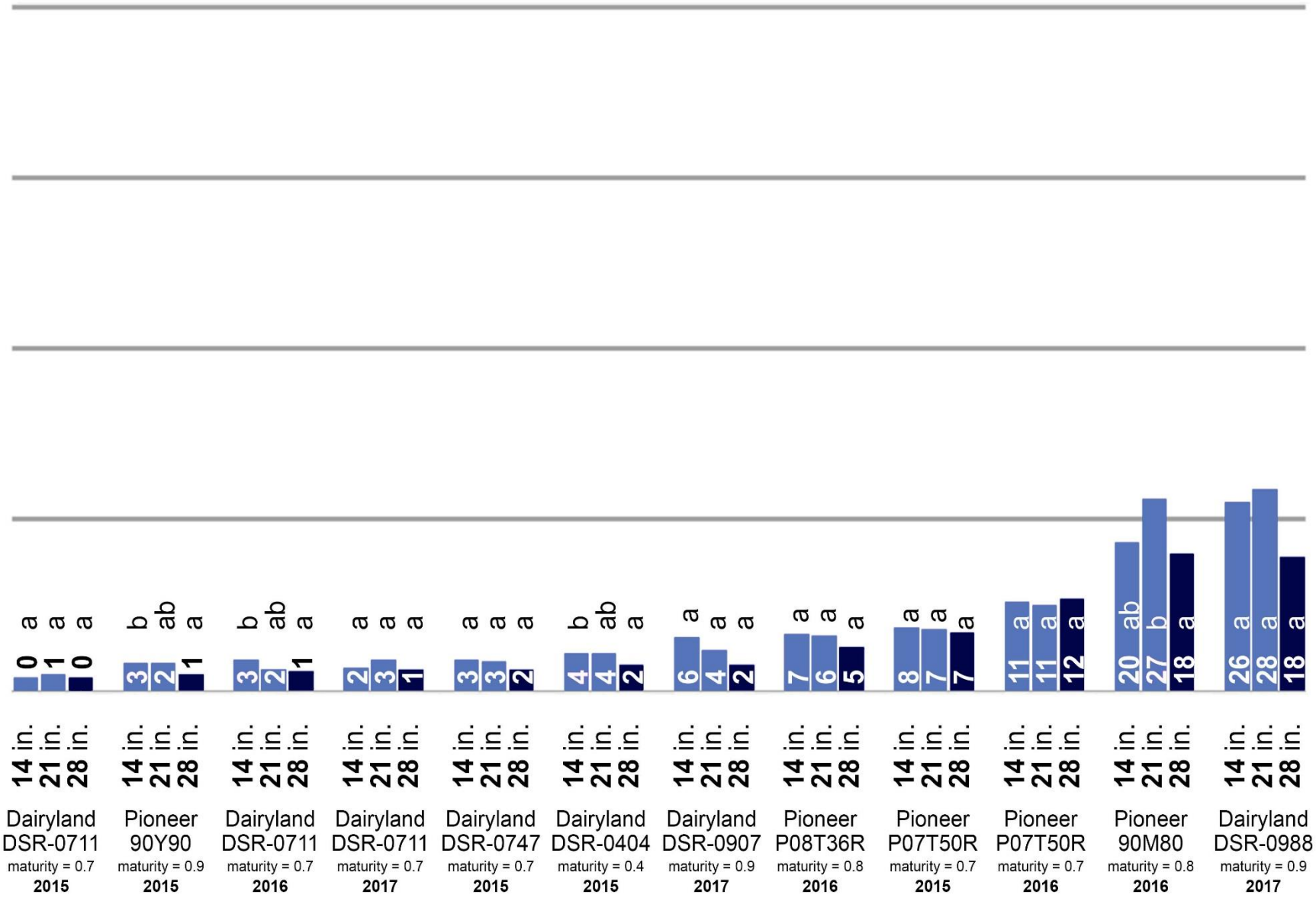

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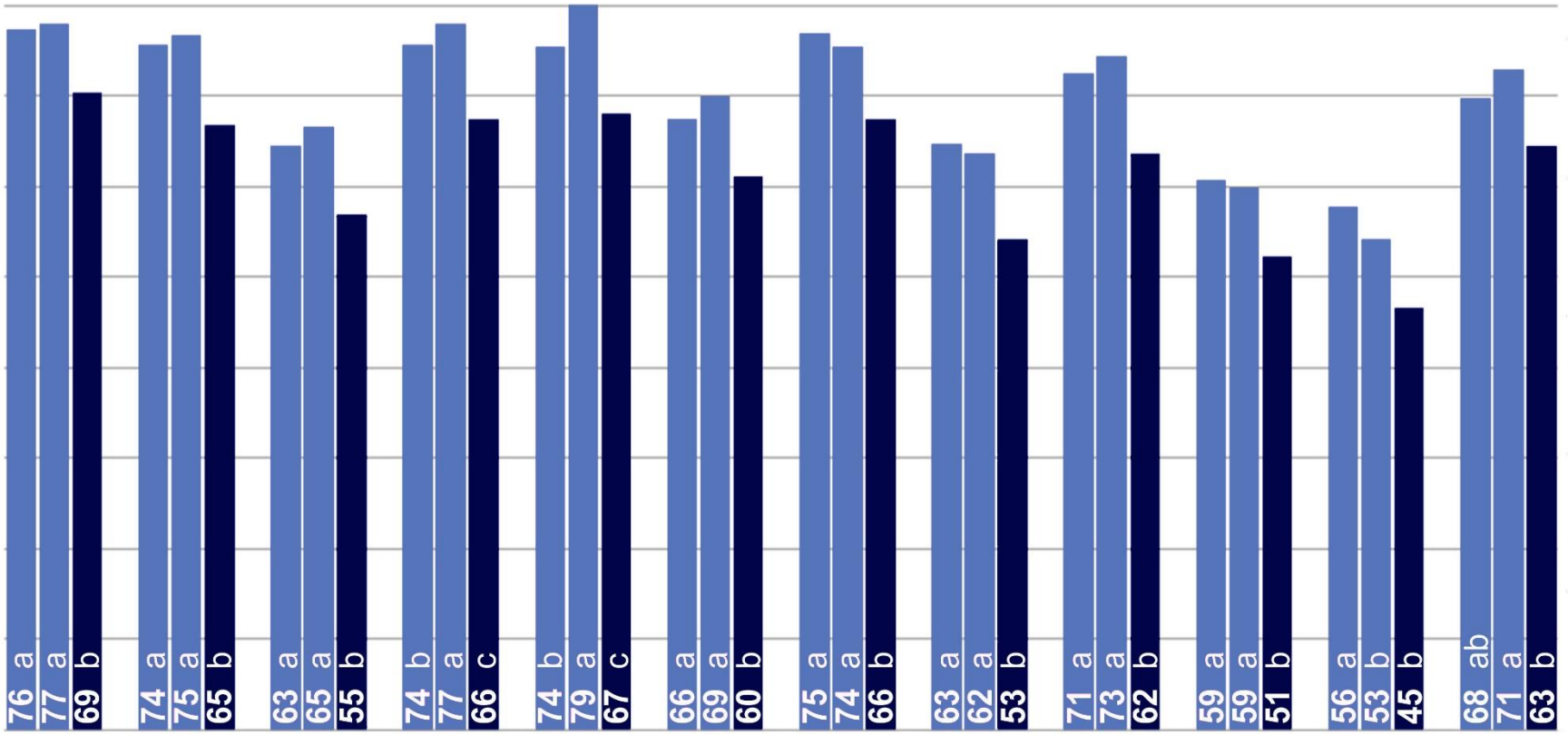
Soybean Yield (bushels/acre; 13% moisture)

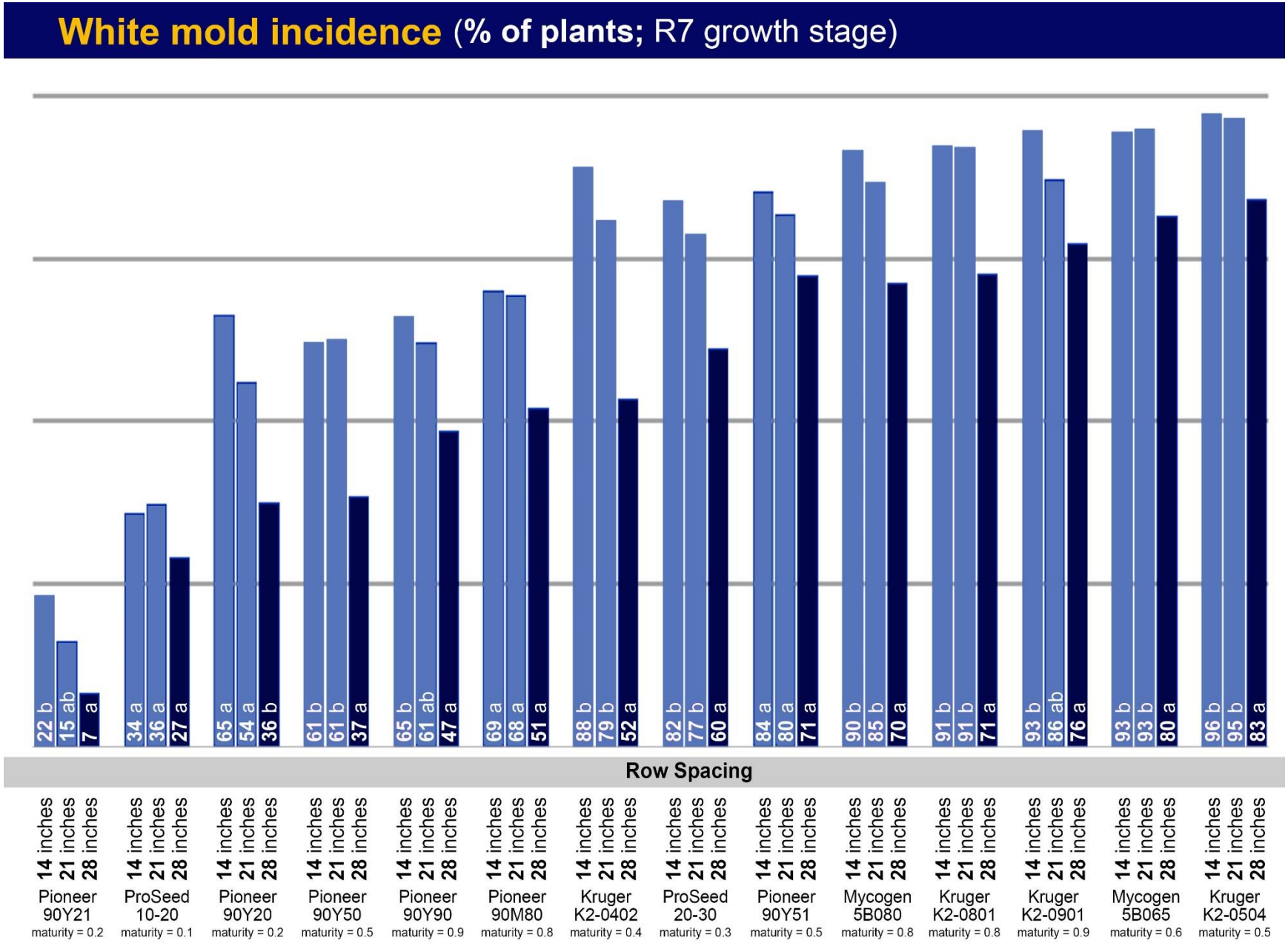


Row Spacing

14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.	14 in. 21 in. 28 in.
Dairyland DSR-0711 maturity = 0.7 **2015**	Pioneer 90Y90 maturity = 0.9 **2015**	Dairyland DSR-0711 maturity = 0.7 **2016**	Dairyland DSR-0711 maturity = 0.7 **2017**	Dairyland DSR-0747 maturity = 0.7 **2015**	Dairyland DSR-0404 maturity = 0.4 **2015**	Dairyland DSR-0907 maturity = 0.9 **2017**	Pioneer P08T36R maturity = 0.8 **2016**	Pioneer P07T50R maturity = 0.7 **2015**	Pioneer P07T50R maturity = 0.7 **2016**	Pioneer 90M80 maturity = 0.8 **2016**	Dairyland DSR-0988 maturity = 0.9 **2017**

Impact of row spacing on soybean agronomic performance under white mold pressure

Carrington, ND (2014) Seeding rate: 165,000 viable seeds/ac



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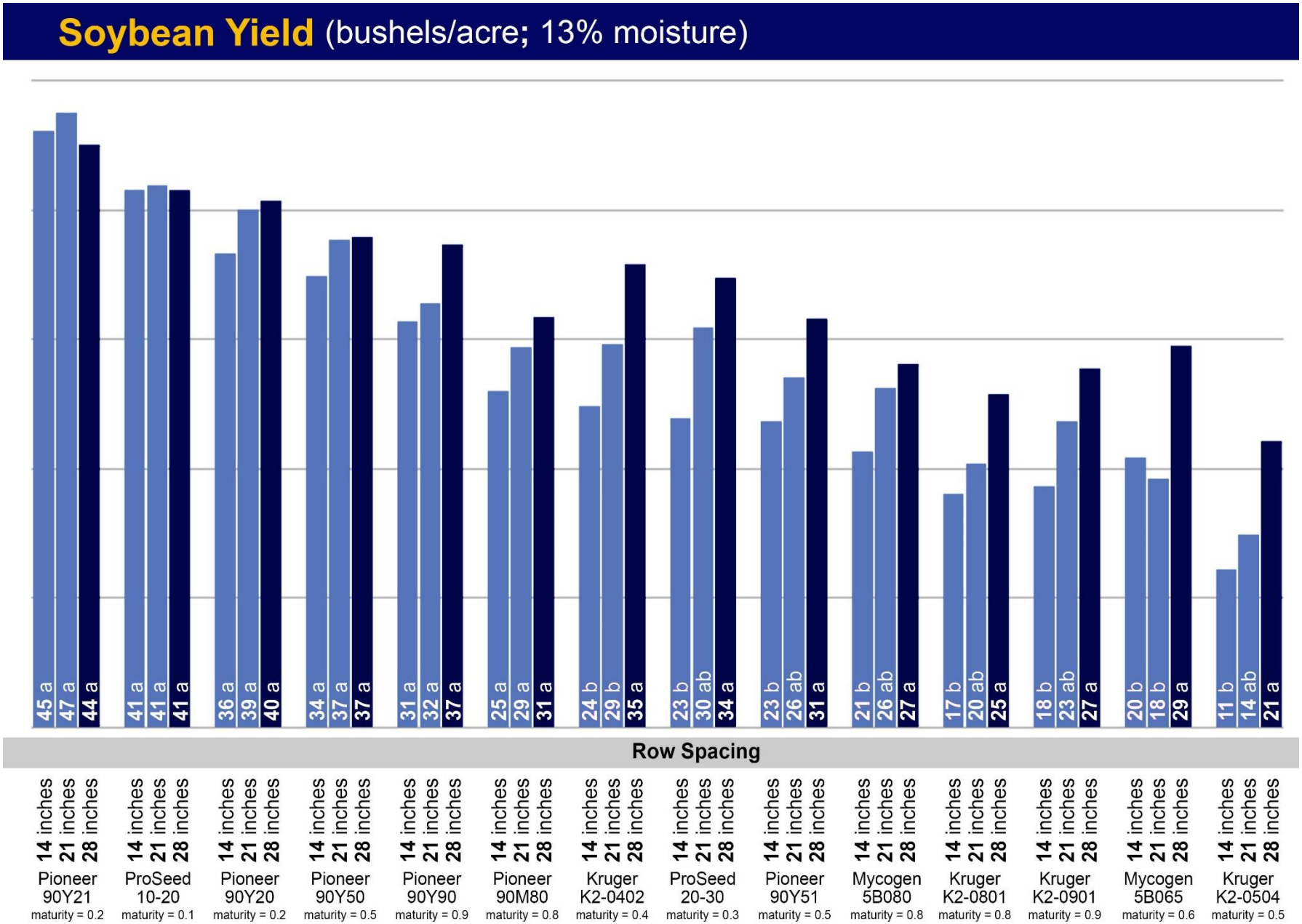

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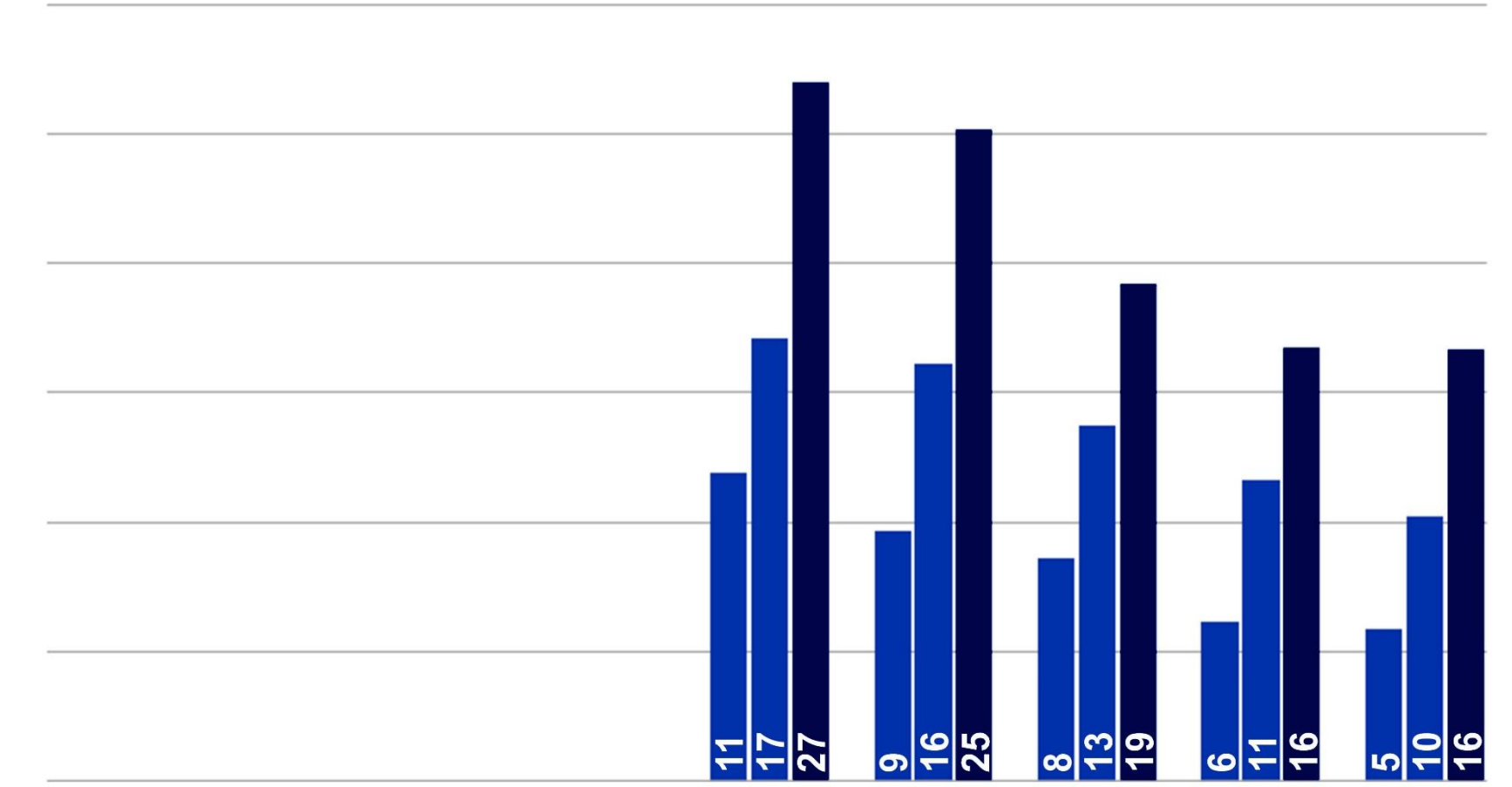

