North Dakota State University
CROP & PEST REPORT
NDSU EXTENSION

No. 10 July 7, 2022

Inside this Issue...

AG NDSU FIELD DAYS SET

The North Dakota State University Research Extension Centers annual field days are set. The events take place at the Research Extension Center sites across the state and feature speakers, presentations and tours covering a diverse array of topics. NDSU's 15th President David Cook will be attending this year's field day events.

The dates and locations for the field days are:

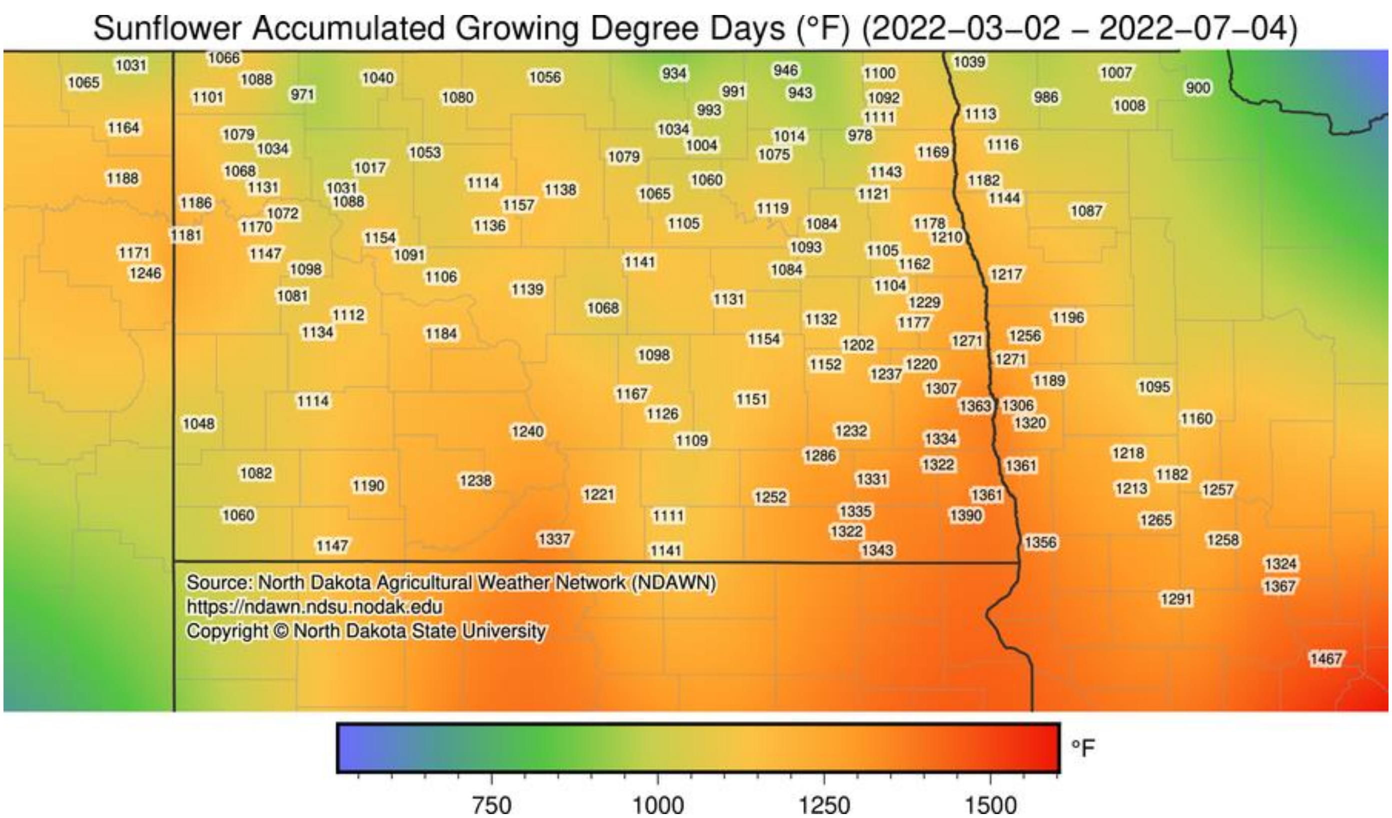
July 11 – Central Grasslands Research Extension Center – Streeter (10 a.m.-3 p.m. CDT)
July 12 – Hettinger Research Extension Center – Hettinger (5-7 p.m. MDT followed by supper)
July 13 – Dickinson Research Extension Center – Dickinson (8 a.m.-Noon MDT agronomy with lunch, 1-3 p.m. horticulture, 5 p.m. supper)
July 13 – Williston Research Extension Center main site (4-8 p.m. CDT agronomy and horticulture)
July 14 – Williston Research Extension Center irrigated tour – Nesson Research and Development farm, located 23 miles E of Williston on Hwy 1804 (8:30 a.m.-Noon CDT)
July 18 – Agronomy Seed Farm – Casselton (5 p.m. agronomy tour, 7 p.m. supper CDT)
July 19 – Carrington Research Extension Center – Carrington (9:15 a.m.-3:30 p.m. CDT)
July 20 – North Central Research Extension Center – Minot (8:30 a.m.-Noon CDT)
July 21 – Langdon Research Extension Center – Langdon (8:45 a.m.-Noon CDT)
August 4 – CREC Oakes Irrigation Research Site – Oakes (8:30 a.m.-Noon CDT)
August 9 – NDSU Horticulture Research & Demonstration Gardens – Fargo (3-7 p.m. CDT plants, local foods and outdoor spaces)
September 10 – NDSU Horticulture Research Farm near Amenia (10 a.m.-3 p.m. CDT trees and ornamentals) Pre-registration required

