

Improving the management of *Ascochyta* blight in chickpeas



Collaborative research –

NDSU Carrington and NDSU Williston Research Extension Centers

Michael Wunsch, Jesse Hafner, Suanne Kallis, Aaron Fauss, Thomas Miorini - Carrington

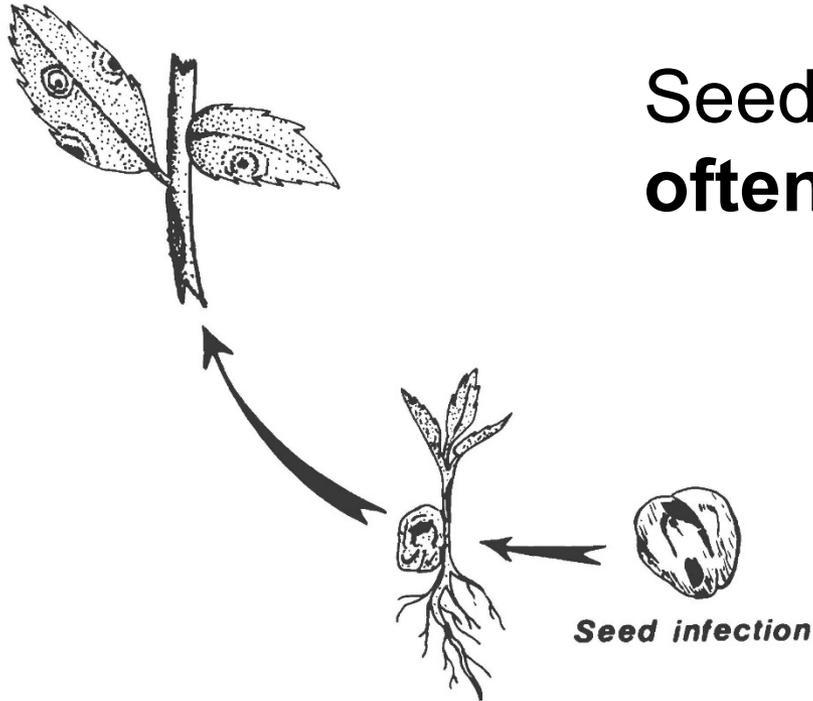
Audrey Kalil, John Teixeira, Edson Ncube, Tyler Tjelde, Justin Jacobs, Andrina Turnquist – Williston

Data summary compiled by Michael Wunsch (February 2023)

Initial introduction of *Ascochyta* blight

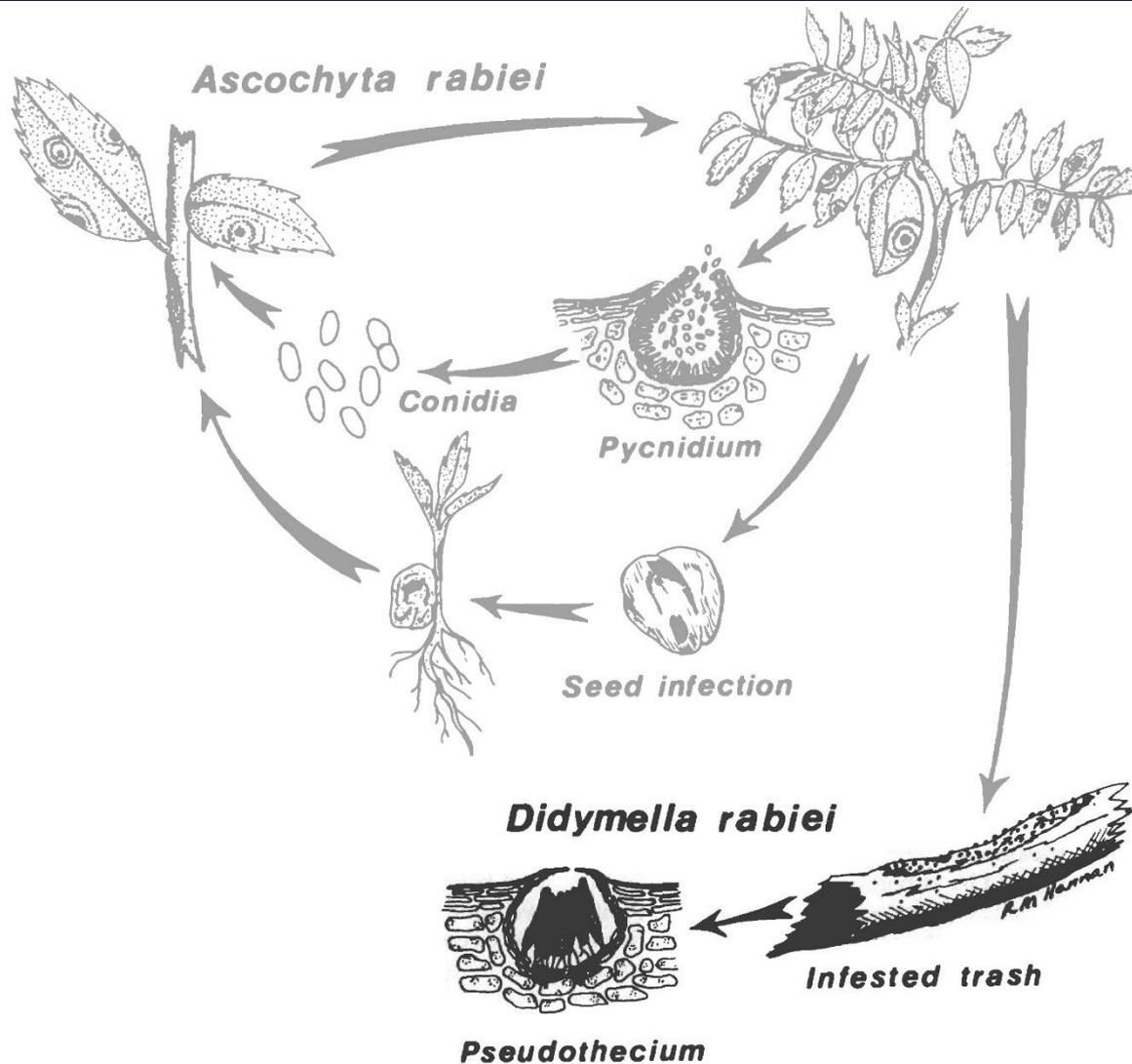
Transmission of disease from infected seed to seedlings.

Seeds within diseased pods are often infected with ***Ascochyta***



Long-distance movement of *Ascochyta*

Spores produced on overwintered crop residues



Sexually produced ascospores are produced on overwintered infested residues.

Can be **carried aloft by air currents**

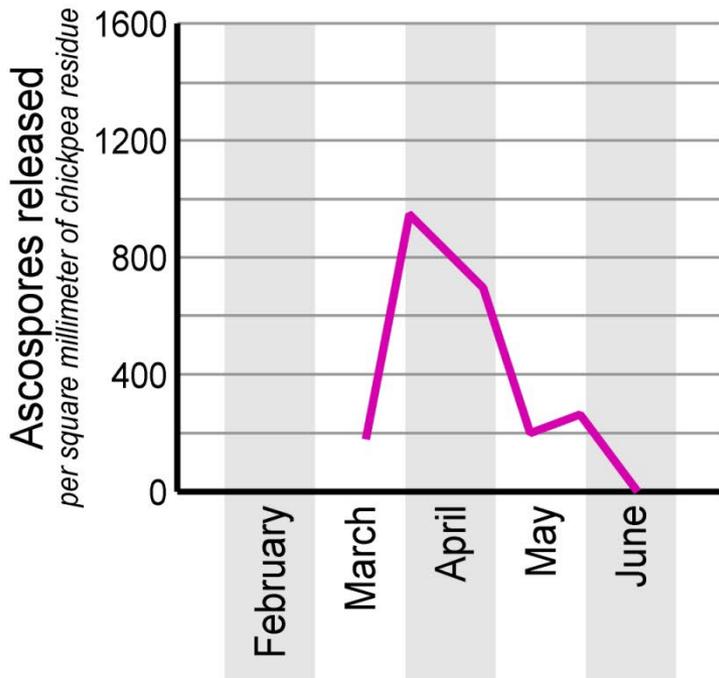
Long-distance movement of *Ascochyta*

Spores produced on overwintered crop residues

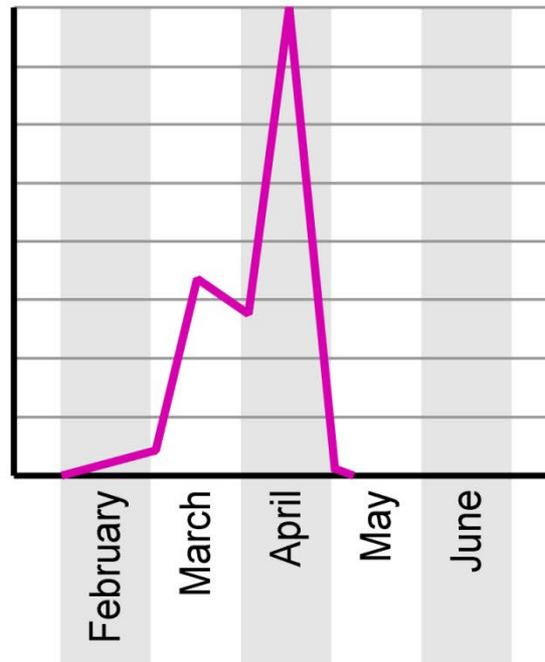
The release of ascospores from overwintered residues can be significant:

200-1,600 ascospores/mm² per day recorded in Pacific NW

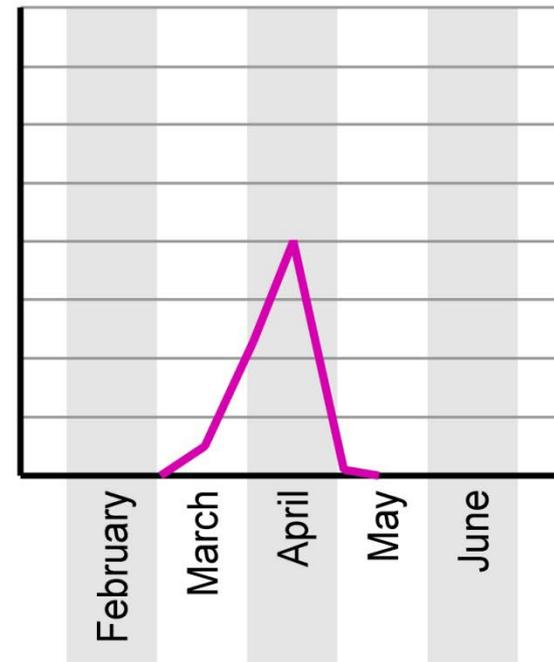
Genesee, ID
1985-1986



Genesee, ID
1986-1987



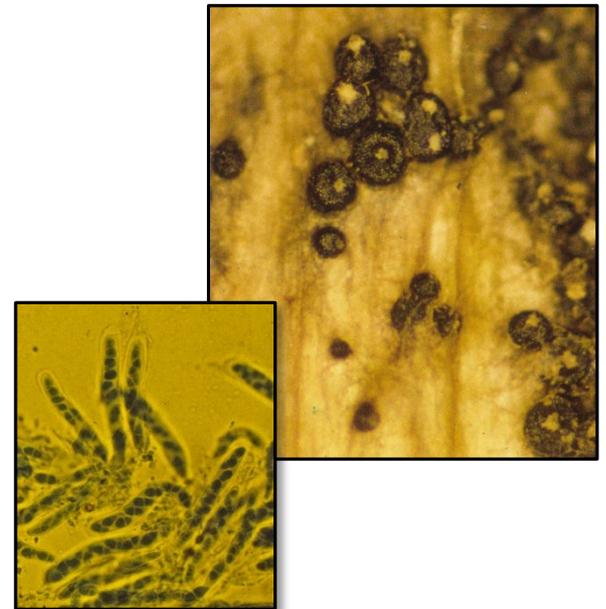
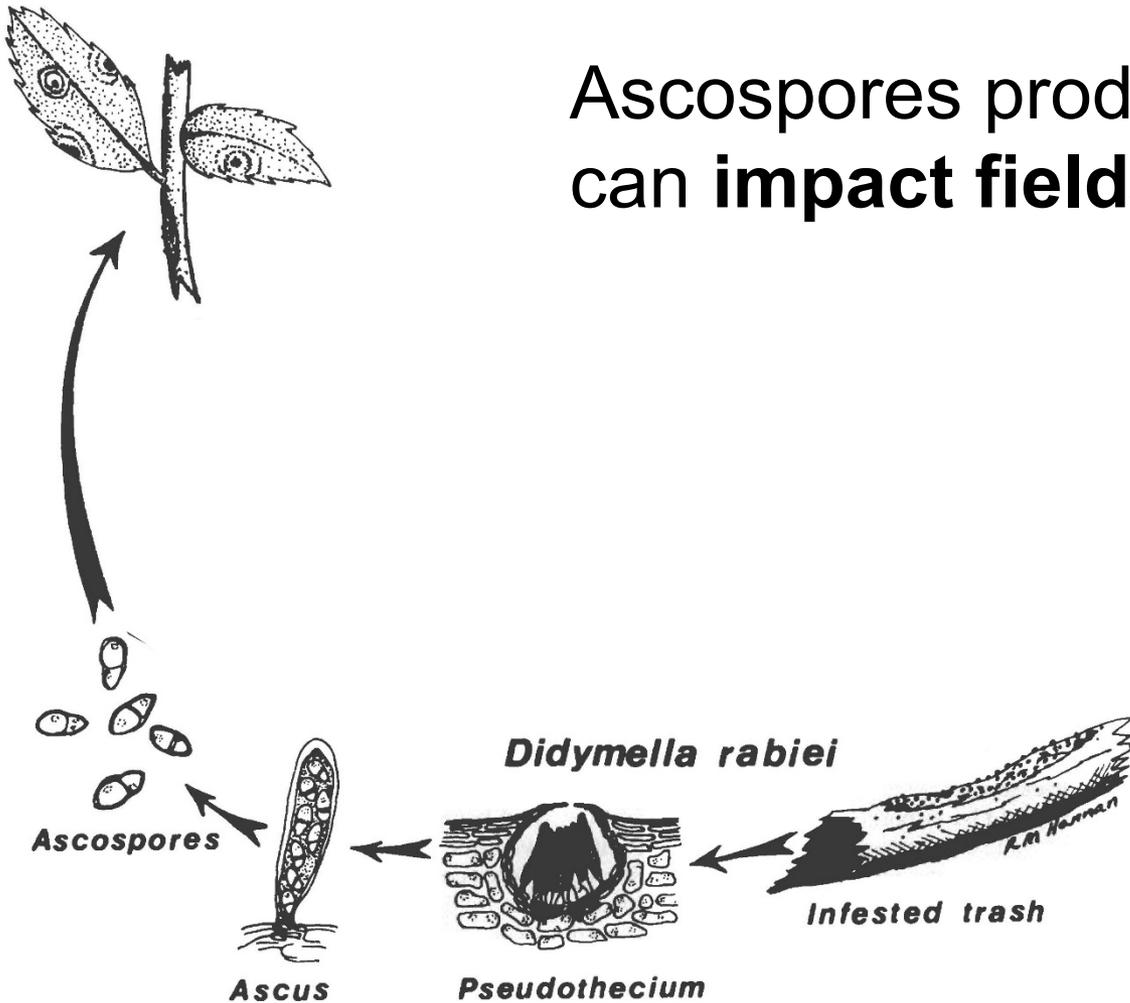
Pullman, WA
1986-1987



Long-distance movement of Ascochyta

Spores produced on overwintered crop residues

Ascospores produced on residues can **impact fields miles away.**



Long-distance movement of *Ascochyta*

The experience from Washington and Idaho

Pre-1983: No *Ascochyta* blight known to occur in Washington or Idaho

1983: *Ascochyta* blight observed in chickpea variety trials in Pullman, WA

SOURCE:

Walter J. Kaiser

Plant pathologist (retired), USDA-ARS in Prosser, WA

Kaiser 1997. **Can. J. Plant Pathology** 19(2):214-224

Long-distance movement of *Ascochyta*

The experience from Washington and Idaho

1984: *Ascochyta* blight observed in 23 of 30 commercial chickpea production fields in northern Idaho

Pullman, WA

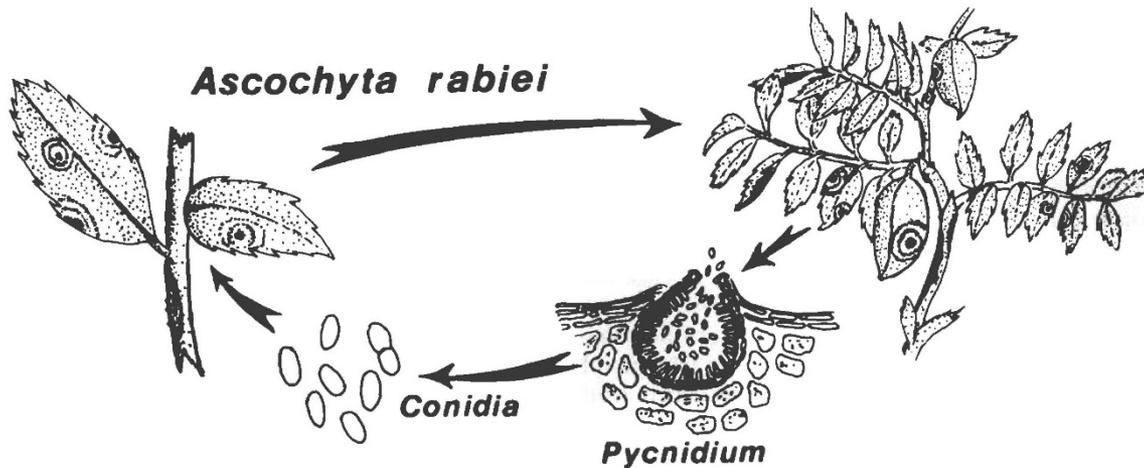


1987: Over 50% of the chickpea crop in Washington and Idaho severely impacted by *Ascochyta* blight