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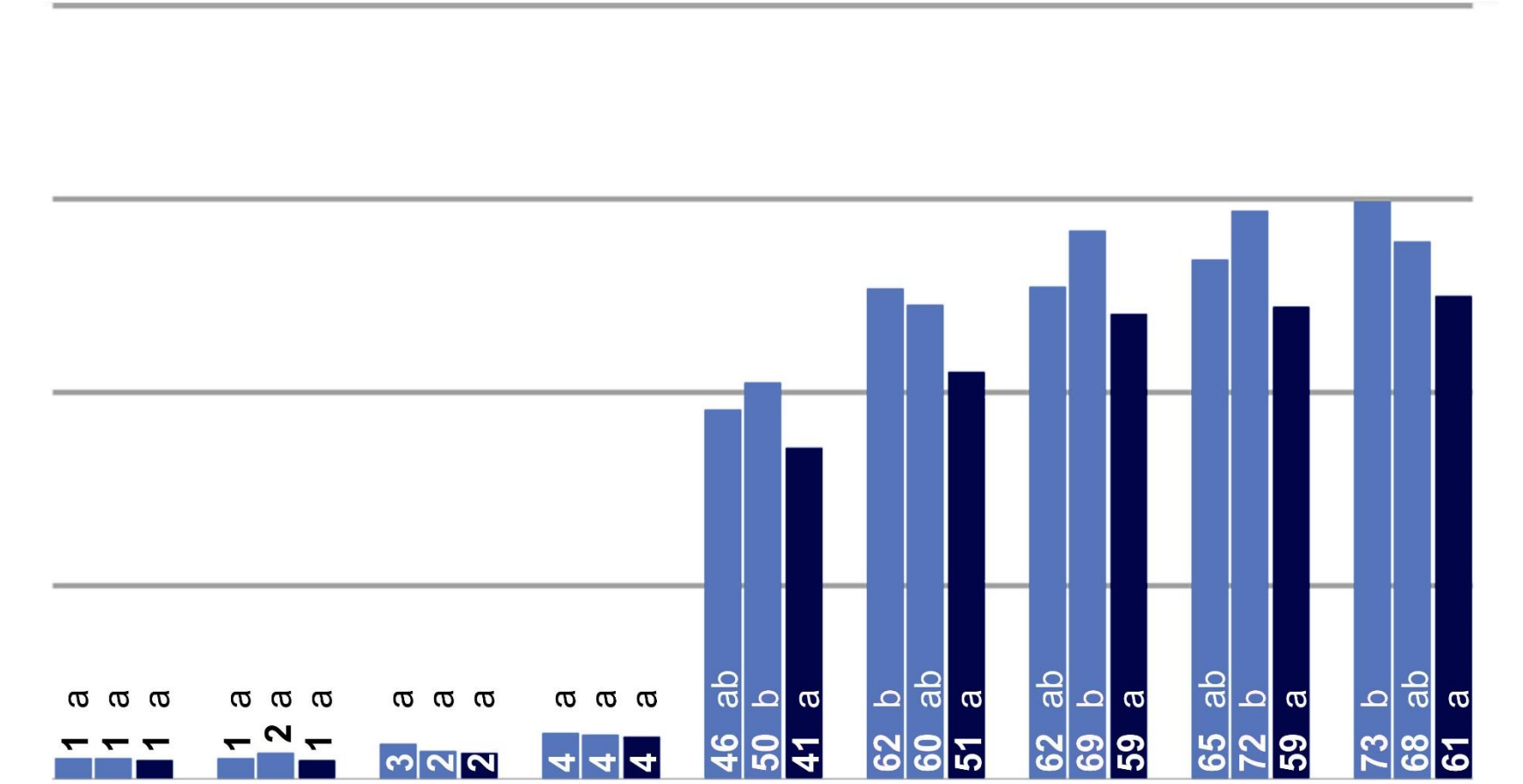

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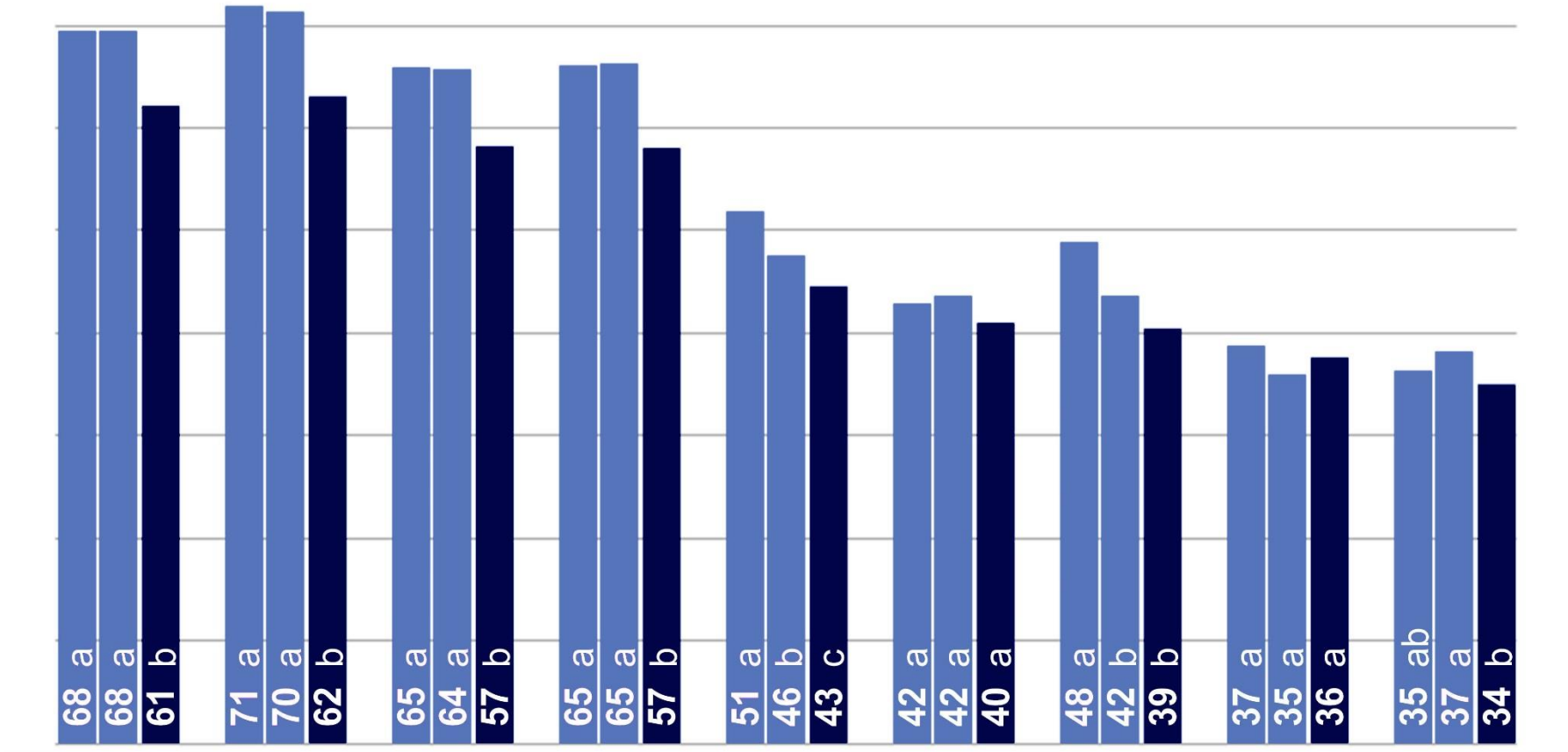

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Pioneer P06T28R	Pioneer P08T96R	Pioneer P05T24R	Pioneer P08T59R	Pioneer P06T28R	Pioneer 90Y50	ProSeed 20-70	Mycogen 5B066	Mycogen 5B080
maturity = 0.6	maturity = 0.8	maturity = 0.5	maturity = 0.8	maturity = 0.6	maturity = 0.5	maturity = 0.7	maturity = 0.6	maturity = 0.8
2017	**2017**	**2017**	**2017**	**2015**	**2015**	**2015**	**2015**	**2015**

White mold incidence:

Wide (28- to 30-inch) vs. Narrow (14- or 15-inch) rows

Soybean maturity: 00 and 0 **Locations:** Carrington, Hofflund, Langdon, and Oakes, ND **Years:** 2013-2017

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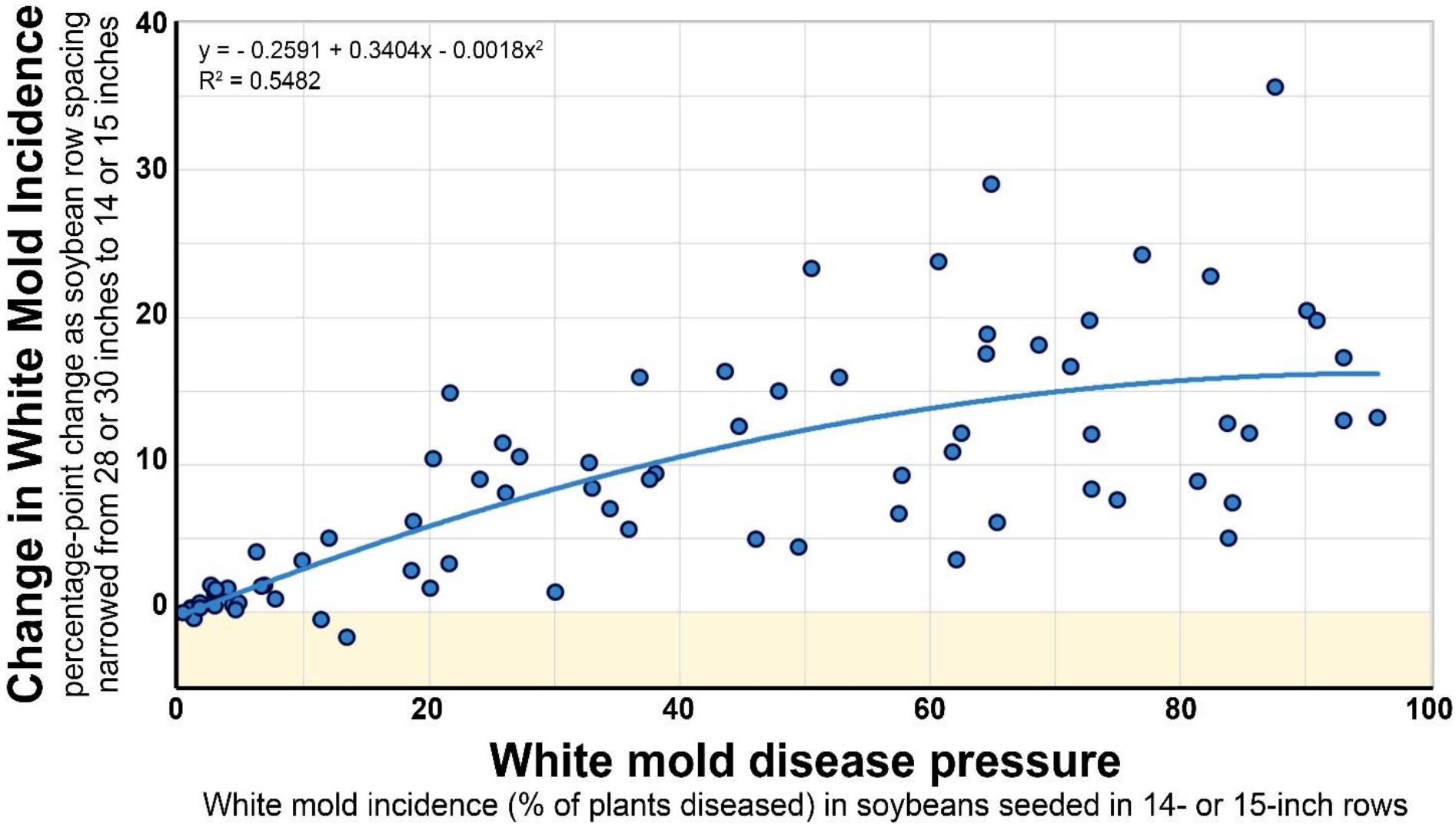

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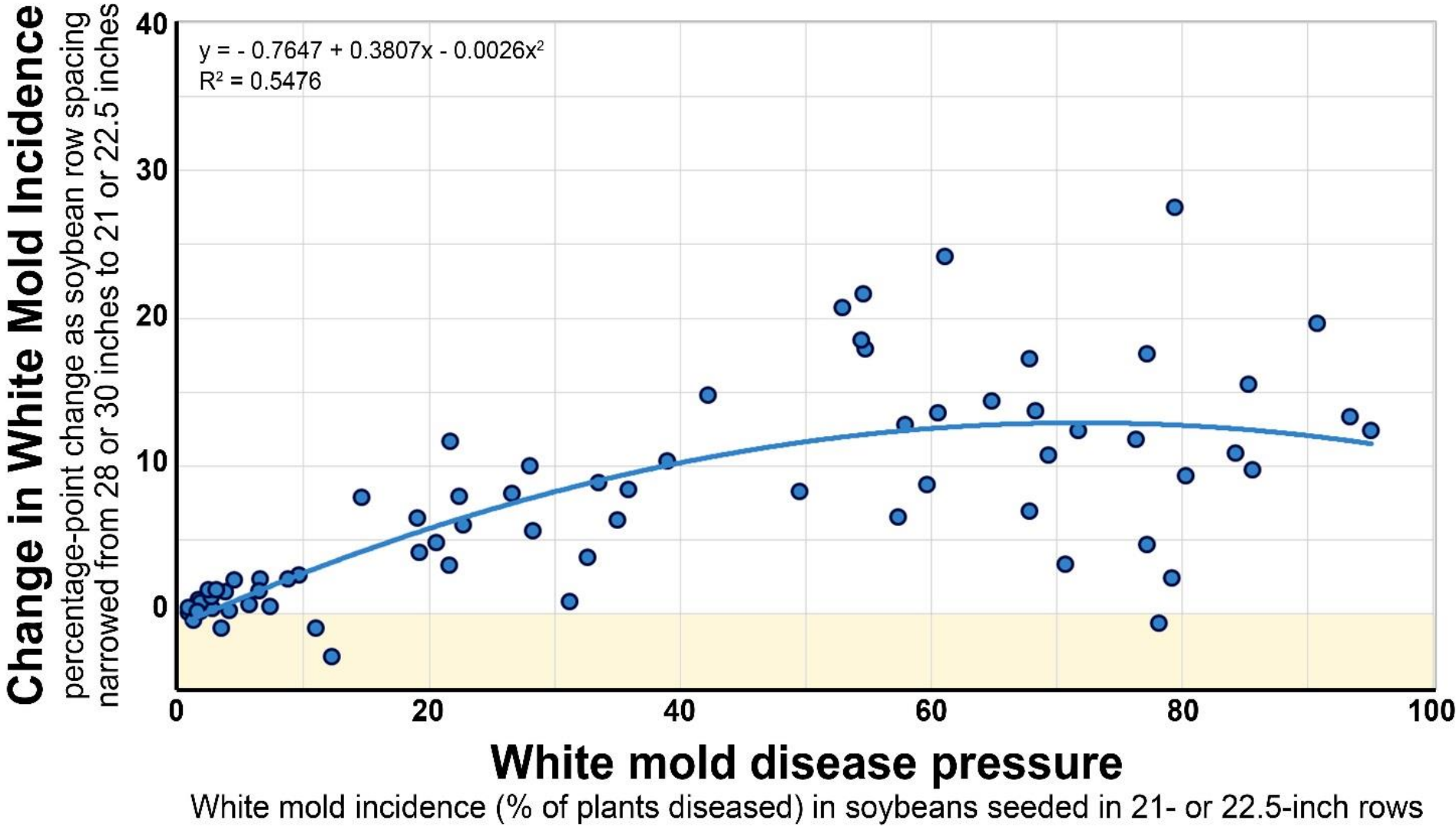

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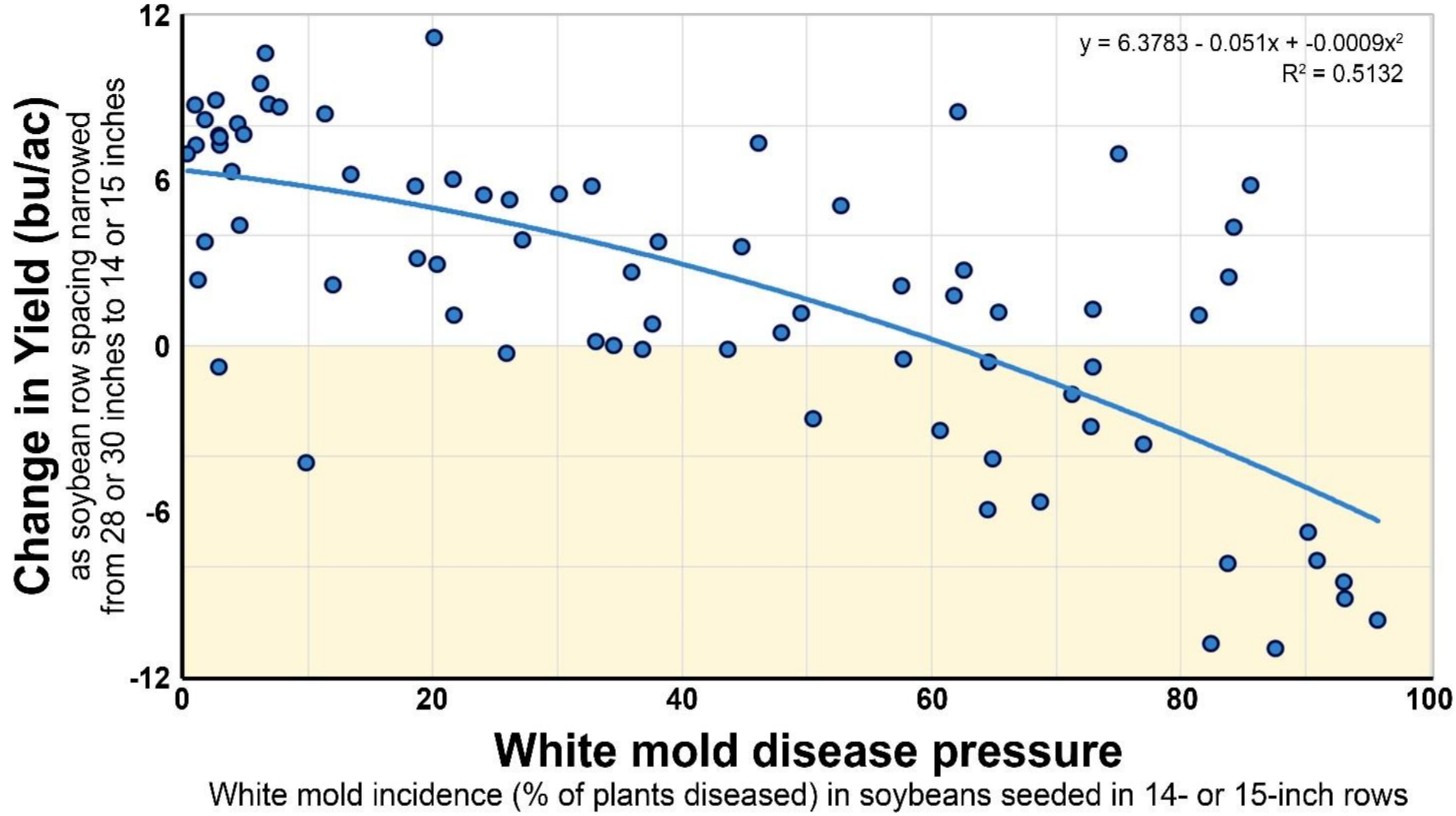

