



Improving management of white mold in soybeans: 1. Optimizing fungicide application timing

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RESEARCH FUNDED BY THE NORTH DAKOTA SOYBEAN COUNCIL

FUNGICIDE APPLICATION TIMING – Single fungicide application

1. Soybean canopy closed at mid/late R1 (60-85% of plants at R1)

Fungicide applied: Endura at 5.5 or 8.0 oz/ac

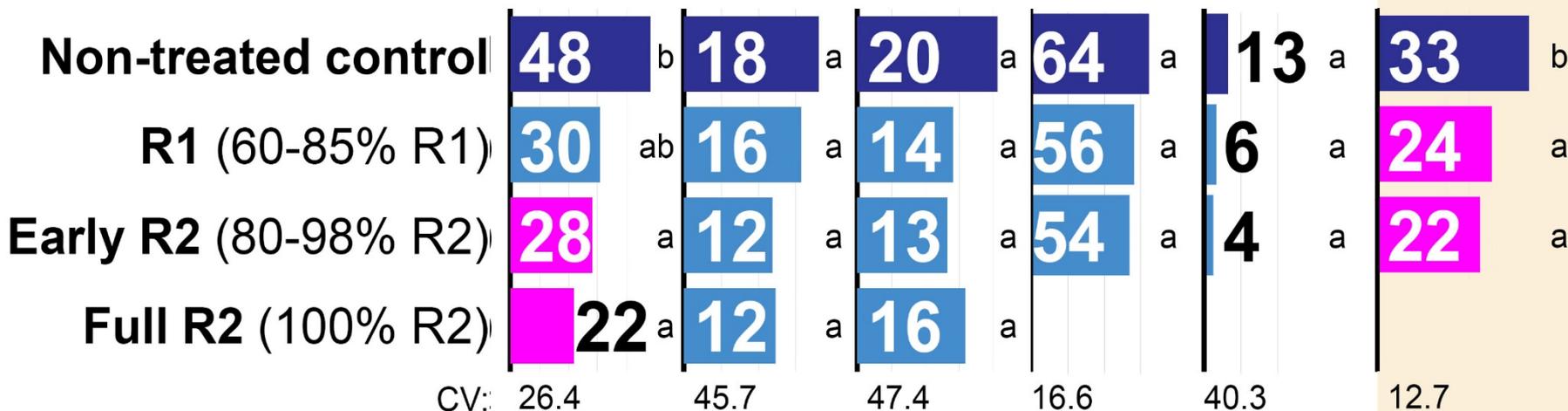
When the canopy was closed at mid/late R1, delaying fungicide applications from R1 to early R2 conferred moderate reductions in white mold.

study location	Carrington	Carrington	Carrington	Oakes	Hofflund	Combined analysis
YEAR	2015	2015	2015	2014	2014	five studies
row spacing	14 inches	14 inches	14 inches	14 inches	7.5 inches	5.5 or 8.0 oz/ac
Endura application rate	5.5 oz/ac	5.5 oz/ac	5.5 oz/ac	8.0 oz/ac	8.0 oz/ac	

CANOPY CLOSURE when fungicides were applied



White mold incidence (% of plants diseased)



Nozzles: XR8001 or XR80015 flat-fan TeeJet nozzles, 35 or 40 psi (droplet size = fine)

Spray volume: 15 or 17.5 gal/ac

FUNGICIDE APPLICATION TIMING – Single fungicide application

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Fungicide applied: Endura at 5.5 or 8.0 oz/ac

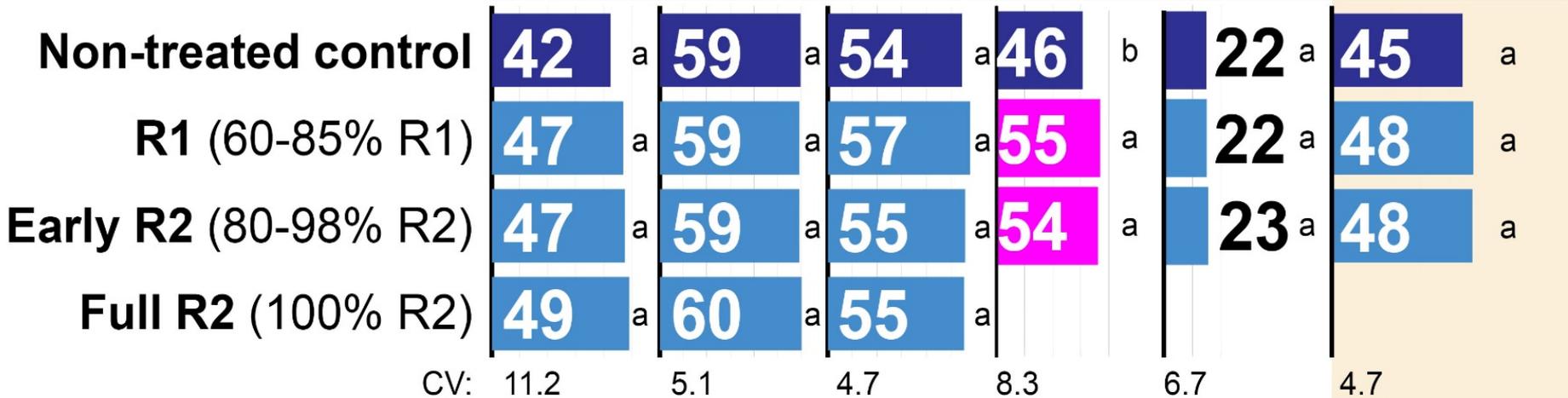
When the canopy was closed at mid/late R1, applying fungicides at mid/late R1 versus early R2 conferred similar yield responses

study location	Carrington	Carrington	Carrington	Oakes	Hofflund	Combined analysis
YEAR	2015	2015	2015	2014	2014	five studies
row spacing	14 inches	14 inches	14 inches	14 inches	7.5 inches	5.5 or 8.0 oz/ac
Endura application rate	5.5 oz/ac	5.5 oz/ac	5.5 oz/ac	8.0 oz/ac	8.0 oz/ac	

CANOPY CLOSURE when fungicides were applied



Soybean Yield (bu/ac; 13% moisture)



Nozzles: XR8001 or XR80015 flat-fan TeeJet nozzles, 35 or 40 psi (droplet size = fine)

Spray volume: 15 or 17.5 gal/ac

FUNGICIDE APPLICATION TIMING – Single fungicide application

2. Soybean canopy at/near closure at early R2 (80-99% of plants at R2)

Fungicide applied: Endura at 5.5 or 8.0 oz/ac

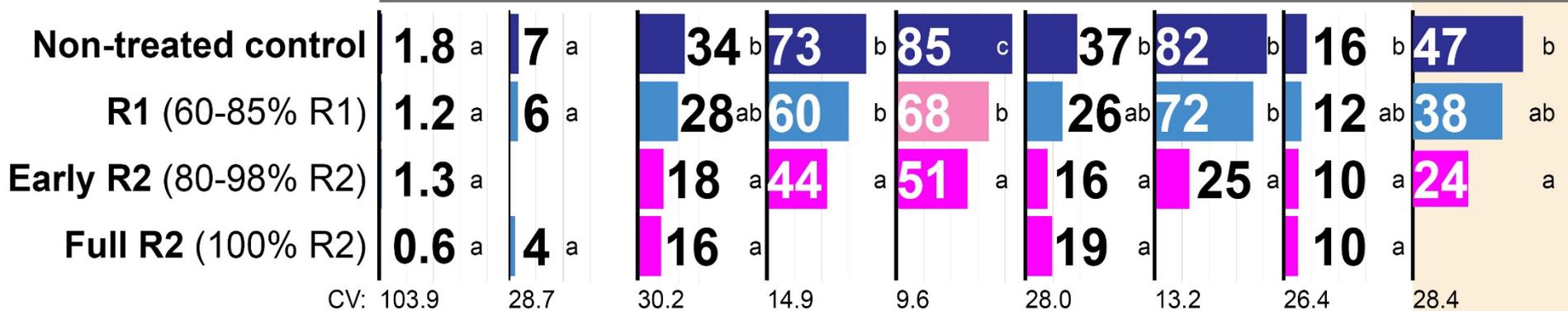
When the canopy was open at late R1 and at/near closure at early R2, delaying fungicide applications from mid/late R1 to early R2 improved white mold control.

