Optimizing the use of fungicides for improved management of Ascochyta blight in chickpeas.
Updated recommendations; July 2022.
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Chickpeas have entered bloom, and we are receiving reports of Ascochyta blight in chickpeas. With the proper deployment of fungicides, Ascochyta blight can be successfully managed in chickpeas even under the most cool and wet conditions. The keys to successful Ascochyta blight management are proper fungicide selection, application timing, and application methods.

Determining disease risk: Unless you are in extreme drought, you should always assume that a low level of Ascochyta is present in your field. Ascochyta develops due to seed-to-seedling transmission and from long-distance spore dispersal in the upper atmosphere: Spores released from overwintered chickpea residues many miles away can cause disease in your crop. Once you are in bloom, the canopy typically begins to close, which means that splash-dispersal of spores from infected tissue to healthy tissue is much more likely and humidity and dew, which facilitates infection and disease development, are held within the canopy better.

Fungicide application timing for management of Ascochyta blight in chickpeas:

- Prior to early flowering (R1): Only apply a fungicide targeting Ascochyta prior to the bloom stage if you are planting a highly susceptible variety such as Sawyer, Sierra or CDC Xena or if you observe disease symptoms.
- Early flowering (R1), defined as approximately 50% of plants have an open blossom. At this stage, apply the first fungicide application preventatively before the next forecasted rain even if you do not observe disease. Do not necessarily rely on scouting. Low levels of disease are almost always present if it is raining and it can expand explosively with rainfall once the canopy begins to develop.
- Post flowering: Make a second application 10-14 days later if rainfall is continuing. Continue additional applications every 10-14 days until early chickpea senescence if rainfall is continuing. If you enter a period of dry weather, the next application can be delayed until shortly before the next forecasted rain even if this is 20 or 25 days after the previous application. Ascochyta spores rely on rain splash to spread. The fungicides only protect against new infections; they don't heal or cure existing infections. The goal with the fungicide application is to prevent new infections that would otherwise occur when spores are moved from diseased tissue to healthy tissue via rainfall-mediated splash dispersal.

The most effective fungicides for Ascochyta management in chickpeas: Proline at 5.7 fl oz/ac, Revytek at 8 fl oz/ac, Miravis Top at 13.7 fl oz/ac, Provysol at 3 fl oz/ac, and Miravis Neo at 13.7 fl oz/ac are all options that have performed well in our research studies when Ascochyta disease pressure is moderate. Priaxor is also fairly good but is somewhat less effective than these four. When disease pressure is high, satisfactory disease control is only obtained when these fungicides are tank-mixed with chlorothalonil (Bravo WeatherStik or generic) at 1.38 pt/ac = 22.1 fl oz/ac. When Proline is applied, it should be applied at 5.7 fl oz/ac: There is a rate response with Proline, and 5.0 fl oz/ac does not perform as well as 5.7 fl oz/ac.

Tank-mixing fungicides with Bravo WeatherStik and generics (chlorothalonil): Adding chlorothalonil to Proline consistently improves Ascochtya management and chickpeas yields (**Figure 1**). In our trials, we have seen consistent yield gains from this tank-mix at all levels of Ascochyta disease pressure, even when Ascochyta pressure is relatively low. The yield gain from adding Bravo WS is generally around 500

lbs/ac. With Priaxor, we consistently see yield and disease control improvements from this tank-mix when Ascochyta pressure is high but not always when disease pressure is low. With Revytek, Miravis Top and Miravis Neo, adding Bravo WS has improved yield and disease control under high disease pressure, and we don't yet have any data on this tank-mix under low to moderate disease pressure.

- Generic versions of chlorothalonil may be satisfactory substitutes for Bravo WS (**Figure 2**). In the combined analysis of four field trials conducted across two locations and two years, we have not observed any statistical separation between Bravo WS vs. Praiz vs. Equus 720 in tank-mixes with Proline. There was a numerical downward trend in yield for Equus 720 vs. Bravo WS, but it's unclear whether that was just due to noise or was real. We saw no difference in disease control. We are continuing this research in 2022.
- When tank-mixing Proline with chlorothalonil, our data indicate that disease control is optimized by applying Proline at 5.7 fl oz/ac and applying Bravo WS (or generic) at 1.38 pt/ac (**Figure 3)**. Increasing the application rate of Proline from 5.0 to 5.7 fl oz/ac in this tank-mix consistently improves disease control. Increasing the application rate of Bravo WS (or generic) from 1.38 to 2.0 pt/ac in this tank-mix sometimes improves disease control but not always.