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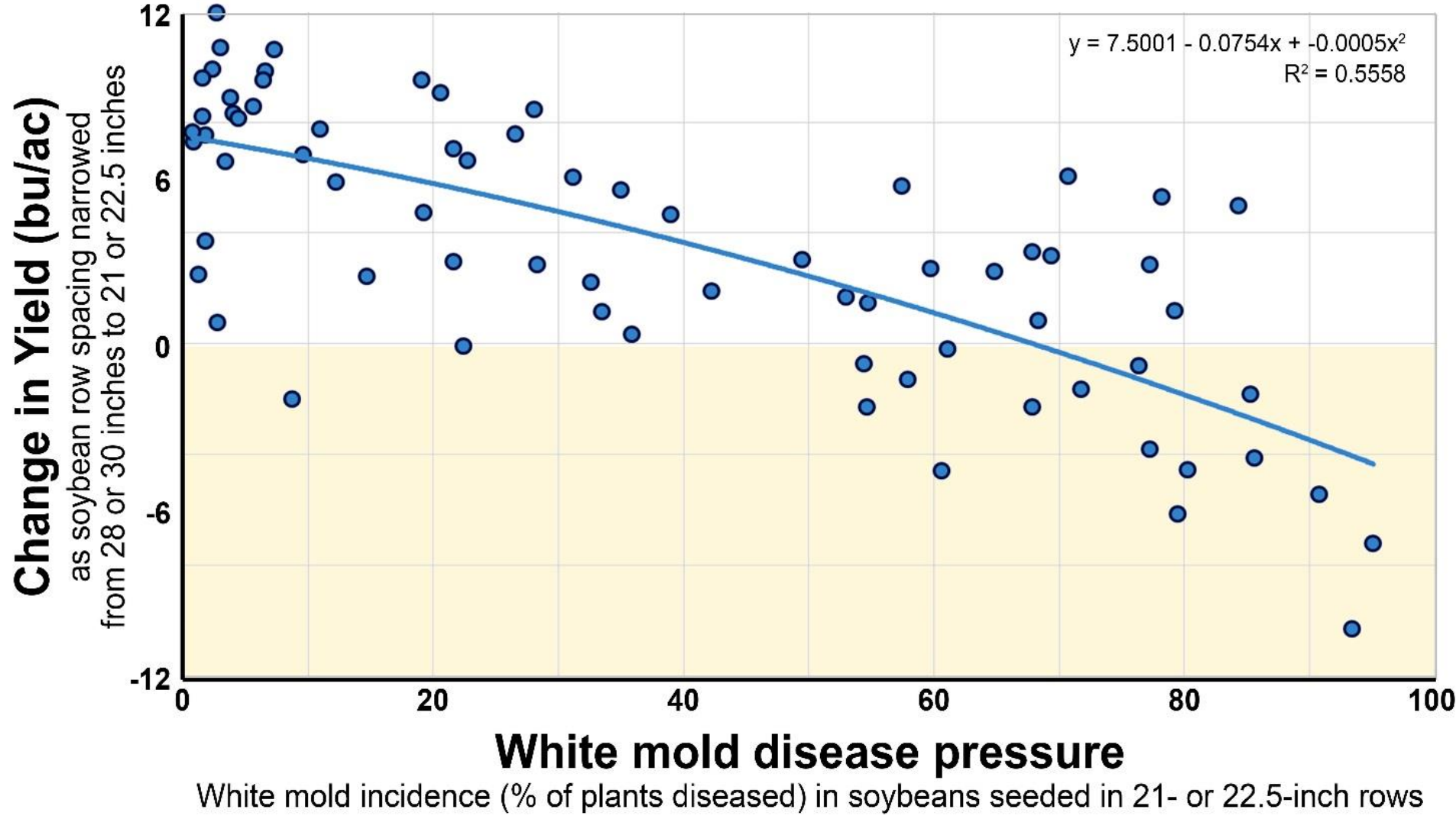

Sclerotia contamination of the grain:

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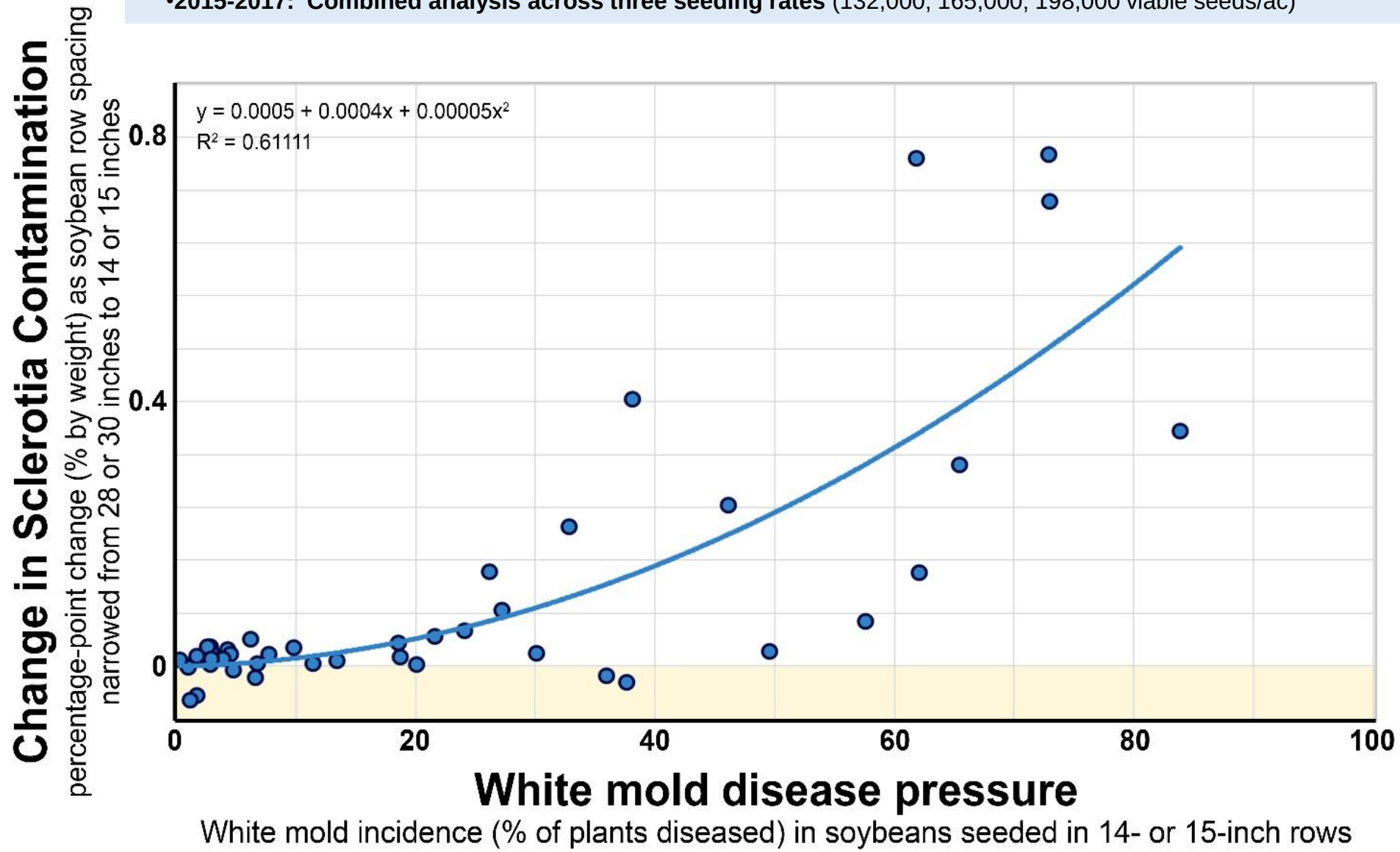

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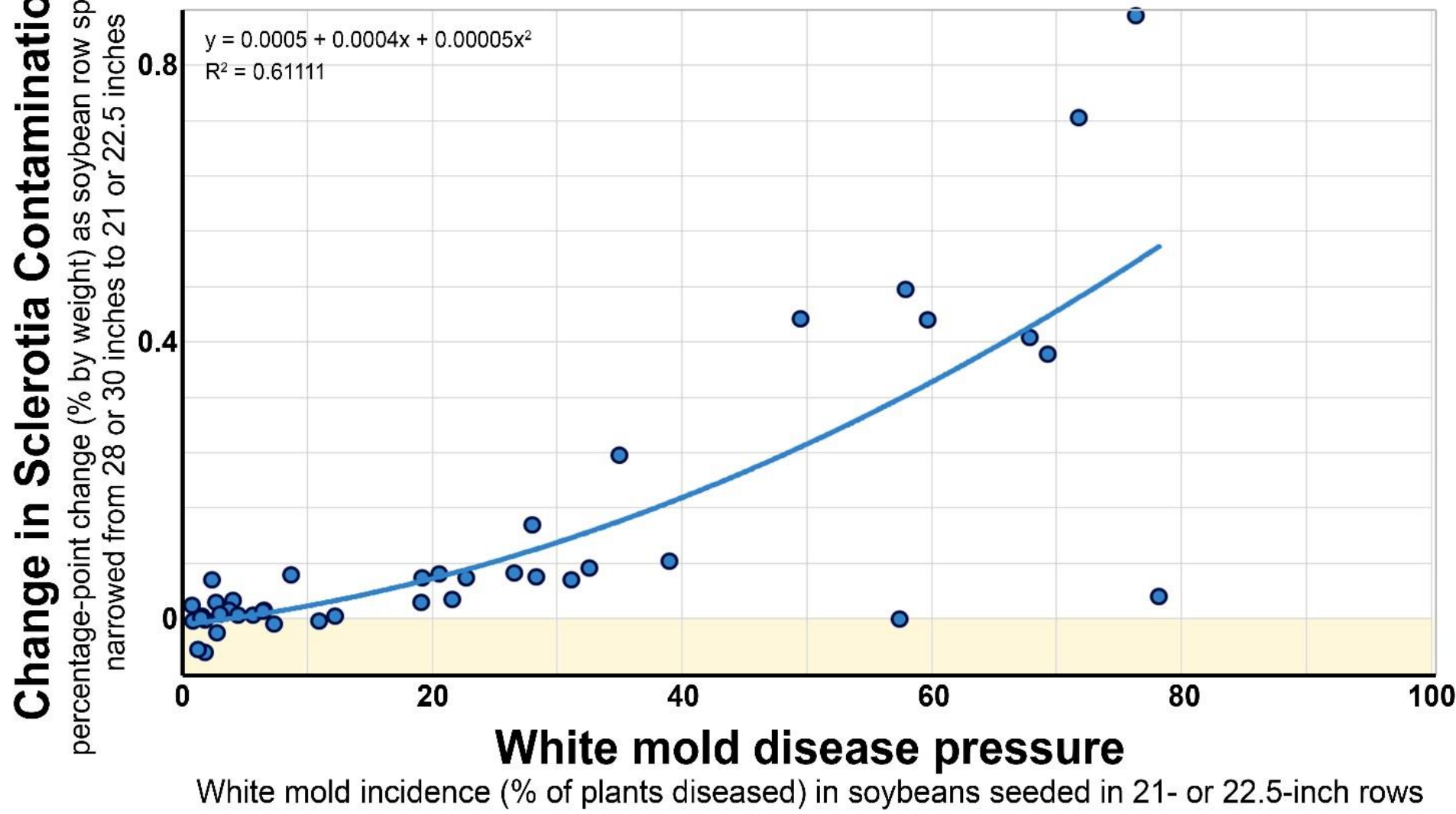


Optimizing row spacing

Impact of row spacing on white mold:

- When end-of-season white mold incidence was less than 50%, soybean yield was maximized when soybeans were grown in narrow (14- or 15-inch) or intermediate (21- or 22.5-inch) rows.

- **Intermediate row spacing was optimal.** Soybeans seeded to 21- or 22.5-inch rows generally developed less white mold and had higher yields than soybeans seeded to 14- or 15-inch rows.

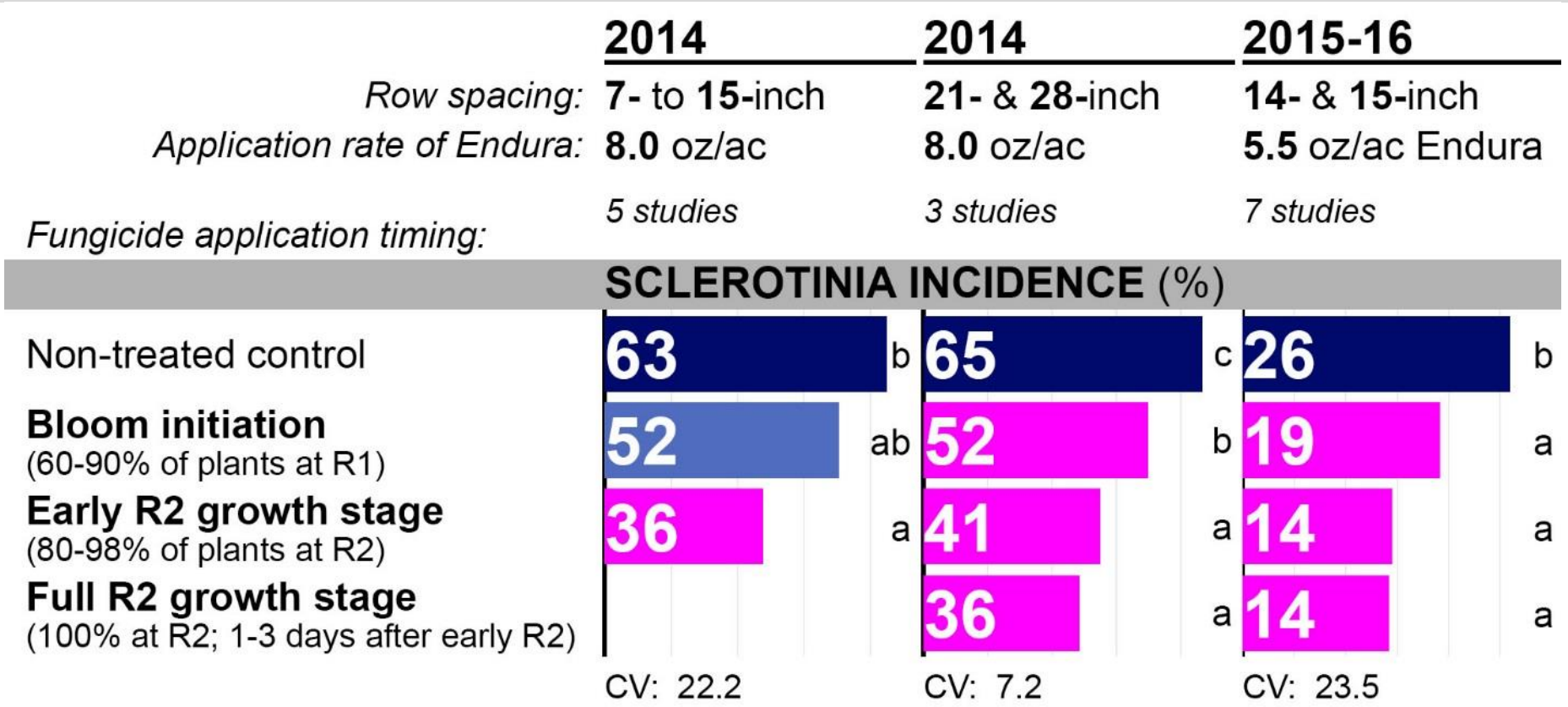
- The **increase in sclerotia contamination of grain** associated with planting to narrow or intermediate rows was negligible when end-of-season white mold incidence was less than 30% and moderate when white mold incidence was less than 50%.

Optimizing application timing – Single fungicide application

Carrington, Hofflund, Langdon, and Oakes ND (2014-2016)

Combined analysis across 15 field studies

Fungicide applied: Endura at 5.5 or 8.0 oz/ac



Nozzles: XR8001 or XR80015 flat-fan TeeJet nozzles, 35 or 40 psi (droplet size = fine)
Spray volume: 15 or 17.5 gal/ac

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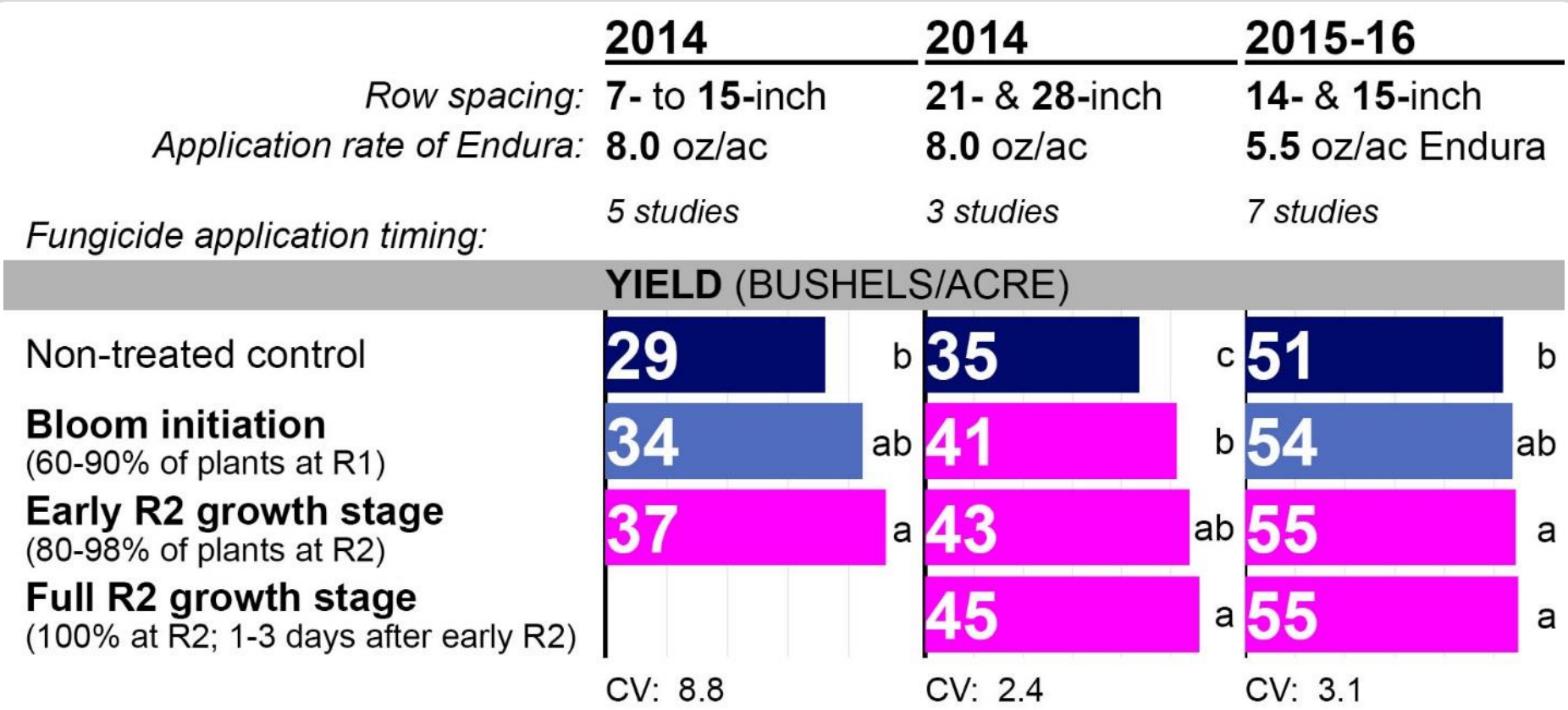

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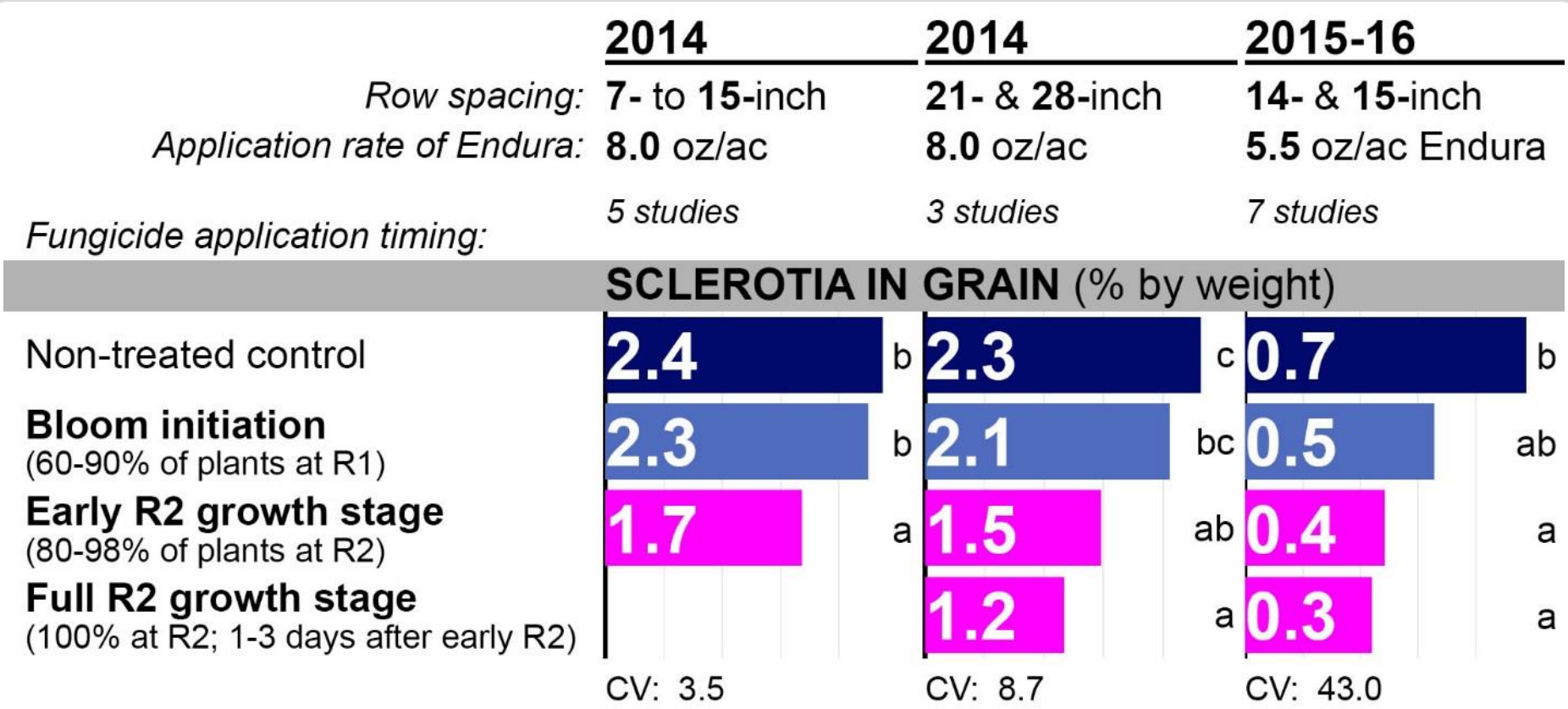