Local, in-season movement of *Ascochyta*

Spores produced on diseased tissue

Spores produced on disease lesions **move short distances** via **splash dispersal, wind-driven rain**



Implications for disease management

Spread of Ascochyta blight

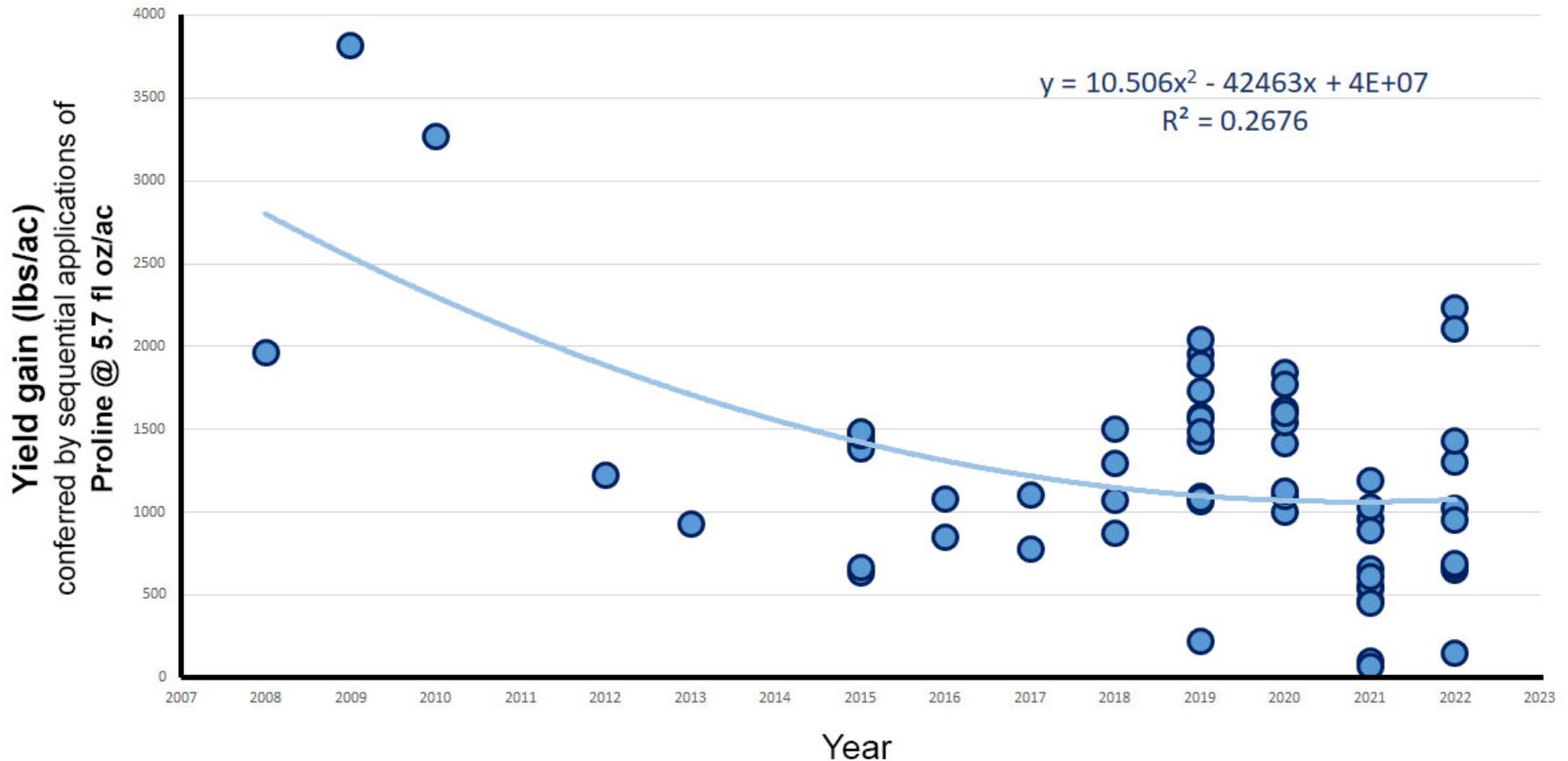
1. New strains of the Ascochyta pathogen can quickly move long distances: When fungicide resistance develops in one location, it can spread quickly.
 - Ascochyta blight is a community disease
2. Once the disease is established in a field, it spreads only during rain events.
 - When it is raining regularly, the first application should be made at the first appearance of disease symptoms or early bloom, whichever occurs first. Subsequent applications should be made 10-14 days apart.
 - If there is no rainfall, applications can be delayed but must be made prior to the next rain event.

Ascochyta blight of chickpeas

The efficacy of Proline may be declining

Proline (5.7 fl oz/ac) tested as sequential applications vs. a non-treated control

YIELD GAIN CONFERRED BY THE FUNGICIDE
vs. time (year 2008 to 2022)

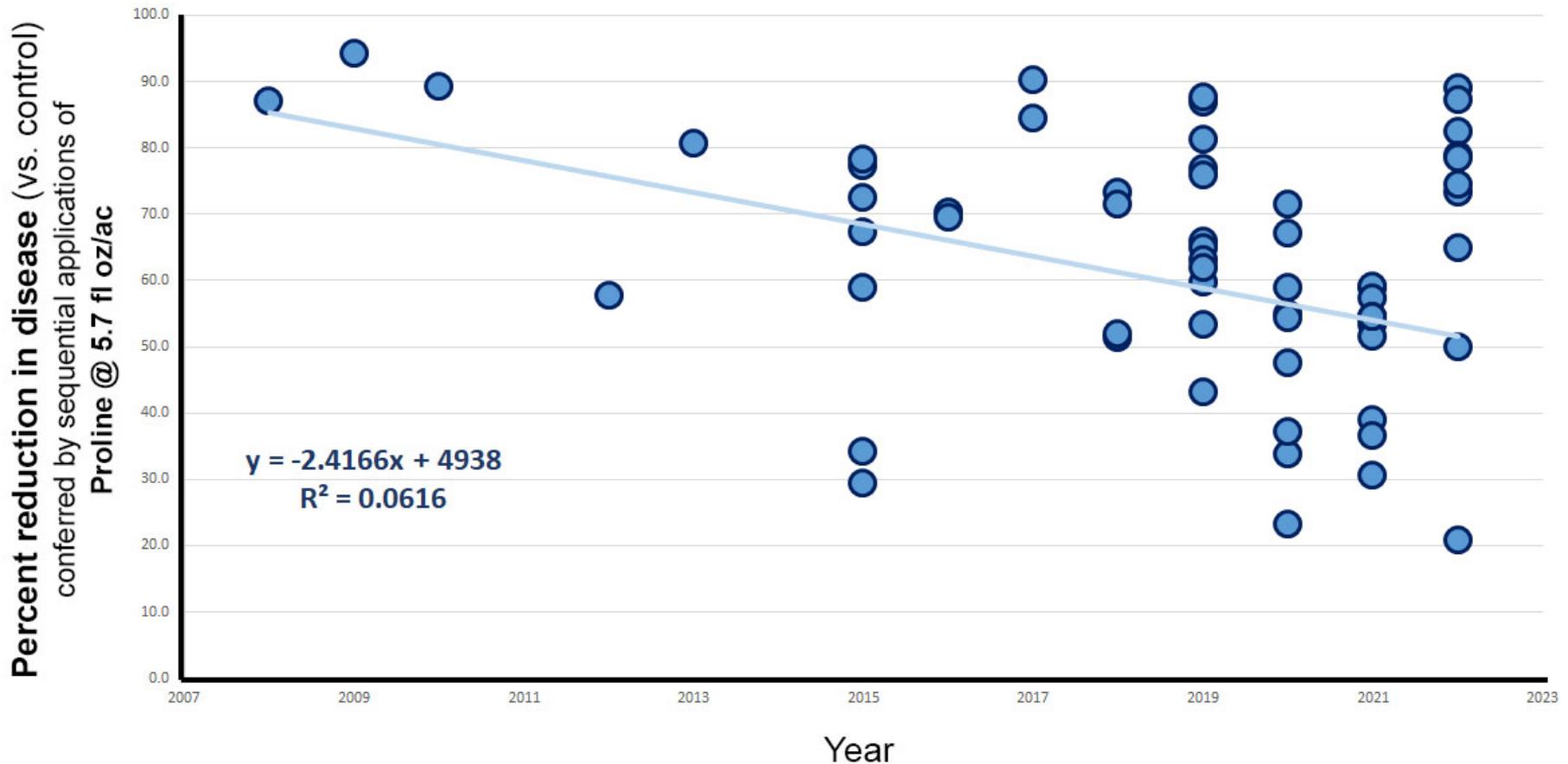


Ascochyta blight of chickpeas

The efficacy of Proline may be declining

Proline (5.7 fl oz/ac) tested as sequential applications vs. a non-treated control

DISEASE REDUCTION CONFERRED BY THE FUNGICIDE
vs. time (year 2008 to 2022)



Ascochyta blight of chickpeas

Efficacy of tank-mixes with chlorothalonil

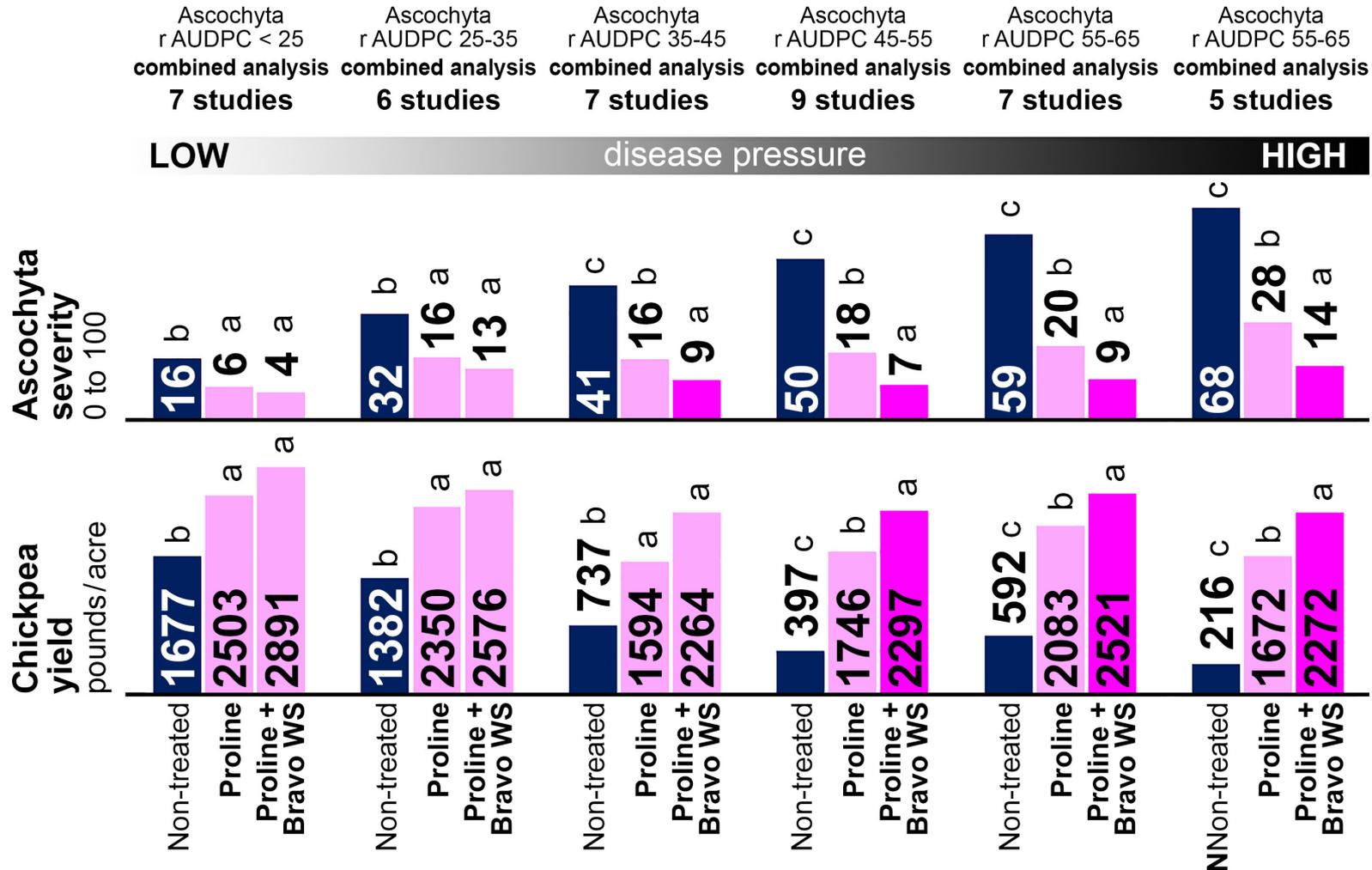
Tank-mixing Bravo WS (1.38 pt/ac) with Proline (5.7 fl oz/ac) has reduced Ascochyta blight and increased chickpea yield at all levels of disease pressure.

Data from replicated studies conducted at three locations (Carrington, Plaza, and Hoffland, ND) from 2015-2022.

Fungicide spray volume = 15 gal/ac

Fungicide droplet size = fine or medium

Letters denote statistical separation ($P < 0.05$; Tukey multiple comparison procedure)



Ascochyta blight of chickpeas

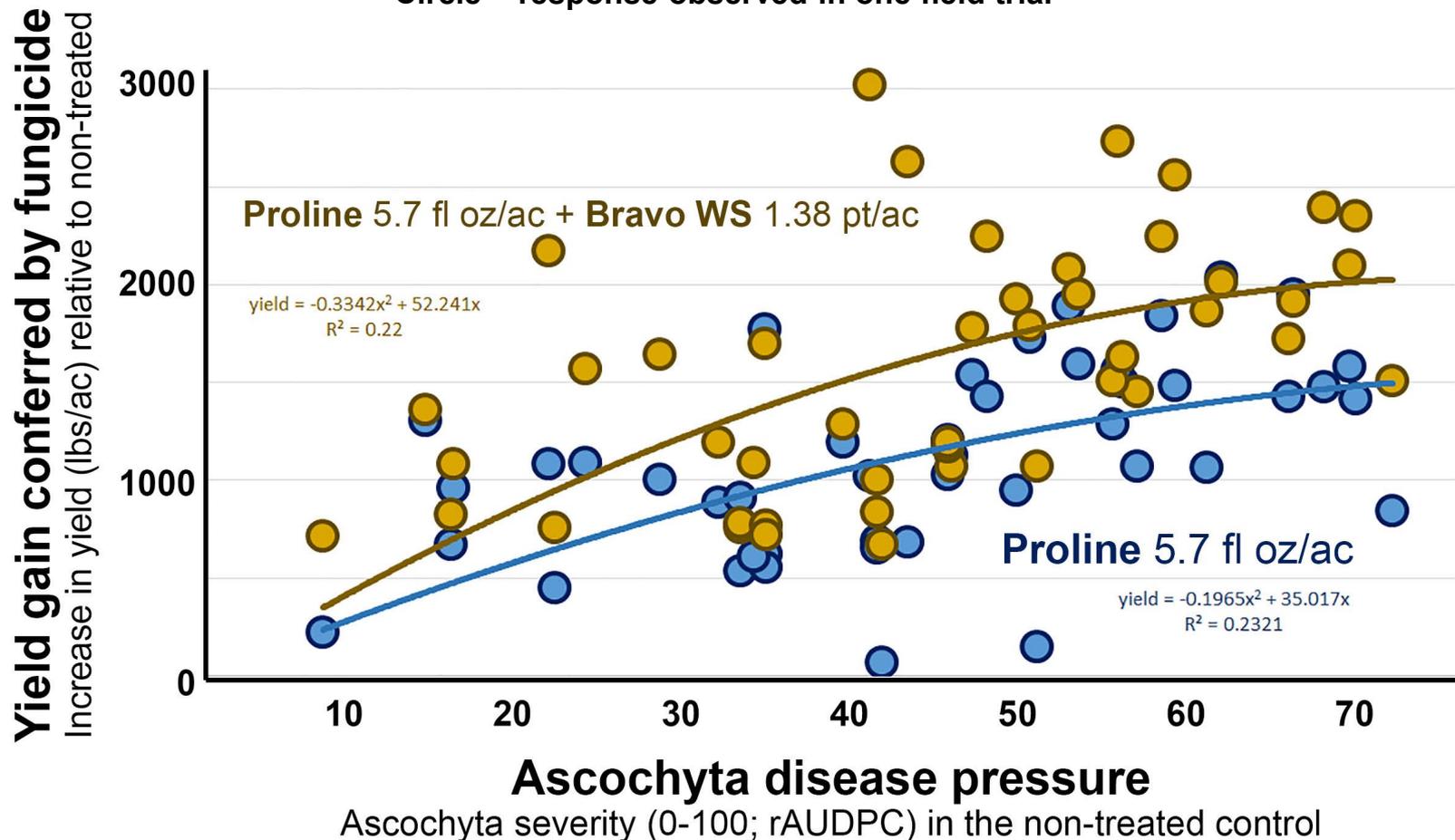
Efficacy of tank-mixes with chlorothalonil

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Circle = response observed in one field trial