Rotating fungicide modes of action: You should rotate a DMI fungicide (FRAC 3) such as Proline with an SDHI fungicide (FRAC 7) to manage fungicide resistance. Target the SDHI application for when rainfall patterns and disease pressure are moderate. Priaxor and Miravis Neo are essentially stand-alone SDHIs for the purpose of Ascochyta control due to pathogen resistance to the QoI fungicides (FRAC11) (e.g. pyraclostobin) and the ineffectiveness of propiconazole against Ascochyta. If you are applying Miravis Top or Revytek, you'll be applying the DMI and the SDHI concurrently. I would strongly recommend adding Bravo WeatherStik or generics (chlorothalonil) when using either of these fungicides, since you have no opportunity to rotate SDHI and DMI modes of action when both are applied concurrently in a premix product such as these.

Optimizing fungicide droplet size (Figures 4 and 5): Our research to-date indicates you should always apply the fungicides with a fine droplet when the chickpea canopy is open. If the chickpea canopy is at or near closure and you are applying a locally systemic fungicide alone (e.g. Proline applied alone without Bravo), you should use a medium droplet size. If the chickpea canopy is at or near closure and you are applying a locally systemic fungicide tank-mixed with chlorothalonil, you should apply with fine droplets. Bravo WS is a contact fungicide; unlike Proline and other locally systemic fungicides, it cannot use local systemic movement in the plant to compensate for the reduction in coverage associated with a larger droplet size.

Optimizing spray volume (Figure 6): When Ascochyta pressure is high, our research indicates that you can expect an average yield gain of approximately 75 to 100 lbs/ac as fungicide spray volume is increased from 10 to 15 gal/ac. An average yield gain of approximately 175 to 225 lbs/ac can be expected as fungicide spray volume is increased from 10 to 20 gal/ac. These were the average yield gains that we observed across 3 years of field trials conducted with a tractor-mounted sprayer in Carrington, ND, but it is important to stress that impact of spray volume was highly variable across years. In two of the three years, we observed strong responses to spray volume; in one year, we observed no response.

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FIGURE 1. EFFICACY OF PROLINE VS. PROLINE + BRAVO WS RELATIVE TO DISEASE PRESSURE. Data are from field trials conducted in Carrington, Hofflund (30 miles east of Williston), and Plaza, ND (2015-2021). Applications were made with a hand-held boom or tractor-mounted boom (6 to 10.5 mph driving speed) in 15 gal/ac using flat-fan nozzles emitting fine or medium droplets.