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Optimizing application timing – Single fungicide application

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Combined analysis across 16 field studies

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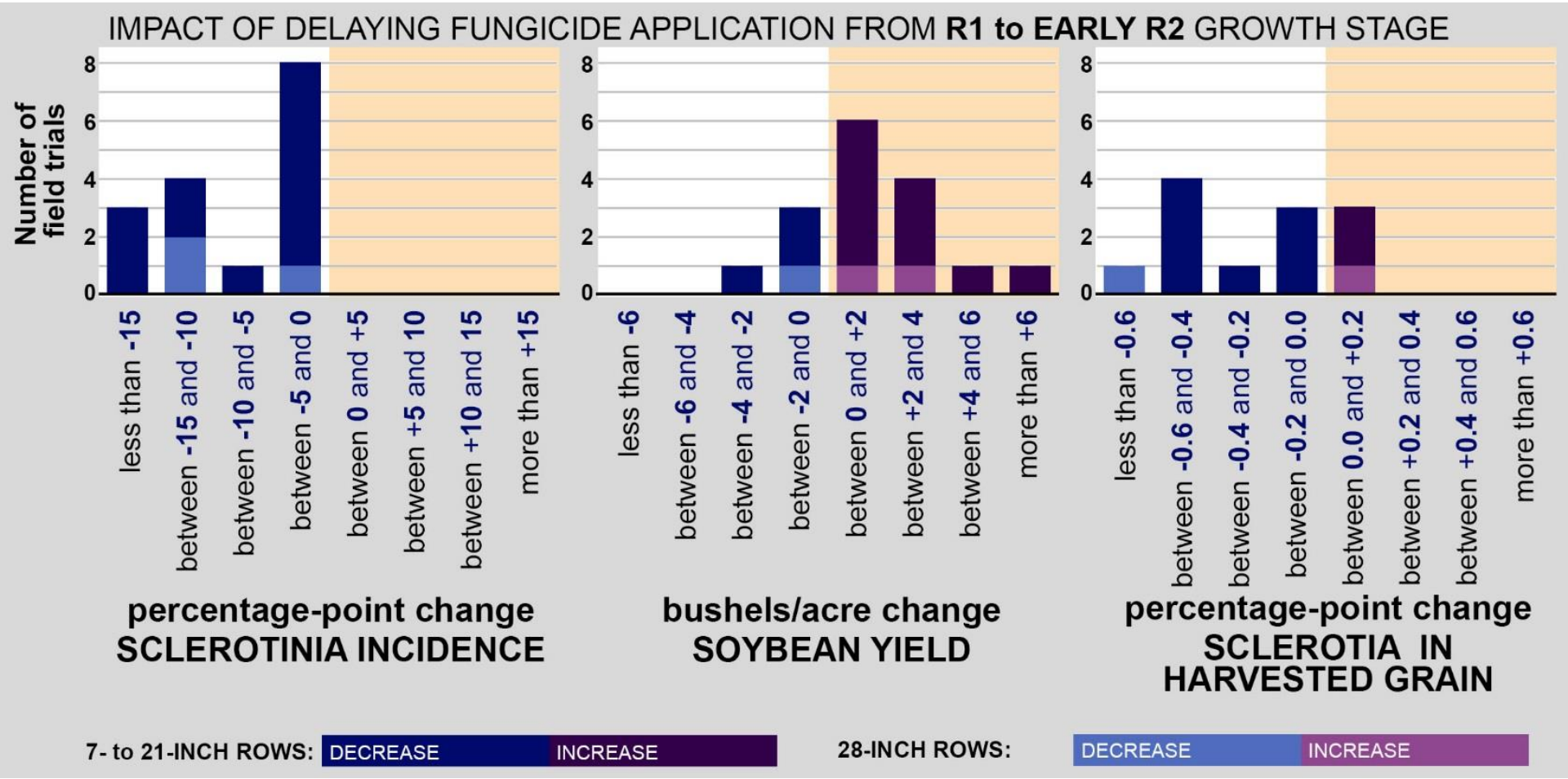

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Combined analysis across 11 field studies

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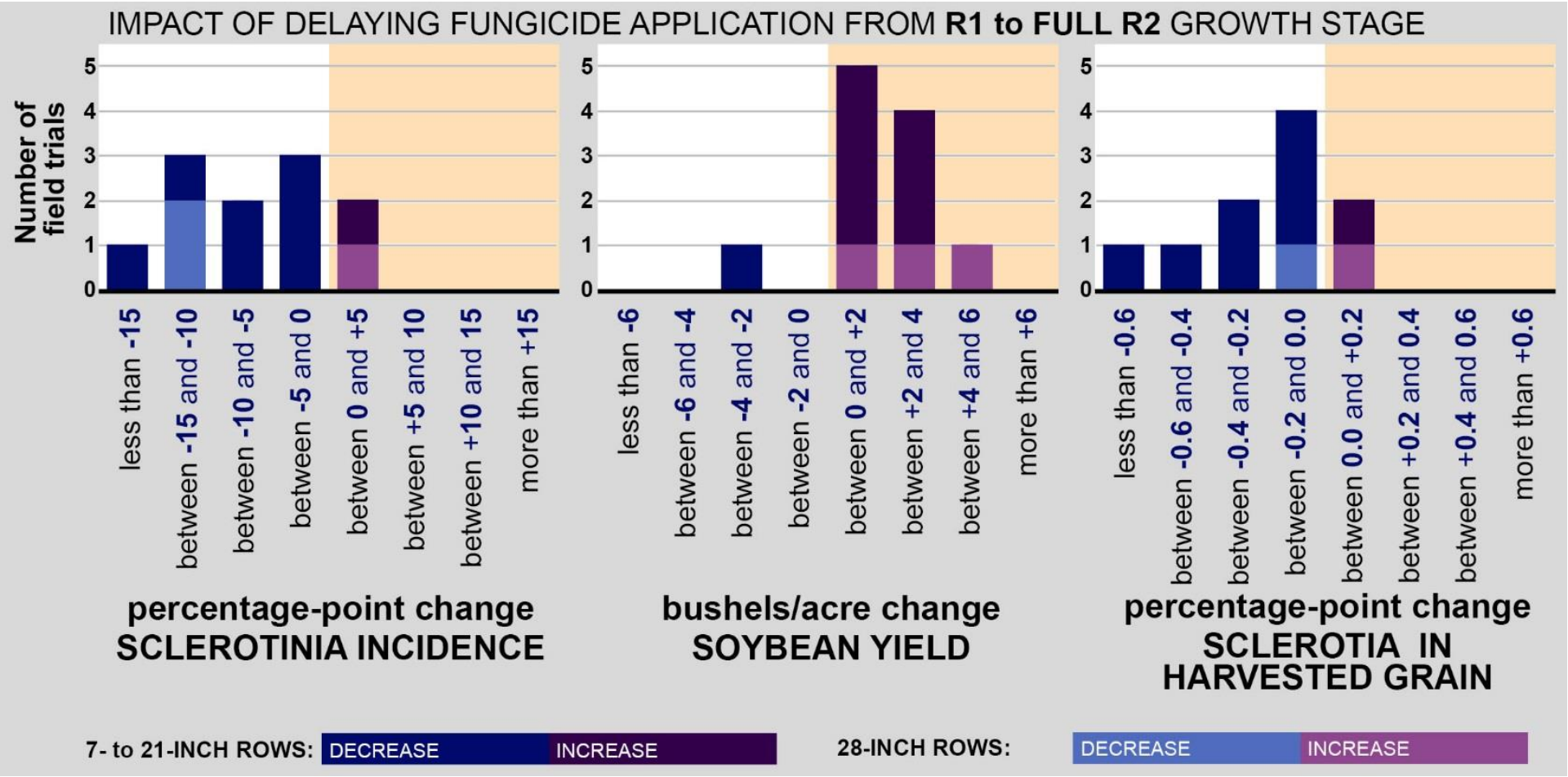

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Optimizing application timing

Soybeans:

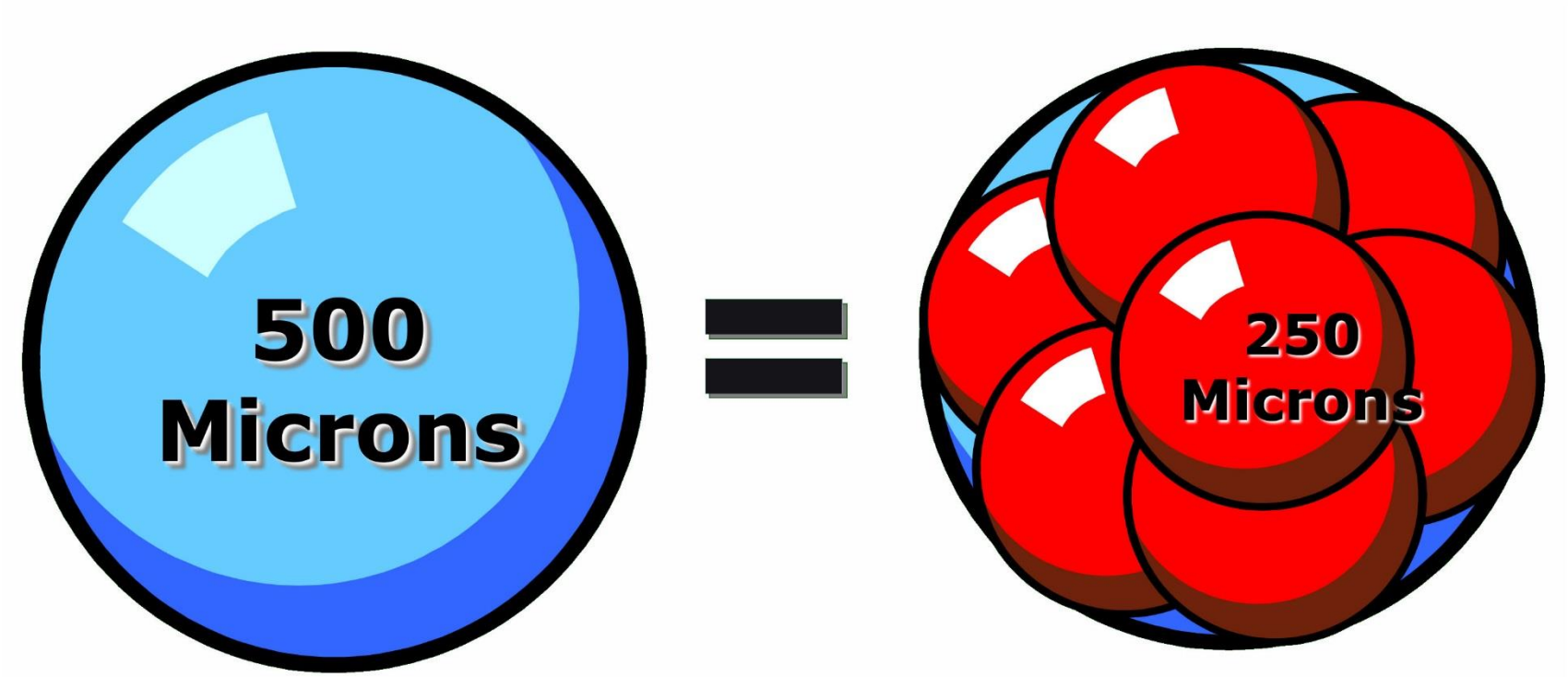
When conditions favored white mold as soybeans entered bloom, white mold control and soybean yield under white mold pressure were maximized when fungicides were applied at **early to full R2 growth stage (80 to 100% of plants at R2 growth stage).**

R2 growth stage:
at least one open blossom at one of the top two nodes of the plant.

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)

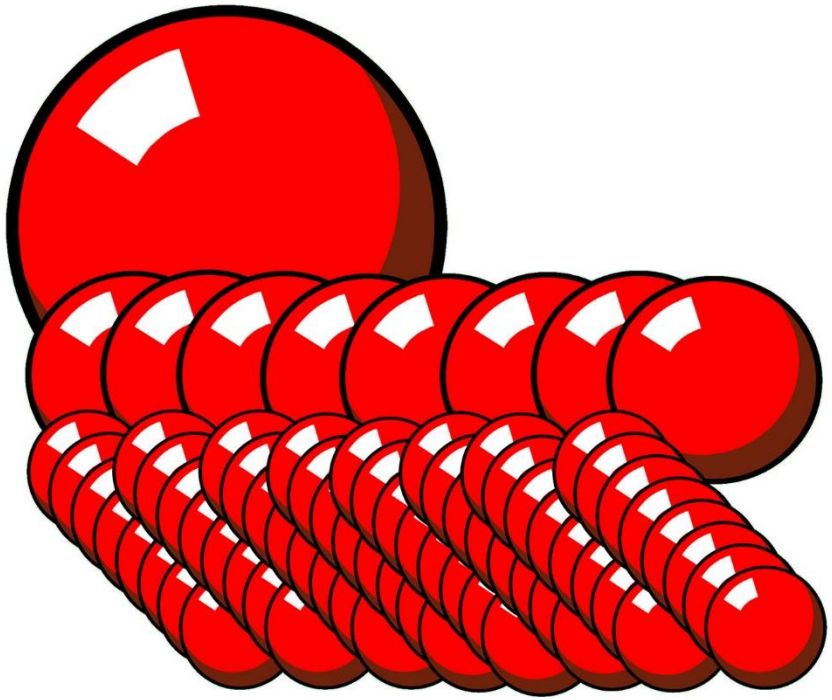
Spray droplet size

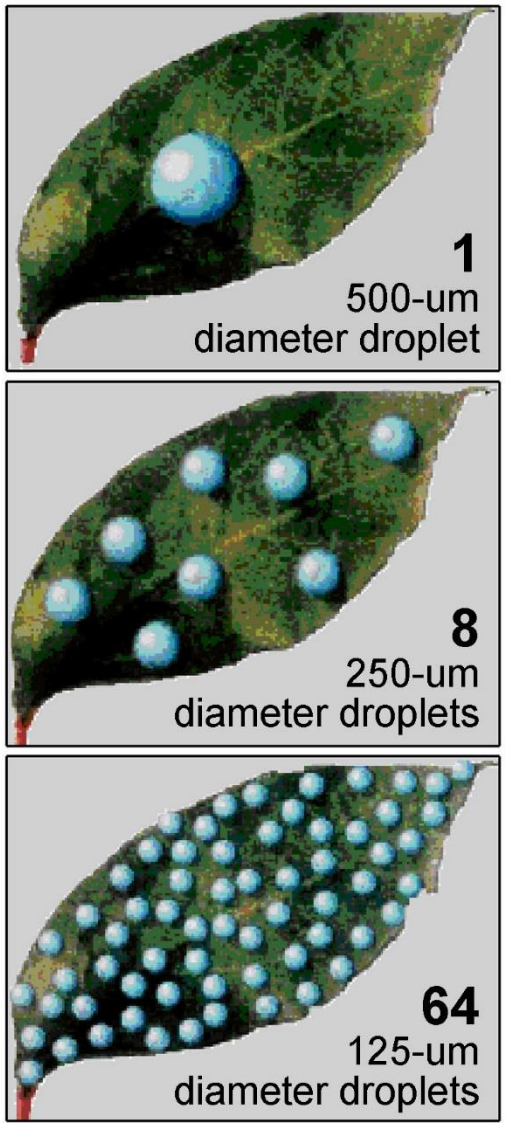
0.065 mm^3 spray volume =

one 500-um diameter droplet

eight 250-um diameter droplets

sixty-four 125-um diameter droplets





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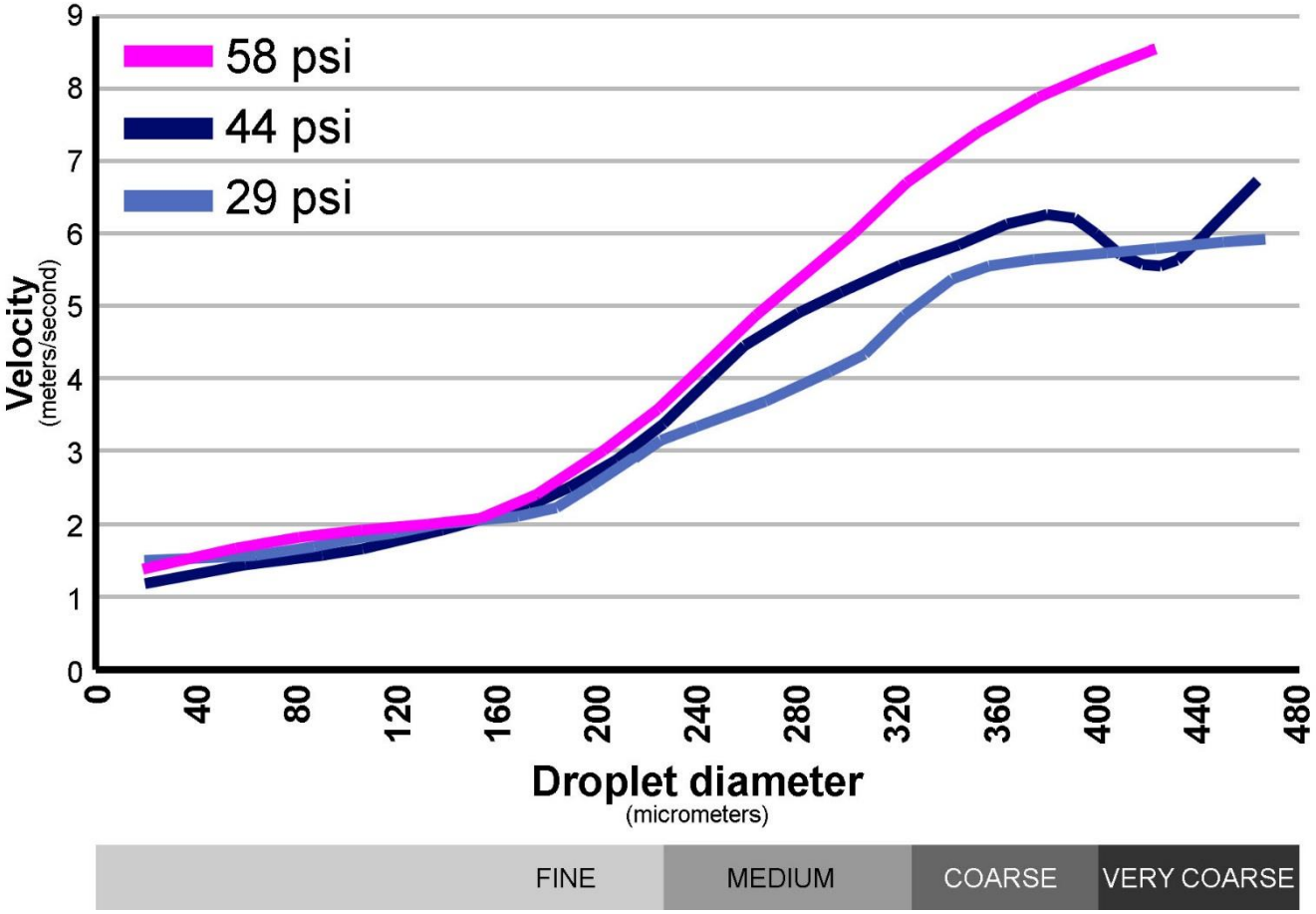
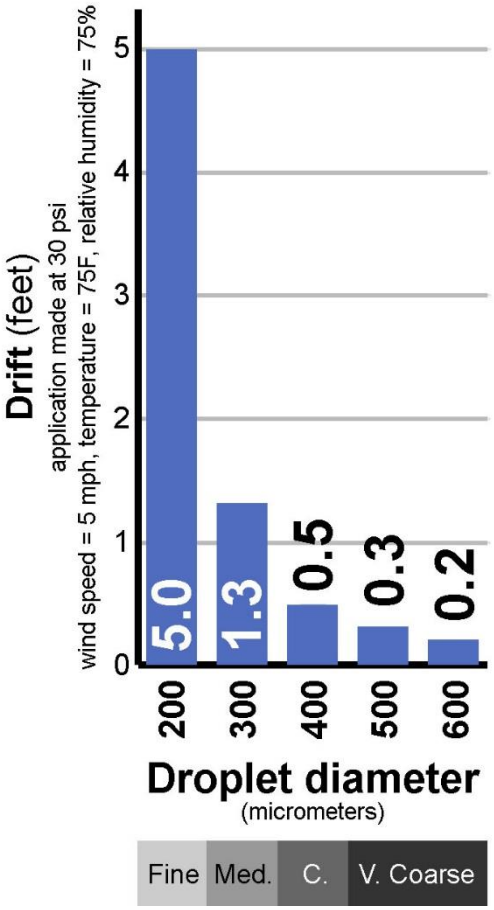
Spray droplet size

… but larger droplets have greater velocity, drift less.