study location	Oakes	Oakes	Carrington	Carrington	Carrington	Carrington	Langdon	Langdon	Combined analysis
YEAR	2015	2016	2015	2014	2014	2015	2014	2016	seven studies
row spacing	14 inches	14 inches	14 inches	7 inches	14 inches	14 inches	14 inches	14 inches	5.5 or 8.0 oz/ac
Endura application rate	5.5 oz/ac	5.5 oz/ac	5.5 oz/ac	8.0 oz/ac	8.0 oz/ac	5.5 oz/ac	8.0 oz/ac	5.5 oz/ac	

CANOPY CLOSURE when fungicides were applied



White mold incidence (% of plants diseased)



Nozzles: XR8001 or XR80015 flat-fan TeeJet nozzles, 35 or 40 psi (droplet size = fine)

Spray volume: 15 or 17.5 gal/ac

FUNGICIDE APPLICATION TIMING – Single fungicide application

2. Soybean canopy at/near closure at early R2 (80-99% of plants at R2)

Fungicide applied: Endura at 5.5 or 8.0 oz/ac

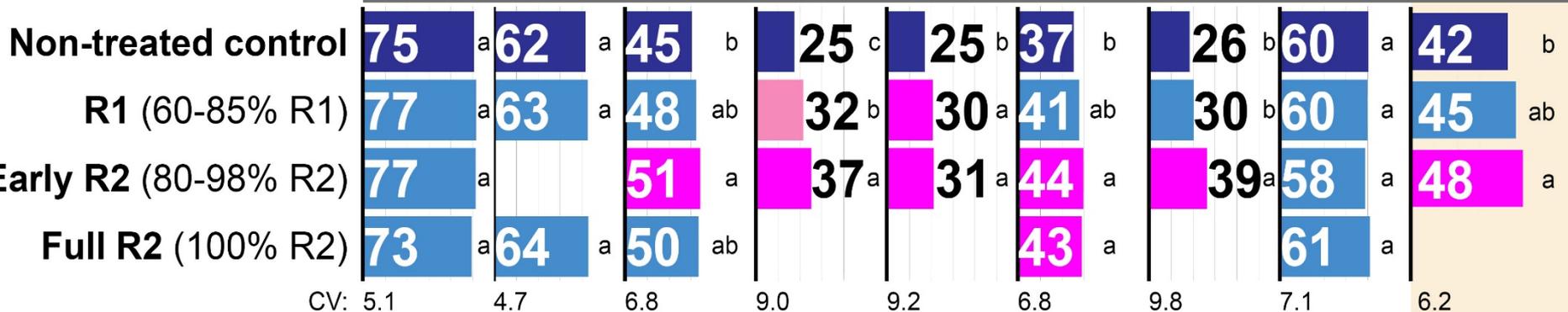
When the canopy was open at late R1 and at/near closure at early R2, delaying fungicide applications from mid/late R1 to early R2 improved soybean yield.

study location	Oakes	Oakes	Carrington	Carrington	Carrington	Carrington	Langdon	Langdon	Combined analysis
YEAR	2015	2016	2015	2014	2014	2015	2014	2016	seven studies
row spacing	14 inches	14 inches	14 inches	7 inches	14 inches	14 inches	14 inches	14 inches	5.5 or 8.0 oz/ac
Endura application rate	5.5 oz/ac	5.5 oz/ac	5.5 oz/ac	8.0 oz/ac	8.0 oz/ac	5.5 oz/ac	8.0 oz/ac	5.5 oz/ac	

CANOPY CLOSURE when fungicides were applied



Soybean Yield (bu/ac; 13% moisture)



Nozzles: XR8001 or XR80015 flat-fan TeeJet nozzles, 35 or 40 psi (droplet size = fine)

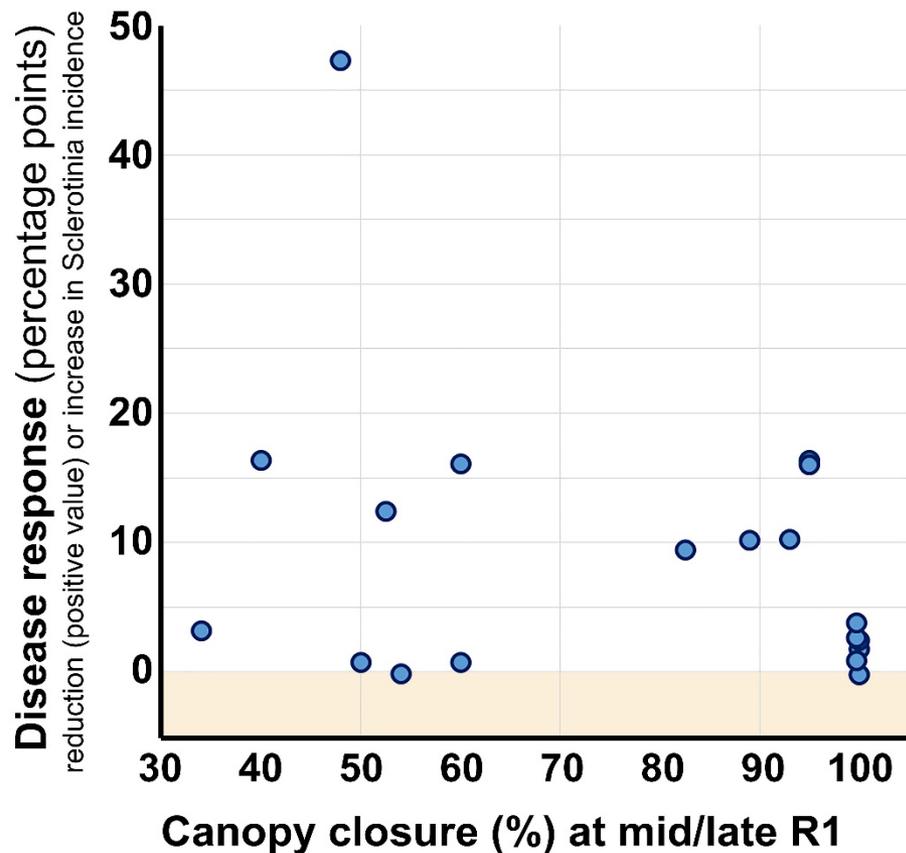
Spray volume: 15 or 17.5 gal/ac

Applications at mid/late R1 (60-85% R1) versus early R2 (80-99% R2)