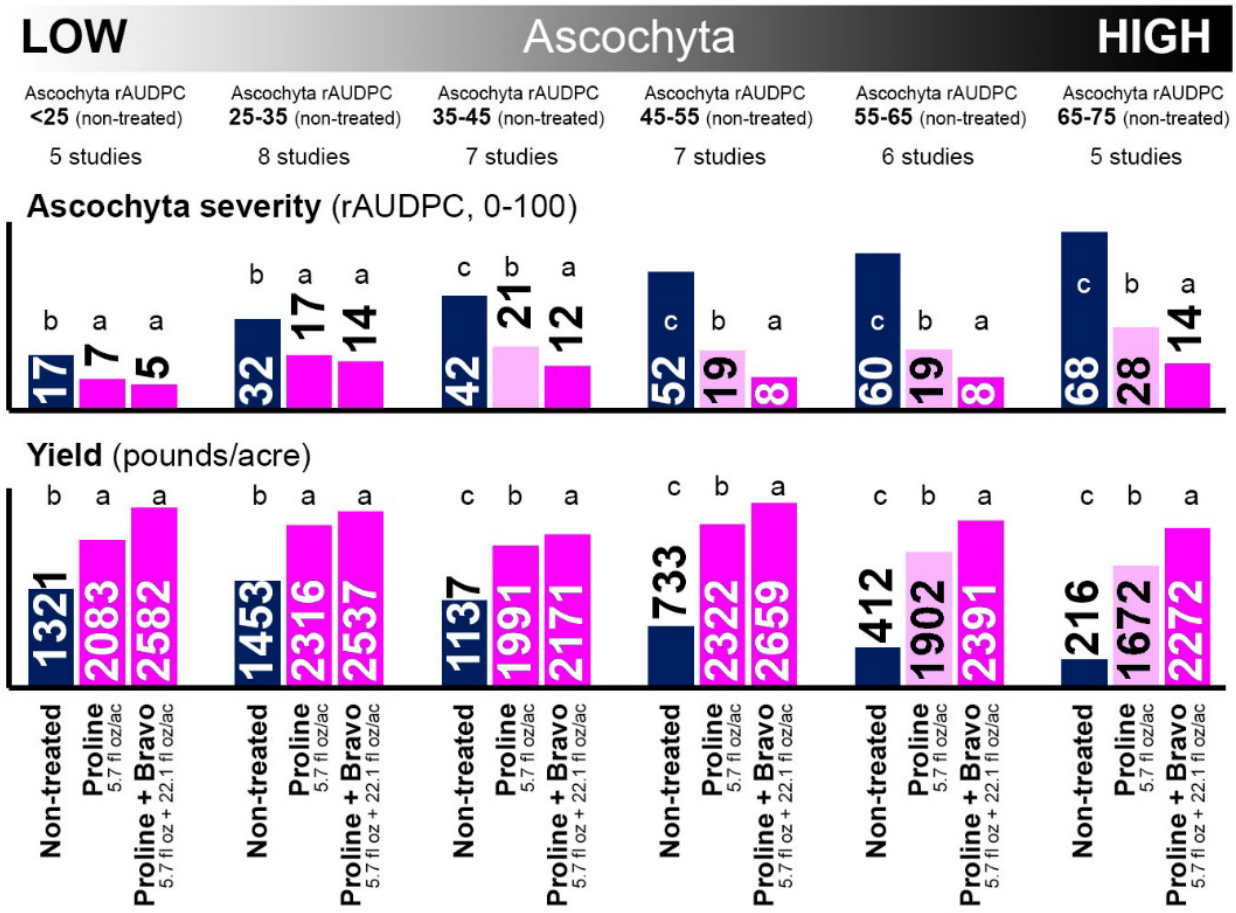


FIGURE 2. IMPACT OF BRAND OF CHLOROTHALONIL (BRAVO WEATHERSTIK, PRAIZ, EQUUS 720) ON EFFICACY OF TANK-MIXES WITH PROLINE. Data from field trials conducted in Carrington and Hofflund, ND (30 miles east of Williston) in 2019-2021. Applications were made with a hand-held boom equipped with flat-fan nozzles emitting fine or medium droplets; spray volume was 15 gal/ac. Letters denote statistical separation ($P < 0.05$; Tukey multiple comparison procedure).

study location:	**Carrington**	**Williston**	**Carrington**	**Williston**	**Combined analysis**
year:	2020	2020	2021	2021	
	ASCOCHYTA SEVERITY (0-100)				
	Average percent of the canopy diseased, bloom initiation to maturity				
Non-treated	**69** c*	**27** b*	**31** c*	**41** e*‡	**42** b*
Proline 5.7 fl oz/ac	**53** b	**18** a	**14** ab	**19** d	**26** a
Proline 5.7 fl oz/ac + **Bravo WS** 1.38 pt/ac	**28** a	**14** a	**9** a	**5** ab	**14** a
Proline 5.7 fl oz/ac + **Praiz** 1.38 pt/ac	**30** a	**15** a	**10** a	**3** a	**15** a
Proline 5.7 fl oz/ac + **Equus 720** 1.38 pt/ac	**24** a	**15** a	**12** ab	**4** ab	**14** a
F:	32.65	11.57	16.08	54.55	12.47
P>F:	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0003
CV:	16.6	22.1	25.7	15.6	31.5
	YIELD (pounds/acre)				
	13.5% moisture				
Non-treated	**514** b*	**1443** c*	**1414** d*	**10** c*‡	**845** b*
Proline 5.7 fl oz/ac	**1931** a	**2447** b	**2301** abc	**81** b	**1690** a
Proline 5.7 fl oz/ac + **Bravo WS** 1.38 pt/ac	**2870** a	**3087** a	**2609** ab	**685** a	**2313** a
Proline 5.7 fl oz/ac + **Praiz** 1.38 pt/ac	**2652** a	**2924** ab	**2725** a	**561** a	**2215** a
Proline 5.7 fl oz/ac + **Equus 720** 1.38 pt/ac	**2371** a	**2575** ab	**2547** a	**687** a	**2045** a
F:	10.13	26.31	11.16	15.50	16.11
P>F:	0.0008	< 0.0001	< 0.0001	< 0.0001	< 0.0001
CV:	28.5	12.3	12.6	16.2	16.3