entomology

DEGREE DAY UPDATE - LEAFY SPURGE FLEA BEETLES

Begin scouting for adult flea beetles when the AGDD approaches 1,000. Flea beetles should be collected between 1,200 and 1,600 AGDD using the sunflower GDD model from NDAWN. Adult flea beetles can be collected easily with a 15-inch sweep net. **All of North Dakota has accumulated enough growing degree days (GDD) for scouting for adult leafy spurge flea beetles**. The southeast area has accumulated enough degree day units for collecting the leafy spurge flea beetles. We are slowly gaining degree days with the recent warmer temperatures.

The accumulated growing degree days (AGDD) for sunflower (base of 44 F) can be used as a guide to determine when to begin scouting for adult flea beetles. Use the sunflower degree days/growth stage application on NDAWN website. Enter “2022-03-01” for the planting date and select “degree day” for map type.



WHEAT MIDGE EMERGENCE

With the very low populations of wheat midge for two years in a row 2020-2021, producers may not have to scout for adult midges this year unless the field is at high risk with continuous wheat on wheat crop rotation, planting during the 200-600 accumulated wheat midge degree days, and/or favorable moist weather in late June to early July. These three factors can cause rapid increases in the numbers of emerging wheat midge adults.

Economic Thresholds for Wheat Midge

- **Hard red spring wheat = one or more midge observed for every four or five heads**
- **Durum wheat = one or more midge observed for every seven or eight heads**

For planting date susceptibility to wheat midge, producers should use the ***wheat midge degree-day model*** by selecting your nearest NDAWN station and entering your wheat planting date. The output indicates the expected growth stage of the wheat and whether the crop is susceptible to midge infestation, as well as the timing of wheat midge emergence for scouting. Producers can access the ***wheat midge degree-day model*** on the North Dakota Agricultural Weather Network (NDAWN) website at: https://ndawn.ndsu.nodak.edu/wheat-growing-degree-days.html

Wheat midge adult (Philip Glogoza)

Due to the late planting of hard red spring wheat in North Dakota this year, much of our HRSW will head after peak wheat midge emergence and be at a lower risk for wheat midge infestation and crop damage.

Field Scouting: Wheat plants are susceptible to wheat midge infestation from **heading to early flowering**. Wheat midge populations are estimated by counting the number of adults on developing wheat heads during night scouting at five locations in a field. Examine wheat heads at dusk (after 8.30 p.m.) with a flash light when temperatures are above 59^{o}F and wind speed is less than 6 mph. The small, orange-colored female wheat midge can be seen fluttering from plant to plant and laying eggs on the wheat heads. Record the number of adult wheat midge and calculate the average number per head for the field. Scouting can be difficult because adults fly at dusk and after dark only when environmental conditions are optimal.

Pheromone trap for monitoring wheat midge adult (J. Knodel)

Pheromone traps are commercially available and attract only the adult male wheat midge. Researchers have not found a significant correlation between the number of captured males and the percent of damaged kernels at harvest. Pheromone traps are useful for indicating when to scout and to determine the first, peak and ending flights of male wheat midge.