Increased velocity and reduced drift improves canopy penetration.





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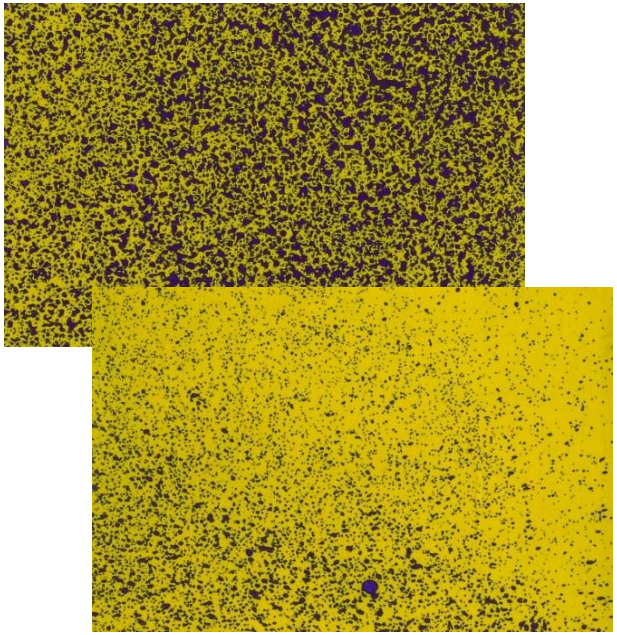
Experimental methods

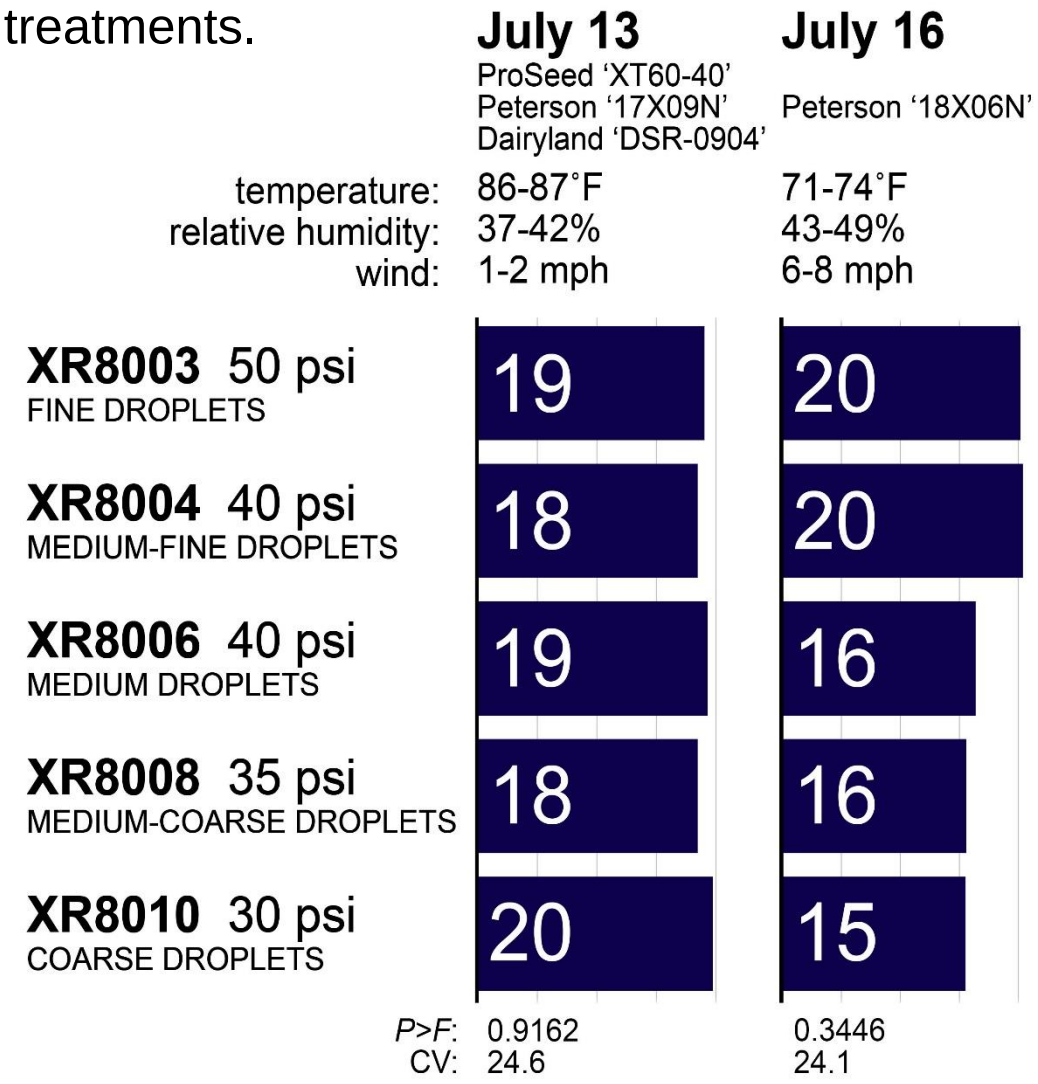
- **Spraying Systems TeeJet extended-range flat-fan nozzles**
- **Tractor-mounted sprayer**
- **Constant driving speed** (6.7 mph), **spray volume** (15 gal/ac)
- **Pulse-width modulation system** (Capstan AG)
- **Pulse width calibrated and confirmed** by quantifying spray nozzle output

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

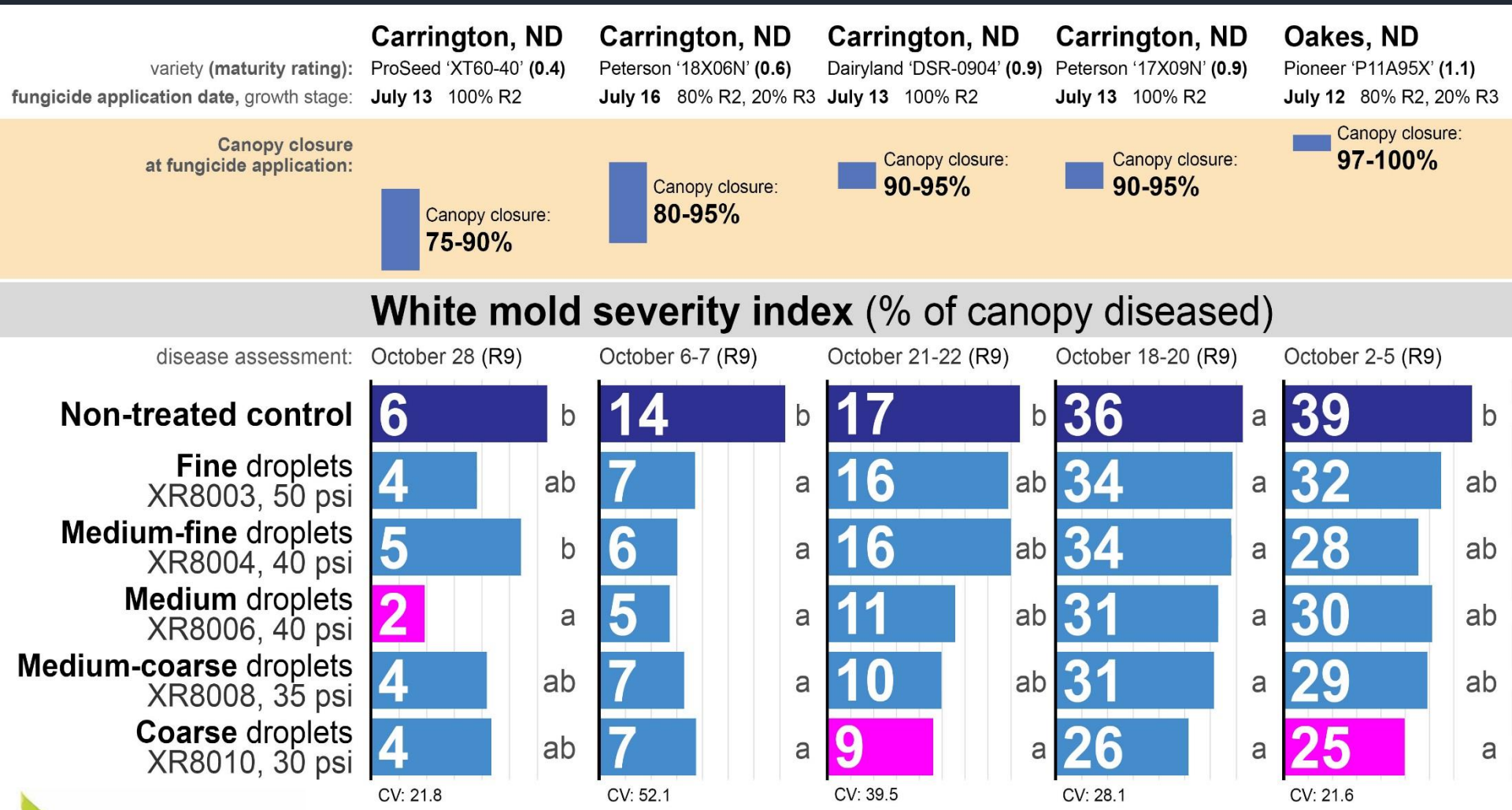
Experimental methods – parallel studies in soybeans

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





Impact of spray droplet size – SOYBEANS (2018)



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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)

	Carrington, ND	Carrington, ND	Carrington, ND	Carrington, ND	Oakes, ND
	bu/ac	bu/ac	bu/ac	bu/ac	bu/ac
Non-treated control	64 a	64 a	58 a	51 a	53 b
Fine droplets XR8003, 50 psi	67 a	66 a	58 a	54 a	59 ab
Medium-fine droplets XR8004, 40 psi	64 a	65 a	57 a	53 a	63 ab
Medium droplets XR8006, 40 psi	68 a	71 a	60 a	54 a	62 ab
Medium-coarse droplets XR8008, 35 psi	66 a	67 a	61 a	58 a	61 ab
Coarse droplets XR8010, 30 psi	66 a	67 a	61 a	59 a	66 a
	CV: 4.9	CV: 8.9	CV: 8.1	CV: 10.9	CV: 10.5

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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)

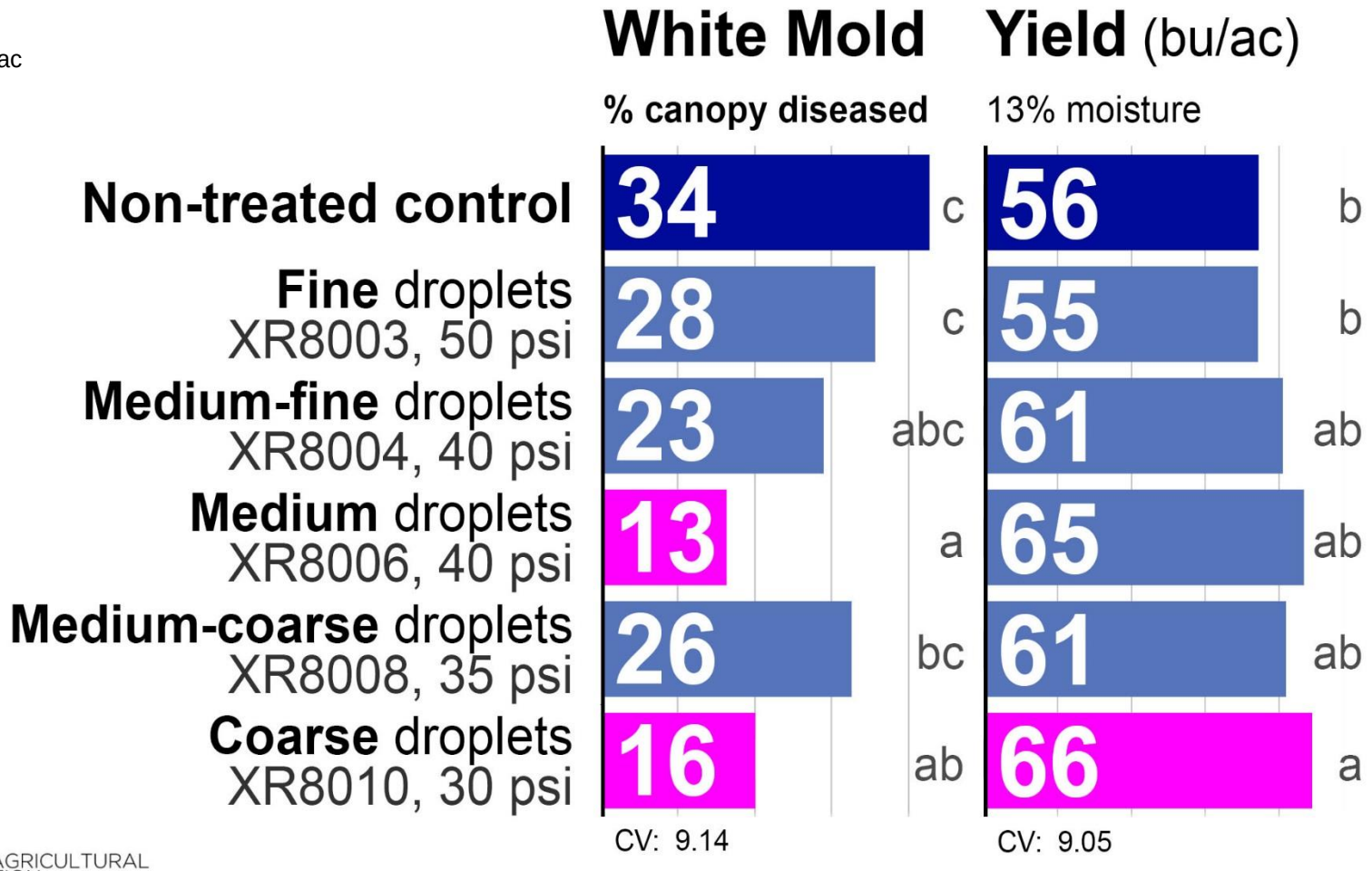
21-inch row spacing

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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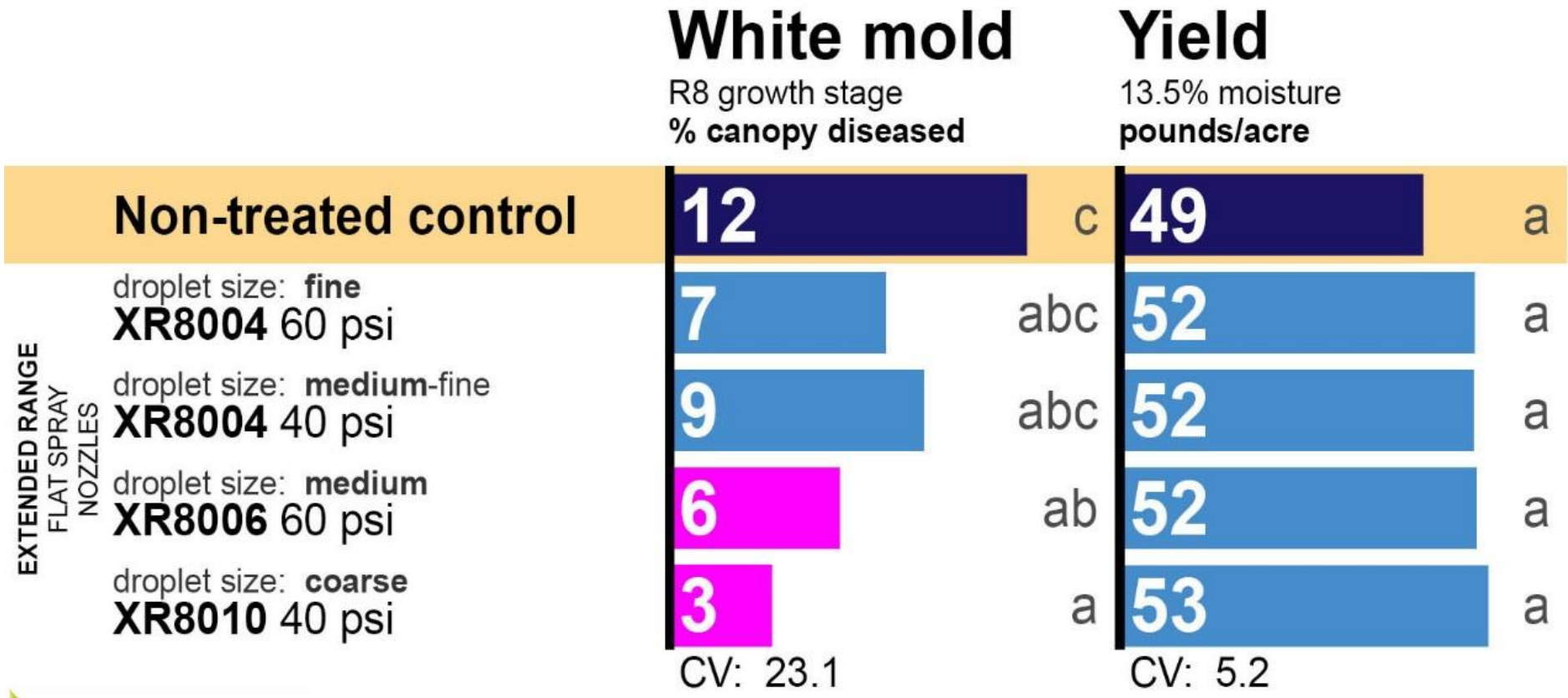
Impact of spray droplet size – SOYBEANS (2017)

Carrington, ND (2017)

Dairyland 'DSR-0619' soybean (0.6 maturity)

21-inch row spacing



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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**.