FIGURE 3. OPTIMIZING FUNGICIDE APPLICATION RATES WHEN TANK-MIXING PROLINE AND BRAVO WS. Data from field trials conducted in Carrington and Hofflund, ND (30 miles east of Williston) in 2019-2021. Applications were made with a hand-held boom equipped with flat-fan nozzles emitting fine or medium droplets; spray volume was 15 gal/ac. Letters denote statistical separation ($P < 0.05$; Tukey multiple comparison procedure).

	study location:	Carrington	Carrington	Williston	Carrington	Williston	Combined analysis
	year:	2019	2020	2020	2021	2021	
		ASCOCHYTA SEVERITY (0-100)					
		Average percent of the canopy diseased, bloom initiation to maturity					
1	**Non-treated control**	**60** d	**69** c	**27** b*	**31** c*	**41** e*‡	**46** c*‡
2	**Bravo WeatherStik** 1.38 pt/ac	**21** c	**49** b	**18** a	**18** b	**19** d	**25** bc
3	**Bravo WeatherStik** 2.0 pt/ac	**6** b	**44** ab	**15** a	**18** b	**15** d	**19** ab
4	**Proline** 5.0 fl oz/ac	**9** b	**62** bc	**19** a	**14** ab	**16** d	**24** abc
5	**Proline** 5.7 fl oz/ac	**8** b	**53** bc	**18** a	**14** ab	**19** d	**22** abc
6	**Proline** 5.0 fl oz/ac + **Bravo WS** 1.38 pt/ac	**3** a	**27** a	**16** a	**11** ab	**6** bc	**12** ab
7	**Proline** 5.7 fl oz/ac + **Bravo WS** 1.38 pt/ac	**3** a	**28** a	**14** a	**9** a	**5** ab	**11** a
8	**Proline** 5.0 fl oz/ac + **Bravo WS** 2.0 pt/ac	**3** a	**25** a	**16** a	**11** ab	**5** ab	**12** a
9	**Proline** 5.7 fl oz/ac + **Bravo WS** 2.0 pt/ac	**3** a	**27** a	**16** a	**11** ab	**3** a	**12** a
	F:	96.39	18.40	7.46	16.08	54.55	8.89
	P>F:	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	CV:	13.0	18.3	19.4	25.7	15.6	15.8
		YIELD (pounds/acre)					
		13.5% moisture					
1	**Non-treated control**	**24** e*	**514** b*	**1443** d*	**1414** d*	**10** c*‡	**681** e*
2	**Bravo WeatherStik** 1.38 pt/ac	**445** de	**2248** a	**2173** bc	**1907** cd	**108** b	**1376** d
3	**Bravo WeatherStik** 2.0 pt/ac	**705** cde	**2045** a	**2421** abc	**1986** bc	**254** ab	**1482** cd
4	**Proline** 5.0 fl oz/ac	**1127** bcd	**2139** a	**2115** c	**2184** abc	**84** b	**1530** cd
5	**Proline** 5.7 fl oz/ac	**1089** bcd	**1931** a	**2447** abc	**2301** abc	**81** b	**1570** bcd
6	**Proline** 5.0 fl oz/ac + **Bravo WS** 1.38 pt/ac	**1606** abc	**2578** a	**2764** abc	**2570** abc	**530** a	**2010** abc
7	**Proline** 5.7 fl oz/ac + **Bravo WS** 1.38 pt/ac	**1893** ab	**2870** a	**3087** a	**2609** ab	**685** a	**2229** a
8	**Proline** 5.0 fl oz/ac + **Bravo WS** 2.0 pt/ac	**2167** a	**2157** a	**2616** abc	**2460** a	**429** a	**1966** a-d
9	**Proline** 5.7 fl oz/ac + **Bravo WS** 2.0 pt/ac	**2269** a	**2628** a	**2789** ab	**2549** a	**649** a	**2177** ab
	F:	15.09	7.14	10.60	11.16	15.50	13.97
	P>F:	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	CV:	35.8	23.9	13.8	12.6	16.2	17.5

