



Ascochyta blight of chickpeas: Comparative fungicide efficacy

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Improving the management of Ascochyta blight in chickpeas:

Fungicide efficacy - methods

Market class = testing was conducted on Kabuli chickpea varieties with partial Ascochyta resistance adapted to the Northern Plains (generally CDC Frontier, CDC Leader, or CDC Orion)

Row spacing = 7 inches

Seeding rate = 4.0, 4.5 or 5.0 viable seeds/square foot

Fungicide spray volume = 15 gal/ac in most studies; 17 or 17.5 gal/ac in some of the early research

Most of the testing was conducted with fungicides applied with a hand-held boom pressurized by CO₂. Some of the testing with Proline vs. Proline + Bravo WS was conducted with a tractor-mounted, PTO-driven sprayer.

Fungicide spray droplet size: fine (2009-2022) or calibrated relative to canopy characteristics (fine, medium or coarse, 2023-2024).

Number of fungicide applications: as needed relative to rainfall patterns; 3, 4, 5, or 6 applications 10-14 days apart, depending on the year.

Application timing in fungicide efficacy studies: First appearance of disease symptoms or early bloom, whichever occurred first. Never prior to late vegetative growth.

Number of experimental replicates = 4, 5 or 6 (depending on the study)

Disease development was facilitated by spreading small quantities of overwintered diseased chickpea residues in non-harvested plots separating treatment plots

Ascochyta disease assessment: Minimum three assessments (concurrent with first fungicide application and then twice during pod-fill, including once shortly before senescence). Disease is reported on a 0 to 100 scale corresponding to disease progress from the first fungicide application to the last disease rating (relative area under the disease progress curve)

Yield: Grain yields were calculated on the basis of the measured plot length at harvest and the grain moisture at harvest and are reported at a standard 13.5% moisture level.

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Part 1: The most effective fungicides

Proline (5.7 fl oz/ac) + Bravo WeatherStik (1.38 pt/ac)

prothioconazole (FRAC 3) chlorothalonil (FRAC M)

Provysol (5 fl oz/ac) + Bravo WeatherStik (1.38 pt/ac)

mefentrifluonazole (FRAC 3) chlorothalonil (FRAC M)

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Tank-mixing **Bravo WS** (1.38 pt/ac) with **Proline** (5.7 fl oz) sharply improves efficacy

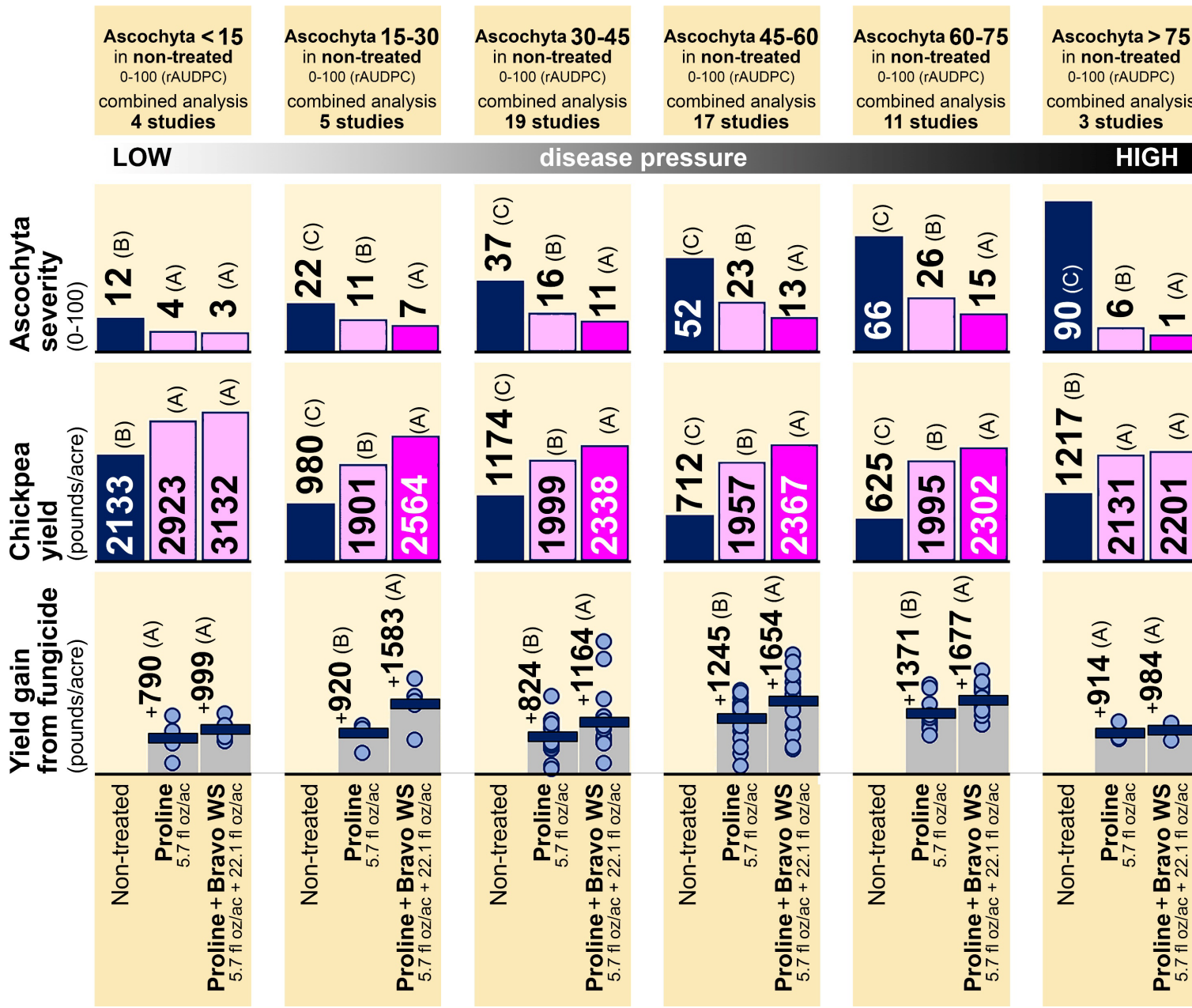
Proline @ 5.7 fl oz/ac + Bravo Weather Stik @ 1.38 pt/ac