Pest Management: Use of insecticides is the most common and an effective method for management of economic population densities of wheat midge. Please consult the ***2022 North Dakota Field Crop Insect Management Guide E1143*** for an updated list of insecticides for wheat midge control. Insecticide application is recommended at dusk because female adults are most active in the top of the crop canopy. However, avoid spraying if there is temperature inversion. Apply in a minimum of 3 to 5 gallons of water per acre for aerial applications and 10 gallons of water per acre for ground applications. Insecticides labeled for wheat midge can be tanked-mixed with fungicides for *Fusarium* head blight (or scab) control during early flowering. Assuming the economic threshold is reached, the optimal timing of an insecticide is:

- If 70 percent of wheat is at heading to early flowering <30%, treat immediately.
- If 30 percent to 60 percent of wheat heads are at flowering (at least one anther visible), spray immediately, but control likely will be reduced.

If >60 percent of the heads are flowering, treatments are not recommended. Applications at this time are no longer effective because most larvae will be feeding on kernels and are well-protected inside the glumes. Or, plants are no longer attractive to adult wheat midge and further infestation of primary heads and first tillers is unlikely.
In addition, **late application will kill the parasitoid wasps, reducing natural biological control.**

Producers are wondering what is the best insecticide to use now that Lorsban (chlorpyrifos) is no longer available for wheat midge control. The table (below)) summarizes our insecticide options and their IRAC group (mode of action), trade name, active ingredient, PHI, low and high label rates and estimated cost. Bottom line is that there are not a lot of insecticides options: Group 1B organophosphate – 2 active ingredients, Group 3A pyrethroid - 2 active ingredients and premix of 3A pyrethroid and 28 diamide. If the temperatures are not hot, above >90^{o}F, the pyrethroids will effectively kill wheat midge adults and provide the longest residual of 7-10 days. Organophosphates will have a shorter residual of 3-5 days. The premix contains mixture of lambda-cyhalothrin (3A) and chlorantraniliprole (28). Diamides are most commonly recommended for caterpillars (armyworms) and grasshopper control in wheat. We have not tested it for wheat midge control in wheat. I would recommend using the higher labeled rate of the insecticide to improve your control and increase the residual length. We need some newer insecticide products registered for wheat midge control in wheat. This will help prevent the development of insecticide resistance by rotating insecticides between different modes of actions.

IRAC Group	Example Trade Name	Active Ingredient(s)	PHI	Rate Range (oz/acre)		Cost ($/acre)	
				Low	High	Low	High
1B	Dimate 4E	dimethoate	35 days	8	12	$ 4.56	$ 4.56
1B	Fyfanon ULV AG	malathion	7 days	8	8	$ 2.88	$ 2.88
3A	Warrior II	lambda-cyhalothrin	30 days	1.28	1.92	$ 3.79	$ 5.68
3A	Silencer VXN	lambda-cyhalothrin	30 days	2.56	3.84	$ 1.77	$ 2.65
3A, 28	Besiege	lambda-cyhalothrin + chlorantraniliprole	30 days	6	10	$ 15.12	$ 25.20

A research efficacy study from Montana State University (courtesy of B. Stougaard) tested Warrior II at a high rate 1.6 fl oz/acre, and Lorsban at 1 pint/acre for wheat midge control. **All insecticide treatments had significantly lower number of larvae per head, lower percent of kernels damaged and higher yield than the untreated check under high densities of wheat midge.**
**Mention of any insecticides is not an endorsement by the author or NDSU Extension.*

IPM INSECT TRAPPING UPDATE

We will be posting and reporting weekly trapping results for insect pests of wheat, canola and sunflower on the NDSU Extension ***IPM website*** and in the ***Crop & Pest Report***. Please send me any new field reports of insect pests.

Wheat: IPM Scouts have placed pheromone traps out for true armyworm and black cutworm at 18 trap sites in 18 counties (Table 1).

Trap catches for **true armyworm** were detected at low numbers, <10 moths per trap per week, at 56% of the trap sites. Although the total number of true armyworms doubled from the first week of trapping, there has been few field report of crop damage in cereal crops.

Black cutworm was observed at three of the 18 trap sites (only 1 moth captured) in Renville, Traill and Slope Counties. Please send me any new field reports of true armyworm or black cutworms.