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

FIGURE 4. OPTIMIZING FUNGICIDE SPRAY DROPLET SIZE WITH <u>SYSTEMIC FUNGICIDES</u> FOR ASCOCHYTA MANAGEMENT - Are fine droplets always optimal when applying locally systemic fungicides? <u>Impact on yield associated with calibrating droplet size relative to canopy closure versus always applying with fine droplets; Carrington, ND (2021).</u> Canopy closure was defined as average ≥ 90% of the ground covered. *Dots represent results from individual studies; bars represent average values. 'NS' indicates no statistically significant difference relative to a spray volume of 10 gal/ac (P < 0.10), * indicates statistical significance at P < 0.10.*

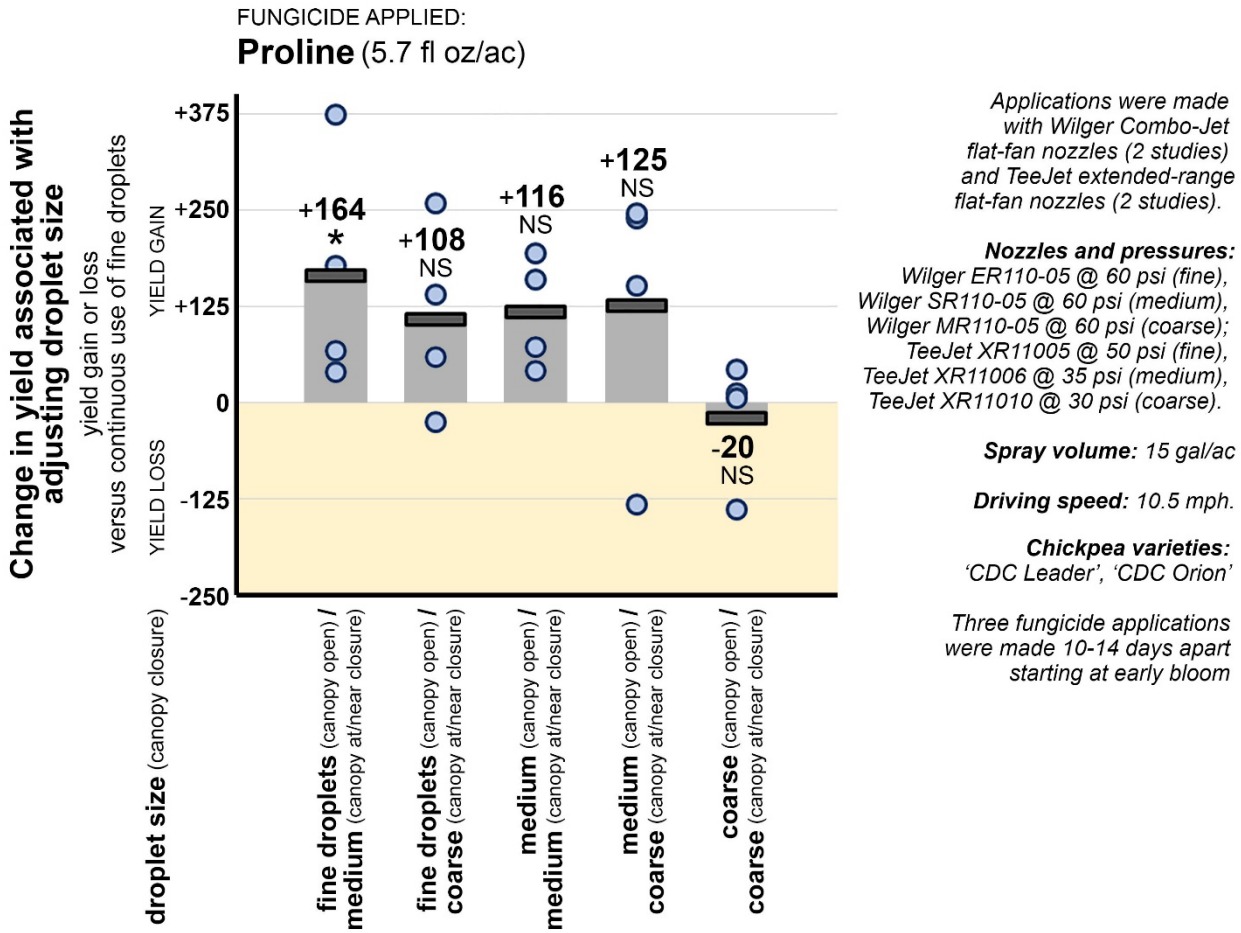
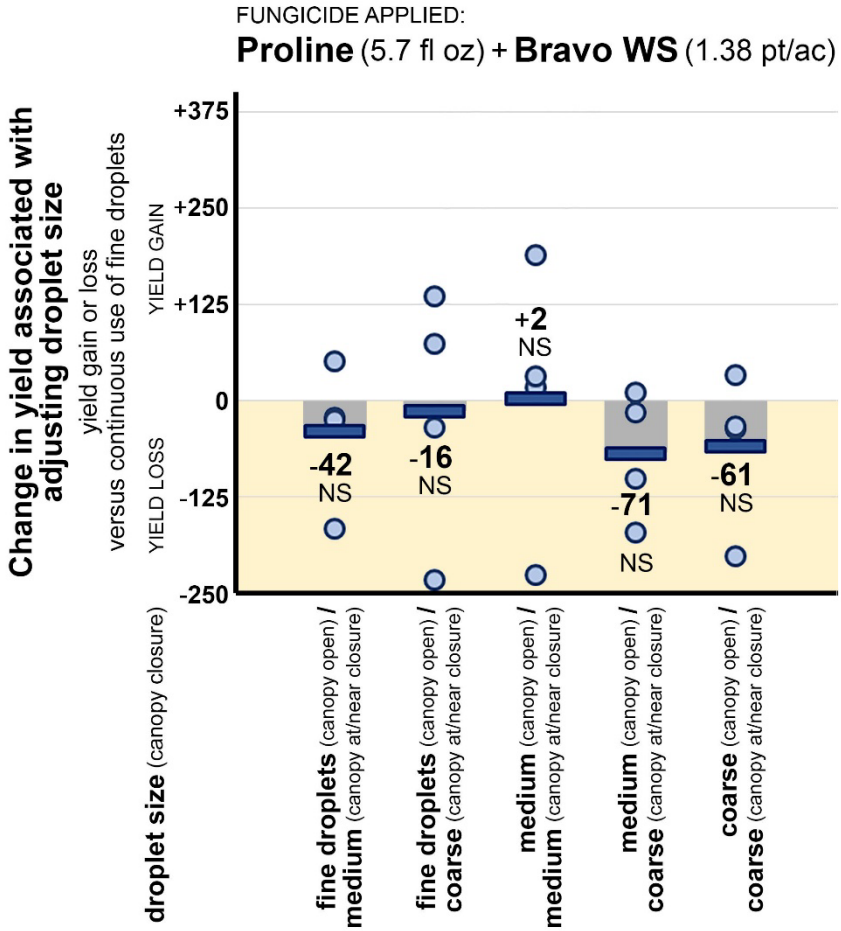