Proline: FRAC group = 3, active ingredient = prothioconazole (4.0 lbs a.i./gal)

Bravo Weather Stik: FRAC group = M5, active ingredient = chlorothalonil (6.0 lbs a.i./gal)

Combined analysis across 59 replicated field studies conducted in Carrington, Hofflund and Plaza, ND (2015-2023). Fungicides were applied in 15 gal/ac with a hand-held boom or in 15 gal/ac at 6.0, 10.0 or 10.5 mph with a tractor-mounted sprayer.

Research funded by the ND Crop Protection Product Harmonization and Registration Board administered by the North Dakota Department of Agriculture, the Northern Pulse Growers Association, and the USDA Specialty Crop Block Grant Program administered by the ND Dept. of Agriculture.



Improving the management of *Ascochyta* blight in chickpeas: Fungicide efficacy

When tank-mixing Bravo WeatherStik with Proline,
applying Proline at the high end of the labeled rate (5.7 fl oz/ac) and
Bravo WS at the low end of the labeled rate (1.38 pt/ac)
optimizes *Ascochyta* management while minimizing cost

Combined analysis across 7 studies:

	<i>Ascochyta</i> (0-100)	Yield (lbs/ac)
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Non-treated

42 e

892

Bravo WS 1.38 pt/ac

24 d

1442 c

Bravo WS 2 pt/ac

20 bcd

1569 c

Proline 5.0 fl oz/ac

23 cd

1618 c

Proline 5.7 fl oz/ac

22 cd

1643 bc

Proline 5.0 fl oz + Bravo WS 1.38 pt/ac

13 abc

2133 a

Proline 5.7 fl oz + Bravo WS 1.38 pt/ac

12 ab

2269 a

Proline 5.0 fl oz + Bravo WS 2.0 pt/ac

12 a

2118 ab

Proline 5.7 fl oz + Bravo WS 2.0 pt/ac

12 a

2310 a

CV: 54.6

20.3

Provysol tank-mixed with Bravo WeatherStik
also provides very good Ascochyta management

COMBINED ANALYSIS ACROSS 9 STUDIES

Provysol 3 fl oz/ac vs.

Provysol 3 fl oz + Bravo WS 1.38 pt/ac

PROVYSOL: active ingredient = mefentrifluconazole

BRAVO WS: active ingredient = chlorothalonil

Ascochyta

Yield

0 to 100

lbs/ac

Non-treated control

50 b

1009 b

Provysol 3 fl oz/ac

18 a

2041 a

Provysol 3 fl oz + Bravo WS 1.38 pt

11 a

2461 a

CV: 17.9

26.0

Applying Provysol at 5 fl oz/ac (vs. 3 fl oz) improves efficacy.
Like Proline, Provysol must be tank-mixed with Bravo WeatherStik for
satisfactory *Ascochyta* management.

COMBINED ANALYSIS ACROSS 6 STUDIES

Provysol, 3 vs. 5 fl oz

active ingredient = mefentrifluconazole

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	62 b	765 b
Proline 5.7 fl oz/ac	18 a	1761 a
Provysol 3 fl oz/ac	17 a	1607 a
Provysol 5 fl oz/ac	17 a	1873 a
CV:	39.4	17.7

Improving the management
of Ascochyta blight in
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Fungicide efficacy

Applying Provysol
at 5 fl oz/ac
(vs. 3 fl oz)
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Like Proline, Provysol must
be tank-mixed with Bravo
WeatherStik for satisfactory
Ascochyta management.