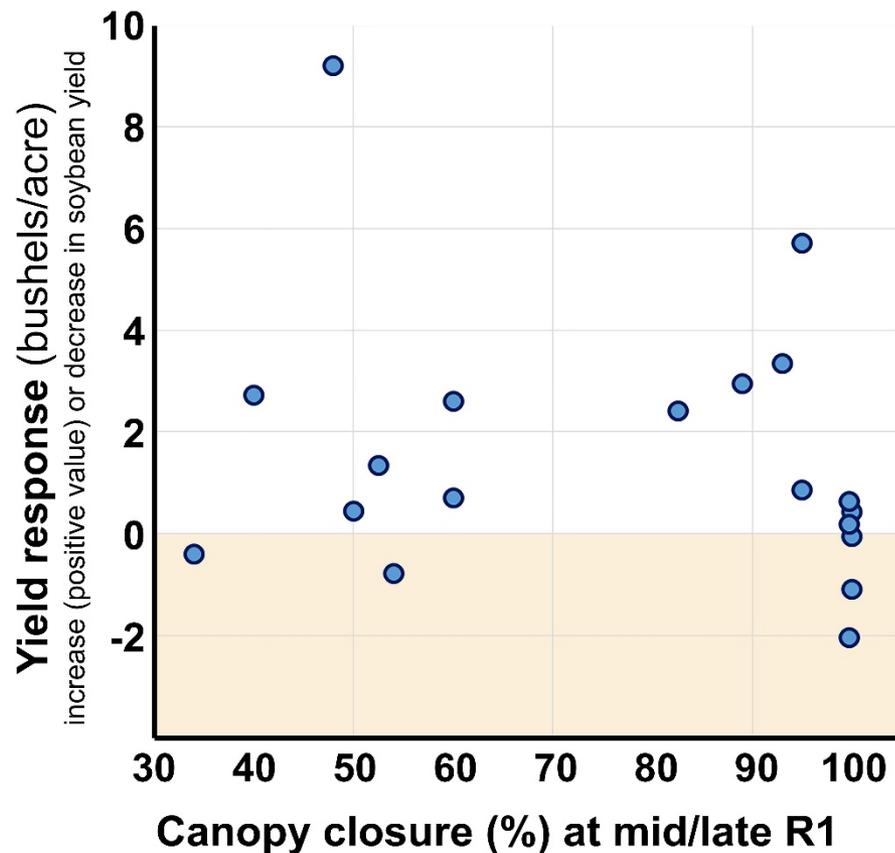
Across 19 field trials conducted at four locations and two years, **delaying fungicide applications from mid/late R1 (60-85% R1) to early R2 (80-99% R2) improved disease control in 95% of studies and soybean yield in 74% of studies.**

- Applying fungicides at early R2 was optimal except when canopy closure was 100% at mid/late R1 and weather favorable for white mold occurred at mid/late R1

Impact of delaying fungicide application from mid/late R1 (60-85% R1) to early R2 (80-99% R2):



BLUE DOT = response observed in an individual study



Optimizing application timing

When conditions favored white mold as soybeans entered bloom:

Applying fungicides at the mid/late R1 growth stage (60-85% R1)
optimized white mold management
when the canopy was closed at mid/late R1.
(100% of the ground covered by the canopy)

Applying fungicides at early R2 growth stage (80-99% R2)
optimized white mold management
when the canopy was at or near closure at early R2.
(95-100% of the ground covered by the canopy)

R1: at least one open blossom on the plant.

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



FUNGICIDE APPLICATION TIMING – Single fungicide application

3. Soybean canopy at/near closure at full R2 (100% of plants at R2)

Fungicide applied: Endura at 5.5 or 8.0 oz/ac

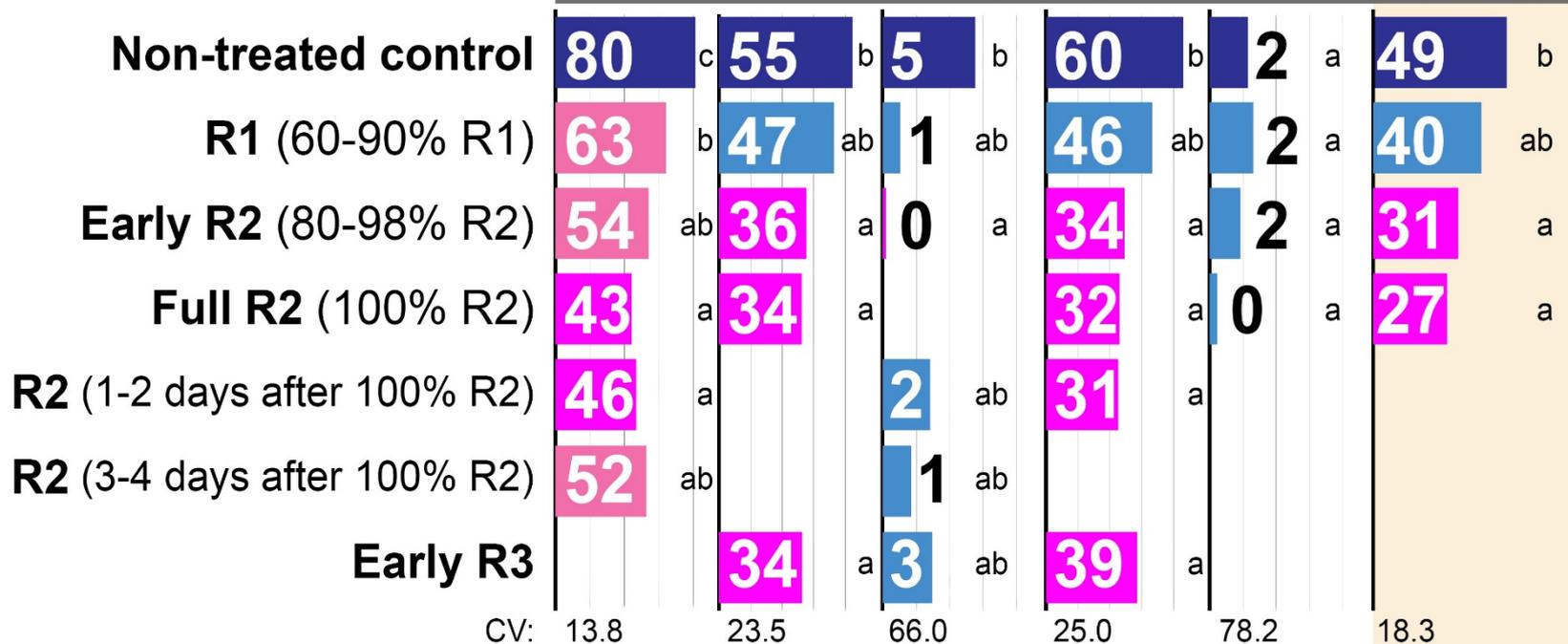
When the canopy was open at early R2 (<100% of plants at R2), delaying fungicide applications until 100% of plants were at R2 improved white mold control.

study location	Carrington	Oakes	Hofflund	Carrington	Oakes	Combined analysis
YEAR	2014	2014	2014	2014	2015	four studies
row spacing	21 inches	28 inches	30 inches	28 inches	28 inches	5.5 or 8.0 oz/ac
Endura application rate	8.0 oz/ac	8.0 oz/ac	8.0 oz/ac	8.0 oz/ac	5.5 oz/ac	