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 soybeans at R3 growth stage, July 27, 2018 (Carrington)

Drop nozzles kidney beans at full bloom, mid-pod, Aug. 1, 2018 (Carrington)

Drop nozzles kidney beans at full bloom, mid-pod, Aug. 1, 2018 (Carrington)

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

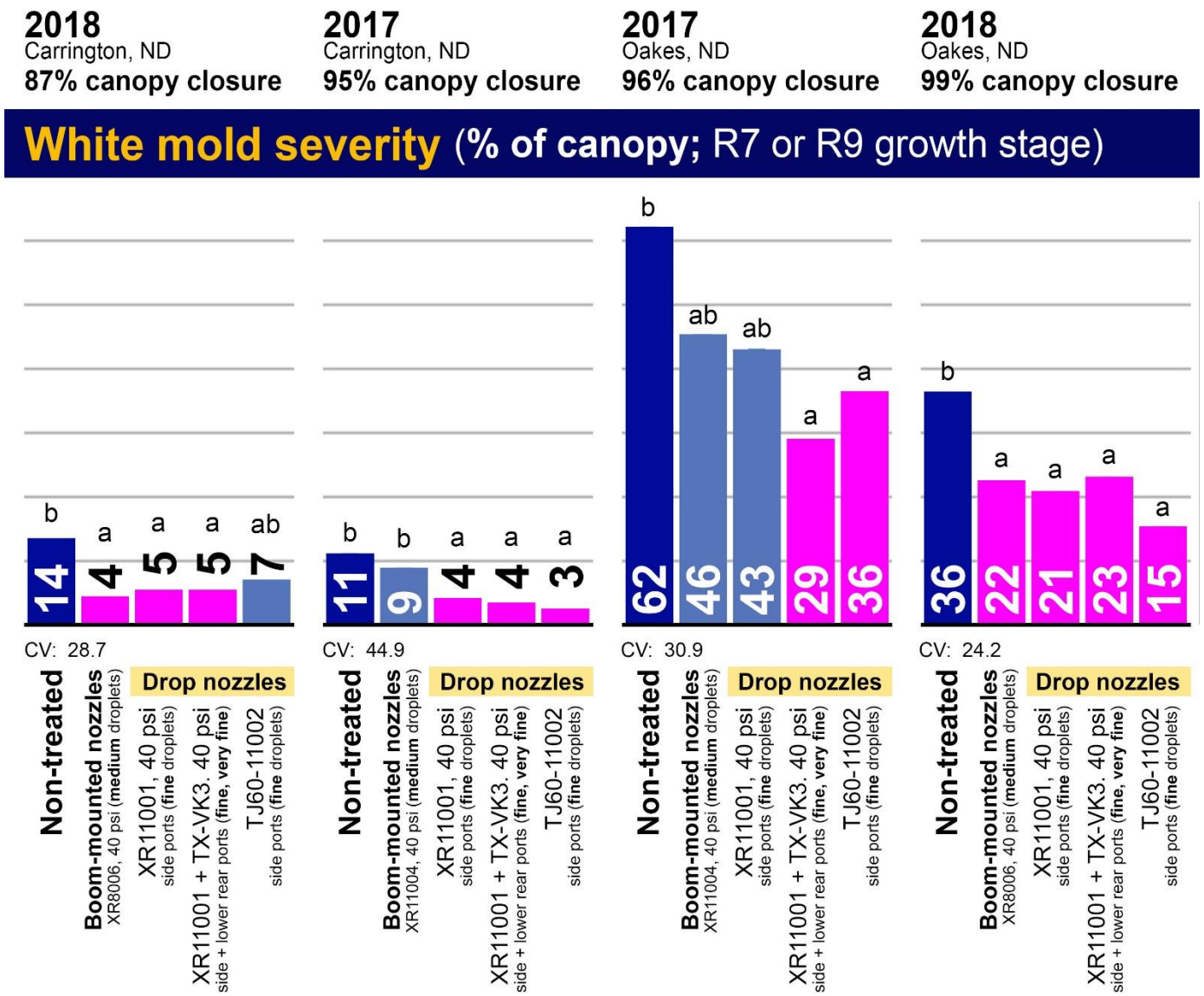
Spray volume: 15 gal/ac

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

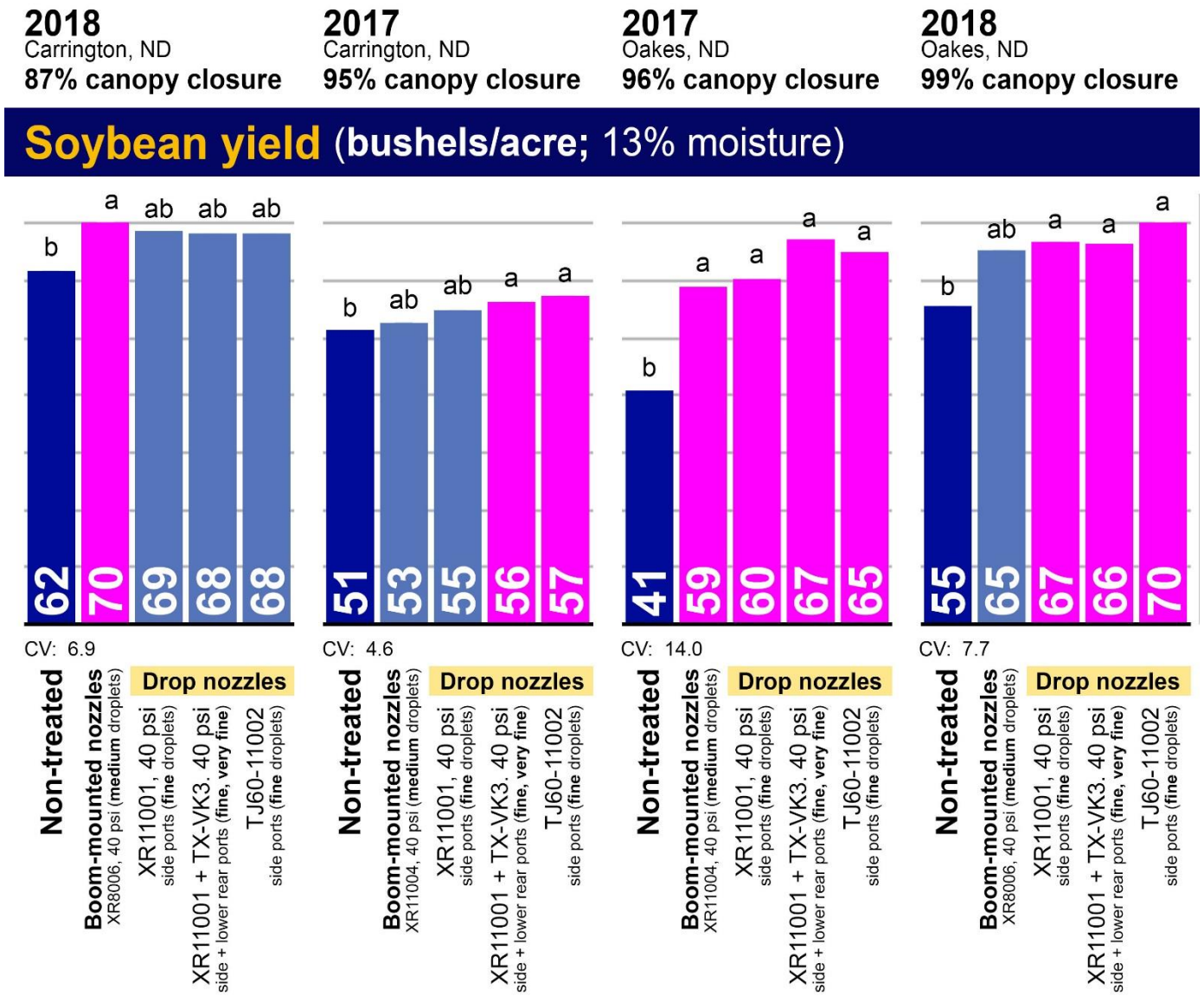
Spray volume: 15 gal/ac

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)

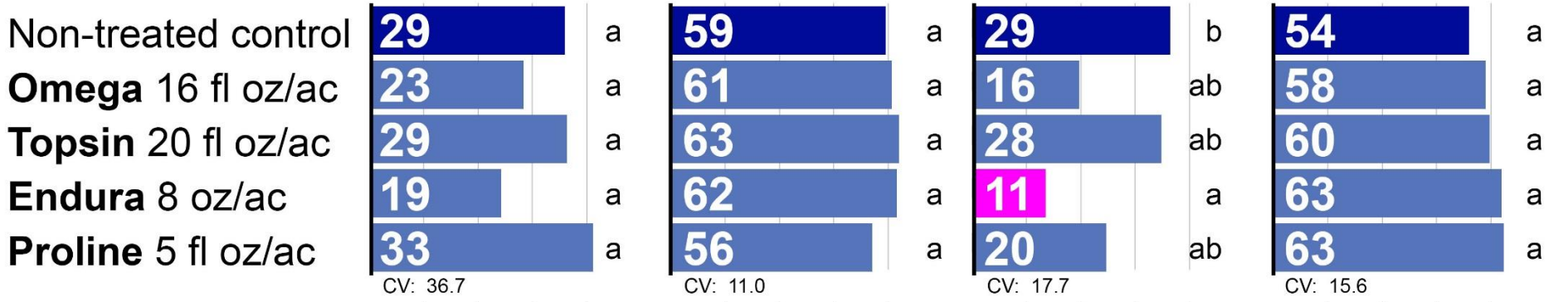
Peterson Farms '17X09N' (0.9 maturity)

Oakes, ND (2018)

Pioneer 'P11A95X' (1.1 maturity)

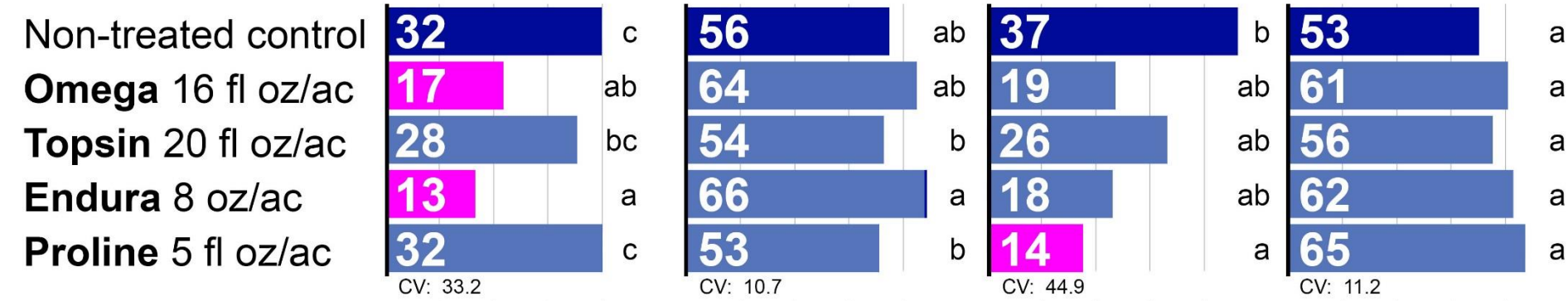
BOOM-MOUNTED NOZZLES: **One fungicide application** (R2 growth stage)

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

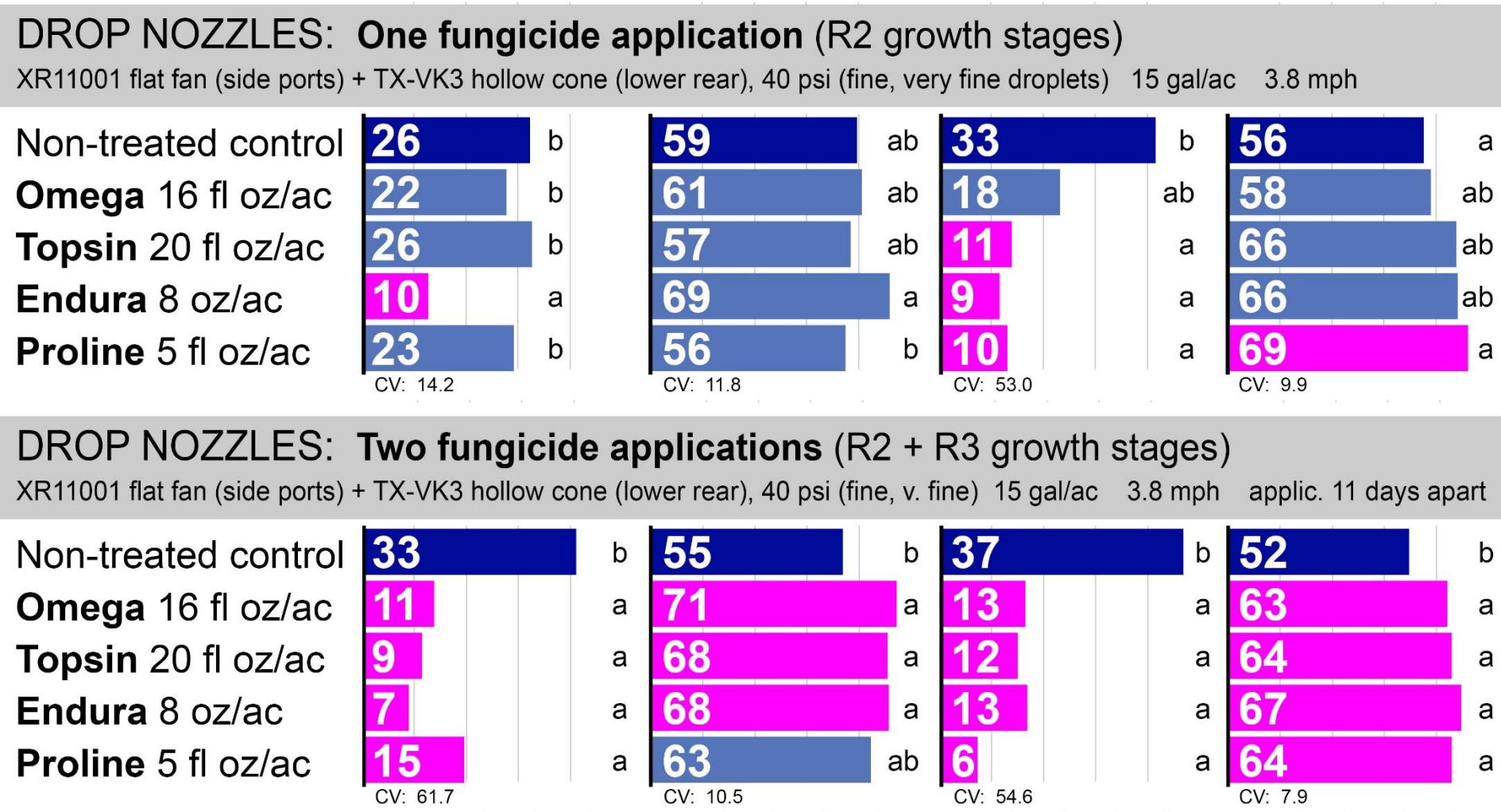
Soybean row spacing:
21 inches

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

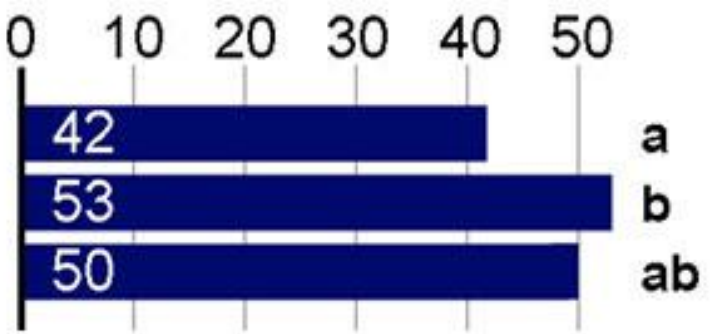
.

Impact of row spacing on soybean agronomic performance under white mold pressure

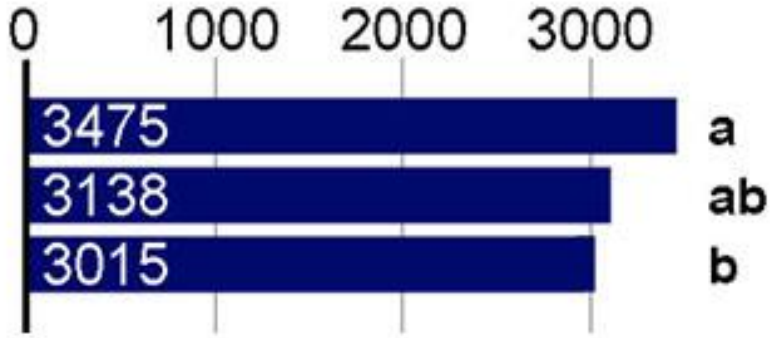
Ingham County, Michigan (1999-2000)

Even under high Sclerotinia disease pressure, wide row spacing does not always optimize soybean yields.

	Seeding Rate seeds/ac	Disease Severity Index 0 to 100
7.5-inch row	174,015	42 a
7.5-inch row	226,624	53 b
30-inch row	174,015	50 ab



	Seeding Rate seeds/ac	Yield pounds per acre
7.5-inch row	174,015	3475 a
7.5-inch row	226,624	3138 ab
30-inch row	174,015	3015 b

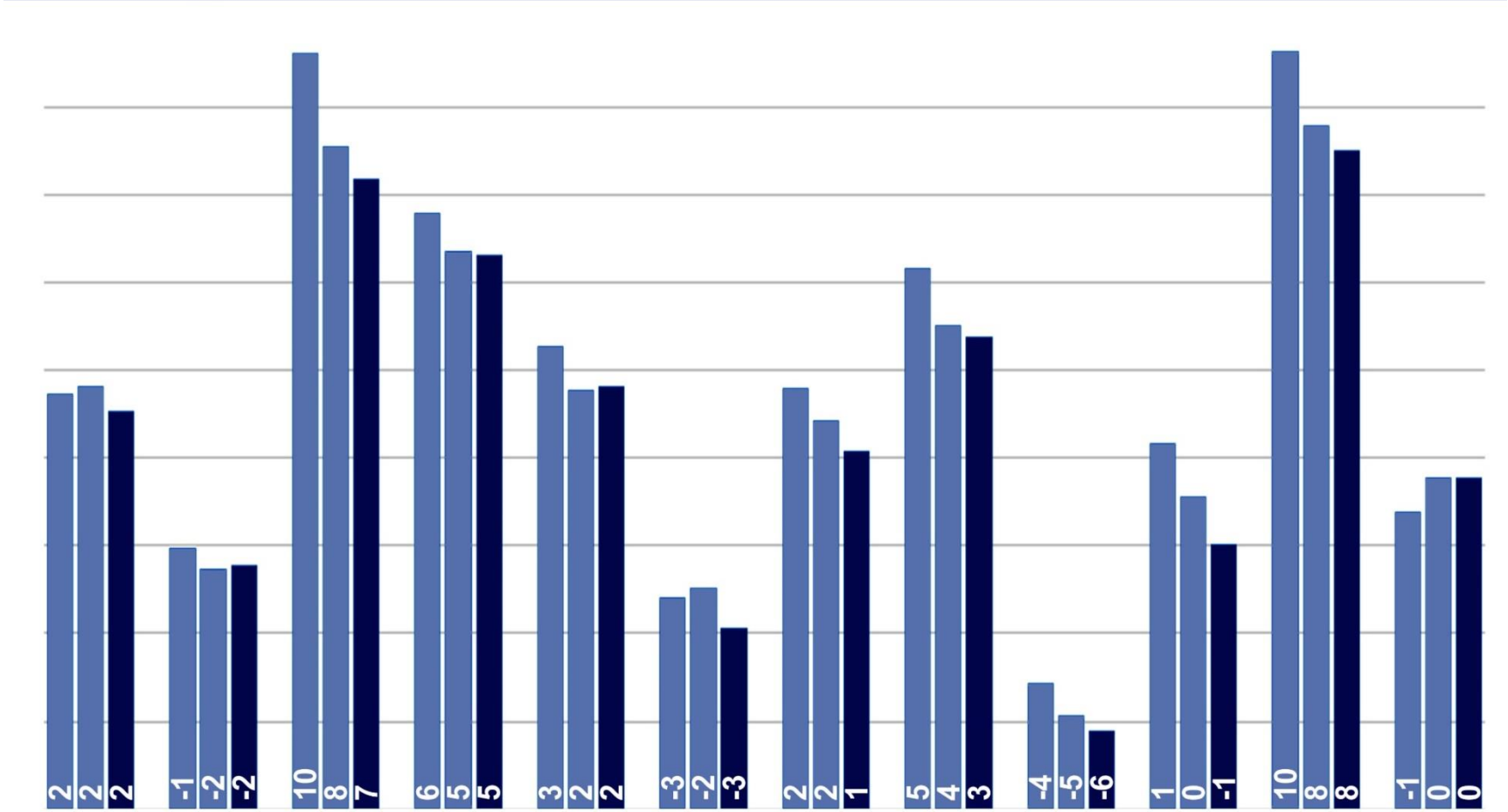


Lee et al. 2005. Weed Technology 19:580-588.