COMBINED ANALYSIS ACROSS 11 STUDIES

Provysol, 3 fl oz/ac

active ingredient = mefentrifluconazole

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	46 b	1086 b
Proline 5.7 fl oz/ac	13 a	2080 a
Provysol 3 fl oz/ac	14 a	1872 a
CV:	52.5	13.9

COMBINED ANALYSIS ACROSS 8 STUDIES

Provysol, 5 fl oz/ac

active ingredient = mefentrifluconazole

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	64 b	684 b
Proline 5.7 fl oz/ac	19 a	1873 a
Provysol 5 fl oz/ac	17 a	2099 a
CV:	34.2	22.4

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

When tank-mixing chlorothalonil with Proline or Provysol, **generic and brand-name versions of chlorothalonil are equivalent**

testing conducted on Bravo WeatherStik, Praiz, Equus 720

COMBINED ANALYSIS ACROSS 9 STUDIES			Ascochyta 0 to 100	Yield lbs/ac
Non-treated	47 c	953 c		
Proline 3 fl oz/ac or Proline 5.7 fl oz/ac	23 b	1864 a		
Proline or Provysol + Bravo WS 1.38 pt/ac	12 a	2240 a		
Proline or Provysol + Praiz 1.38 pt/ac	14 ab	2149 a		
Proline or Provysol + Equus 720 1.38 pt/ac	12 ab	2247 a		
CV: 19.0			20.3	

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Part 2: Rotational chemistries with alternate modes of action

BEST OPTION:

Miravis Top (13.7 fl oz/ac) + **Bravo WS** (1.38 pt/ac)

difenoconazole (FRAC 3) + pydiflumetofen (FRAC 7)

ANOTHER OPTION:

One application per season of a premix product that contains prothioconazole or mefentrifluconazole (the active ingredients in Proline and Provysol) and another active ingredient.

Even if Ascochyta has developed resistance to the other active ingredient, there is generally a mixture of resistance and susceptible pathogen strains. A single application of that mode of action when applied together with Bravo WS and prothioconazole or mefentrifluconazole can improve management of the susceptible strains.

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Applied alone without Bravo WeatherStik,
Miravis Top and Proline exhibit similar efficacy

COMBINED ANALYSIS ACROSS 11 STUDIES

Miravis Top, 13.7 fl oz

active ingredients = pydiflumetofen, difenoconazole (FRAC 7, 3)

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	42 b	1101 b
Proline 5.7 fl oz/ac	10 a	2042 a
Miravis Top 13.7 fl oz	12 a	2043 a
CV:	15.0	19.2

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Miravis Top has not responded as strongly as Proline to tank-mixing with Bravo WeatherStik

COMBINED ANALYSIS ACROSS 7 STUDIES

Miravis TOP 13.7 fl oz/ac vs.

Miravis TOP 13.7 fl oz + Bravo WS 1.38 pt

MIRAVIS TOP: active ingredients = pydiflumetofen + difenoconazole

BRAVO WS: active ingredient = chlorothalonil

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	47 c	1075 b
Proline 5.7 fl oz/ac	11 ab	2249 a
Proline 5.7 fl oz + Bravo WS 1.38 pt/ac	4 a	2504 a
Miravis TOP 13.7 fl oz	14 b	2290 a
Miravis Top 13.7 fl oz + Bravo WS 1.38 pt	7 ab	2291 a

CV: 27.3

11.7

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Applying Miravis Top + Bravo WS in rotation with Proline + Bravo WS is best conducted when disease pressure is moderate

Results from **Carrington (2024)**: very wet summer with very high Ascochyta pressure

Six fungicide applications 10-14 days apart

Zorina 20 fl oz = premix of Provysol 5 fl oz + Endura 6 oz

	ASCOCHYTA 0 to 100	YIELD lbs/ac
Non-treated control	67 d	17 e
Proline 5.7 fl oz rotated with Miravis Neo 13.7 fl oz/ac	34 c	92 de
Proline 5.7 fl oz rotated with Miravis Top 13.7 fl oz/ac	27 b	222 de
Proline 5.7 fl oz rotated with Zorina 20 fl oz/ac	21 b	597 d
Proline 5.7 fl oz	21 b	477 de
Proline 5.7 fl oz + Bravo WS 1.38 pt rotated with Miravis Neo 13.7 fl oz + Bravo WS 1.38 pt/ac	11 a	1342 c
Proline 5.7 fl oz + Bravo WS 1.38 pt rotated with Miravis Top 13.7 fl oz + Bravo WS 1.38 pt/ac	9 a	1525 bc
Proline 5.7 fl oz + Bravo WS 1.38 pt rotated with Zorina 20 fl oz + Bravo WS 1.38 pt/ac	6 a	1986 ab
Proline 5.7 fl oz + Bravo WS 1.38 pt/ac	5 a	2216 a
CV:	15.8	30.9

Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comparison procedure).

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

The efficacy of Miravis Neo has been slipping,
suggesting possible resistance development to the SDHI

Miravis Neo = SDHI fungicide pydiflumetofen + two fungicides with little or efficacy against Ascochyta (azoxystrobin and propiconazole).