CANOPY CLOSURE when fungicides were applied



White mold incidence (% of plants diseased)



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

FUNGICIDE APPLICATION TIMING – Single fungicide application

3. Soybean canopy at/near closure at full R2 (100% of plants at R2)

Fungicide applied: Endura at 5.5 or 8.0 oz/ac

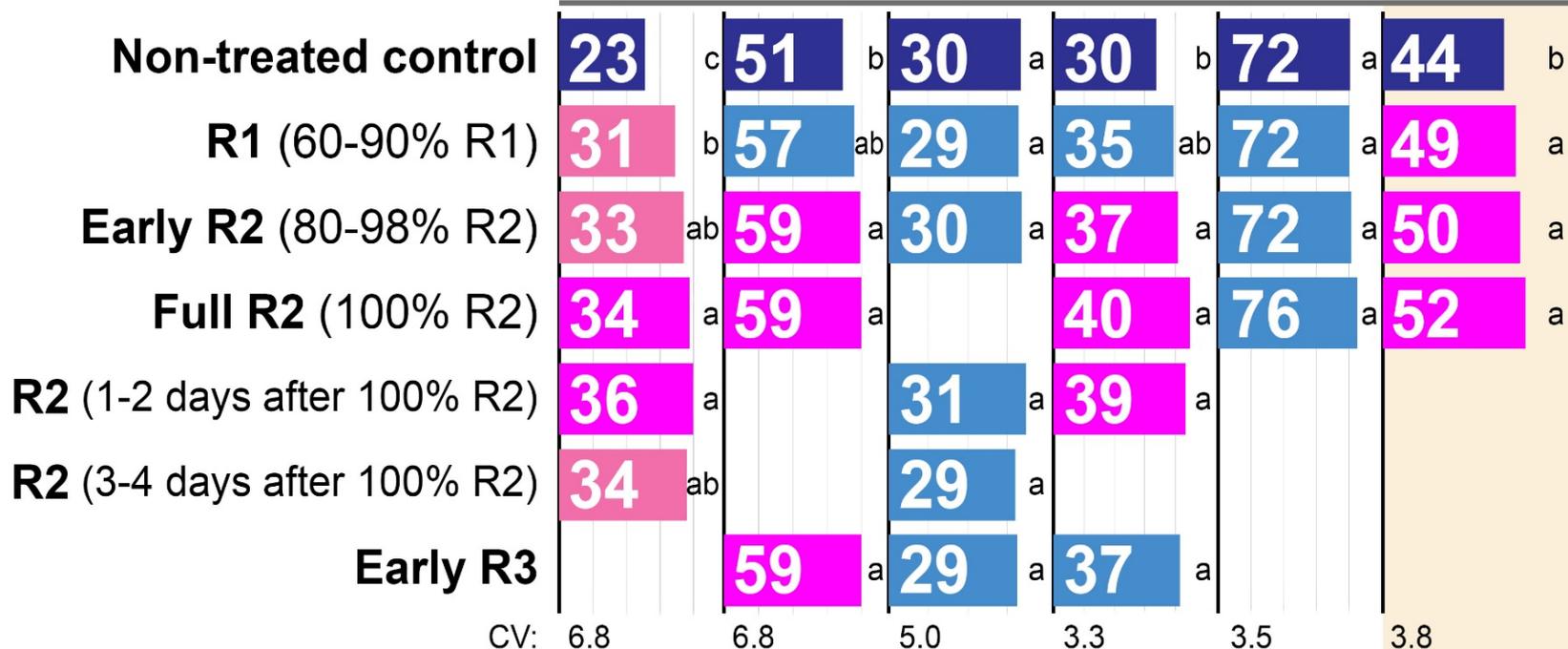
When the canopy was open at early R2 (<100% of plants at R2), delaying fungicide applications until 100% of plants were at R2 improved soybean yield.

study location	Carrington	Oakes	Hofflund	Carrington	Oakes	Combined analysis
YEAR	2014	2014	2014	2014	2015	four studies
row spacing	21 inches	28 inches	30 inches	28 inches	28 inches	5.5 or 8.0 oz/ac
Endura application rate	8.0 oz/ac	8.0 oz/ac	8.0 oz/ac	8.0 oz/ac	5.5 oz/ac	

CANOPY CLOSURE when fungicides were applied



Soybean Yield (bu/ac; 13% moisture)



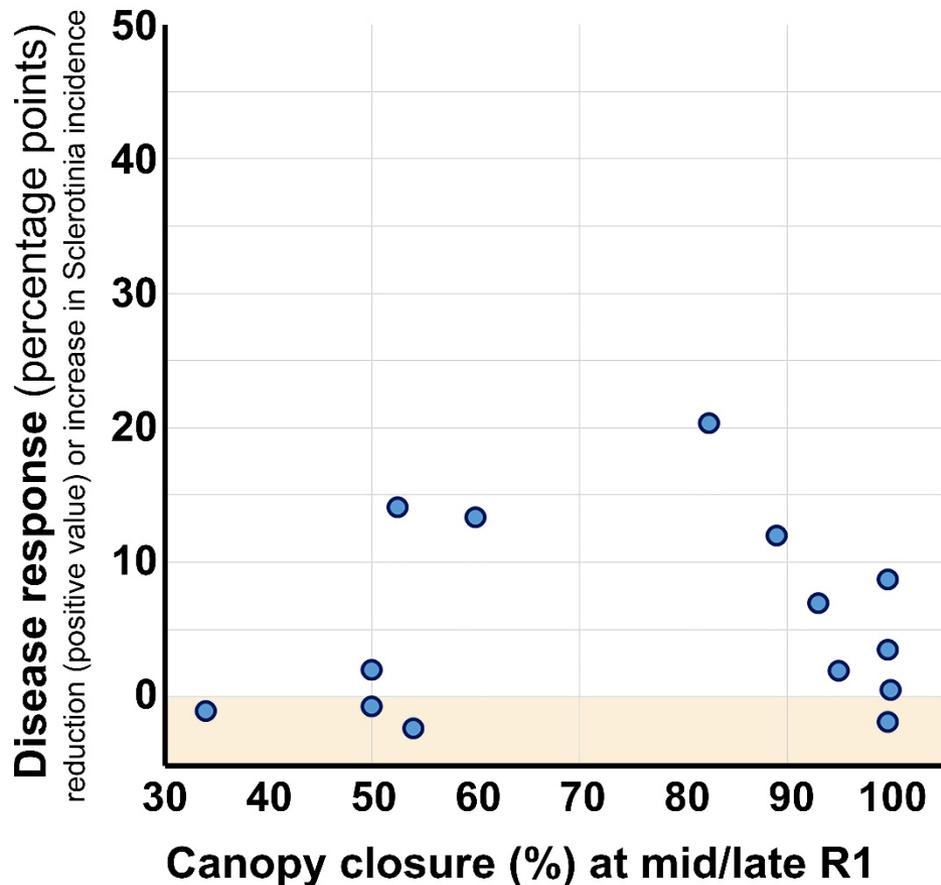
Nozzles: XR8001 or XR80015 flat-fan TeeJet nozzles, 35 or 40 psi (droplet size = fine) Spray volume: 15 or 17.5 gal/ac

Applications at mid/late R1 (60-85% R1) versus full R2 (100% R2)