Table 1. 2022 pheromone trap catches for true armyworm and black cutworm in wheat, ND.							
Area	County	True armyworm			Black cutworm		
		June 13-19	June 20-26	June 27-July 3	June 13-19	June 20-26	June 27-July 3
SE	Cass	-	0	7	-	0	0
EC	Traill	-	-	9	-	-	1
EC	Griggs	-	-	4	-	-	0
NE	Pembina	-	-	0	-	-	0
NE	Ramsey	-	0	2	-	0	0
NE	Rolette	-	-	1			0
Central	Foster	0	0	0	0	0	0
Central	Wells	1	0	2	0	0	0
SC	McIntosh	-	0	0	-	0	0
NC	Renville	-	0	3	-	0	1
NC	Ward	-	1	0	-	0	0
WC	McLean	-	0	0	-	0	0
NW	Divide	-	0	0	-	0	0
NW	Mountrail	-	0	0	-	0	0
NW	Williams	-	0	0	-	0	0
SW	Golden Valley	10	3	6	0	1	0
SW	Morton	0	0	5	0	0	0
SW	Slope	1	0	1	0	0	1
	Total #	**12**	**4**	**40**	**0**	**1**	**3**

Canola:

IPM Scouts have placed pheromone traps out for bertha armyworm and diamondback moth at 18 traps site in 11 counties, mainly northern canola growing areas (Table 2, next page).

Trap catches for **bertha armyworm** were detected at low numbers, <15 moths per trap per week, at 27% of the trap sites. Adult bertha armyworm has a wing span of about 1½ inches. The forewings are predominantly gray, with patches of black, brown, olive and white scales. Each forewing is characterized by a silvery kidney-shaped spot and silvery fringed margins.

Bertha armyworm (Gerald Fauske, Dept. Entomology, NDSU)

Diamondback moths were observed at 53% of the trap sites with increasing numbers at most trap sites in the northeast (especially Cavalier and Towner Counties), and Cass County in the southeast. The adult diamondback moth is a small gray or brown moth about ½ inch long. At rest, wings are folded rooflike over its body. Light tan marks can be seen on the margin of the forewing. Male moths have three diamond-shaped markings on the back of the forewing when the wings are folded together, hence the name diamondback moth.

Diamondback moth (Gerald Fauske, Dept. Entomology, NDSU)

When diamondback moth trap catches are above 100 moths per trap per week, canola field should be scouted for economic larval densities in canola fields. More on scouting for diamondback moth larvae in canola in next week's issue.

Table 2. 2022 pheromone trap catches for bertha armyworm and diamondback moth in canola, ND.							
Area	County	Bertha armyworm			Diamondback moth		
		June 20-26	June 27-July 3	Total trap catch	June 20-26	June 27-July 3	Total trap catch
NC	Bottineau1	-	-	0	-	-	0
NC	Bottineau2	-	-	0	-	-	0
NC	Bottineau3	-	-	0	-	-	0
NC	Renville1	0	0	0	0	0	0
NC	Renville2	0	0	0	0	0	0
NC	Renville3	0	0	0	0	0	0
NC	Ward1	1	0	1	0	0	0
NC	Ward2	-	0	0	-	0	0
NC	Ward3	0	0	0	0	0	0
NC	Ward4	0	0	0	-	0	0
NE	Benson	-	0	0	-	0	0
NE	Cavalier	9	8	17	13	28	41
NE	Pembina	0	0	0	0	1	1
NE	Ramsey	8	1	9	0	22	22
NE	Rolette	-	0	0	-	10	10
NE	Towner	10	5	15	1	70	71
NE	Walsh	0	14	14	0	12	12
SE	Cass	0	0	0	0	45	45
	Total #	28	28	56	14	188	202

Sunflower:
IPM Scouts have placed some pheromone traps out for banded sunflower moth, Arthuri sunflower moth and sunflower head moth at 6 traps site in 7 counties. So far, only one sunflower head moth per trap per site was collected at Cass County and Dunn County trap sites, and one banded sunflower moth at Dunn County.

Banded sunflower moth, *Cochylis hospes*, is a small (¼ inch long), straw yellow moth with a wingspan of about ½ inch. Its forewings have a triangular, dark brown band crossing through the middle of the wing.
Arthuri sunflower moth, *Cochylis arthuri*, is a small (¼ inch long), whitish-gray moth with a wingspan of about ½ inch. Its forewings are crossed by a broken brown and gray band and the outer ¼ has brownish markings and dark fringe.
Sunflower head moth, *Homoeosoma electellum*, is a small (<½ inch long), light-colored moths that hold their wings over the abdomen and appear cigar-shaped. When the wings are spread, they can be recognized by having a pale leading edge of the forewing, and a small black discal spot on each forewing.