Miravis Neo relies on the SDHI pydiflumetofen for efficacy against Ascochyta.

COMBINED ANALYSIS ACROSS 10 STUDIES

Miravis Neo, 13.7 fl oz

active ingredients = pydiflumetofen
(FRAC 7), azoxystrobin (FRAC 11),
propiconazole (FRAC 3)

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	55 b	1126 b
Proline 5.7 fl oz/ac	15 a	2105 a
Miravis Neo 13.7 fl oz	23 a	1896 a
CV:	19.4	17.9

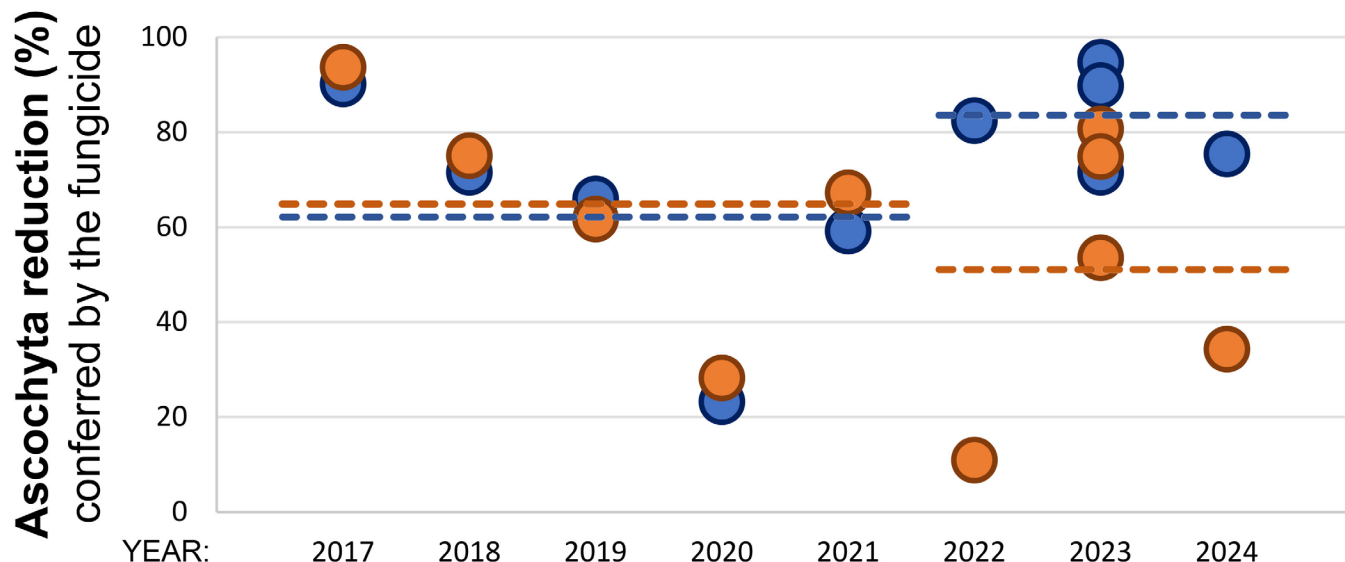
Improving the management of *Ascochyta* blight in chickpeas: Fungicide efficacy

The efficacy of Miravis Neo has been slipping,
suggesting possible resistance development to the SDHI

From 2017 to 2021, the *Ascochyta* management conferred by Proline and Miravis Neo was equivalent in field studies.

From 2022 to 2024, Proline conferred better *Ascochyta* management than Miravis Neo.

Efficacy of Proline vs. Miravis Neo from 2017 to 2024



Miravis Neo = SDHI fungicide pydiflumetofen + two fungicides with little or efficacy against *Ascochyta* (azoxystrobin and propiconazole).

Miravis Neo relies on the SDHI pydiflumetofen for efficacy against *Ascochyta*.