Impact of seeding rate on soybean agronomic performance under white mold pressure

Oakes, ND (2015-2017) Combined analysis across 7-, 14-, 21- and 28-inch row spacing

Canopy closure (days before or after bloom initiation - 90% of plants at R1)



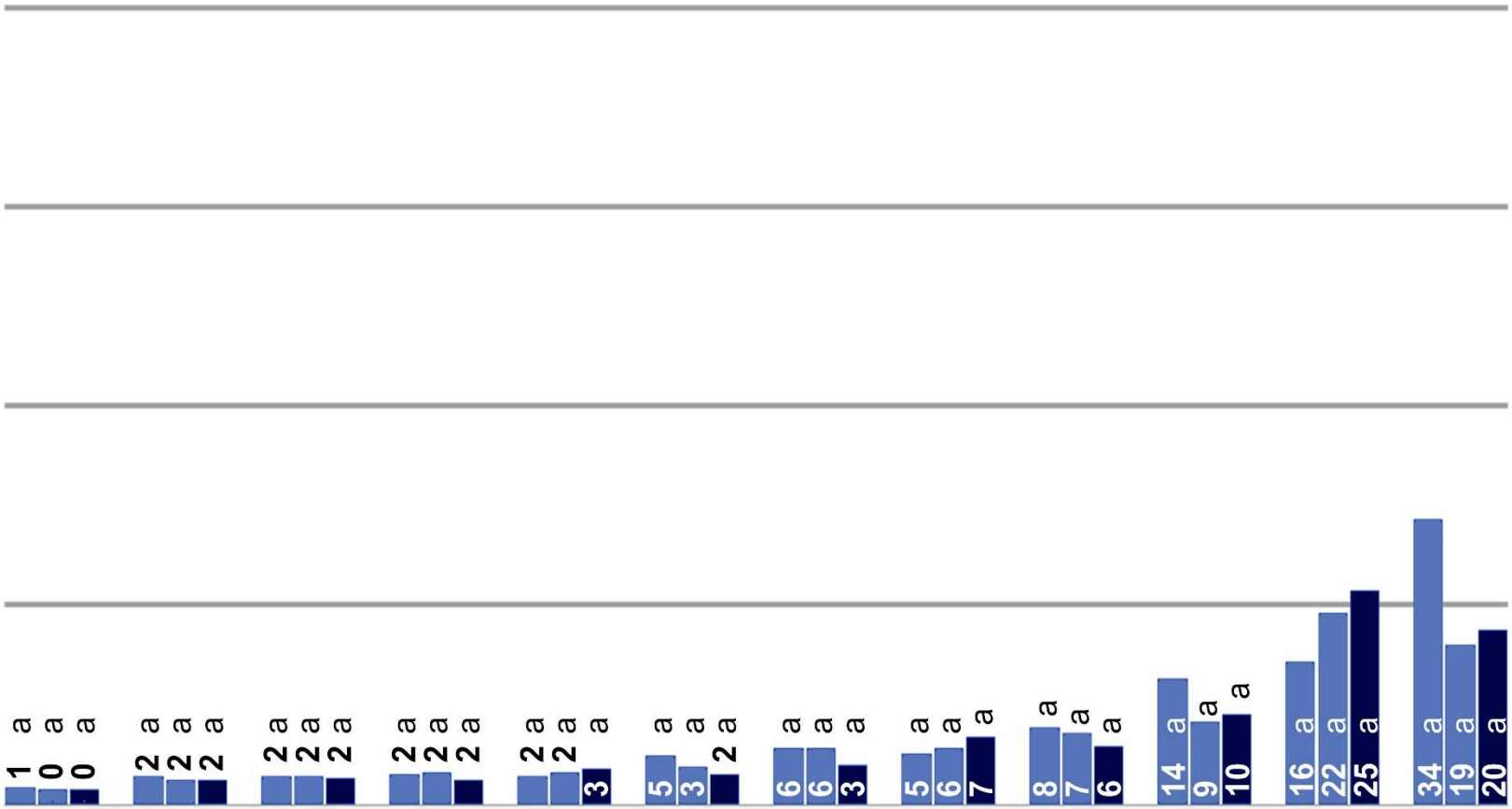
Seeding Rate (pure live seeds / acre)

132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000
Dairyland DSR-0711	Pioneer 90Y90	Dairyland DSR-0711	Dairyland DSR-0711	Dairyland DSR-0747	Dairyland DSR-0404	Dairyland DSR-0907	Pioneer P08T36R	Pioneer P07T50R	Pioneer P07T50R	Pioneer 90M80	Dairyland DSR-0988
maturity = 0.7	maturity = 0.9	maturity = 0.7	maturity = 0.7	maturity = 0.7	maturity = 0.4	maturity = 0.9	maturity = 0.8	maturity = 0.7	maturity = 0.7	maturity = 0.8	maturity = 0.9
2015	**2015**	**2016**	**2017**	**2015**	**2015**	**2017**	**2016**	**2015**	**2016**	**2016**	**2017**

Impact of seeding rate on soybean agronomic performance under white mold pressure

Oakes, ND (2015-2017) Combined analysis across 7-, 14-, 21- and 28-inch row spacing

White mold incidence (**% of plants;** R7 growth stage)



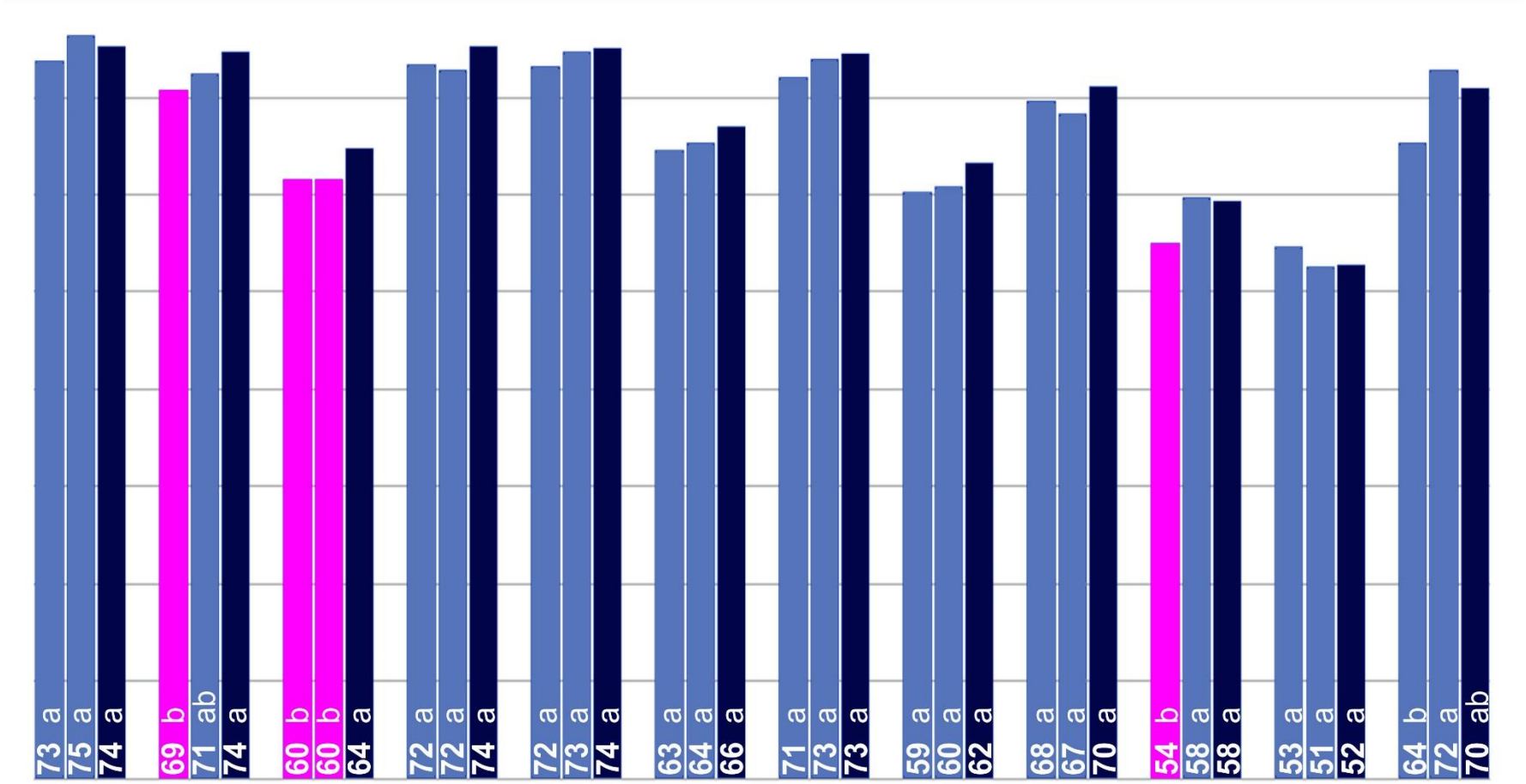
Seeding Rate (pure live seeds / acre)

132,000 165,000 198,000	Dairyland DSR-0711 maturity = 0.7 **2015**	Pioneer 90Y90 maturity = 0.9 **2015**	Dairyland DSR-0711 maturity = 0.7 **2016**	Dairyland DSR-0711 maturity = 0.7 **2017**	Dairyland DSR-0747 maturity = 0.7 **2015**	Dairyland DSR-0404 maturity = 0.4 **2015**	Dairyland DSR-0907 maturity = 0.9 **2017**	Pioneer P08T36R maturity = 0.8 **2016**	Pioneer P07T50R maturity = 0.7 **2015**	Pioneer P07T50R maturity = 0.7 **2016**	Pioneer 90M80 maturity = 0.8 **2016**	Dairyland DSR-0988 maturity = 0.9 **2017**
132,000	a 1	a 2	a 2	a 2	a 2	a 5	a 6	a 5	a 8	a 14	a 16	a 34
165,000	a 0	a 2	a 2	a 2	a 2	a 3	a 6	a 6	a 7	a 9	a 22	a 19
198,000	a 0	a 2	a 2	a 2	a 3	a 2	a 3	a 7	a 6	a 10	a 25	a 20

Impact of seeding rate on soybean agronomic performance under white mold pressure

Oakes, ND (2015-2017) Combined analysis across 7-, 14-, 21- and 28-inch row spacing

Soybean Yield (bushels/acre; 13% moisture)



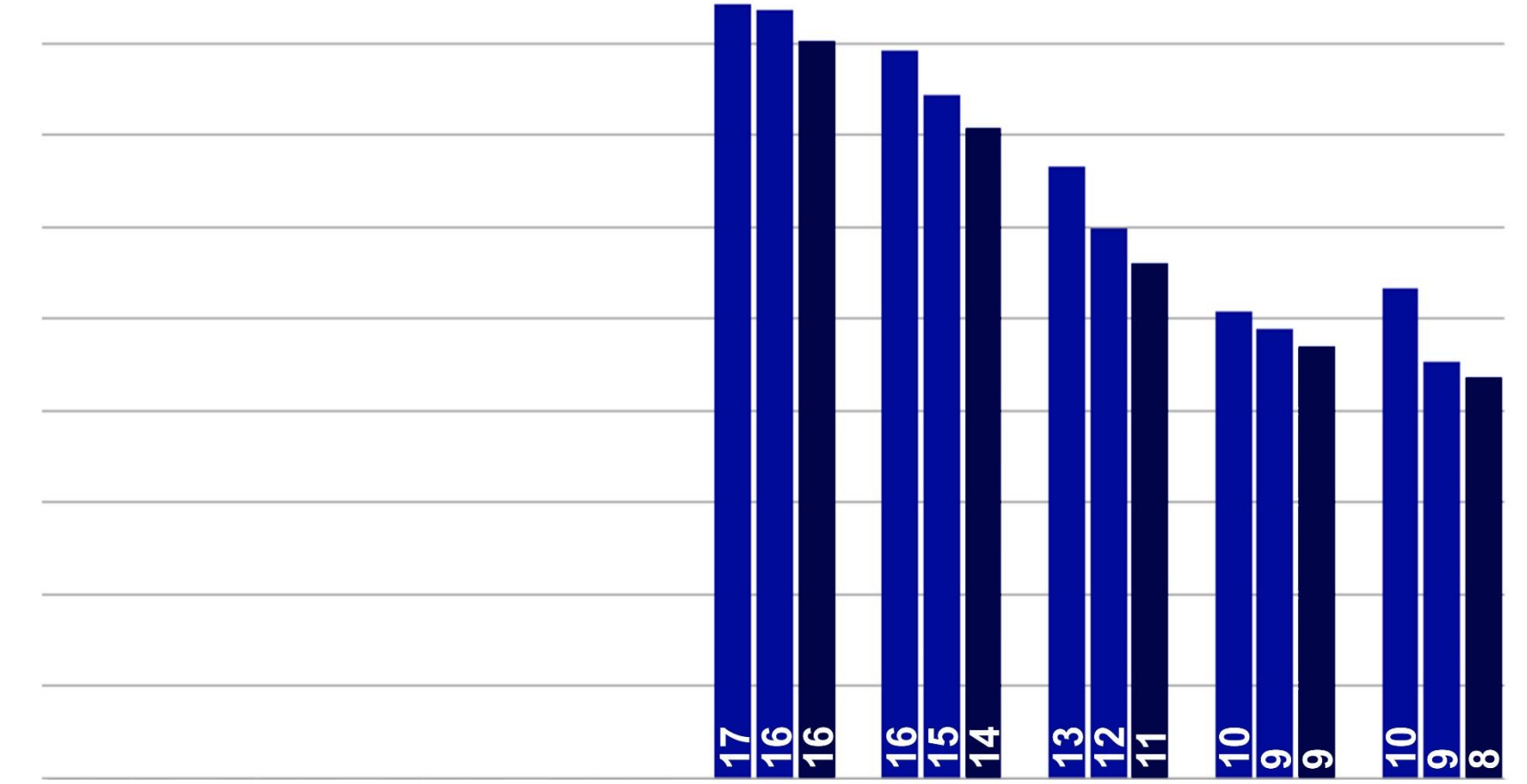
Seeding Rate (pure live seeds / acre)

132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000	132,000 165,000 198,000
Dairyland DSR-0711	Pioneer 90Y90	Dairyland DSR-0711	Dairyland DSR-0711	Dairyland DSR-0747	Dairyland DSR-0404	Dairyland DSR-0907	Pioneer P08T36R	Pioneer P07T50R	Pioneer P07T50R	Pioneer 90M80	Dairyland DSR-0988
maturity = 0.7	maturity = 0.9	maturity = 0.7	maturity = 0.7	maturity = 0.7	maturity = 0.4	maturity = 0.9	maturity = 0.8	maturity = 0.7	maturity = 0.7	maturity = 0.8	maturity = 0.9
2015	**2015**	**2016**	**2017**	**2015**	**2015**	**2017**	**2016**	**2015**	**2016**	**2016**	**2017**

Impact of seeding rate on soybean agronomic performance under white mold pressure

Carrington, ND (2015, 2017) Combined analysis across 7-, 14-, 21- and 28-inch row spacing

Canopy closure (days before or after bloom initiation - 90% of plants at R1)



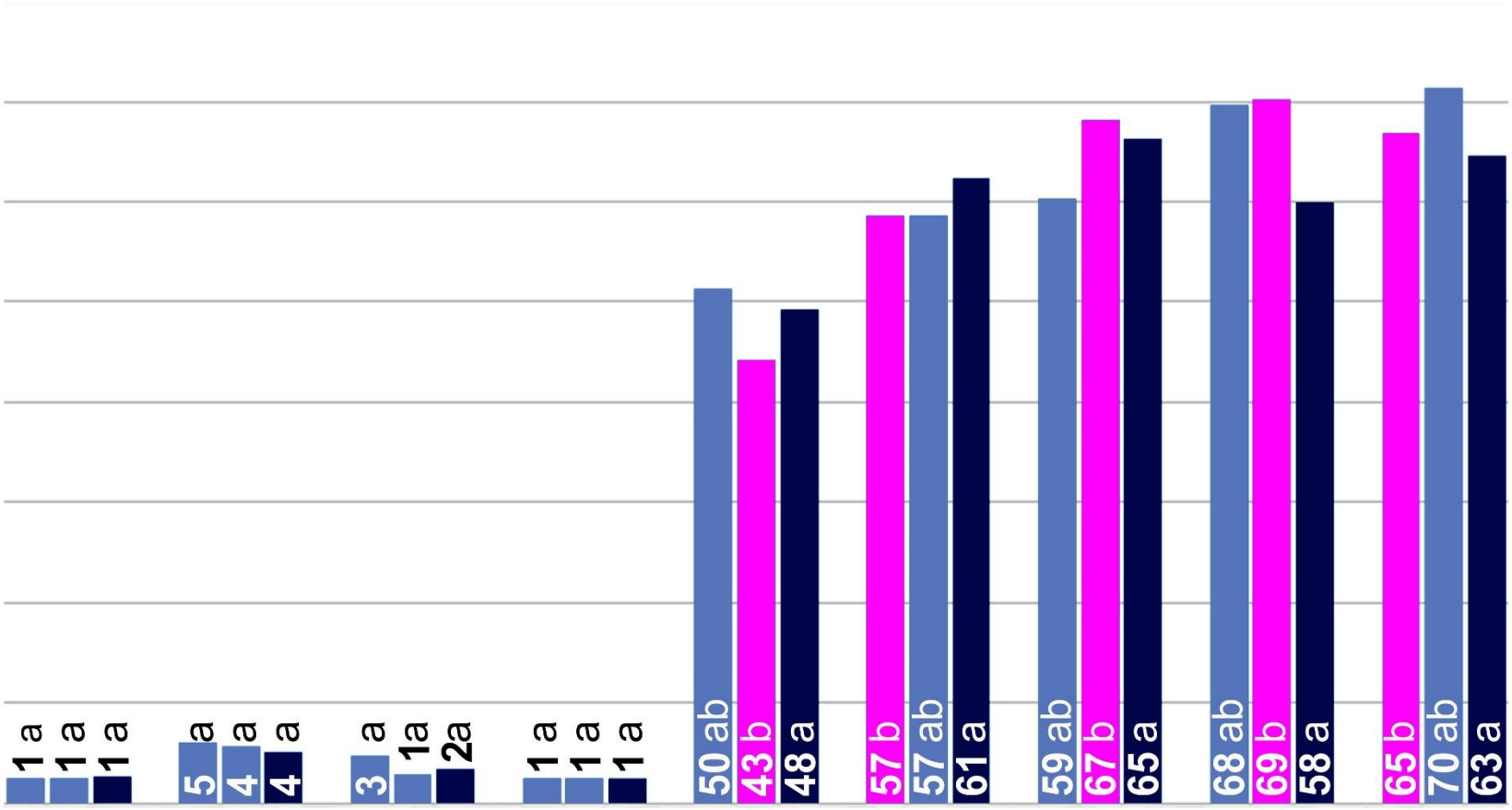
Seeding rate (pure live seeds / acre)

132,000	165,000	198,000
Pioneer P06T28R, maturity = 0.6, 2017		
Pioneer P08T96R, maturity = 0.8, 2017		
Pioneer P05T24R, maturity = 0.5, 2017		
Pioneer P08T59R, maturity = 0.8, 2017		
Pioneer P06T28R, maturity = 0.6, 2015		
Pioneer 90Y50, maturity = 0.5, 2015		
ProSeed 20-70, maturity = 0.7, 2015		
Mycogen 5B066, maturity = 0.6, 2015		
Mycogen 5B080, maturity = 0.8, 2015		

Impact of seeding rate on soybean agronomic performance under white mold pressure

Carrington, ND (2015, 2017) Combined analysis across 7-, 14-, 21- and 28-inch row spacing

White mold incidence (% of plants; R7 growth stage)