Banded sunflower moth (left, Gerald Fauske), Arthuri sunflower moth (middle, Gerald Fauske) and sunflower head moth (right, Patrick Beauzay)

Janet J. Knodel
Extension Entomologist

plant pathology

FUSARIUM HEAD BLIGHT (SCAB) RISK

The NDSU model (Figure 1) and the National Fusarium Risk Tool model (Figure 2) indicate low to moderate scab risk for susceptible varieties in North Dakota. However, the sporadic thunderstorms, forecast for higher relative humidity and prolonged dew points suggest scab risk will increase in the next 7 to 10 days. At this time, it is important to monitor the growth stages in your wheat and barley fields and evaluate scab risk as the small grain crops start to enter heading and flowering stages. As we move further into July, our relative humidity values tend to increase, which will also increase our scab risk for small grains crops.

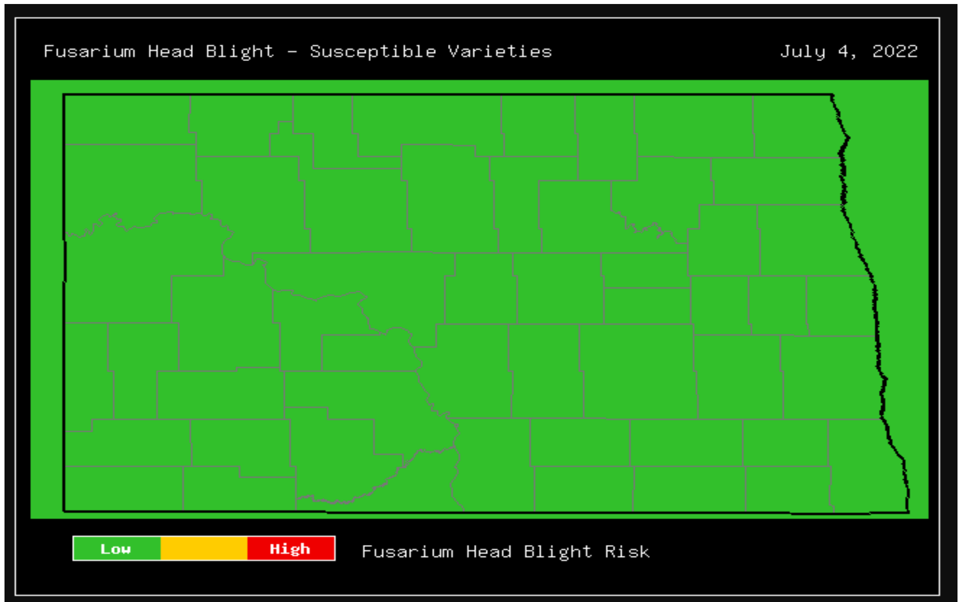


Figure 1. Fusarium head blight (scab) risk as indicated by the NDSU Small Grain Disease Forecasting Model for susceptible varieties on July 4. This model indicates low scab risk for the state.

Figure 2. Fusarium head blight (scab) risk as indicated by the Fusarium Risk Tool for susceptible varieties on July 5. Note moderate risk indicated by the model for areas in northwest North Dakota.

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Extension Plant Pathology, Cereal Crops

GETTING READY FOR MANAGING CERCOSPORA LEAF SPOT OF SUGARBEET

Cercospora leaf spot (CLS) (Figure 1) is the most economically damaging foliar disease of sugarbeet in North Dakota and Minnesota. The causal agent of CLS is the fungus *Cercospora beticola,* which is most destructive in warm weather (day temperature of 77 to 90° F and night temperature above 60° F) and in the presence of moisture from rain or dew on the leaves for 8 or more hours. The fungus destroys the leaves, starting with the oldest that are the most productive. The longer and more severe the infestation, the greater the reduction in tonnage, sugar concentration and recoverable sucrose. Roots of CLS infected plants have higher impurities, extends the duration of the extraction of recoverable sucrose and are more costly to process.

Figure 1. Cercospora beticola kills the mature and productive leaves resulting in re-growth of new leaves. Severe disease starting in early summer results in reduced tonnage, significantly lower sugar concentration and recoverable sucrose with higher processing costs.

Growers typically mange CLS by integrating crop rotation with non-hosts crops including corn, soybean and wheat, planting CLS tolerant varieties including CR+ varieties, planting away from a previously infected crop, incorporating infected debris, and applying fungicide mixtures in a timely manner.