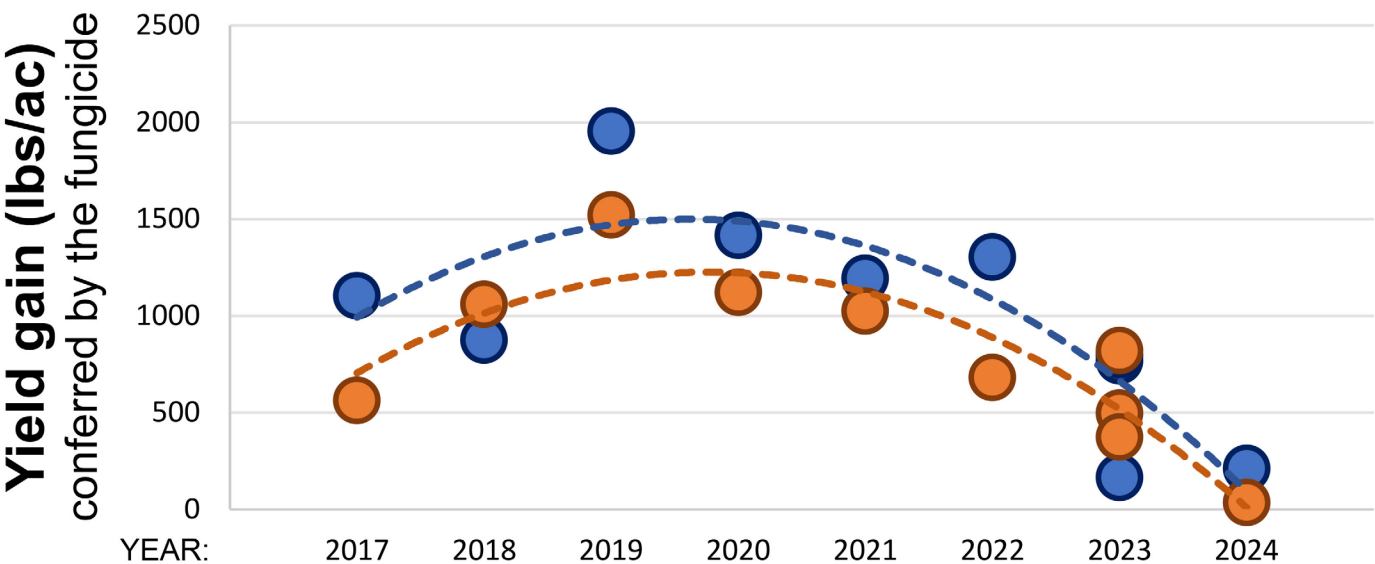
Non-treated	52 b	59 b
Proline 5.7 fl oz	22 a	8 a
Miravis Neo 13.7 fl oz	21 a	25 b
	Ascochyta (0-100)	Ascochyta (0-100)
	5 studies conducted from 2016 to 2021	5 studies conducted from 2022 to 2024
Proline:	● one study - - - average	● one study - - - average

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

The efficacy of Miravis Neo has been slipping, suggesting possible resistance development to the SDHI

The erosion in Ascochyta disease control by Miravis Neo observed since 2022 has not yet translated into a complete loss in efficacy in field studies.

Efficacy of Proline vs. Miravis Neo from 2017 to 2024



Miravis Neo = SDHI fungicide pydiflumetofen + two fungicides with little or efficacy against Ascochyta (azoxystrobin and propiconazole).

Miravis Neo relies on the SDHI pydiflumetofen for efficacy against Ascochyta.

Non-treated	1095	b	1158	b
Proline 5.7 fl oz	2404	a	1807	a
Miravis Neo 13.7 fl oz	2153	a	1639	a
	Yield (lbs/ac)		Yield (lbs/ac)	
	5 studies conducted from 2016 to 2021		5 studies conducted from 2022 to 2024	
Proline:	● one study	-- average	Miravis Neo:	● one study -- average

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Miravis Neo responds strongly to tank-mixing with chlorothalonil and is best applied with this tank-mix

COMBINED ANALYSIS ACROSS 6 STUDIES

Miravis Neo 13.7 fl oz/ac vs.
Miravis Neo 13.7 fl oz + Bravo WS 1.38 pt/ac

MIRAVIS TOP: active ingredients = pydiflumetofen, azoxystrobin, propiconazole (FRAC 7, 11, 3)

BRAVO WS: active ingredient = chlorothalonil (FRAC M)

	Ascochyta	Yield
	0 to 100	lbs/ac

Non-treated	57 c	1104 c
Proline 5.7 fl oz/ac	20 ab	2438 ab
Proline 5.7 fl oz + Bravo WS 1.38 pt/ac	8 a	2718 a
Miravis Neo 13.7 fl oz	27 bc	2137 b
Miravis Neo 13.7 fl oz + Bravo WS 1.38 pt	10 a	2606 ab

CV:	24.2	11.7
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Because of possible resistance problems developing with the SDHI pydimflumetofen, Miravis Top + Bravo WS – which contains a much more effective triazole fungicide than Miravis Neo – is a better choice for rotating with Proline + Bravo.

Applying Miravis Top + Bravo WS in a rotation with Proline + Bravo WS is best conducted when disease pressure is moderate. Under high disease pressure, Miravis Top + Bravo is less effective than Proline + Bravo.

Results from **Carrington (2024): very wet summer with very high Ascochyta pressure**

Six fungicide applications 10-14 days apart

Zorina 20 fl oz = premix of Provysol 5 fl oz + Endura 6 oz

	ASCOCHYTA 0 to 100	YIELD lbs/ac
Non-treated control	67 d	17 e
Proline 5.7 fl oz rotated with Miravis Neo 13.7 fl oz/ac	34 c	92 de
Proline 5.7 fl oz rotated with Miravis Top 13.7 fl oz/ac	27 b	222 de
Proline 5.7 fl oz rotated with Zorina 20 fl oz/ac	21 b	597 d
Proline 5.7 fl oz	21 b	477 de
Proline 5.7 fl oz + Bravo WS 1.38 pt rotated with Miravis Neo 13.7 fl oz + Bravo WS 1.38 pt/ac	11 a	1342 c
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Proline 5.7 fl oz + Bravo WS 1.38 pt rotated with Zorina 20 fl oz + Bravo WS 1.38 pt/ac	6 a	1986 ab
Proline 5.7 fl oz + Bravo WS 1.38 pt/ac	5 a	2216 a
	CV: 15.8	30.9

Within-column means followed by different letters are significantly different ($P < 0.05$; Tukey multiple comparison procedure).