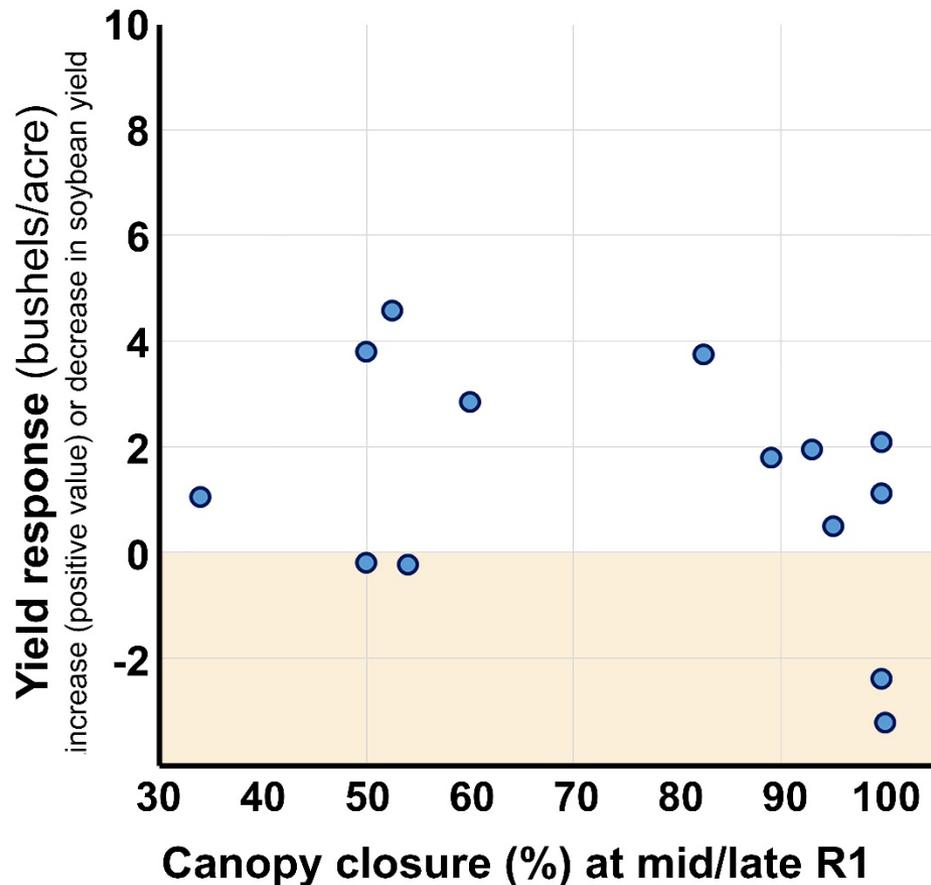
Across 14 field trials conducted at two locations and three years, **delaying fungicide applications from mid/late R1 (60-85% R1) to full R2 (100% R2)** improved disease control and yield in 71% of studies.

- Applying fungicides at full R2 was optimal except when canopy closure was 100% at mid/late R1 and weather favorable for white mold occurred at mid/late R1

Impact of delaying fungicide application from mid/late R1 (60-85% R1) to full R2 (100% R2):



BLUE DOT = response observed in an individual study



Optimizing application timing

When conditions favored white mold as soybeans entered bloom:

Applying fungicides at the mid/late R1 growth stage (60-85% R1)

optimized white mold management

when the canopy was closed at mid/late R1.

(100% of the ground covered by the canopy)

Applying fungicides at early R2 growth stage (80-99% R2)

optimized white mold management

when the canopy was at or near closure at early R2.

(97-100% of the ground covered by the canopy)

Applying fungicides at full R2 growth stage (100% R2)

optimized white mold management

when the canopy was open at early R2.

(<95% of the ground covered by the canopy)

R1: at least one open blossom on the plant.

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

4. Soybean canopy at/near closure at early to full R3

Fungicide applied: Endura at 5.5 or 8.0 oz/ac

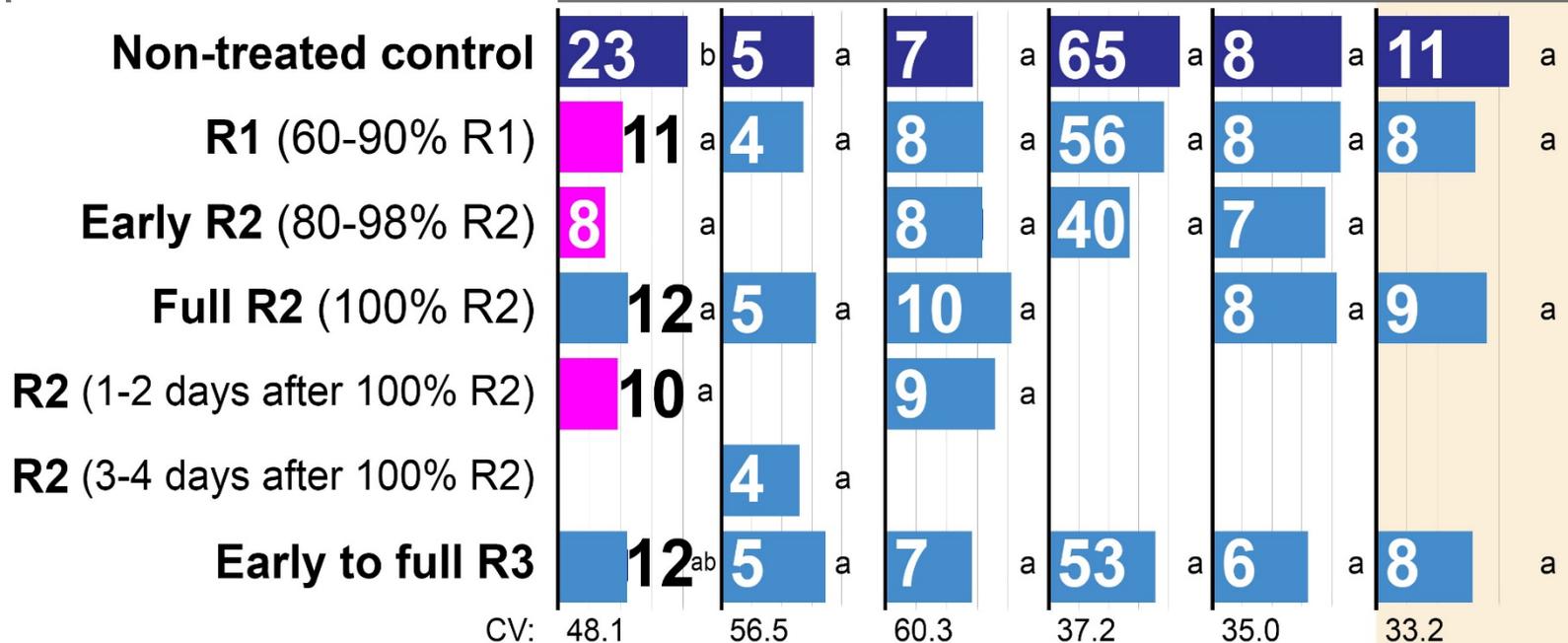
When conditions favored white mold as soybeans entered bloom, applying fungicides at early-full R2 optimized white mold control even when canopy did not close until R3.

study location	Carrington	Oakes	Carrington	Langdon	Langdon	Combined analysis
YEAR	2015	2016	2015	2014	2016	four studies
row spacing	28 inches	28 inches	28 inches	30 inches	30 inches	5.5 oz/ac
Endura application rate	5.5 oz/ac	5.5 oz/ac	5.5 oz/ac	8.0 oz/ac	5.5 oz/ac	