Ascochyta blight of chickpeas

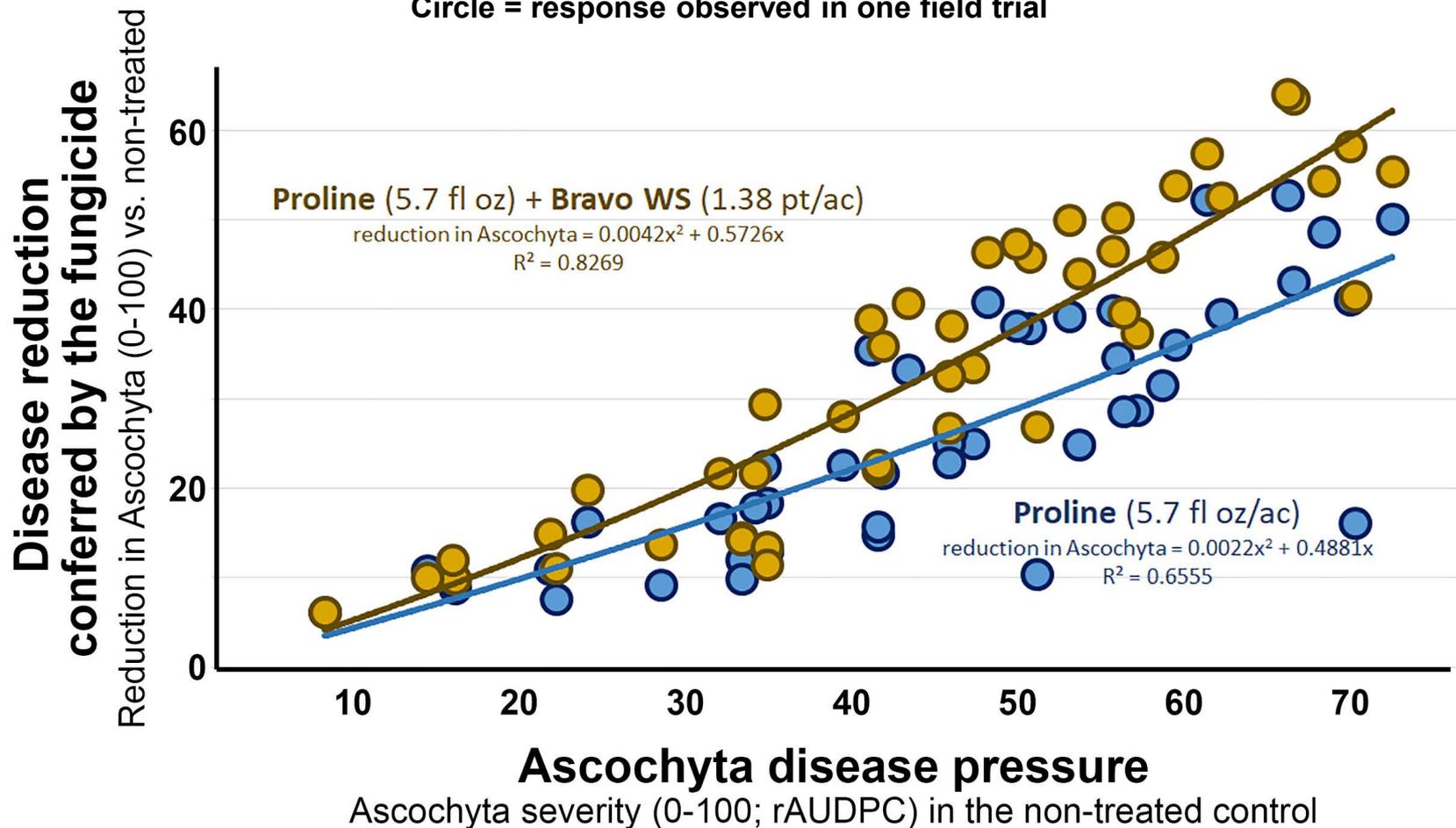
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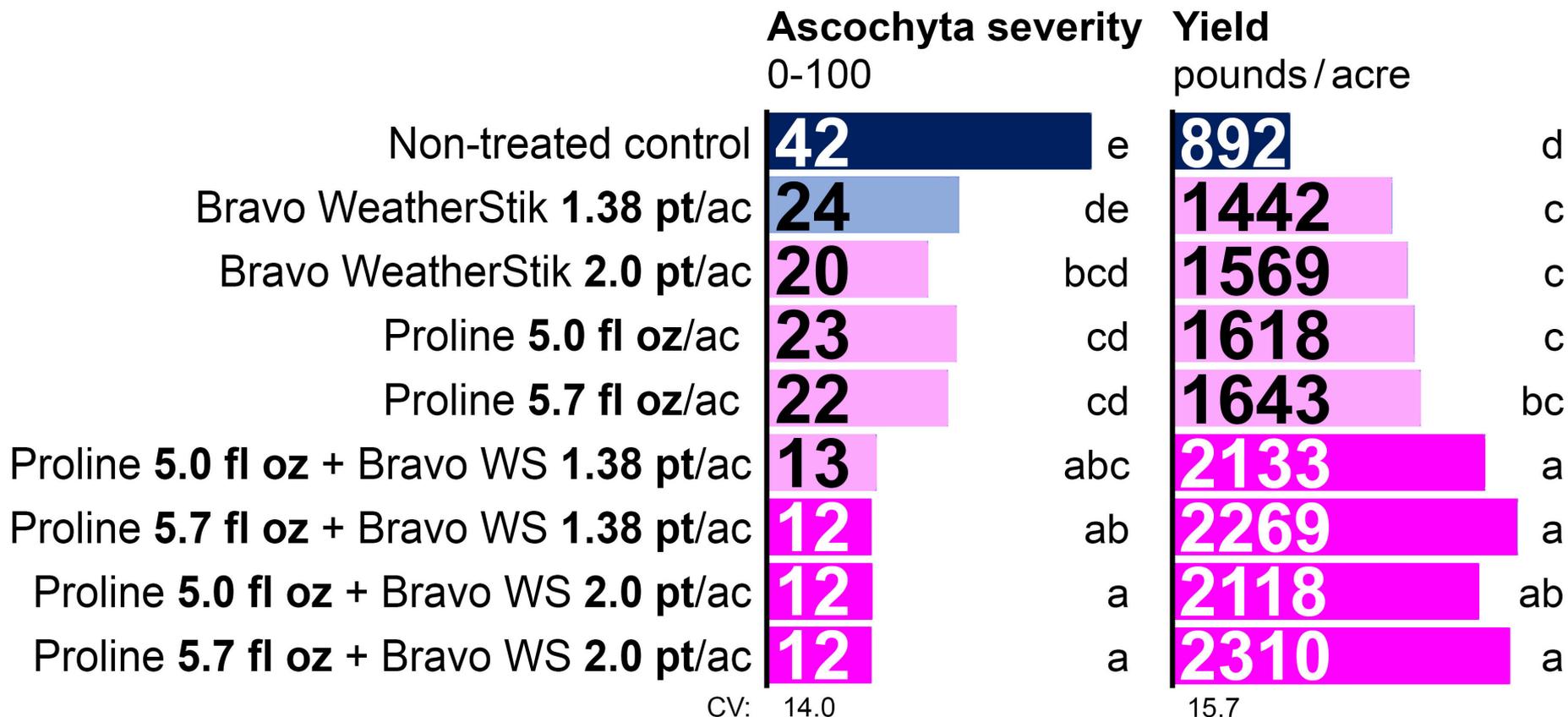
Circle = response observed in one field trial



Ascochyta blight of chickpeas

Optimizing the Proline + Bravo WS tank-mix

Tank-mixes with Proline and Bravo WS are optimized (efficacy vs. cost) **when Proline is applied at 5.7 fl oz/ac and Bravo WS is applied at 1.38 pt/ac.**

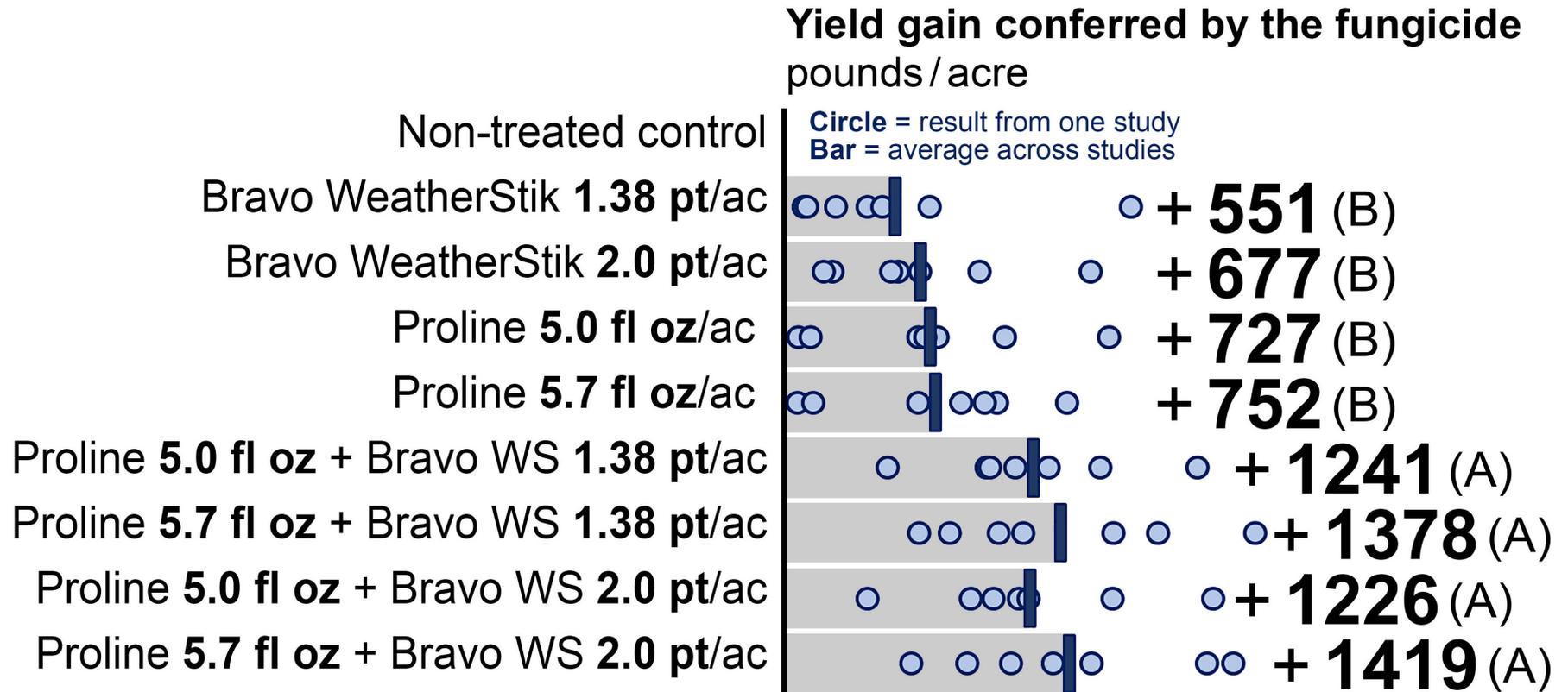


within-column means followed by different letters significantly different ($P < 0.05$)

Ascochyta blight of chickpeas

Optimizing the Proline + Bravo WS tank-mix

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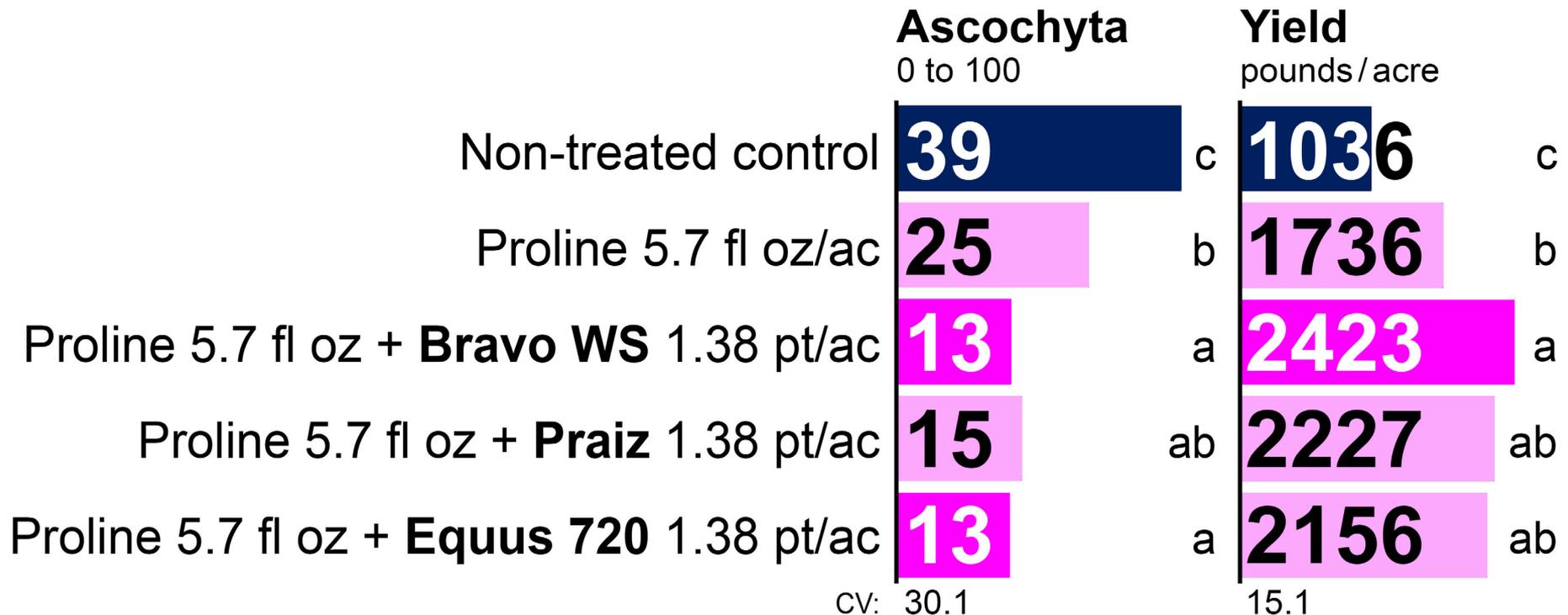


within-column means followed by different letters significantly different ($P < 0.05$)

Ascochyta blight of chickpeas

Are other brands of chlorothalonil equivalent to Bravo WS?

Across six field trials, yield gains trended downward for tank-mixes with Proline and Praiz or Equus 720 vs. Bravo WS but differences were not statistically significant. **Disease control was equivalent across brands.**



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Ascochyta blight of chickpeas

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Yield gain conferred by the fungicide
pounds/acre

Circle = result from one study
Bar = average across studies

Non-treated control

Proline 5.7 fl oz/ac 700 (B)

Proline 5.7 fl oz + **Bravo WS** 1.38 pt/ac 1387 (A)

Proline 5.7 fl oz + **Praiz** 1.38 pt/ac 1191 (A)

Proline 5.7 fl oz + **Equus 720** 1.38 pt/ac 1119 (A)

CV:

within-column means followed by different letters significantly different ($P < 0.05$)

Implications for disease management

Observed decline in the efficacy of Proline

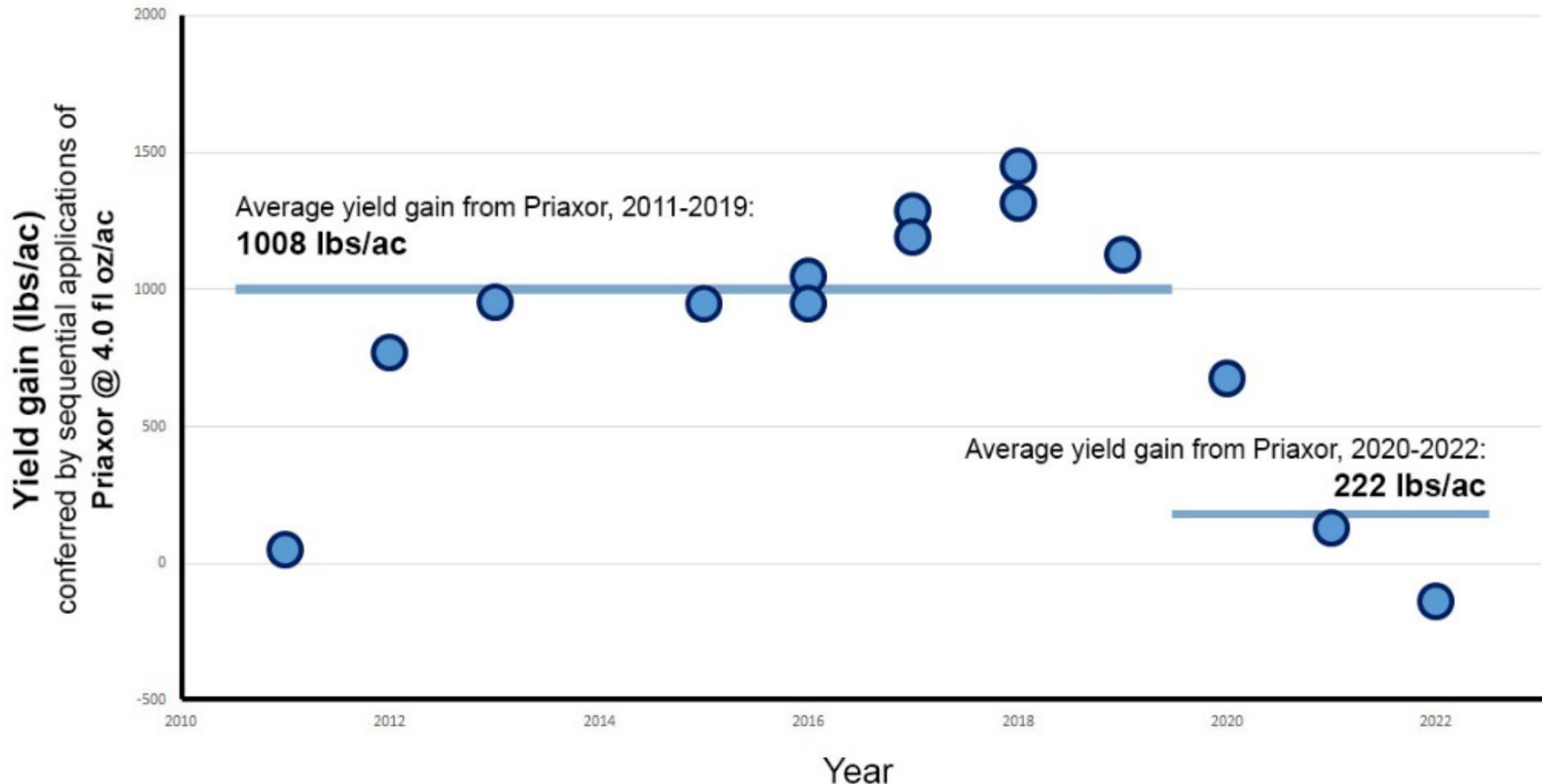
1. Tank-mixing Proline with Bravo WS (chlorothalonil) improves *Ascochyta* management and chickpea yields at all levels of disease pressure
2. Applying Proline at 5.7 fl oz/ac and Bravo WS at 1.38 pt/ac maximizes profitability of this tank-mix
3. Tank-mixing Proline with generic versions of Bravo WS (chlorothalonil) may be slightly less effective than tank-mixing with Bravo WS but should provide satisfactory results under most conditions