Since the CLS epidemic of 2016, the *C. beticola* population has remained highly resistant to quinone outside inhibitor (QoI) fungicides (Headline, Gem), and has become less sensitive to demethylation inhibitors (DMI) or triazoles (Eminent, Minerva, Inspire XT, Provysol, Proline, Enable, Topguard), triphenyltin hydroxide (TPTH) (Super Tin, Agri Tin), and thiophanate methyl (Topsin). Mixtures of succinate dehydrogenase inhibitor (SDHIs) and QoIs, such as Priaxor, and SDHIs and DMIS, such as Lucento, were ineffective at controlling *C. beticola* in 2021 (Figure 2).

Figure 2. Sugarbeet field with multiple fungicide applications did not provide effective CLS control because of fungicide resistance.

The efficacy of fungicides to control *C. beticola* have been significantly reduced and there is currently no individual fungicide that can effectively control *C. beticola* during the growing season. In 2021, only certain fungicide mixtures were effective at providing season long control of CLS (Figure 3).

Figure 3. Sugarbeet plots sprayed with 31 individual and fungicide mixtures showed that only certain fungicide mixtures (9) provided effective season long control of CLS in 2021 near Foxhome, MN.

What can growers do in 2022 to manage CLS?

The 2022 sugarbeet crop was planted late because of wet field conditions. A small percent of fields were replanted because of poor stand caused by heavy wind, flooding or poor emergence. The sugarbeet crop is at different growth stages: some fields have rows that are touching or are about to close rows, some fields are at the cotyledon stage, and most fields are in the 8- to 12-leaf stage based on planting date and environmental conditions.

In areas where rows are closed and conditions are favorable for infection (2-day daily infection value equal or greater than 7, Figure 4), and where the pathogen is endemic, growers should start to apply fungicides at this time or when symptoms are first observed in a field. Fields where the rows are not closed (as in Figure 5, planted on May 27), growers should wait until just prior to or at row closure and conditions are favorable for infection to start fungicide applications.

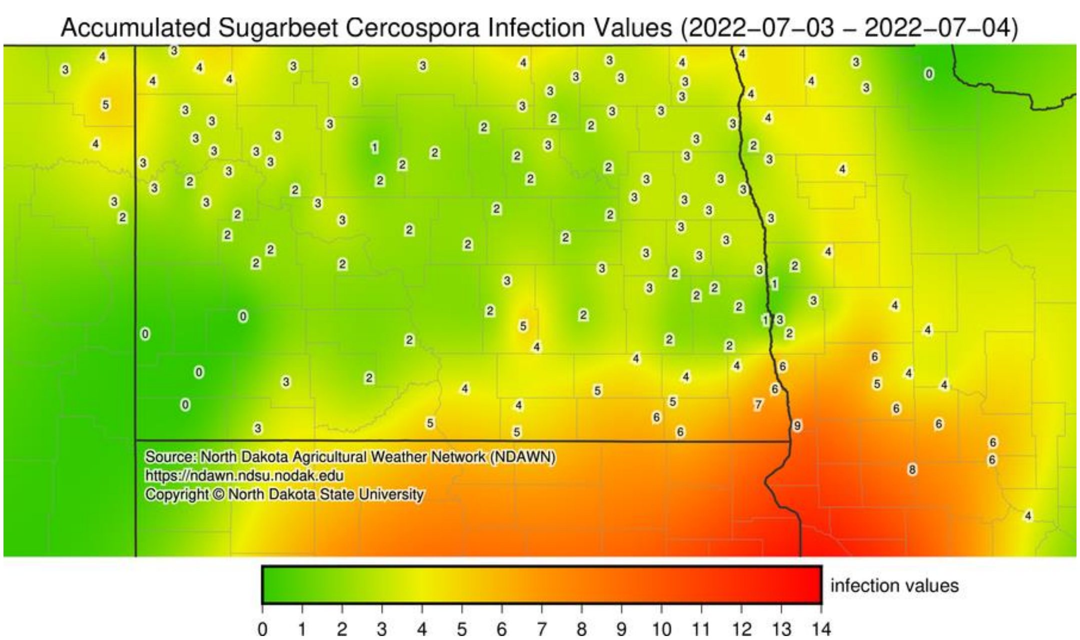

Figure 4. North Dakota Weather Network illustrating the accumulated Cercospora infection values for July 3 and 4, with favorable conditions for infection in Mooreton and Cambell. (values of 7 or greater)

Some factory districts now have a significant acreage of CR+ varieties with improved tolerance to *C. beticola*. We are conducting field research to determine how best to manage these varieties to control CLS with timely application of fungicide mixtures and delay the pathogen from overcoming the host's resistance. Additional information will be provided as we learn from current field trials.