CANOPY CLOSURE when fungicides were applied



White mold incidence (% of plants diseased)



4. Soybean canopy at/near closure at early to full R3

Fungicide applied: Endura at 5.5 or 8.0 oz/ac

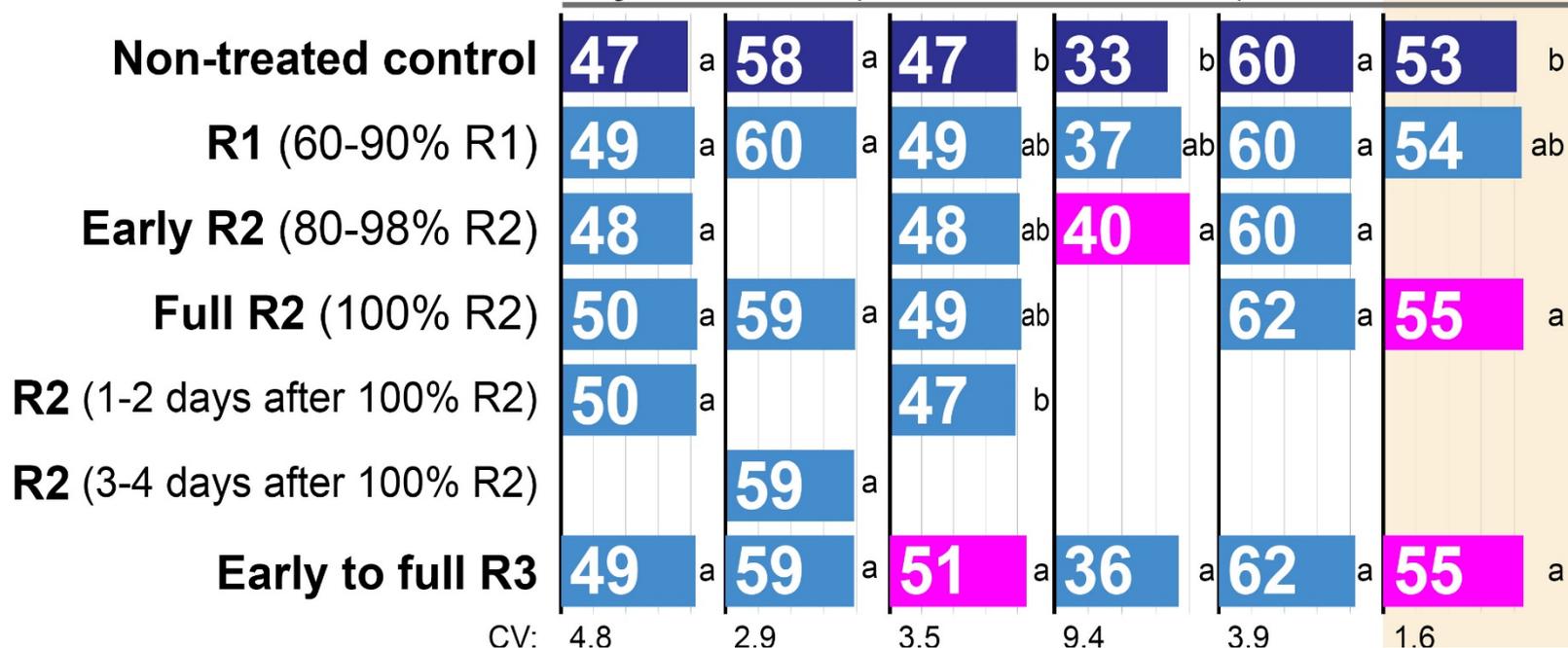
When conditions favored white mold as soybeans entered bloom, applying fungicides at early-full R2 optimized white mold control even when canopy did not close until R3.

study location	Carrington	Oakes	Carrington	Langdon	Langdon	Combined analysis four studies 5.5 oz/ac
YEAR	2015	2016	2015	2014	2016	
row spacing	28 inches	28 inches	28 inches	30 inches	30 inches	
Endura application rate	5.5 oz/ac	5.5 oz/ac	5.5 oz/ac	8.0 oz/ac	5.5 oz/ac	

CANOPY CLOSURE when fungicides were applied



Soybean Yield (bu/ac; 13% moisture)



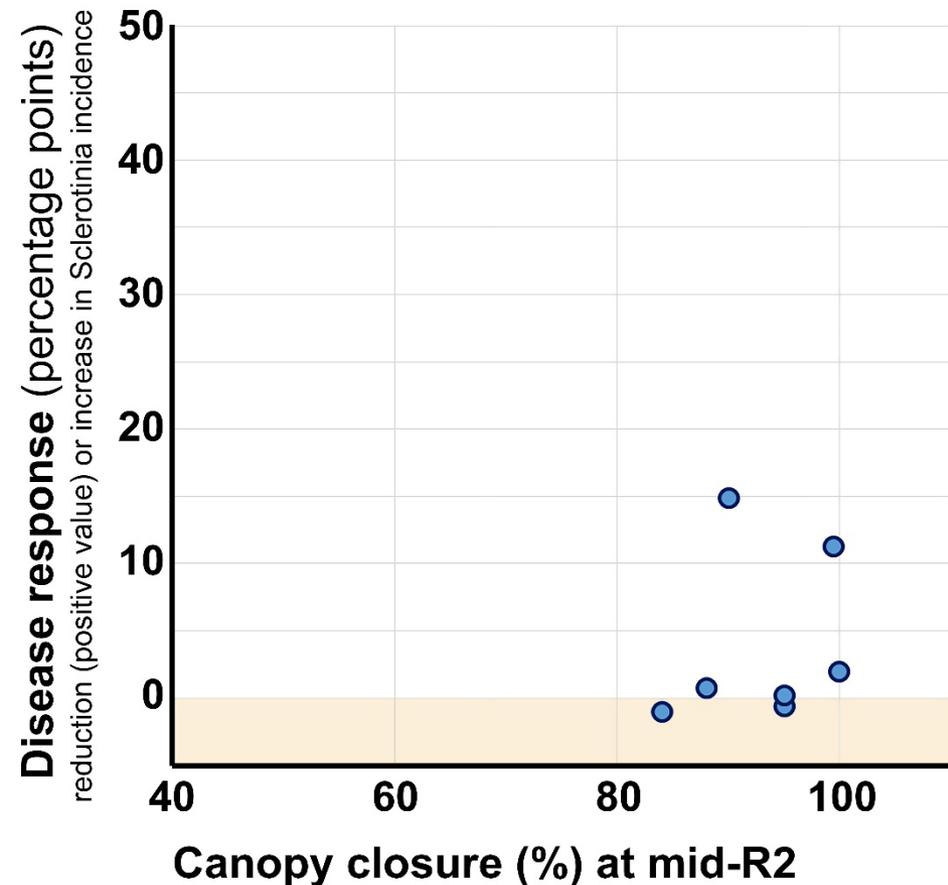
Nozzles: XR8001 or XR80015 flat-fan TeeJet nozzles, 35 or 40 psi (droplet size = fine) Spray volume: 15 or 17.5 gal/ac

Applications at mid/late R1 versus mid/late R2 (2-4 days after 100% R2)