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Omega – which has a completely different mode of action – would be an option if it were not prohibitively expensive.

COMBINED ANALYSIS ACROSS 9 STUDIES

Omega, 13.6 fl oz

active ingredient = fluazinam

FRAC 29

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	45 b	1236 b
Proline 5.7 fl oz/ac	20 a	2288 a
Omega 13.6 fl oz/ac	26 a	1988 a
CV:	24.2	16.9

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

ANOTHER OPTION FOR INCLUDING OTHER MODES OF ACTION:

One application per season of a premix product that contains prothioconazole or mefentrifluconazole (the active ingredients in Proline and Provysol) and another active ingredient.

Even if Ascochyta has developed resistance to the other active ingredient, there is generally a mixture of resistance and susceptible pathogen strains. A single application of that mode of action when applied together with Bravo WS and prothioconazole or mefentrifluconazole can improve management of the susceptible strains.

REVYTEK: mefentrifluconazole + pyraclostrobin + fluxapyroxad

Revytek at 9 fl oz/ac delivers the same amount of mefentrifluconazole as Provysol at 3 fl oz

REVYLOK: mefentrifluconazole + fluxapyroxad

Revylok at 6.5 fl oz delivers the same amount of mefentrifluconazole as Provysol at 4.9 fl oz

Revylok at 4.5 fl oz delivers the same amount of mefentrifluconazole as Provysol at 3.4 fl oz

DELARO: prothioconazole + picoxystrobin

Delaro at 12 fl oz delivers the same amount of prothioconazole as Proline at 4.5 fl oz

Supplemental Proline at 1.2 fl oz/ac should be added to Delaro 12 fl oz/ac

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

ANOTHER OPTION FOR INCLUDING OTHER MODES OF ACTION:

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Even if Ascochyta has developed resistance to the other active ingredient, there is generally a mixture of resistance and susceptible pathogen strains. A single application of that mode of action when applied together with Bravo WS and prothioconazole or mefentrifluconazole can improve management of the susceptible strains.

REVYTEK: mefentrifluconazole + pyraclostrobin + fluxapyroxad

Revytek at 9 fl oz/ac delivers the same amount of mefentrifluconazole as Provysol at 3 fl oz

COMBINED ANALYSIS ACROSS 4 STUDIES

Revytek, 8 fl oz

Provysol: mefentrifluconazole

Revytek: mefentrifluconazole, pyraclostrobin, fluxapyroxad

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	42 b	1448 b
Proline 5.7 fl oz/ac	9 a	2470 a
Revytek 8 fl oz/ac	10 a	2265 a
Provysol 3 fl oz/ac	11 a	2246 a
CV:	17.0	8.0

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

ANOTHER OPTION FOR INCLUDING OTHER MODES OF ACTION:

One application per season of a premix product that contains prothioconazole or mefentrifluconazole (the active ingredients in Proline and Provysol) and another active ingredient.

Even if Ascochyta has developed resistance to the other active ingredient, there is generally a mixture of resistance and susceptible pathogen strains. A single application of that mode of action when applied together with Bravo WS and prothioconazole or mefentrifluconazole can improve management of the susceptible strains.

DELARO: prothioconazole + picoxystrobin

Delaro at 12 fl oz delivers the same amount of prothioconazole as Proline at 4.5 fl oz

Supplemental 1.2 fl oz/ac Proline should be added to 12 fl oz/ac Delaro to increase the application rate of prothioconazole to the equivalent of Proline 5.7 fl oz/ac

COMBINED ANALYSIS ACROSS 3 STUDIES

Delaro, 12 fl oz/ac

active ingredients = prothioconazole + trifloxystrobin

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	61 b	1187 b
Proline 5.7 fl oz/ac	7 a	2459 a
Delaro 12 fl oz/ac	13 a	2330 a
CV:	22.1	7.1

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Part 3: Fungicides with poor efficacy

Priaxor (4 fl oz/ac)

fluxapyroxad (FRAC 7) + pyraclostrobin (FRAC 11)

Endura (6 oz/ac)

boscalid (FRAC 7)

Headline, Quadris, Aproach

The Ascochyta blight pathogen of chickpeas has developed resistance to the QoI fungicides.