FIGURE 5. OPTIMIZING FUNGICIDE SPRAY DROPLET SIZE WHEN APPLYING FUNGICIDE TANK-MIXES WITH BRAVO WEATHERSTIK FOR ASCOCHYTA MANAGEMENT - Are fine droplets always optimal when applying locally systemic fungicides in a tank-mix with the contact fungicide Bravo WeatherStik?
Impact on yield associated with calibrating droplet size relative to canopy closure versus always applying with fine droplets; Carrington, ND (2021). Canopy closure was defined as average ≥ 90% of the ground covered. *Dots represent results from individual studies; bars represent average values. 'NS' indicates no statistically significant difference relative to a spray volume of 10 gal/ac (P < 0.10), * indicates statistical significance at P < 0.10.*



Applications were made with Wilger Combo-Jet flat-fan nozzles (2 studies) and TeeJet extended-range flat-fan nozzles (2 studies).

Nozzles and pressures: *Wilger ER110-05 @ 60 psi (fine), Wilger SR110-05 @ 60 psi (medium), Wilger MR110-05 @ 60 psi (coarse); TeeJet XR11005 @ 50 psi (fine), TeeJet XR11006 @ 35 psi (medium), TeeJet XR11010 @ 30 psi (coarse).*

Spray volume: *15 gal/ac*

Driving speed: *10.5 mph.*

Chickpea varieties: *'CDC Leader', 'CDC Orion'*

Three fungicide applications were made 10-14 days apart starting at early bloom

FIGURE 6. Impact of increasing spray volume from 10 gal/ac to either 15 or 20 gal/ac on Ascochyta management and chickpea yield; Carrington, ND (2019, 2020, 2021). *Dots represent results from individual studies; bars represent average values. 'NS' indicates no statistically significant difference relative to a spray volume of 10 gal/ac (P < 0.10).*