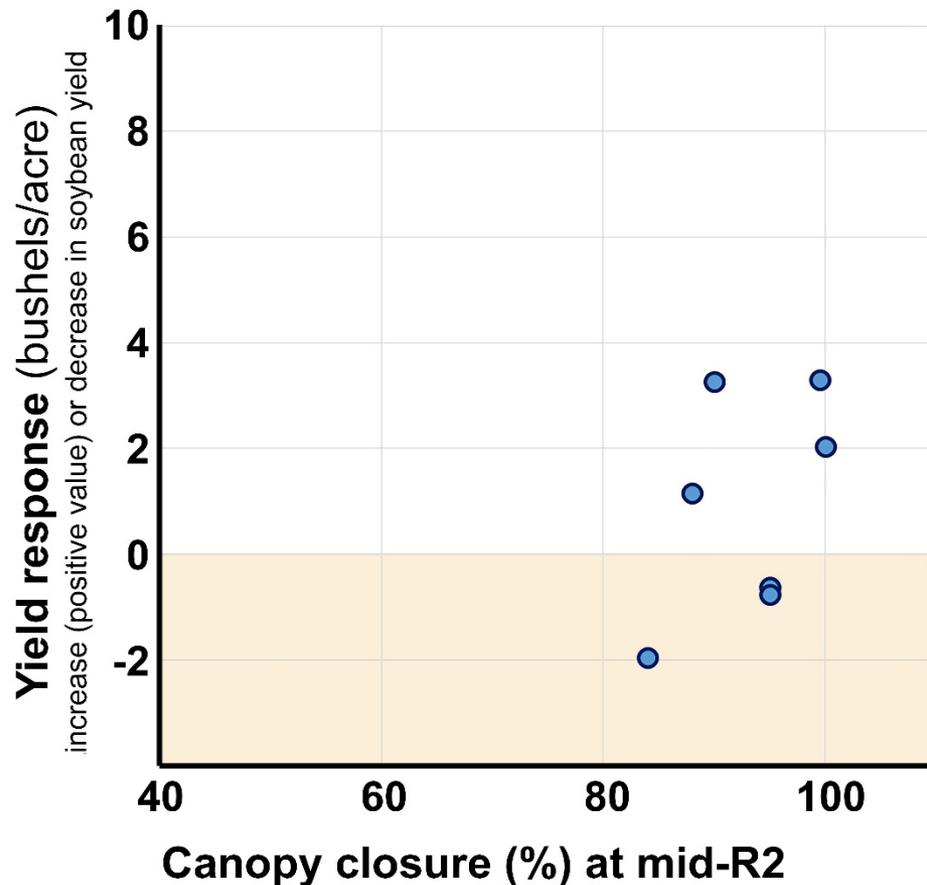
Across 7 field trials conducted at three locations and three years, **delaying fungicide applications from mid/late R1 (60-85% R1) to mid/late R2 (2 to 4 days after 100% R2) improved yield in 57% of studies.**

- Applying fungicides at mid/late R2 was optimal only when conditions favorable for white mold did not develop earlier irrespective of canopy closure.

Impact of delaying fungicide application, R1 (60-85% R1) to mid-R2 (2-4 days after 100% R2):



BLUE DOT = response observed in an individual study

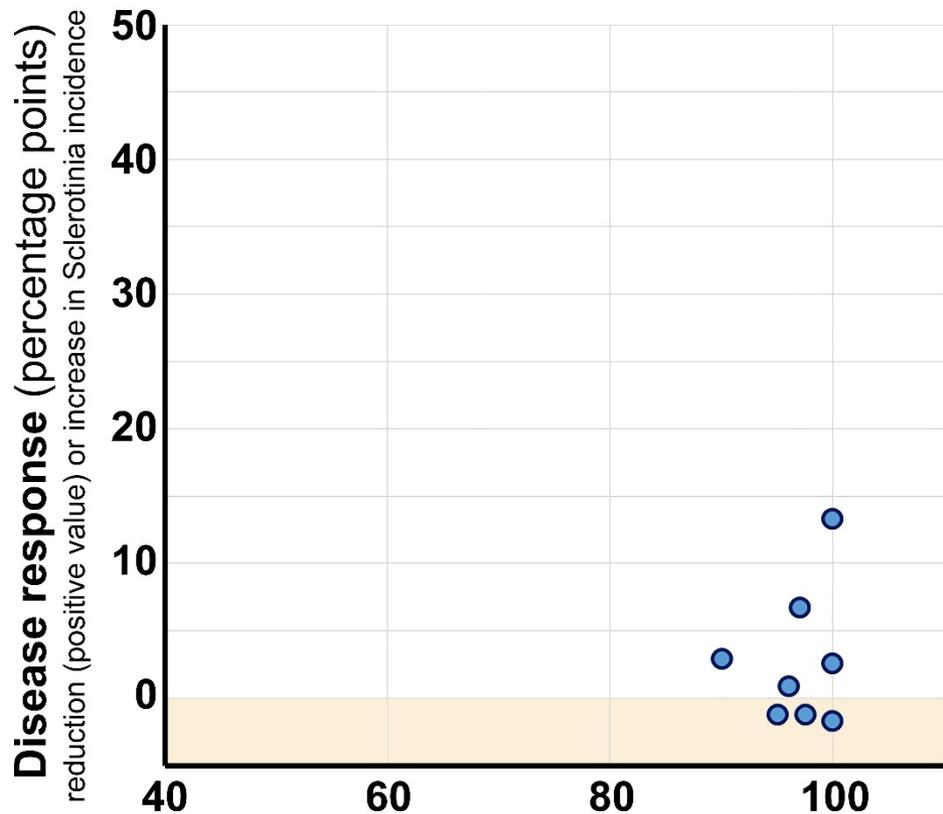


Applications at mid/late R1 versus mid/late R2 (2-4 days after 100% R2)

Across 8 field trials conducted at three locations and three years, **delaying fungicide applications from mid/late R1 (60-85% R1) to early to full R3** improved yield in 50% of studies.

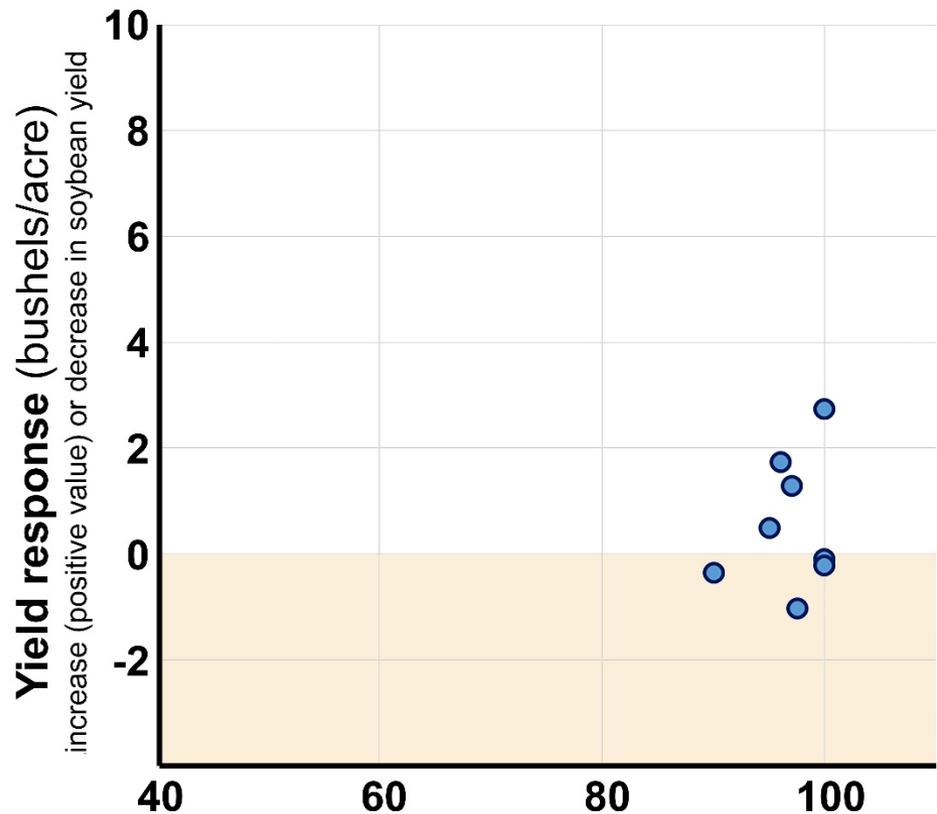
- Applying fungicides at early to full R3 was optimal only when conditions favorable for white mold did not develop earlier irrespective of canopy closure.