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Due to apparent resistance development with the SDHI fungicide fluxapyroxad, **Priaxor is no longer effective**

COMBINED ANALYSIS ACROSS 6 STUDIES

Priaxor, 4 fl oz/ac

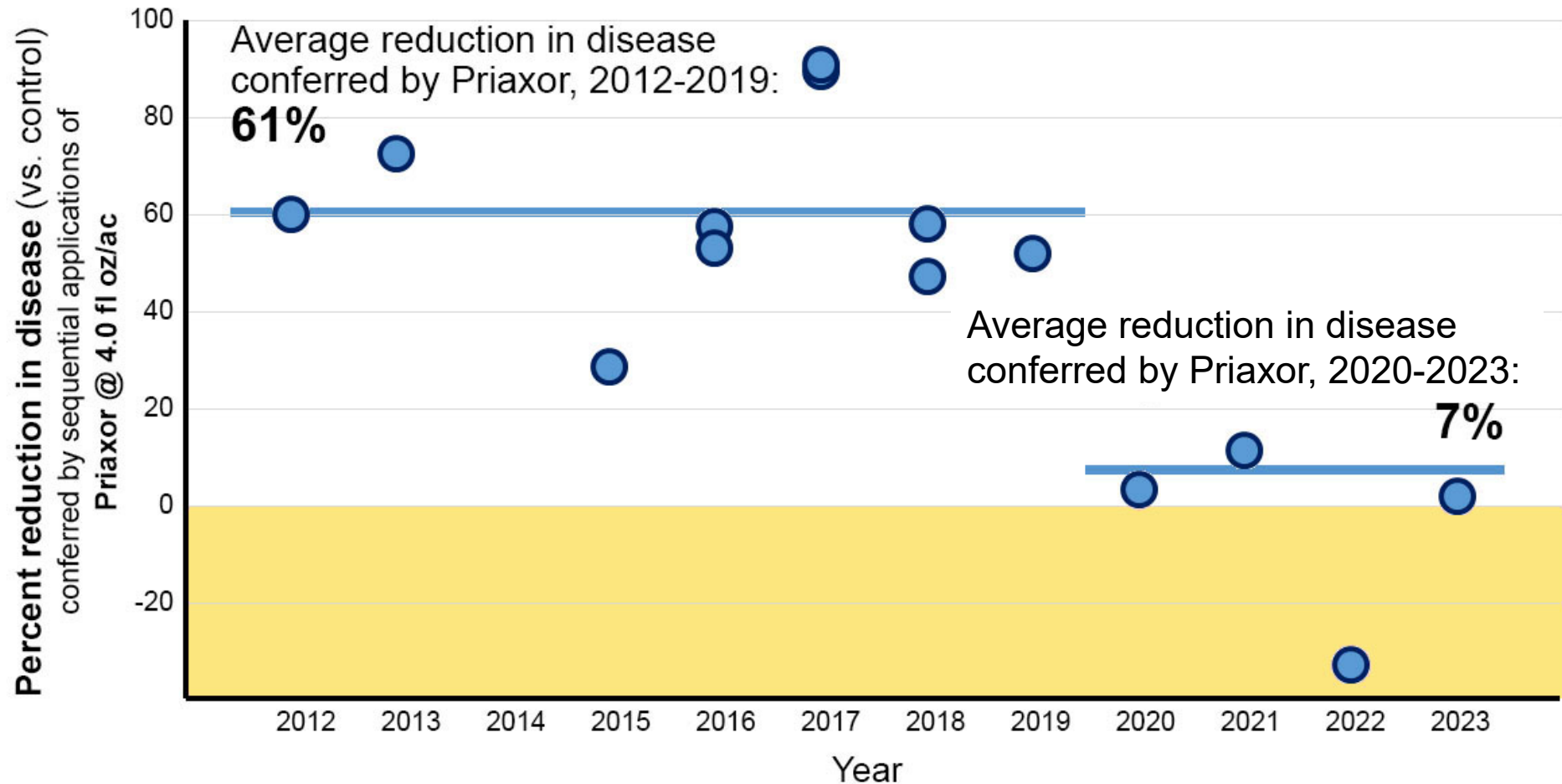
active ingredients = fluxapyroxad + pyraclostrobin

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	49 b	1121 b
Proline 5.7 fl oz/ac	17 a	2103 a
Priaxor 4 fl oz/ac	48 b	1335 b
CV:	44.1	18.6

Suspected fungicide resistance, *Ascochyta* blight of chickpeas: SDHI fungicide fluxapyroxad