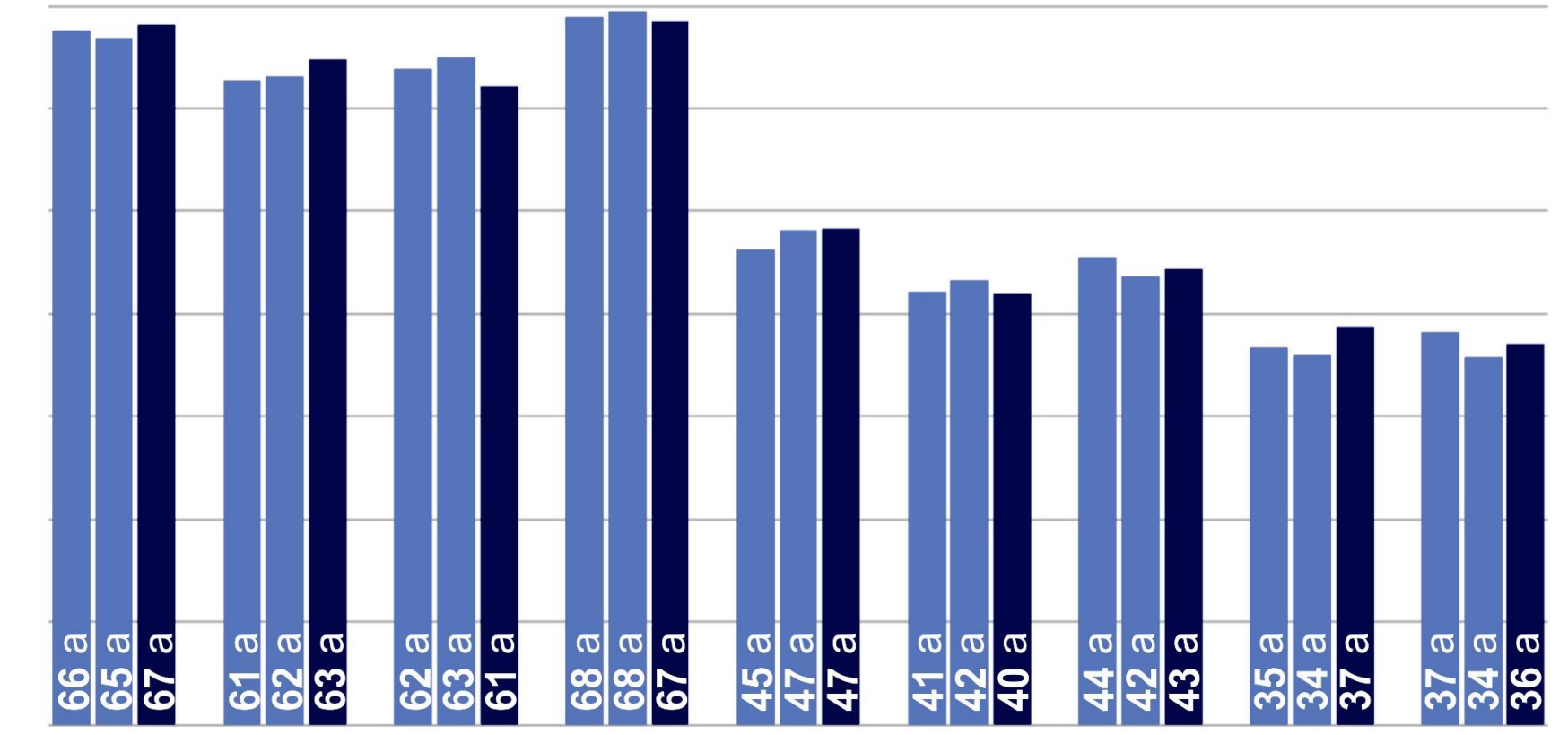
Seeding rate (pure live seeds / acre)

132,000	165,000	198,000	Variety	Maturity	Year
1 a	1 a	1 a	Pioneer P06T28R	maturity = 0.6	2017
5 a	4 a	4 a	Pioneer P08T96R	maturity = 0.8	2017
3 a	1a	2a	Pioneer P05T24R	maturity = 0.5	2017
1 a	1 a	1 a	Pioneer P08T59R	maturity = 0.8	2017
50 ab	43 b	48 a	Pioneer P06T28R	maturity = 0.6	2015
57 b	57 ab	61 a	Pioneer 90Y50	maturity = 0.5	2015
59 ab	67 b	65 a	ProSeed 20-70	maturity = 0.7	2015
68 ab	69 b	58 a	Mycogen 5B066	maturity = 0.6	2015
65 b	70 ab	63 a	Mycogen 5B080	maturity = 0.8	2015

Impact of seeding rate on soybean agronomic performance under white mold pressure

Carrington, ND (2015, 2017) Combined analysis across 7-, 14-, 21- and 28-inch row spacing

Soybean Yield (bushels/acre; 13% moisture)



Seeding rate (pure live seeds / acre)

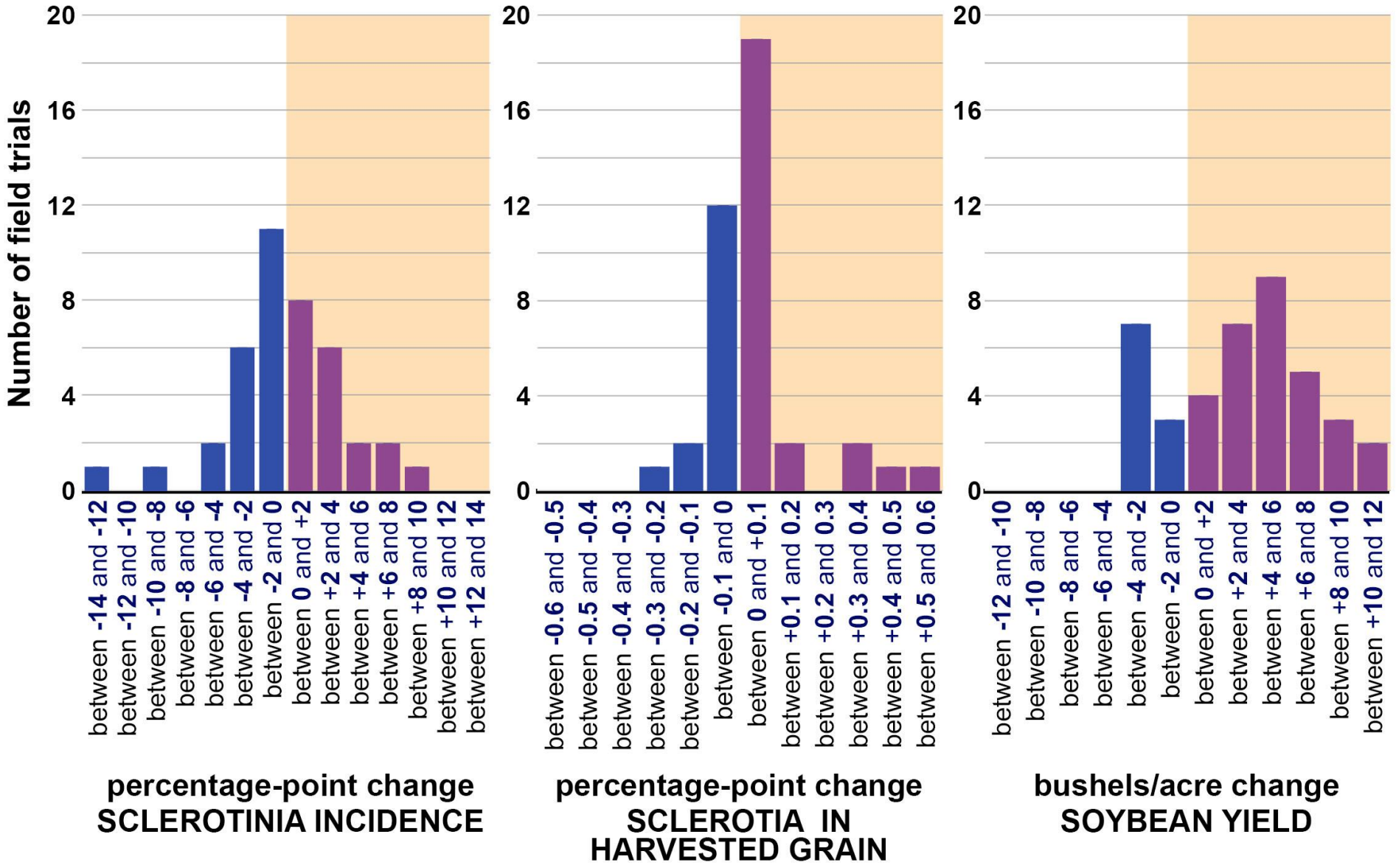
132,000 / 165,000 / 198,000	Pioneer P06T28R	Pioneer P08T96R	Pioneer P05T24R	Pioneer P08T59R	Pioneer P06T28R	Pioneer 90Y50	ProSeed 20-70	Mycogen 5B066	Mycogen 5B080
	maturity = 0.6	maturity = 0.8	maturity = 0.5	maturity = 0.8	maturity = 0.6	maturity = 0.5	maturity = 0.7	maturity = 0.6	maturity = 0.8
	2017	**2017**	**2017**	**2017**	**2015**	**2015**	**2015**	**2015**	**2015**

Impact of increasing seeding rate:

132,000 to 198,000 pure live seeds/ac

Soybean maturity: 00 and 0 **Locations:** Carrington, Hofflund, Langdon, and Oakes, ND **Years:** 2015-2017

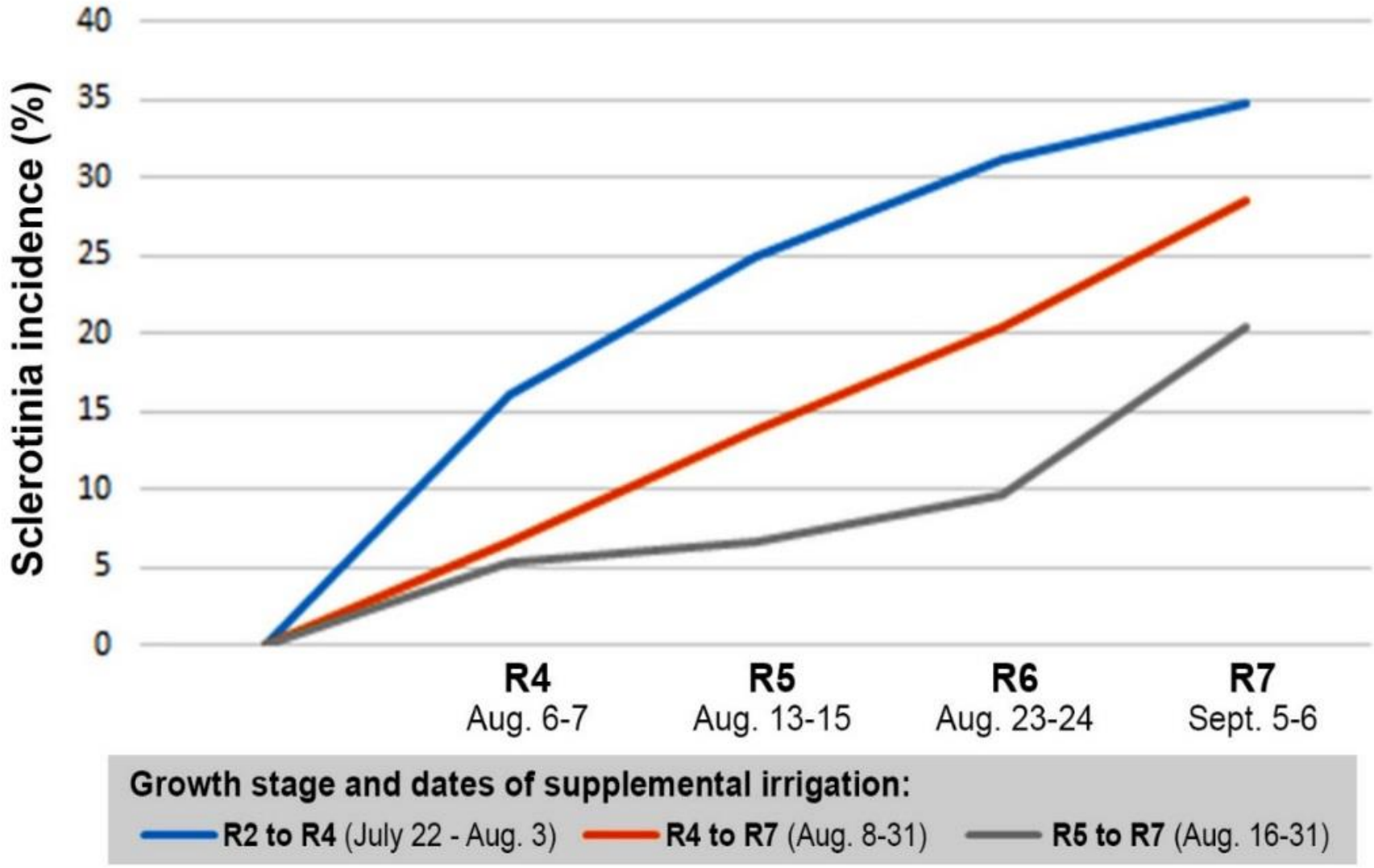
Combined analysis across four row spacings (7, 14, 21 and 28 inches or 7.5, 15, 22.5 and 30 inches)



Impact of increasing seeding rate:

132,000, 165,000 vs. 198,000 pure live seeds/ac

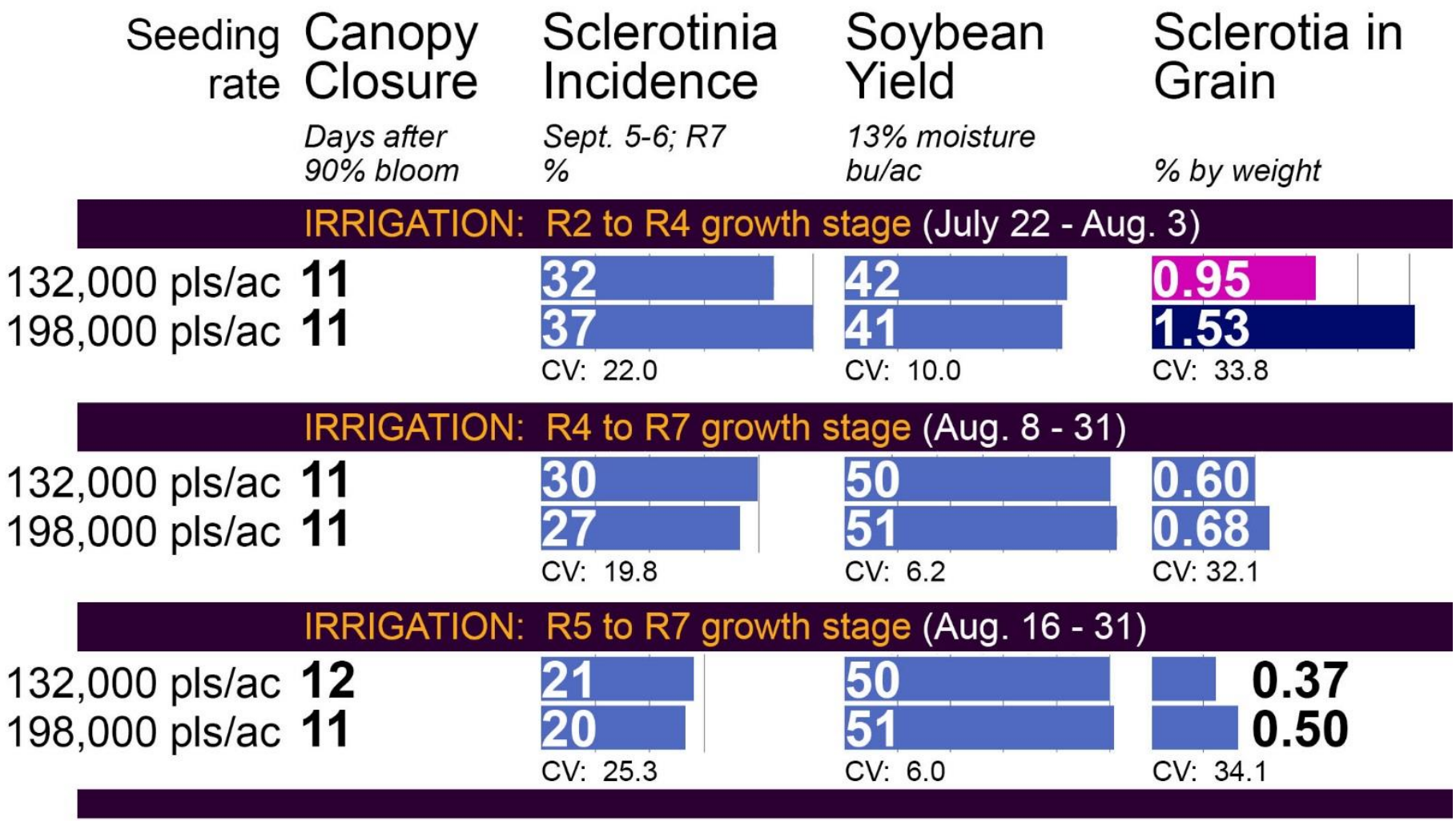
Soybean maturity: 0.3 **Location:** Carrington, ND **Year:** 2015
Combined analysis across four row spacings (7, 14, 21 and 28 inches)



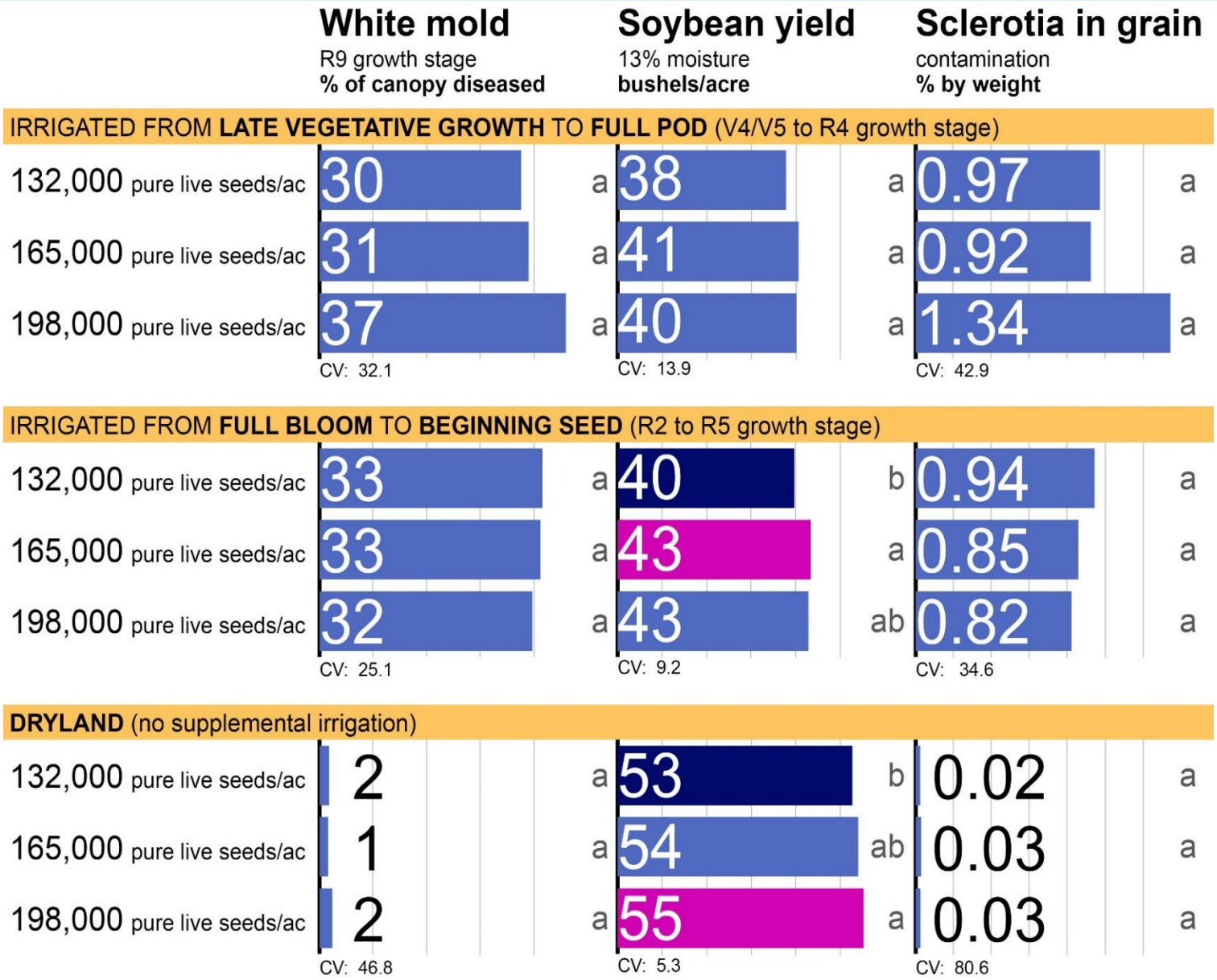
Impact of increasing seeding rate:

132,000, 165,000 vs. 198,000 pure live seeds/ac

Soybean maturity: 0.3 **Location:** Carrington, ND **Year:** 2015
Combined analysis across four row spacings (7, 14, 21 and 28 inches)



Impact of increasing seeding rate:
132,000, 165,000 vs. 198,000 pure live seeds/ac



Soybean maturity:
0.7

Location:
Carrington, ND

Year: 2017

Combined analysis across four row spacings:
7, 14, 21, 28 in.

Optimizing planting rate

Impact of seeding rate on white mold:

- Within the range of seeding rates evaluated in this study (132,000 to 198,000 pure live seeds/ac), **seeding rate generally had little or no effect on white mold.**

- *Possible exception:* Higher seeding rates were associated with a modest increase in white mold when conditions favored disease at canopy closure.

- Different results may obtained from seeding rates outside of the range tested in this study.

Thank You!

Research funding:
North Dakota Soybean Council
USDA National Sclerotinia Initiative

North Dakota Soybean Council
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