Ascochyta blight of chickpeas

Priaxor has not performed well in Carrington in the past 3 seasons

Priaxor (4.0 fl oz/ac) tested as sequential applications vs. a non-treated control

**YIELD GAIN CONFERRED BY THE FUNGICIDE
vs. time (year 2008 to 2022)**

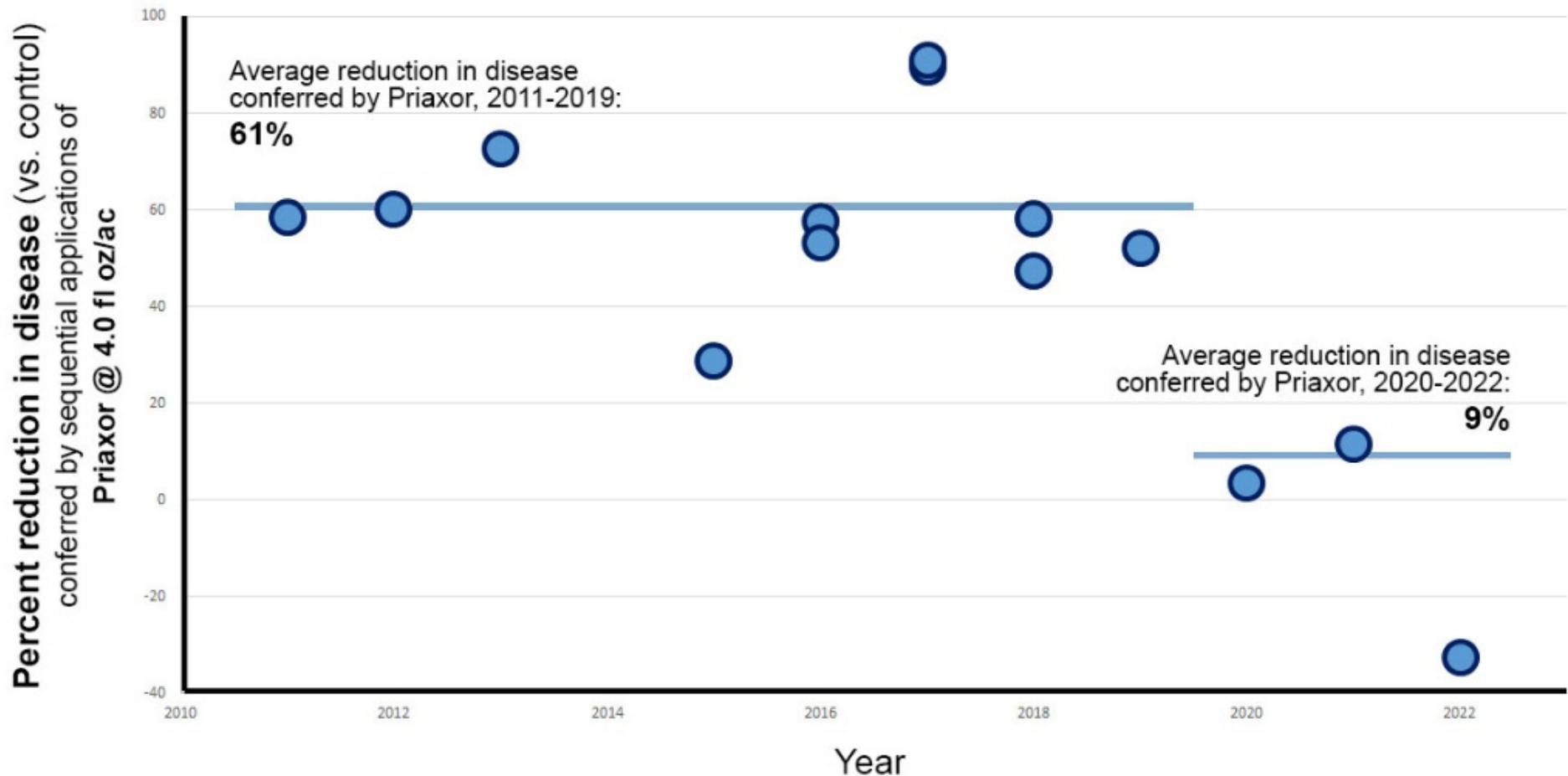


Ascochyta blight of chickpeas

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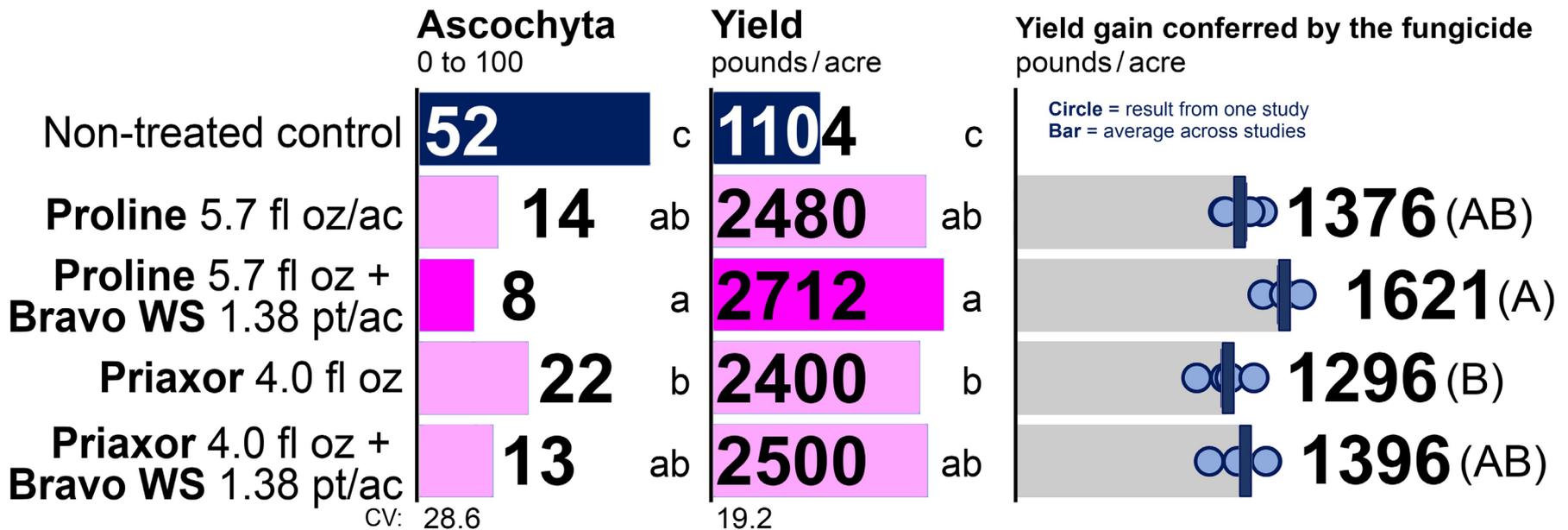
DISEASE REDUCTION CONFERRED BY THE FUNGICIDE
vs. time (year 2008 to 2022)



Ascochyta blight of chickpeas

Priaxor has not performed well in Carrington in the past 3 seasons

PERFORMANCE OF PRIAXOR with and without Bravo WeatherStik (chlorothalonil) 2017, 2018, 2019

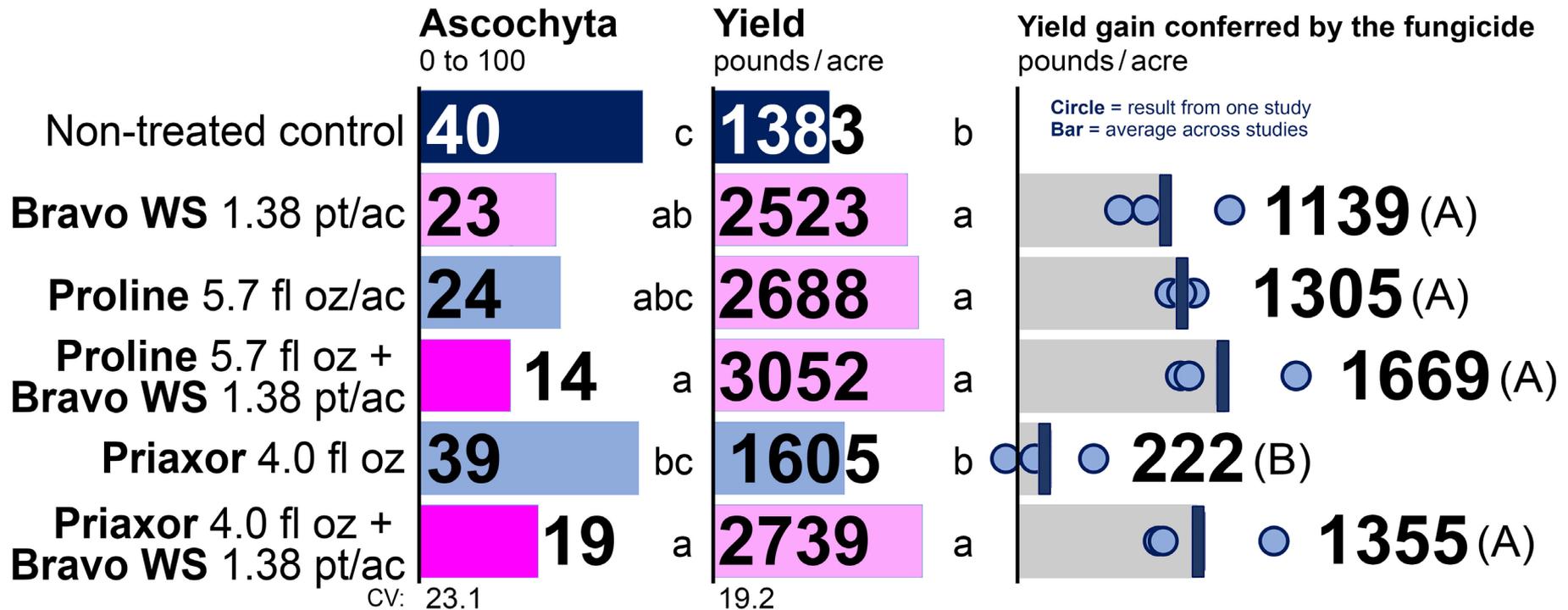


within-column means followed by different letters significantly different ($P < 0.05$)

Ascochyta blight of chickpeas

Priaxor has not performed well in Carrington in the past 3 seasons

PERFORMANCE OF PRIAXOR with and without Bravo WeatherStik (chlorothalonil) 2020, 2021, 2022



within-column means followed by different letters significantly different ($P < 0.05$)

Ascochyta blight of chickpeas

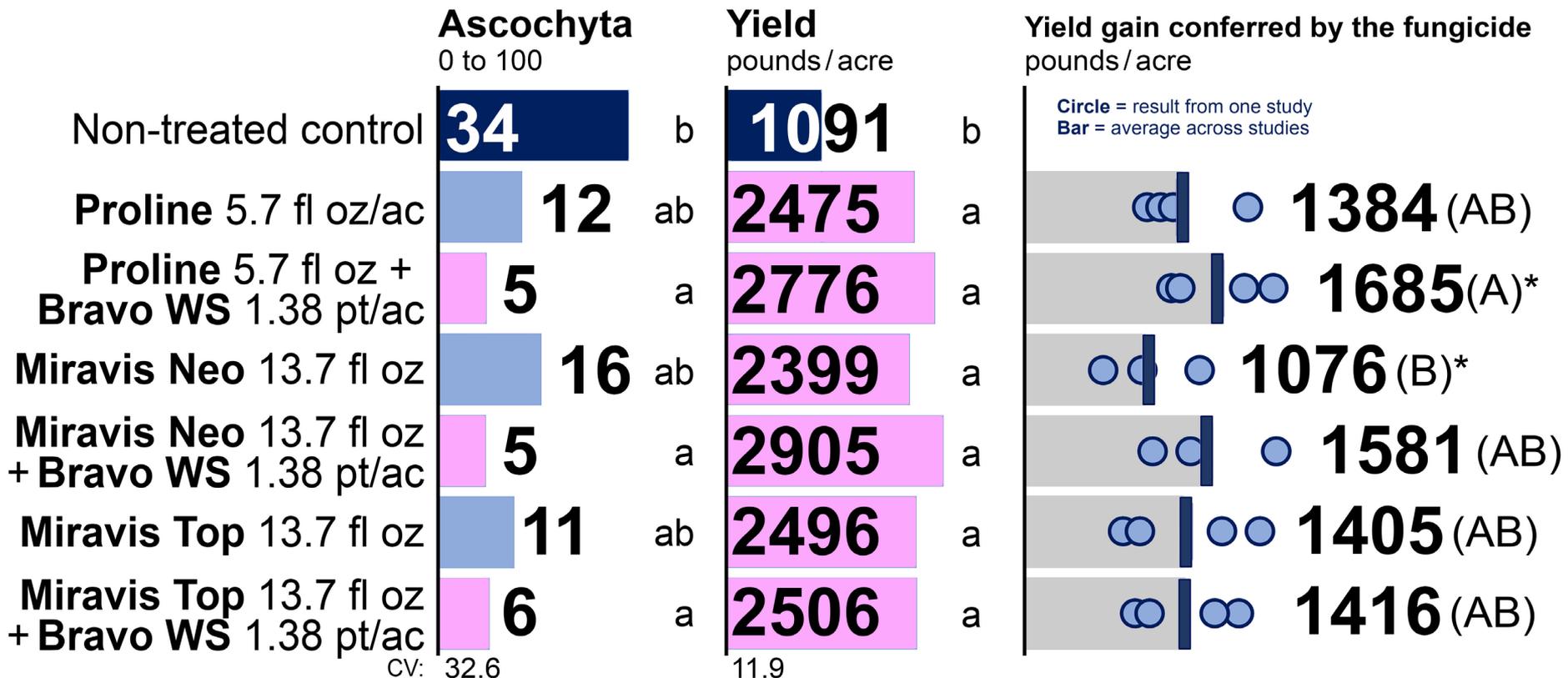
Priaxor has not performed well in Carrington in the past 3 seasons

MIRAVIS NEO is an alternative to Priaxor

primary SDHI mode of action (other a.i.'s have little/no efficacy)

performance in 2017, 2021, 2022

Miravis Neo should be applied with Bravo WS/generic chlorothalonil



within-column means followed by different letters significantly different ($P < 0.05$) or ($P < 0.10$) when followed by an asterisk

Implications for disease management

Poor efficacy of Priaxor in field trials the last 3 years

1. Priaxor is essentially a stand-alone SDHI fungicide.
 - The other fungicide in this premix (pyraclostrobin) is ineffective due to fungicide resistance.
2. Fungicide resistance has not been confirmed.
3. Resistance cannot be assumed, but the poor efficacy observed from 2020-2022 is a cause for concern.
4. Tank-mixing Priaxor with Bravo WS (chlorothalonil) reduces the risk of losses.
5. Miravis Neo is essentially a stand-alone SDHI given poor efficacy of other active ingredients in this premix.
 - This SDHI has continued to show efficacy but must tank-mixed with Bravo WS to provide satisfactory disease control.

Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 3 fungicides

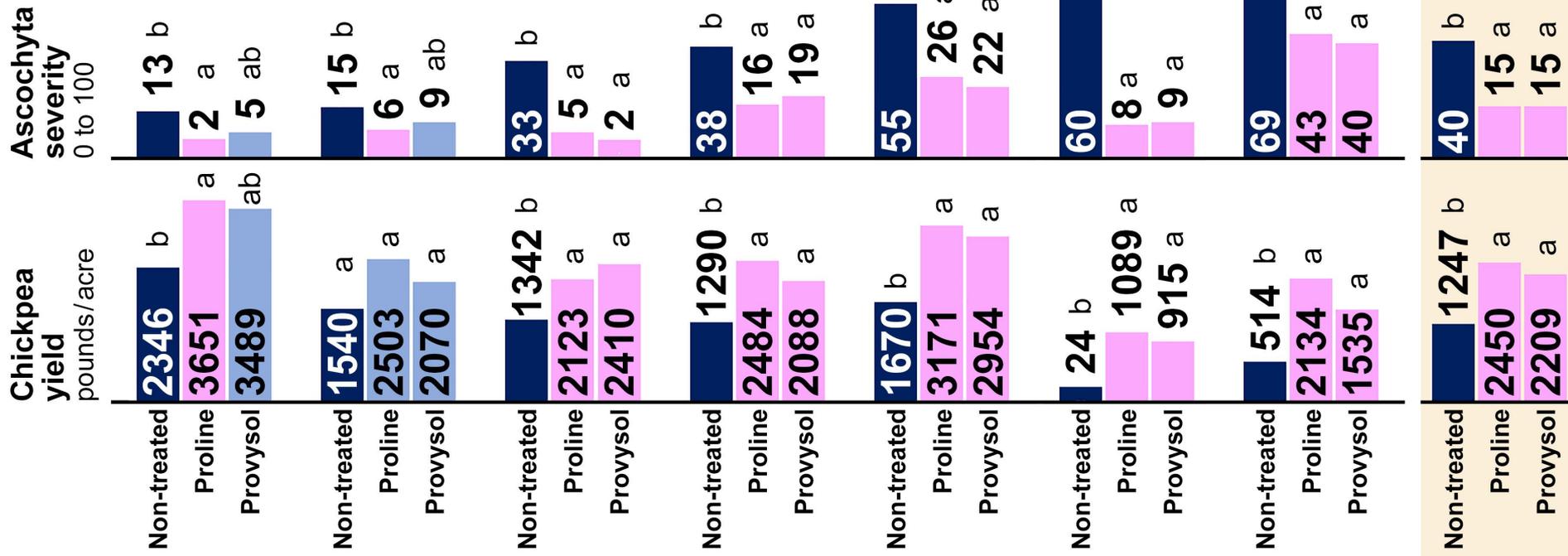
Provysol (mefentrifluconazole)

Provysol (3 fl oz) vs. Proline (5.7 fl oz/ac)

Year	2022	2021	2017	2021	2018	2019	2020
Location	Carrington, ND	Carrington, ND	Carrington	Carrington, ND	Carrington	Carrington	Carrington, ND
Variety	CDC 'Orion'	CDC 'Orion'	CDC 'Frontier'	CDC 'Orion'	CDC 'Frontier'	'CDC Frontier'	'CDC Orion'
First application	5% of plants with open blossom, 5% of plants with 1+ Ascochyta lesions	bloom initiation, 0% Ascochyta	20% of plants with an open blossom, 2% Ascochyta severity	bloom initiation, 0% Ascochyta	1% of plants with an open blossom, 2.5% Ascochyta severity	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions	90% of plants with open blossom; trace levels of Ascochyta
Number of applications	Three	Three	Five (10 to 14 days apart)	Three	Four (10-13 days apart)	Five (11-14 days apart)	four (11-14 days apart)
Nozzles	XR11002, 30 psi (app #1, 2) DG110015, 40 psi (app #3)	XR11002, 30 psi (app #1) DG110015, 30 psi (app #2, 3)	DG110015, 35 psi	XR11002, 30 psi (app #1) DG110015, 30 psi (app #2, 3)	DG110015, 40 psi	XR11002, 30 psi	XR11002, 30 psi
Droplet size	fine	fine (app #1), medium (app #2, 3)	fine	fine (app #1), medium (app #2, 3)	fine	fine	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 16	April 28	April 22	April 28	April 29	April 25	May 7-8
Disease assessments	July 28-29, Aug. 5-8	June 24, July 7, July 22	June 16, June 27, July 16, Aug. 10	June 24, July 8-12, July 28-29	June 16, July 20, Aug. 14	June 19, July 22, Aug. 22-24	June 26; July 30-31; Aug 31-Sept 1
Harvest date	Sept. 6	Aug. 17	Sept. 5	Aug. 18	Sept. 25	Oct. 7	Sept. 23-25
Seeding rate	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	5 viable seeds/sq ft	4.5 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	4.5 viable seeds/sq ft
Row spacing	7", 7 rows/plot	7", 7 rows/plot	7 inches, 7 rows/plot	7", 7 rows/plot	7 inches, 7 rows/plot	7.5 inches	7.5 inches, 7 rows/plot

Combined analysis (7 studies)

LOW disease pressure **HIGH**



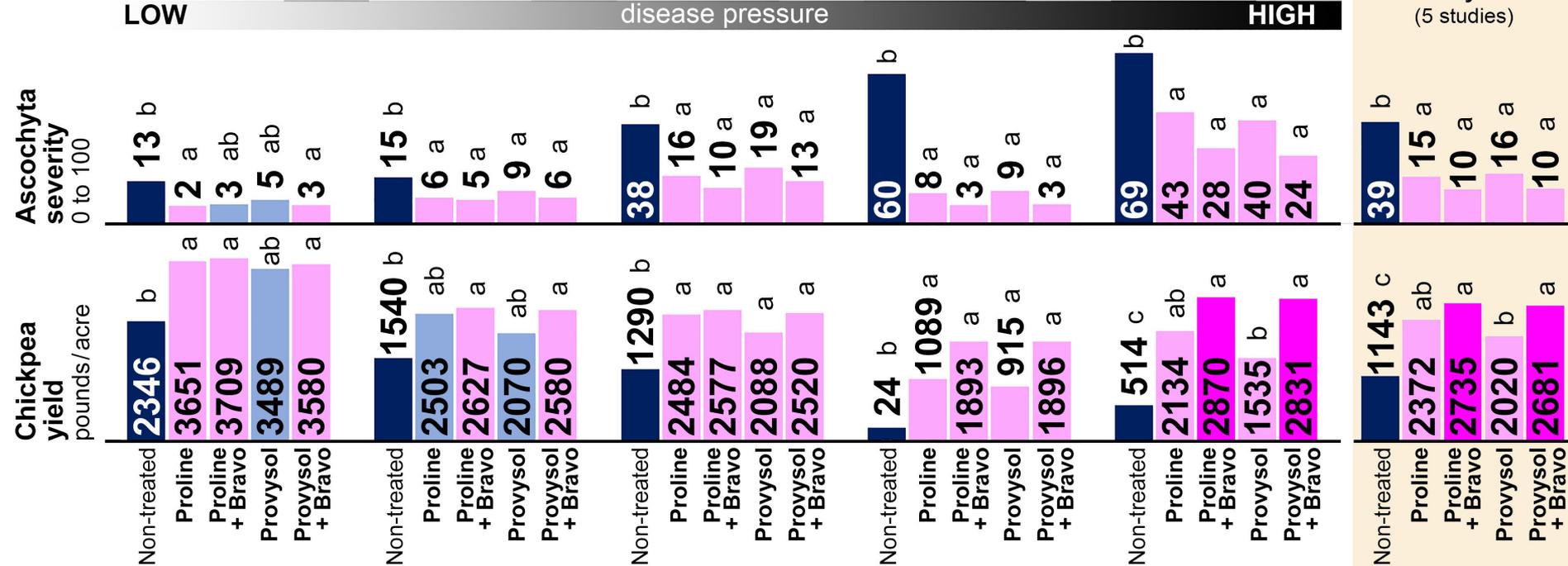
Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 3 fungicides

Provysol (mefentrifluconazole)

Provysol (3 fl oz) vs. Proline (5.7 fl oz/ac) with and without Bravo WeatherStik (1.38 pt/ac)

Year	2022	2021	2021	2019	2020
Location	Carrington, ND	Carrington, ND	Carrington, ND	Carrington	Carrington, ND
Variety	CDC 'Orion'	CDC 'Orion'	CDC 'Orion'	'CDC Frontier'	'CDC Orion'
First application	5% of plants with open blossom, 5% of plants with 1+ Ascochyta lesions	bloom initiation, 0% Ascochyta	bloom initiation, 0% Ascochyta	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions	90% of plants with open blossom; trace levels of Ascochyta
Number of applications	Three	Three	Three	Five (11-14 days apart)	four (11-14 days apart)
Nozzles	XR11002, 30 psi (app #1, 2) DG110015, 40 psi (app #3)	XR11002, 30 psi (app #1) DG110015, 30 psi (app #2, 3)	XR11002, 30 psi (app #1) DG110015, 30 psi (app #2, 3)	XR11002, 30 psi	XR11002, 30 psi
Droplet size	fine	fine (app #1), medium (app #2, 3)	fine (app #1), medium (app #2, 3)	fine	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 16	April 28	April 28	April 25	May 7-8
Disease assessments	July 28-29, Aug. 5-8	June 24, July 7, July 22	June 24, July 8-12, July 28-29	June 19, July 22, Aug. 22-24	June 26; July 30-31; Aug 31-Sept 1
Harvest date	Sept. 6	Aug. 17	Aug. 18	Oct. 7	Sept. 23-25
Seeding rate	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	4 viable seeds/sq ft	4.5 viable seeds/sq ft
Row spacing	7", 7 rows/plot	7", 7 rows/plot	7", 7 rows/plot	7.5 inches	7.5 inches, 7 rows/plot

Combined analysis (5 studies)

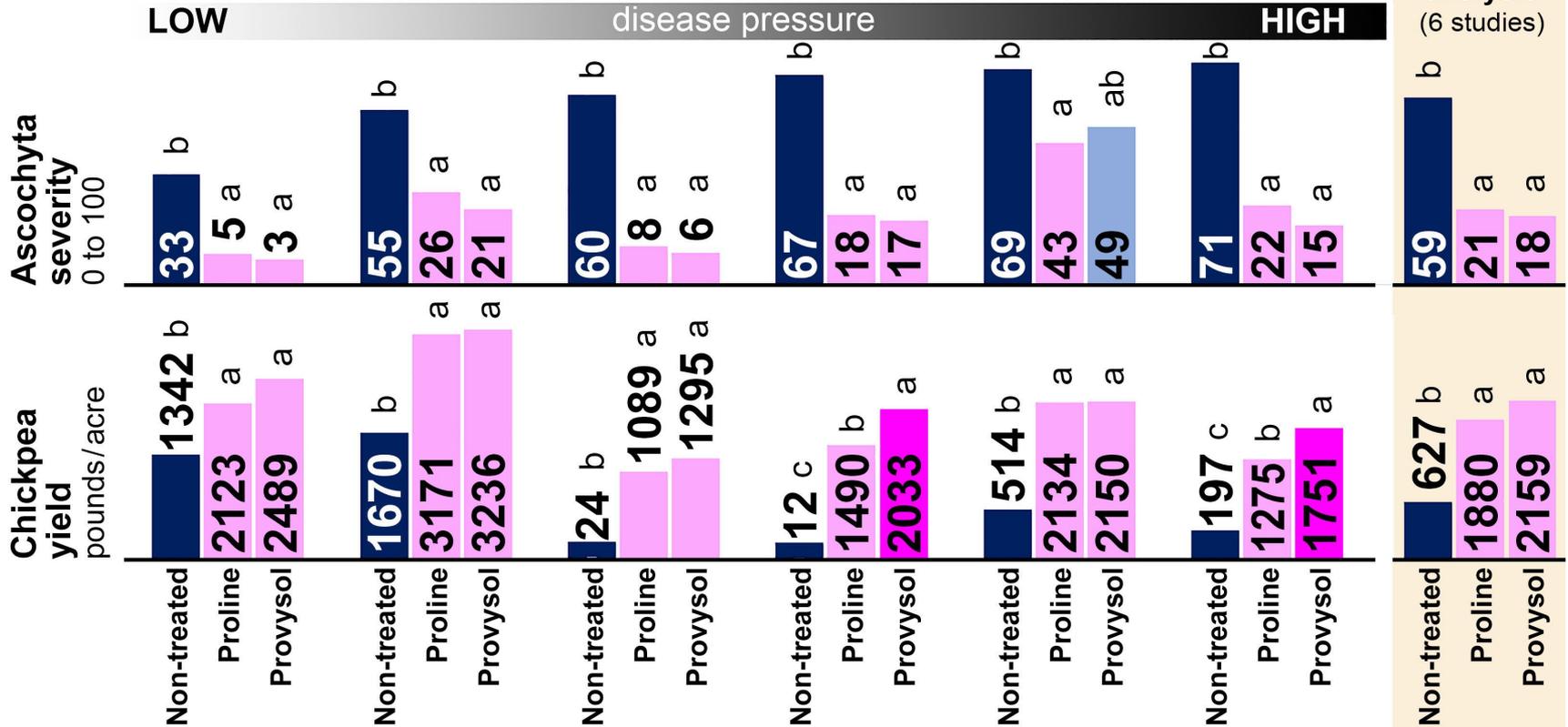


Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 3 fungicides

Provysol (mefentrifluconazole)

Provysol (5 fl oz) vs. Proline (5.7 fl oz/ac)

Year	2017	2018	2019	2015	2020	2016
Location	Carrington	Carrington	Carrington	Carrington	Carrington, ND	Carrington
Variety	CDC 'Frontier'	CDC 'Frontier'	'CDC Frontier'	CDC 'Alma'	CDC 'Orion'	CDC 'Orion'
First application	20% of plants with an open blossom, 2% Ascochyta severity	1% of plants with an open blossom, 2.5% Ascochyta severity	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions	late vegetative growth, 0.1% Ascochyta severity	90% of plants with open blossom; trace levels of Ascochyta	70% of plants with open blossom, 0.5% Ascochyta severity
Number of applications	Five (10 to 14 days apart)	Four (10-13 days apart)	Five (11-14 days apart)	Four (12 to 15 days apart)	four (11-14 days apart)	Six (12-15 days apart)
Nozzles	DG110015, 35 psi	DG110015, 40 psi	XR11002, 30 psi	XR80015 flat-fan nozzles, 40 psi	XR11002, 30 psi	XR80015 flat-fan, 35 psi
Droplet size	fine	fine	fine	fine	fine	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	April 22	April 29	April 25	April 23	May 7-8	April 22
Disease assessments	June 16, June 27, July 16, Aug. 10	June 16, July 20, Aug. 14	June 19, July 22, Aug. 22-24	June 25, July 27, Aug. 25	June 26; July 30-31; Aug 31-Sep 1	June 9; July 20, 29; Aug. 4, 16, 30
Harvest date	Sept. 5	Sept. 25	Oct. 7	Sept. 29	Sept. 23-25	Sept. 14
Seeding rate	5 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	4.5 viable seeds/sq ft	4 viable seeds/sq ft
Row spacing	7 inches, 7 rows/plot	7 inches, 7 rows/plot	7.5 inches	7 inches, 7 rows/plot	7.5 inches, 7 rows/plot	7 inches, 7 rows/plot



Fungicide efficacy – FRAC 3

Ascochyta blight of chickpeas

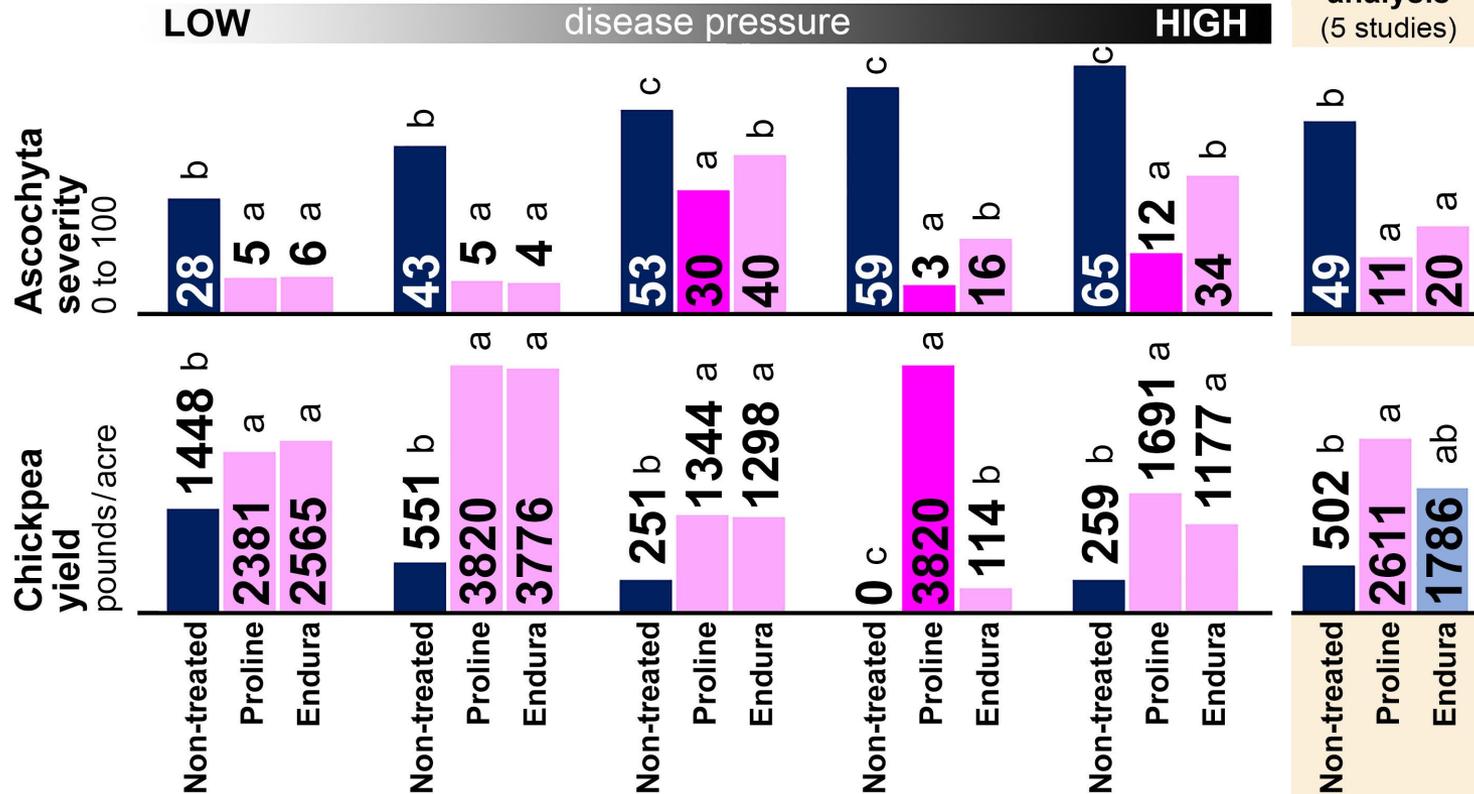
1. Provysol is an alternative to Proline with the same mode of action and comparable efficacy.
2. Provysol exhibits a rate response
 - 3 fl oz Provysol is a bit less effective than 5.7 fl oz Proline
 - 5 fl oz Provysol is a bit more effective than 5.7 fl oz Proline
3. Provysol performs very well when tank-mixed with Bravo WeatherStik (chlorothalonil)
 - 3 fl oz Provysol + 1.38 pt Bravo WS performs nearly identically to 5.7 fl oz Proline + 1.38 pt Bravo WS
 - 3 fl oz Provysol + 1.38 pt Bravo WS performs much better than 5 fl oz Provysol applied alone

Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 7 fungicides

Endura (boscalid)

Endura (8 oz) vs. Proline (5.7 fl oz/ac)

Year	2013	2010	2019	2009	2019
Location	Hofflund	Carrington	Carrington	Carrington	Carrington
Variety	CDC 'Frontier'	Sierra	CDC 'Frontier'	Sierra	CDC 'Frontier'
First application	10% of plants with open blossom, Ascochyta at trace levels	late vegetative growth, trace levels of disease	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions	late vegetative growth, Ascochyta at trace levels	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions
Number of applications	Three (13-17 days apart)	Four, 13-14 days apart	Five (11-14 days apart)	Three (14-15 days apart)	Five (11-14 days apart)
Nozzles	XR8002, 40 psi	TJ60-8002, 35 psi	XR11002, 30 psi	XR80015, 35 psi	XR11002, 30 psi
Droplet size	fine	very fine	fine	fine	fine
Spray volume	20 gal/ac	17 gal/ac	15 gal/ac	17 gal/ac	15 gal/ac
Planting date	May 6	May 18	April 25	May 22	April 25
Disease assessments	July 8, July 23, Aug. 12	June 25, Aug. 6, Aug. 20	June 19, July 23, Sept. 10	June 30; July 15, 27; Aug. 11, 31	June 19, July 23, Sept. 10
Harvest date	Sept. 16	Sept. 27	Oct. 30	Sept. 24	Oct. 30
Seeding rate	4.5 viable seeds/sq rt	4.5 viable seeds/sq rt	4 viable seeds/sq rt	4.5 viable seeds/sq rt	4 viable seeds/sq rt
Row spacing	7.5 inches, 7 rows/plot	7 inches, 7 rows/plot	7.5 inches, 7 rows/plot	7 inches, 7 rows/plot	7.5 inches, 7 rows/plot



Combined analysis
(5 studies)

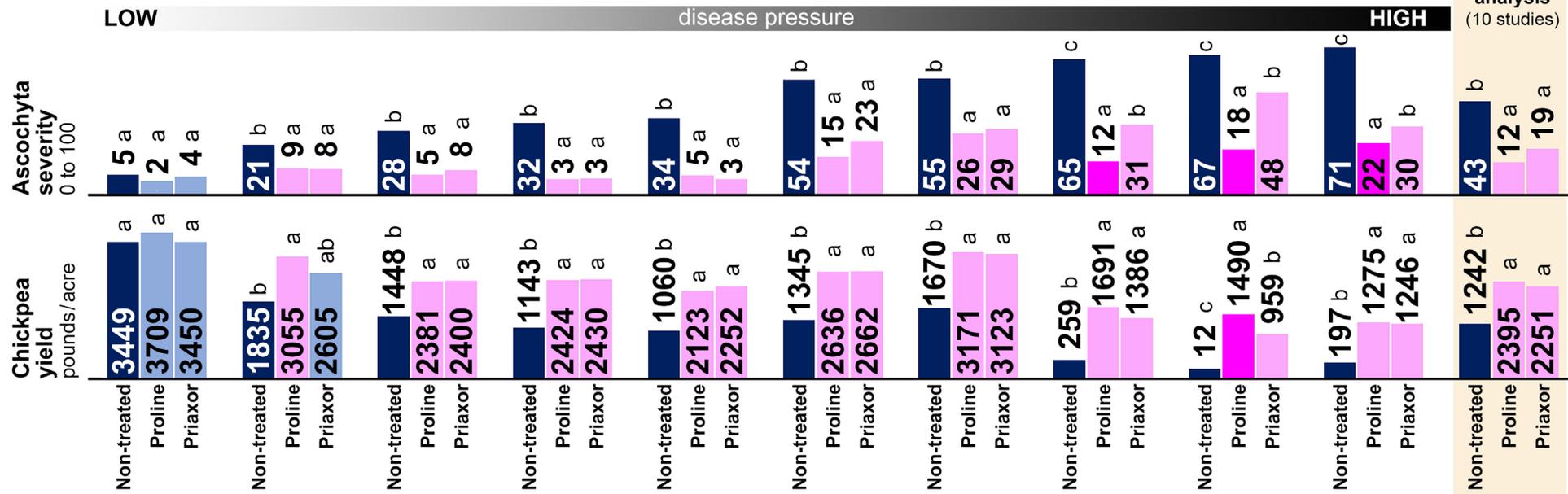
Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 7 fungicides

Priaxor (fluxapyroxad + pyraclostrobin)

Priaxor is essentially a stand-alone SDHI for Ascochyta blight management: pyraclostrobin has no efficacy against Ascochyta blight in chickpeas

Priaxor (4 fl oz) vs. Proline (5.7 fl oz/ac): Efficacy observed from 2012-2019

Year	2012	2012	2013	2017	2017	2018	2018	2019	2015	2016	
Location	Carrington	Hofflund	Hofflund	Carrington	Carrington	Carrington	Carrington	Carrington	Carrington	Carrington	
Variety	CDC 'Frontier'	CDC 'Frontier'	CDC 'Frontier'	CDC 'Frontier'	CDC 'Frontier'	CDC 'Frontier'	CDC 'Frontier'	CDC 'Frontier'	'CDC Leader'	CDC 'Alma'	CDC 'Orion'
First application	1% of plants with open blossom, 0.25% Ascochyta severity	<10% plants with open blossom, Ascochyta at trace levels	10% of plants with open blossom, Ascochyta at trace levels	20% of plants with open blossom, 2% Ascochyta severity	20% of plants with open blossom, 2% Ascochyta severity	1% of plants with open blossom, 2.5% Ascochyta severity	1% of plants with open blossom, 2.5% Ascochyta severity	1% of plants with open blossom, 3-5% of plants with 1+ Ascochyta lesions	late vegetative growth, 0.1% Ascochyta severity	70% of plants with open blossom, 0.5% Ascochyta severity	
Number of applications	Three (11-13 days apart)	Four (10-13 days apart)	Three (13-17 days apart)	Five (10 to 19 days apart)	Five (10 to 19 days apart)	Four (10-13 days apart)	Four (10-13 days apart)	Five (11-14 days apart)	Four (12 to 15 days apart)	Six (12-15 days apart)	
Nozzles	XR8001 flat-fan, 35 psi	XR8002 flat-fan, 40 psi	XR8002 flat-fan, 40 psi	DG110015, 35 psi	DG110015, 35 psi	DG110015, 40 psi	DG110015, 40 psi	XR11002, 30 psi	XR80015, 40 psi	XR80015 flat-fan, 35 psi	
Droplet size	fine	fine	fine	fine	fine	fine	fine	fine	fine	fine	
Spray volume	17.5 gal/ac	20 gal/ac	20 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	
Planting date	April 30	May 2	May 6	April 22	April 22	April 29	April 29	April 25	April 22	April 22	
Disease assessments	Three (June 20, July 5, July 18)	Three (June 27, July 7, July 22)	July 8, July 23, Aug. 12	June 16, June 27, July 16, Aug. 10	June 16, June 27, July 16, Aug. 10	June 16, June 27, July 23, Aug. 15	June 16, July 6, July 23, Aug. 15	June 19, July 23, Sept. 10	June 25, July 27, Aug. 25	June 9, July 20, 29; Aug. 4, 16, 30	
Harvest date	Aug. 13	Sept. 7	Sept. 16	Sept. 6	Sept. 6	Sept. 11	Sept. 11	Oct. 30	Sept. 29	Sept. 14	
Seeding rate	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	5 viable seeds/sq ft	5 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	
Row spacing	7 inches, 7 rows/plot	7 inches, 6 rows/plot	7.5 inches, 7 rows/plot	7 inches, 7 rows/plot	7 inches, 7 rows/plot	7 inches, 7 rows/plot	7 inches, 7 rows/plot	7.5 inches, 7 rows/plot	7 inches, 7 rows/plot	7 inches, 7 rows/plot	



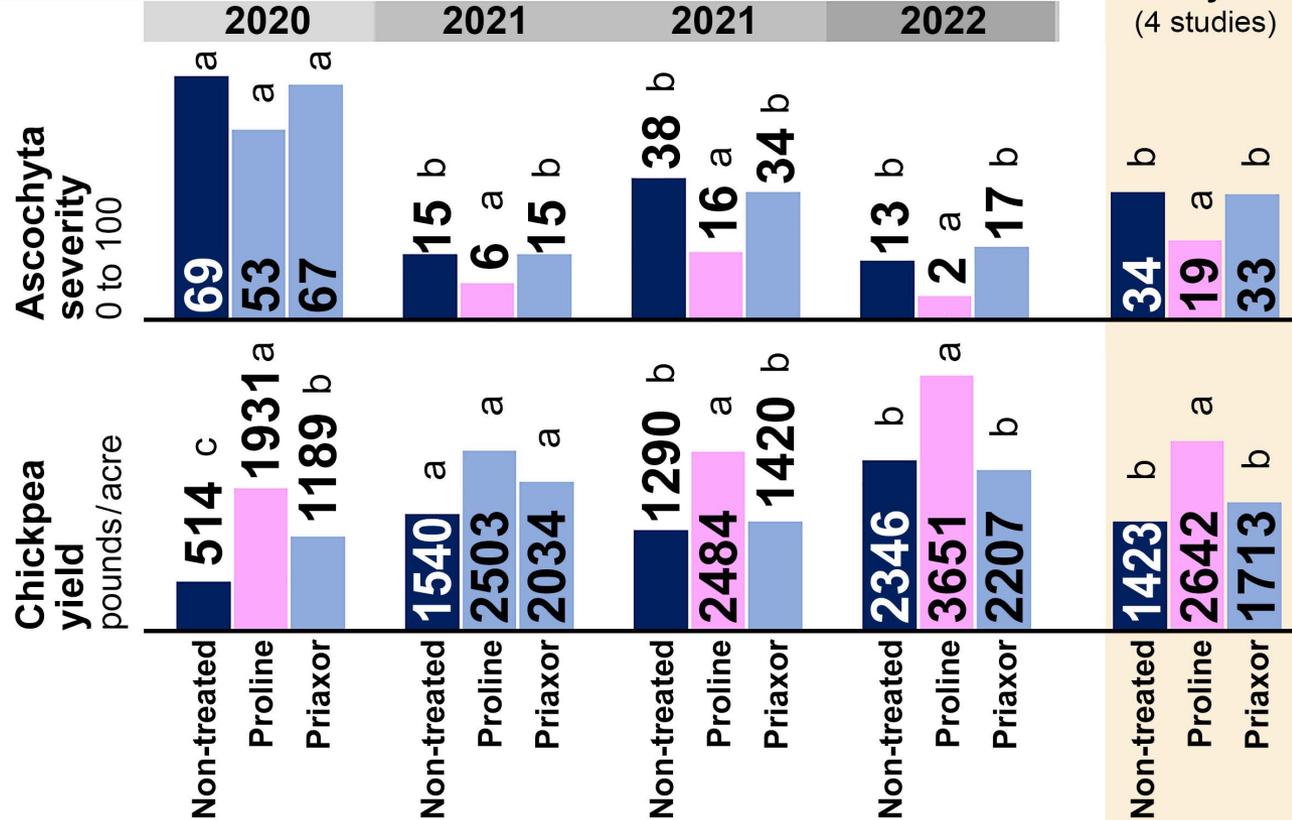
Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 7 fungicides

Priaxor (fluxapyroxad + pyraclostrobin)

**Priaxor (4 fl oz)
vs. Proline
(5.7 fl oz/ac):**

**Efficacy observed
from 2020-2022**

Year	2020	2021	2021	2022
Location	Carrington, ND	Carrington, ND	Carrington, ND	Carrington, ND
Variety	'CDC Orion'	CDC 'Orion'	CDC 'Orion'	CDC 'Orion'
First application	90% of plants with open blossom; trace levels of Ascochyta	bloom initiation, 0% Ascochyta	bloom initiation, 0% Ascochyta	5% of plants with open blossom, 5% of plants with 1+ Ascochyta lesions
Number of applications	four (11-14 days apart)	Three	Three	Three
Nozzles	XR11002, 30 psi	XR11002, 30 psi (app #1) DG110015, 30 psi (app #2, 3)	XR11002, 30 psi (app #1) DG110015, 30 psi (app #2, 3)	XR11002, 30 psi (app #1, 2) DG110015, 40 psi (app #3)
Droplet size	fine	fine (app #1), medium (app #2, 3)	fine (app #1), medium (app #2, 3)	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 7-8	April 28	April 28	May 16
Disease assessments	June 26; July 30-31; August 31-Sep	June 24, July 7, July 22	June 24, July 8-12, July 28-29	July 28-29, Aug. 5-8
Harvest date	Sept. 23-25	Aug. 17	Aug. 18	Sept. 6
Seeding rate	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft
Row spacing	7.5 inches, 7 rows/plot	7", 7 rows/plot	7", 7 rows/plot	7", 7 rows/plot



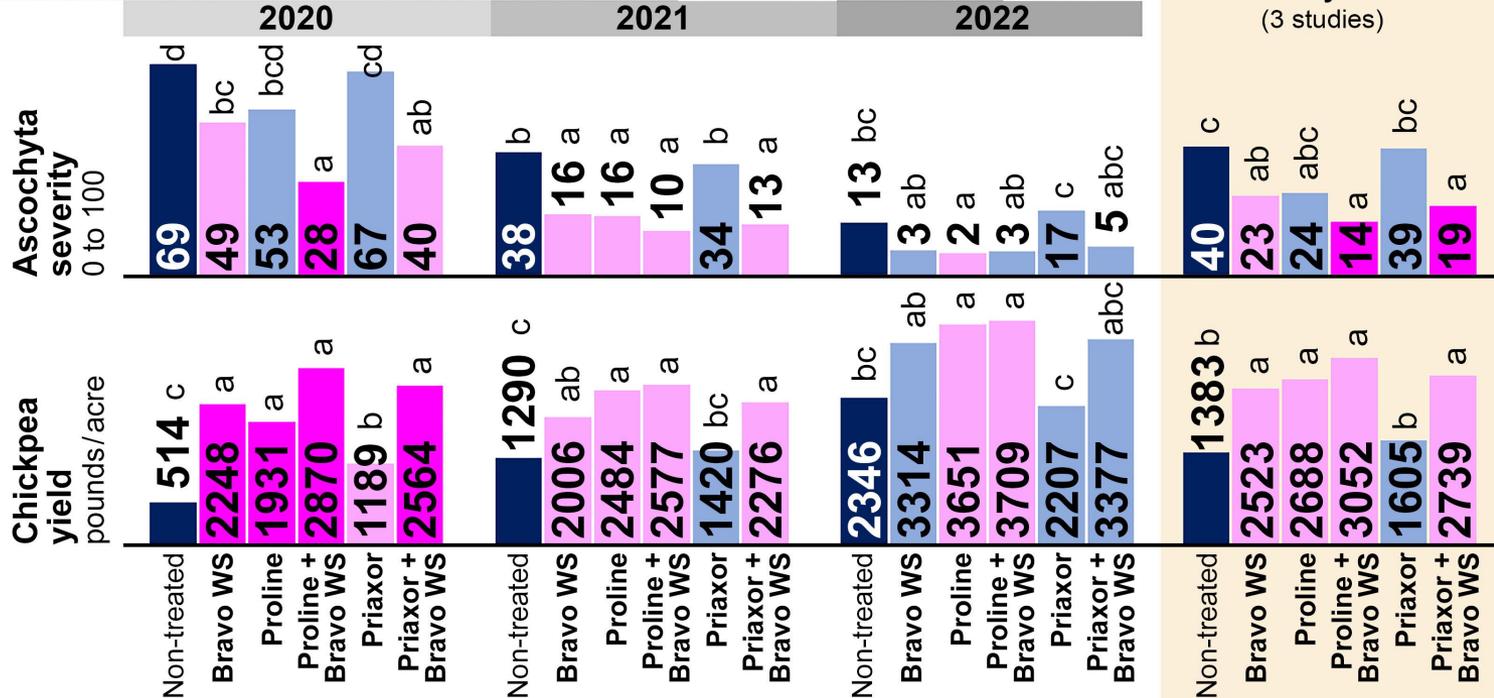
Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 7 fungicides

Priaxor (fluxapyroxad + pyraclostrobin)

Priaxor (4 fl oz) vs. Proline (5.7 fl oz/ac): Efficacy observed from 2020-2022

with and without Bravo WeatherStik (chlorothalonil)

Year	2020	2021	2022
Location	Carrington, ND	Carrington, ND	Carrington, ND
Variety	'CDC Orion'	CDC 'Orion'	CDC 'Orion'
First application	90% of plants with open blossom; trace levels of Ascochyta	bloom initiation, 0% Ascochyta	5% of plants with open blossom; 5% of plants with 1+ Ascochyta lesions
Number of applications	four (11-14 days apart)	Three	Three
Nozzles	XR11002, 30 psi	XR11002, 30 psi (app #1) DG110015, 30 psi (app #2, 3)	XR11002, 30 psi (app #1, 2) DG110015, 40 psi (app #3)
Droplet size	fine	fine (app #1), medium (app #2, 3)	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 7-8	April 28	May 16
Disease assessments	June 26; July 30-31; August 31-Sep	June 24, July 8-12, July 28-29	July 28-29, Aug. 5-8
Harvest date	Sept. 23-25	Aug. 18	Sept. 6
Seeding rate	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft
Row spacing	7.5 inches, 7 rows/plot	7", 7 rows/plot	7", 7 rows/plot