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

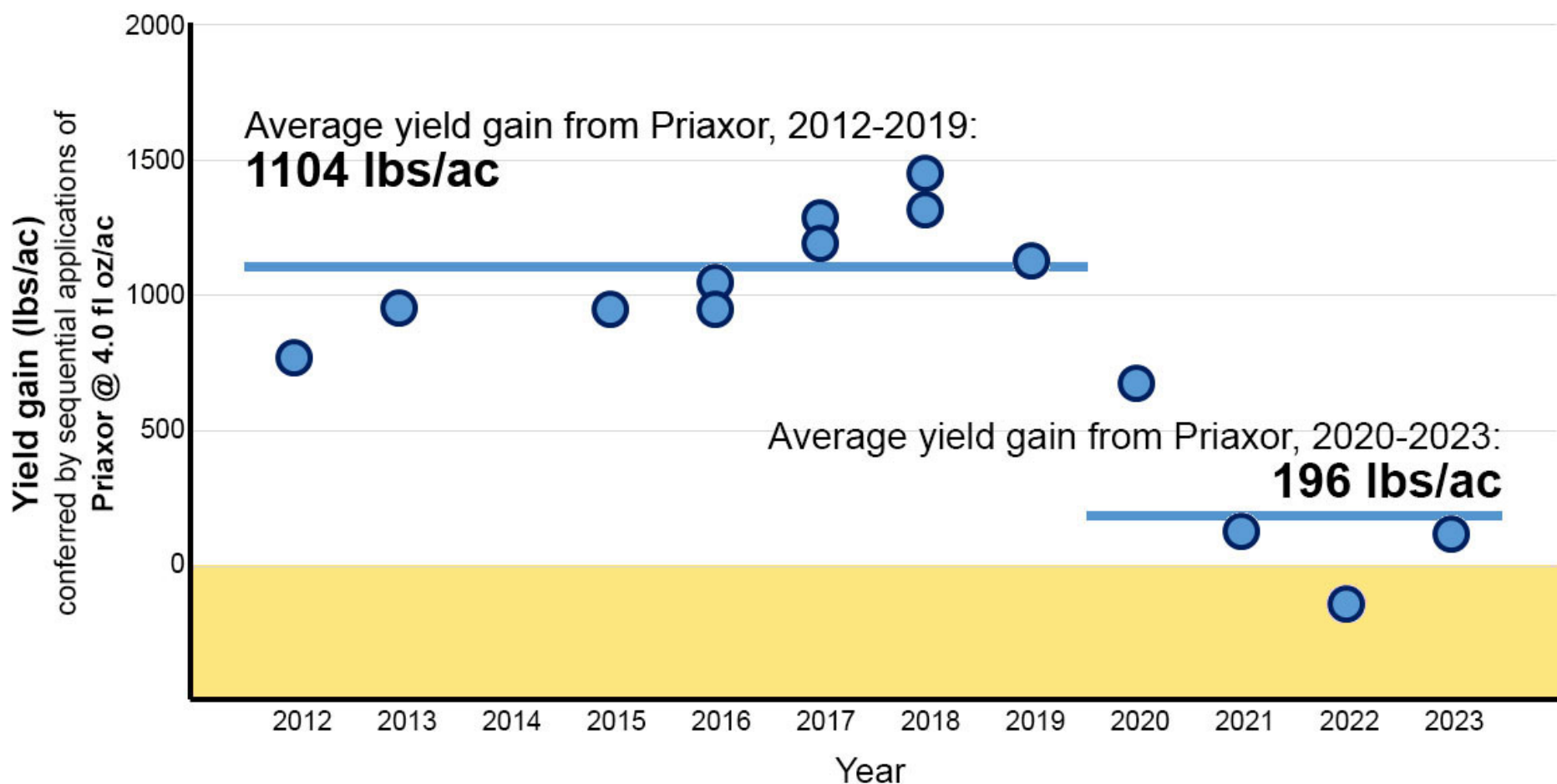
Priaxor = fluxapyroxad (FRAC 7) + pyraclostrobin (FRAC 11)



Suspected fungicide resistance, *Ascochyta* blight of chickpeas: SDHI fungicide fluxapyroxad

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

Priaxor = fluxapyroxad (FRAC 7) + pyraclostrobin (FRAC 11)



Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Endura has always exhibited poor efficacy against Ascochyta blight in chickpeas. Since the apparent loss of efficacy for fluxapyroxad, Endura has shown zero efficacy.

COMBINED ANALYSIS ACROSS 7 STUDIES

Endura, 6 oz/ac

active ingredient = boscalid

	Ascochyta 0 to 100	Yield lbs/ac
Non-treated	57 b	520 b
Proline 5.7 fl oz/ac	11 a	2166 a
Endura 6.0 oz/ac	36 b	1498 ab
CV:	49.0	64.6

Improving the management of Ascochyta blight in chickpeas: Fungicide efficacy

Conclusions

Proline and Provysol, tank-mixed with Bravo WeatherStik or generic, are most effective.

Miravis Top is the best rotational fungicide with an alternate mode of action. It is best applied tank-mixed with Bravo WS/generic, and this tank-mix is best applied when disease pressure is moderate.

Premix fungicides that contain the active ingredients in Proline or Provysol and an active ingredient that has lost efficacy due to resistance development can sometimes provide some benefit when applied once in the season. They should be applied such that the application rate of the active ingredients in Proline and Provysol is equivalent to the labeled rates of those products, and they should be applied in a tank-mix with Bravo WeatherStik / generic.



Thank you!

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