Figure 5. Sugarbeet planted on May 27, 2022 near Foxhome, MN

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OPTIMIZING THE USE OF FUNGICIDES FOR IMPROVED MANAGEMENT OF ASCOCHYTA BLIGHT IN CHICKPEAS

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 facilitate 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.

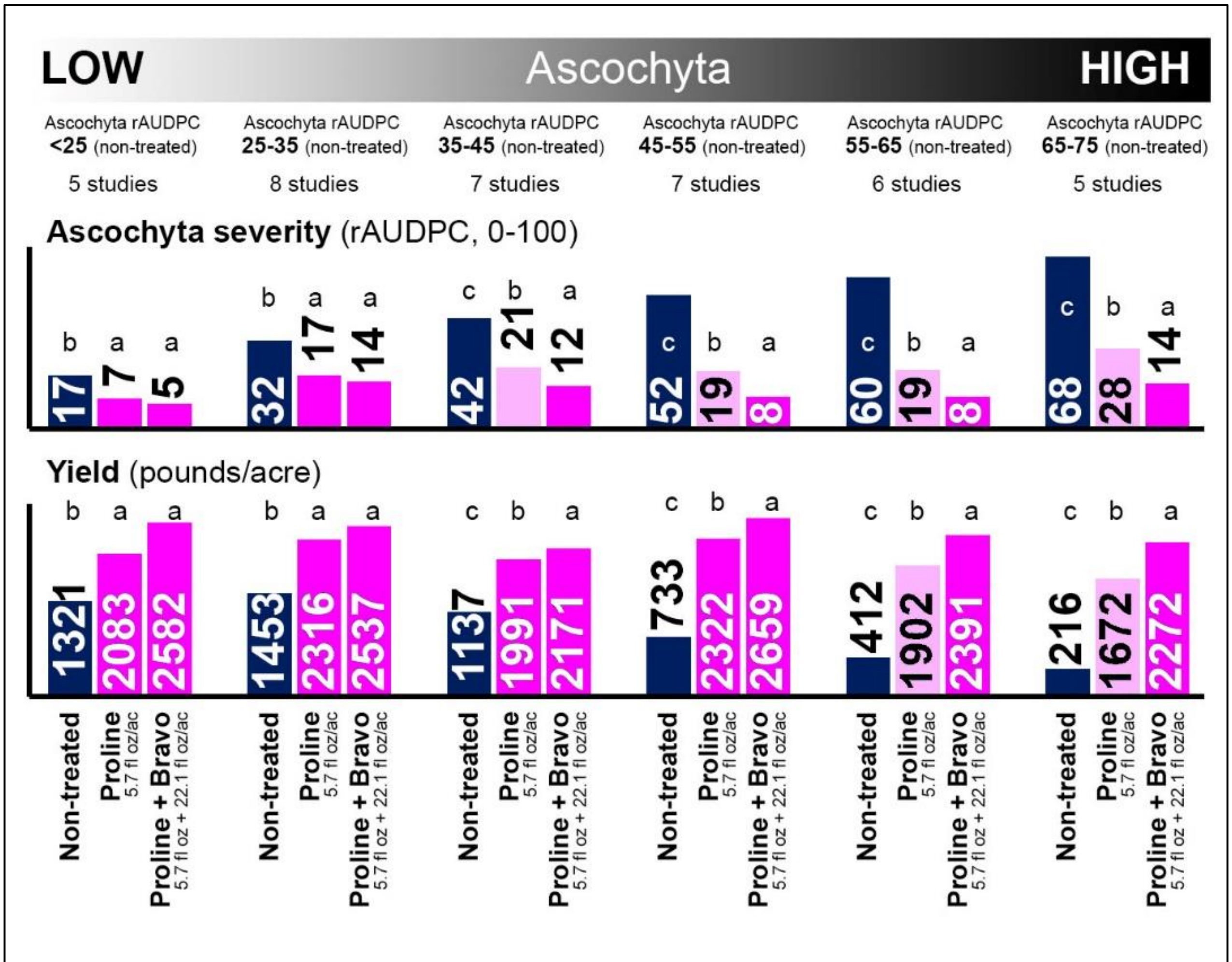

FIGURE 1. EFFICACY OF PROLINE VS. PROLINE + BRAVO WS RELATIVE TO DISEASE PRESSURE. Data are from field trials conducted in Carrington, Hofflund (30 miles east of Williston), and Plaza, ND (2015-2021). Applications were made with a hand-held boom or tractor-mounted boom (6 to 10.5 mph driving speed) in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