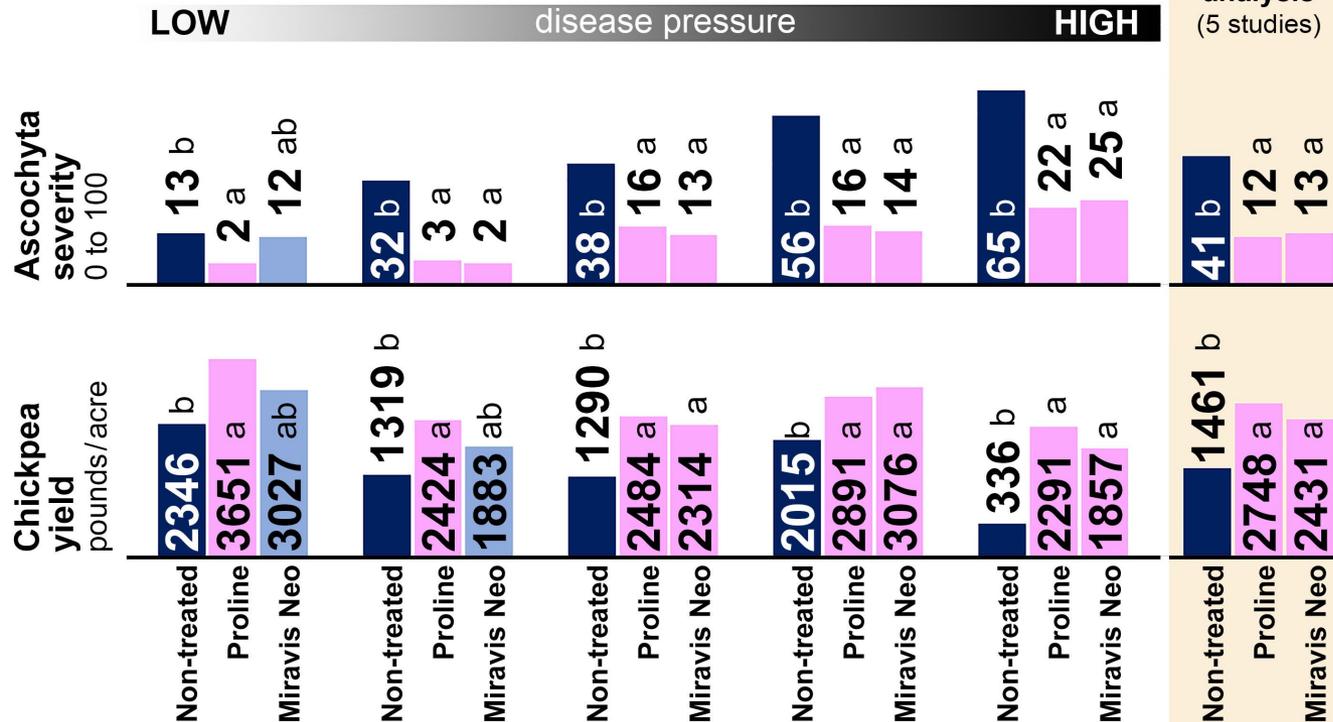
Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 7 fungicides

Miravis Neo (pydiflumetofen + azoxystrobin + propiconazole)

Miravis Neo is essentially a stand-alone SDHI for Ascochyta blight management:
 azoxystrobin and propiconazole have little/no efficacy against Ascochyta blight in chickpeas

Miravis Neo (13.7 fl oz) vs. Proline (5.7 fl oz/ac):

	2022	2017	2021	2018	2019
	Carrington CDC 'Orion'	Carrington CDC 'Frontier'	Carrington CDC 'Orion'	Carrington CDC 'Frontier'	Carrington CDC 'Frontier'
First application	5% plants in bloom, 3-5% plants with 1+ Ascochyta lesions	20% of plants with an open blossom, 2% Ascochyta severity	bloom initiation, 0% Ascochyta	1% of plants with an open blossom, 2.5% Ascochyta severity	Late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions
Number of applications	Three	Five	Three	Four	Five
Nozzles	XR11002, 30 psi (app #1, 2); DG110015, 40 psi (app #3)	DG110015 flat-fan nozzles, 35 psi	XR11002 @ 30 psi (app #1), DG110015 @ 30 psi (app #2, 3)	DG110015 flat-fan, 40 psi	XR11002, 30 psi
Droplet size:	fine	medium	fine (app #1), medium (#2, 3)	fine	fine
Spray volume:	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 16	April 22	April 28	April 29	April 25
Disease assessments	July 28-29, Aug. 5-8	June 16, June 27, July 16, Aug. 10	June 24, July 8-12, July 28-29	June 16, July 6, July 20, Aug. 15	June 18, July 22-23, Sept. 10
Harvest date	Sept. 6	Sept. 5	Aug. 18	Sept. 25	Oct. 7
Seeding rate	4.5 viable seeds/sq ft	5 viable seeds/sq ft	4.5 viable seeds	4 viable seeds/sq ft	4 viable seeds/sq ft
Row spacing	7", 7 rows/plot	7 inches, 7 rows/plot	7", 7 rows/plot	7 inches, 7 rows/plot	7.5 inches



Combined analysis
(5 studies)

Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 7 fungicides

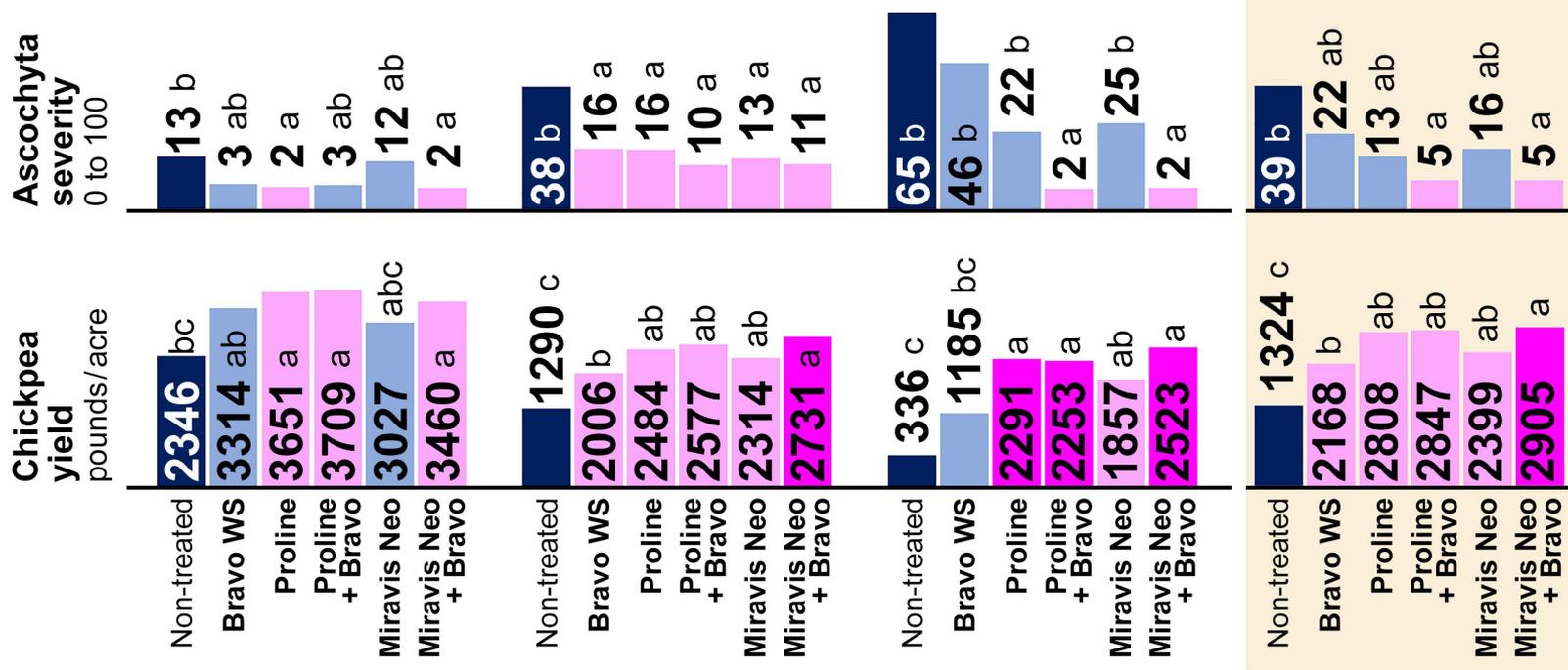
Miravis Neo (pydiflumetofen + azoxystrobin + propiconazole)

Miravis Neo (13.7 fl oz) vs. Proline (5.7 fl oz/ac)
with and without 1.38 pt/ac Bravo WeatherStik (chlorothalonil)

	2022	2021	2019
	Carrington, ND	Carrington, ND	Carrington
	CDC 'Orion'	CDC 'Orion'	CDC 'Leader'
First application	5% plants in bloom, 3-5% plants with 1+ Ascochyta lesions	bloom initiation, 0% Ascochyta	Late vegetative growth, 3-5% plants with 1+ Ascochyta lesions
Number of applications	Three	Three	Five
Nozzles	XR11002 @ 30 psi (app #1, 2) DG110015 @ 40 psi (app #3)	XR11002 @ 30 psi (app #1) DG110015 @ 30 psi (app #2, 3)	XR11002, 30 psi
Droplet size:	fine	fine (app #1), medium (#2, 3)	fine
Spray volume:	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 16	April 28	April 25
Disease assessments	July 28-29, Aug. 5-8	June 24, July 8-12, July 28-29	June 18, July 22-23, Sept. 10
Harvest date	Sept. 6	Aug. 18	Oct. 7
Seeding rate	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	4 viable seeds/sq ft
Row spacing	7", 7 rows/plot	7", 7 rows/plot	7.5", 7 rows/plot

LOW disease pressure **HIGH**

Combined analysis
(3 studies)



Fungicide efficacy – FRAC 7

Ascochyta blight of chickpeas

1. Endura exhibits poor efficacy against Ascochyta blight of chickpeas.
2. Priaxor has shown poor efficacy in field trials since 2020.
3. Miravis Neo (13.7 fl oz/ac) has performed well but must be tank-mixed with Bravo WS (1.38 pt/ac) for satisfactory efficacy.

Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 3 + 7 fungicides

Miravis Top (pydiflumetofen + difenoconazole)

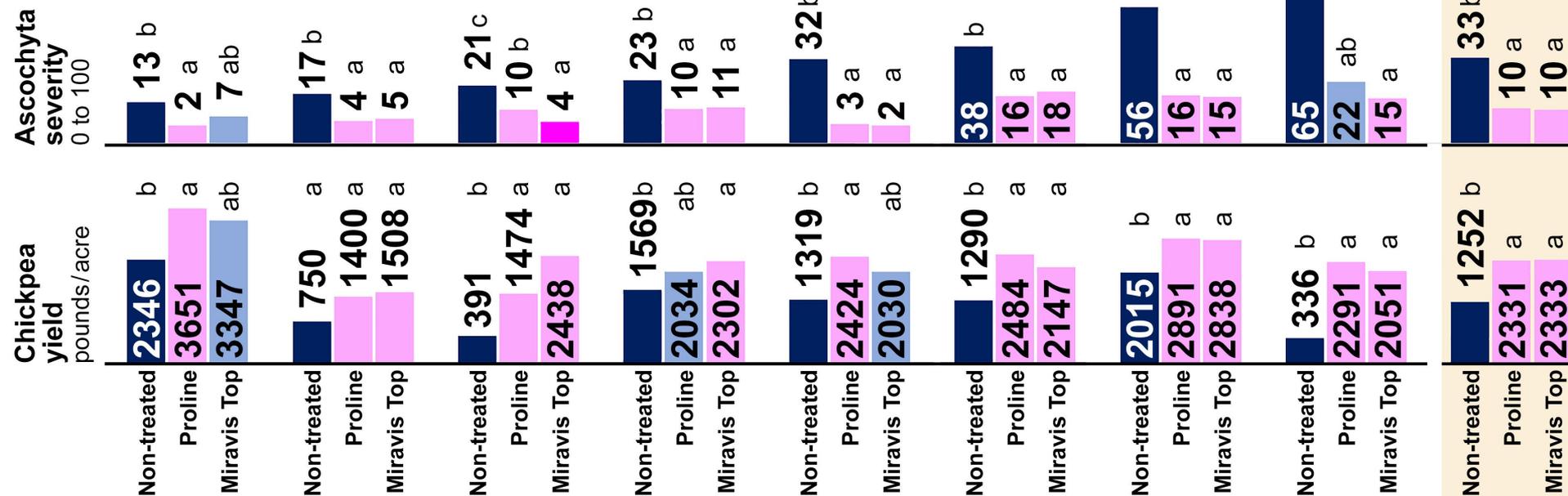
Miravis Top (13.7 fl oz) vs. Proline (5.7 fl oz/ac):

Year	2022	2022	2019	2021	2017	2021	2018	2019
Location	Carrington, ND	Carrington, ND	Hofflund, ND	Carrington, ND	Carrington	Carrington, ND	Carrington	Carrington
Variety	CDC Orion	CDC Orion	'CDC Frontier'	CDC Orion	CDC 'Frontier'	CDC Orion	CDC 'Frontier'	'CDC Leader'
First application	5% of plants with open blossom, 5% of plants with 1+ Ascochyta lesions)	5% of plants with open blossom, 5% of plants with 1+ Ascochyta lesions)	5% bloom initiation, average 1.3% Ascochyta severity	bloom initiation, 0% Ascochyta	20% of plants with an open blossom, 2% Ascochyta severity	bloom initiation, 0% Ascochyta	1% of plants with an open blossom, 2.5% Ascochyta severity	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions
Number of applications	Three	Three	three (13-15 days apart)	Three	Five (10 to 14 days apart)	Three	Four (10-13 days apart)	Five (12-14 days apart)
Nozzles	XR11002, 30 psi (app. #1, 2) DG110015, 40 psi (app. #3)	XR11002, 30 psi (app. #1, 2) DG110015, 40 psi (app. #3)	Wilger ER110-015, 40 psi	XR11002 @ 30 psi (app #1) DG110015 @ 30 psi (app #2, 3)	DG110015, 35 psi	XR11002 @ 30 psi (app #1) DG110015 @ 30 psi (app #2, 3)	DG110015 flat-fan, 40 psi	XR11002, 30 psi
Droplet size	fine	fine	fine	fine (app #1), medium (#2, 3)	medium	fine (app #1), medium (#2, 3)	fine	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15	15 gal/ac	15	15 gal/ac
Planting date	May 16	May 16	Apr. 24	April 28	April 22	April 28	April 29	April 25
Disease assessments	July 28-29, Aug. 5-8	July 25, Aug. 4	three (June 25, July 11, Aug. 5)	June 24, July 7, July 22	June 16, June 27, July 16, Aug. 10	June 24, July 8-12, July 28-29	June 16, July 6, July 20, Aug. 15	June 18, July 22-23, Sept. 10
Harvest date	Sept. 6	Sept. 6	Sept. 6	Aug. 17	Sept. 5	Aug. 18	Sept. 25	Oct. 7
Seeding rate	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	6 viable seeds/sq ft	4.5 viable seeds/sq ft	5 viable seeds/sq ft	4.5 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft
Row spacing	7", 7 rows/plot	7", 7 rows/plot	7.5 inches	7", 7 rows/plot	7 inches, 7 rows/plot	7", 7 rows/plot	7 inches, 7 rows/plot	7.5 inches

LOW

disease pressure

HIGH



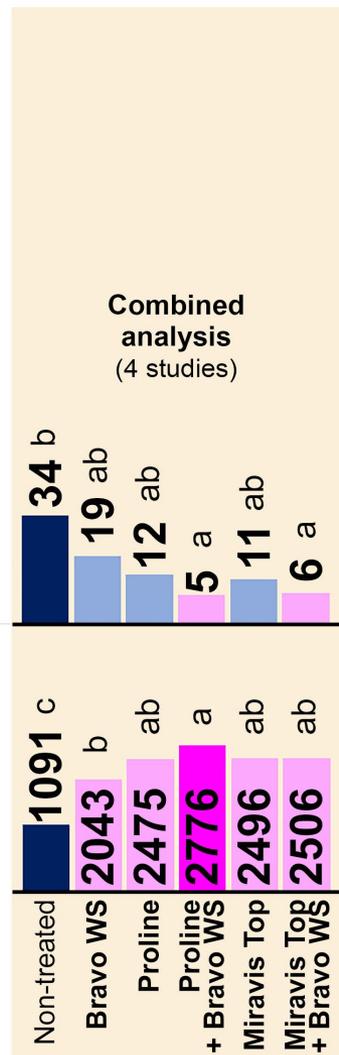
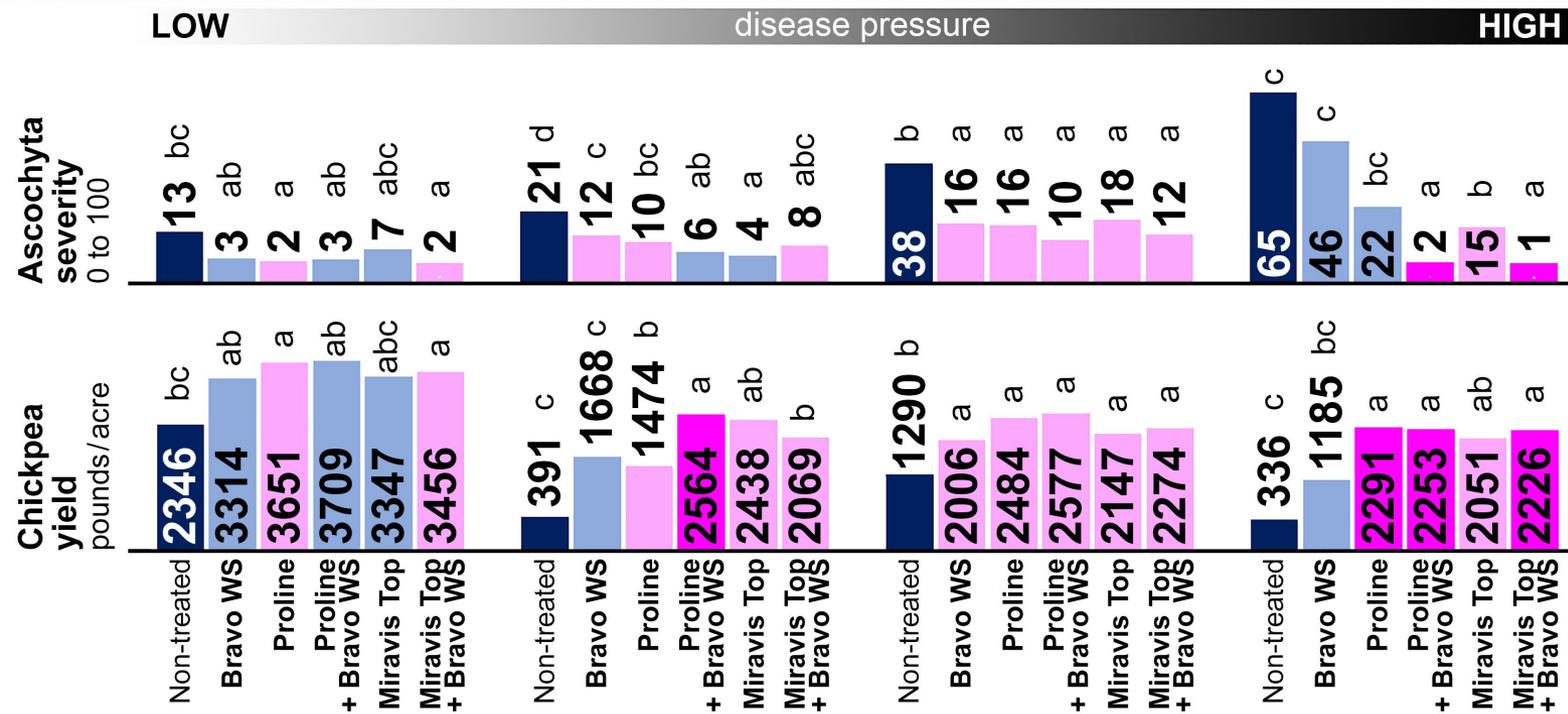
Combined analysis (8 studies)

Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 3 + 7 fungicides

Miravis Top (pydiflumetofen + difenoconazole)

Miravis Top (13.7 fl oz) vs. Proline (5.7 fl oz/ac)
 applied with and without Bravo WeatherStik (1.38 pt/ac)

Year	2022	2019	2021	2019
Location	Carrington, ND	Hofflund, ND	Carrington, ND	Carrington
Variety	CDC Orion	'CDC Frontier'	CDC Orion	'CDC Leader'
First application	5% of plants with open blossom, 5% of plants 1+ Ascochyta lesions)	bloom initiation, average 1.3% Ascochyta severity	bloom initiation, 0% Ascochyta	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions
Number of applications	Three	three (13-15 days apart)	Three	Five (12-14 days apart)
Nozzles	XR11002, 30 psi (app. #1, 2) DG110015, 40 psi (app. #3)	Wilger ER110-015, 40 psi	XR11002 @ 30 psi (app #1) DG110015 @ 30 psi (app #2, 3)	XR11002, 30 psi
Droplet size	fine	fine	fine (app #1), medium (#2, 3)	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 16	Apr. 24	April 28	April 25
Disease assessments	July 28-29, Aug. 5-8	three (June 25, July 11, Aug. 5)	June 24, July 8-12, July 28-29	June 18, July 22-23, Sept. 10
Harvest date	Sept. 6	Sept. 6	Aug. 18	Oct. 7
Seeding rate	4.5 viable seeds/sq ft	6 viable seeds/sq ft	4.5 viable seeds/sq ft	4 viable seeds/sq ft
Row spacing	7", 7 rows/plot	7.5 inches	7", 7 rows/plot	7.5 inches

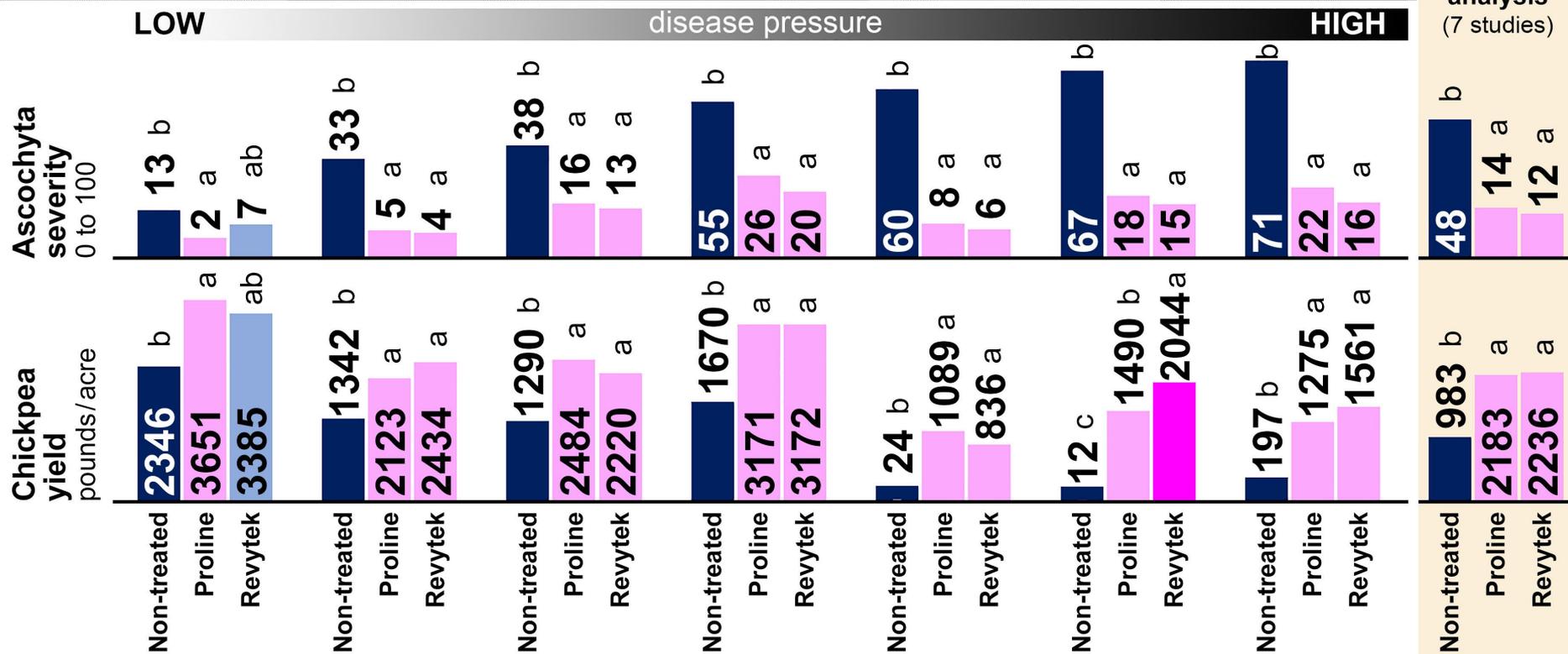


Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 3 + 7 fungicides

Revytek (mefentrifluconazole + fluxapyroxad + pyraclostrobin)

Revytek (8 fl oz) vs. Proline (5.7 fl oz/ac)

Year	2022	2017	2021	2018	2019	2015	2016
Location	Carrington, ND	Carrington	Carrington, ND	Carrington	Carrington	Carrington	Carrington
Variety	CDC 'Orion'	CDC 'Frontier'	CDC 'Orion'	CDC 'Frontier'	'CDC Frontier'	CDC 'Alma'	CDC 'Orion'
First application	5% of plants with open blossom, 5% of plants with 1+ Ascochyta lesions	20% of plants with an open blossom, 2% Ascochyta severity	bloom initiation, 0% Ascochyta	1% of plants with an open blossom, 2.5% Ascochyta severity	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions	late vegetative growth, 0.1% Ascochyta severity	70% of plants with open blossom, 0.5% Ascochyta severity
Number of applications	Three	Five (10 to 14 days apart)	Three	Four (10-13 days apart)	Five (11-14 days apart)	Four (12 to 15 days apart)	Six (12-15 days apart)
Nozzles	XR11002, 30 psi (app #1, 2) DG110015, 40 psi (app #3)	DG110015, 35 psi	XR11002, 30 psi (app #1) DG110015, 30 psi (app #2, 3)	DG110015, 40 psi	XR11002, 30 psi	XR80015 flat-fan nozzles, 40 psi	XR80015 flat-fan, 35 psi
Droplet size	fine	fine	fine (app #1), medium (app #2, 3)	fine	fine	fine	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 16	April 22	April 22	April 29	April 25	April 23	April 22
Disease assessments	July 28-29, Aug. 5-8	June 16, June 27, July 16, Aug. 10	June 24, July 8-12, July 28-29	June 16, July 20, Aug. 14	June 19, July 22, Aug. 22-24	June 25, July 27, Aug. 25	June 9, July 20, 29, Aug. 4, 16, 30
Harvest date	Sept. 6	Sept. 5	Aug. 18	Sept. 25	Oct. 7	Sept. 29	Sept. 14
Seeding rate	4.5 viable seeds/sq ft	5 viable seeds/sq ft	4.5 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft	4 viable seeds/sq ft
Row spacing	7", 7 rows/plot	7 inches, 7 rows/plot	7", 7 rows/plot	7 inches, 7 rows/plot	7.5 inches	7 inches, 7 rows/plot	7 inches, 7 rows/plot

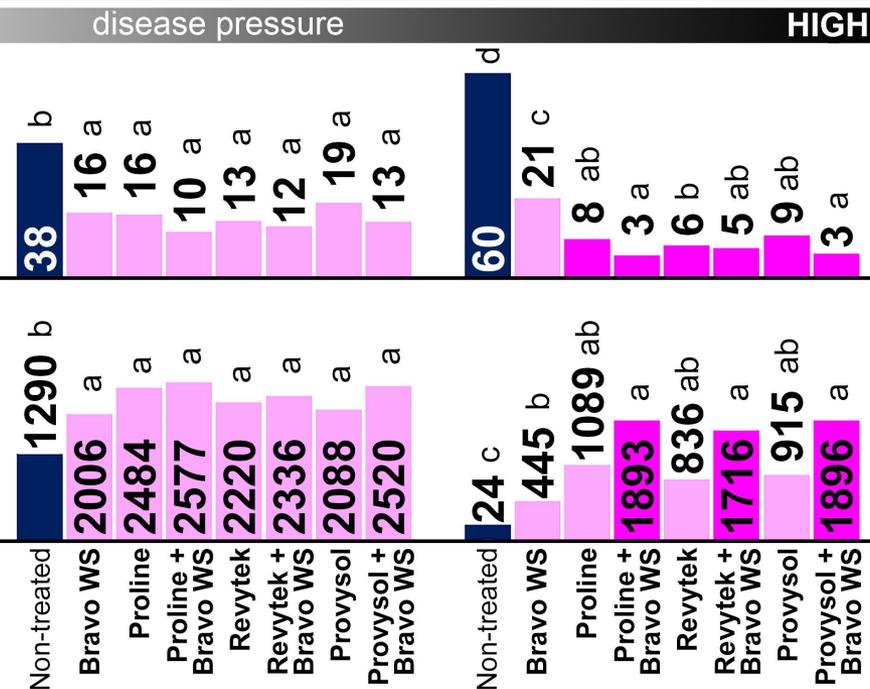
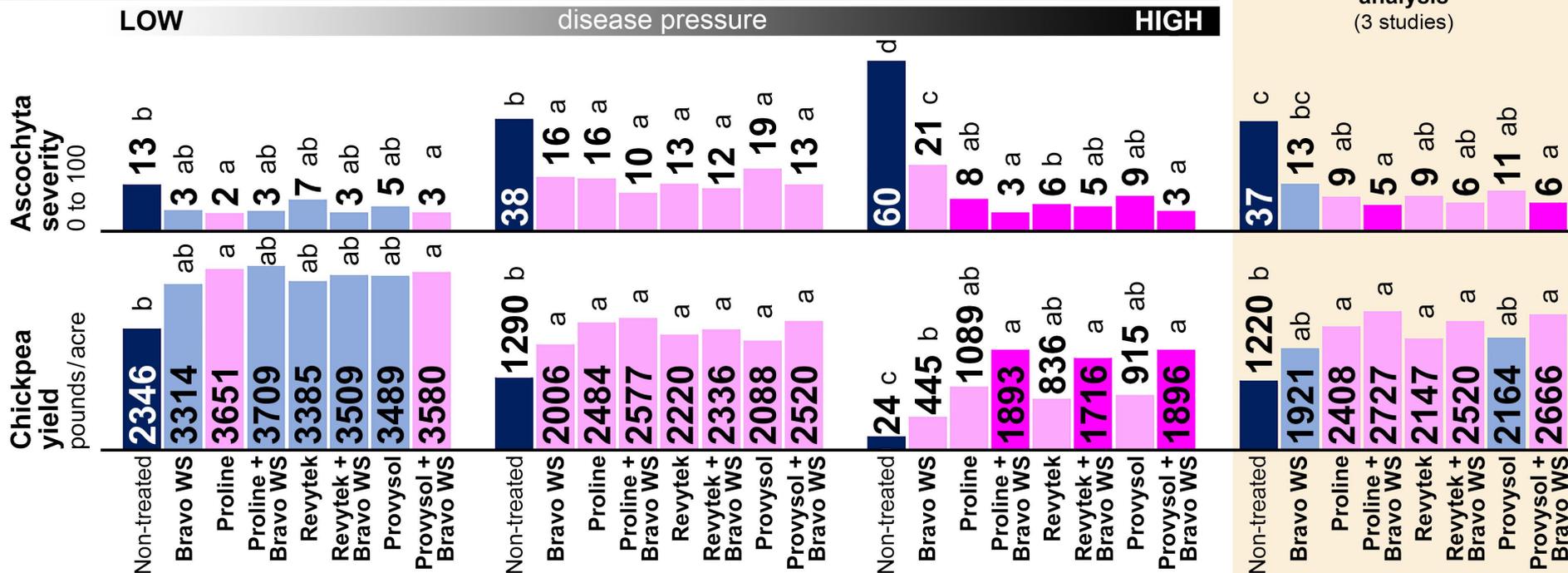
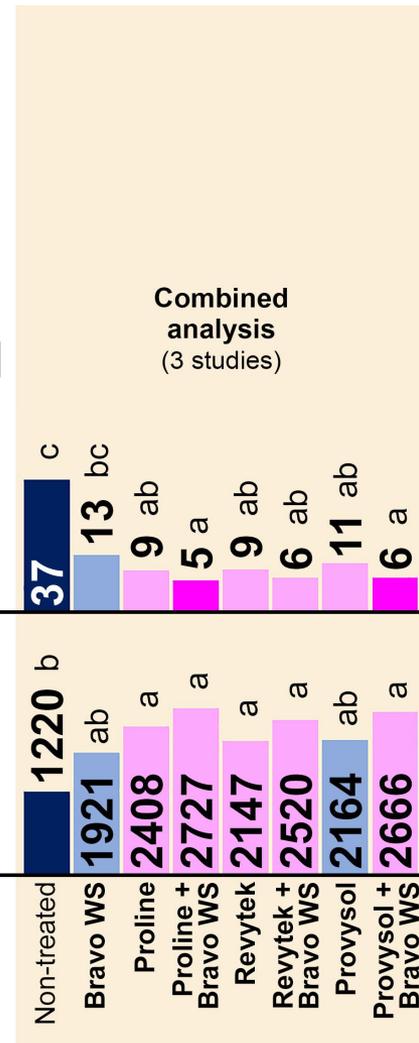


Fungicide efficacy, Ascochyta blight of chickpeas: FRAC 3 + 7 fungicides

Revytek (mefentrifluconazole + fluxapyroxad + pyraclostrobin)

Revytek (8 fl oz) vs. Proline (5.7 fl oz) vs. Provysol (3 fl oz/ac)
 applied with and without Bravo WeatherStik (1.38 pt/ac)

Year	2022	2021	2019
Location	Carrington, ND	Carrington, ND	Carrington
Variety	CDC 'Orion'	CDC 'Orion'	'CDC Frontier'
First application	5% of plants with open blossom, 5% of plants with 1+ Ascochyta lesions	bloom initiation, 0% Ascochyta	late vegetative growth, 3-5% of plants with 1+ Ascochyta lesions
Number of applications	Three	Three	Five (11-14 days apart)
Nozzles	XR11002, 30 psi (app #1, 2), DG110015, 40 psi (app #3)	XR11002, 30 psi (app #1), DG110015, 30 psi (app #2, 3)	XR11002, 30 psi
Droplet size	fine	fine (app #1), medium (app #2, 3)	fine
Spray volume	15 gal/ac	15 gal/ac	15 gal/ac
Planting date	May 16	April 28	April 25
Disease assessments	July 28-29, Aug. 5-8	June 24, July 8-12, July 28-29	June 19, July 22, Aug. 22-24
Harvest date	Sept. 6	Aug. 18	Oct. 7
Seeding rate	4.5 viable seeds/sq ft	4.5 viable seeds/sq ft	4 viable seeds/sq ft
Row spacing	7", 7 rows/plot	7", 7 rows/plot	7.5 inches



Ascochyta severity
0 to 100

Chickpea yield
pounds/acre

Combined analysis
(3 studies)

LOW

disease pressure

HIGH

Fungicide efficacy – FRAC 3 + 7

Ascochyta blight of chickpeas

1. Miravis Top and Proline exhibit similar efficacy
 - Miravis Top contains the same SDHI fungicide as Miravis Neo plus difenoconazole, a triazole with intermediate efficacy against Ascochyta blight
2. Revytek (8 fl oz) exhibits similar efficacy as Provysol (3 fl oz) and Proline (5.7 fl oz)
 - Revytek contains the same SDHI fungicide as Priaxor and the same triazole fungicide as Provysol.
 - A loss of efficacy of Priaxor will negatively impact the performance of Revytek.



Thank you!

Your check-off dollars helped support this research.

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