Impact of delaying fungicide application from mid/late R1 (60-85% R1) to early to full R3:



Canopy closure (%) at early to full R3

BLUE DOT = response observed in an individual study



Canopy closure (%) at early to full R3

Optimizing fungicide application timing

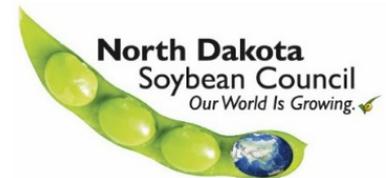
When conditions favor white mold as soybeans entered bloom:

Fungicides should be applied as soon as 100% of plants reach the R2 growth stage unless the canopy closes earlier.

- If the canopy is closed at mid/late R1 (60-85% of plants at R1), fungicides should be applied at mid/late R1.
- If the canopy is closed at early R2 (80-99% R2), fungicides should be applied at early R2.

R1: at least one open blossom on the plant.

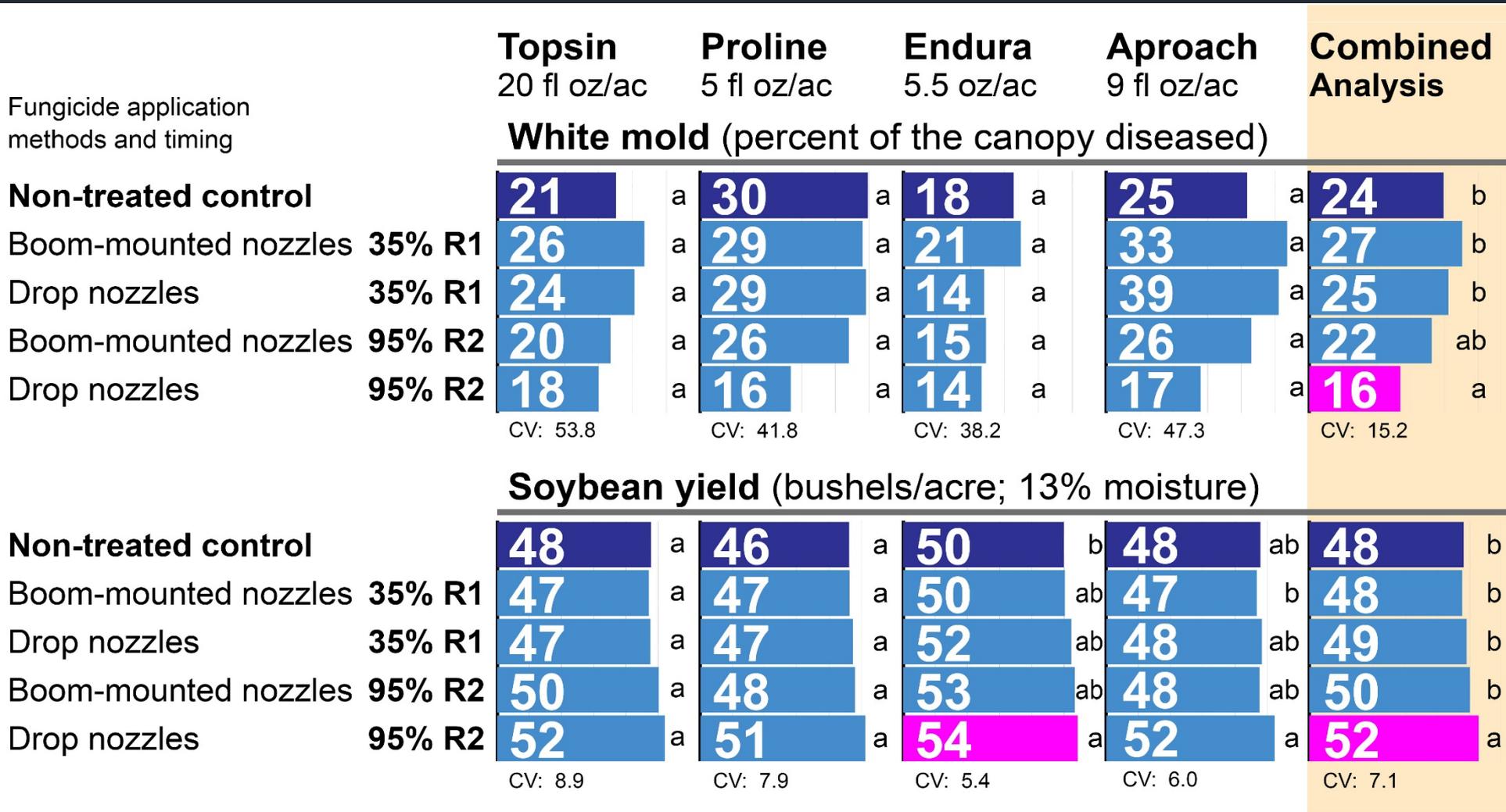
R2: at least one open blossom at one of the top two nodes of the plant.



IMPROVING WHITE MOLD MANAGEMENT IN SOYBEANS

Optimizing fungicide application timing

ACROSS FUNGICIDE APPLICATION METHODS & FUNGICIDE CHEMISTRIES



CARRINGTON, ND (2017)

BOOM-MOUNTED NOZZLES: TeeJet XR11004, 40 psi (medium droplets); 4.0 mph, 15 gal/ac

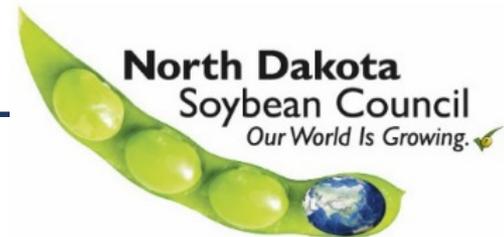
DROP NOZZLES: '360 Undercover' drop nozzles (350 Yield Center; Morton, IL), XR11001 nozzles, side ports; TX-VK3 hollow-cone, lower rear port; 60 psi (very fine droplets); 15 gal/ac, 4.0 mph

ROW SPACING: 21 inches **VARIETY:** Dairyland 'DSR-0619/R2Y' (0.6 maturity) **SEEDING RATE:** 165,000 pure live seeds/ac



Thank You!

Research funding:
North Dakota Soybean Council



NDSU NORTH DAKOTA AGRICULTURAL
EXPERIMENT STATION