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 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	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 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).*

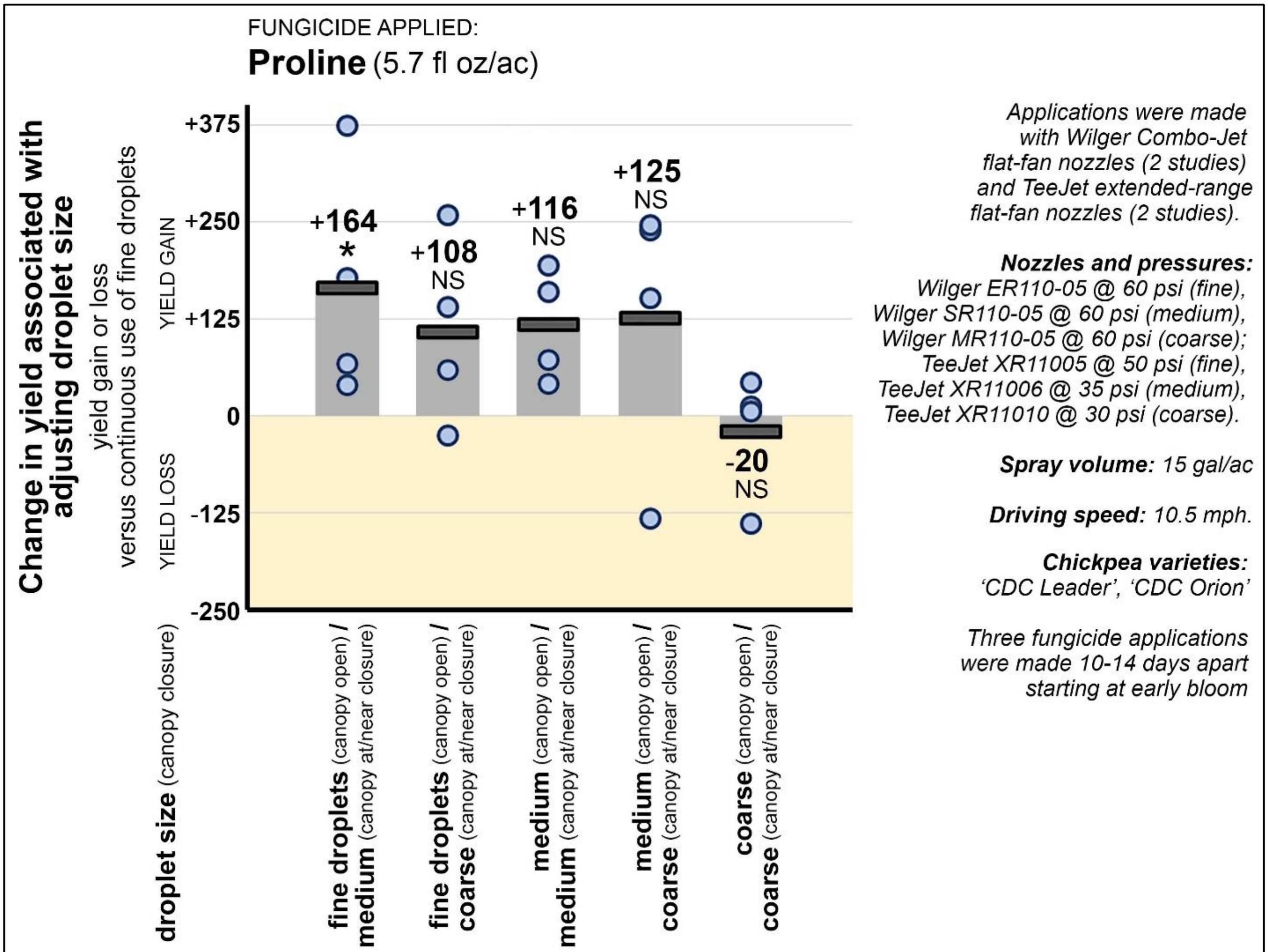

FIGURE 4. OPTIMIZING FUNGICIDE SPRAY DROPLET SIZE WITH <u>SYSTEMIC FUNGICIDES</u> FOR ASCOCHYTA MANAGEMENT - Are fine droplets always optimal when applying locally systemic fungicides? *<u>Impact on yield associated with calibrating droplet size relative to canopy closure versus always applying with 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.*

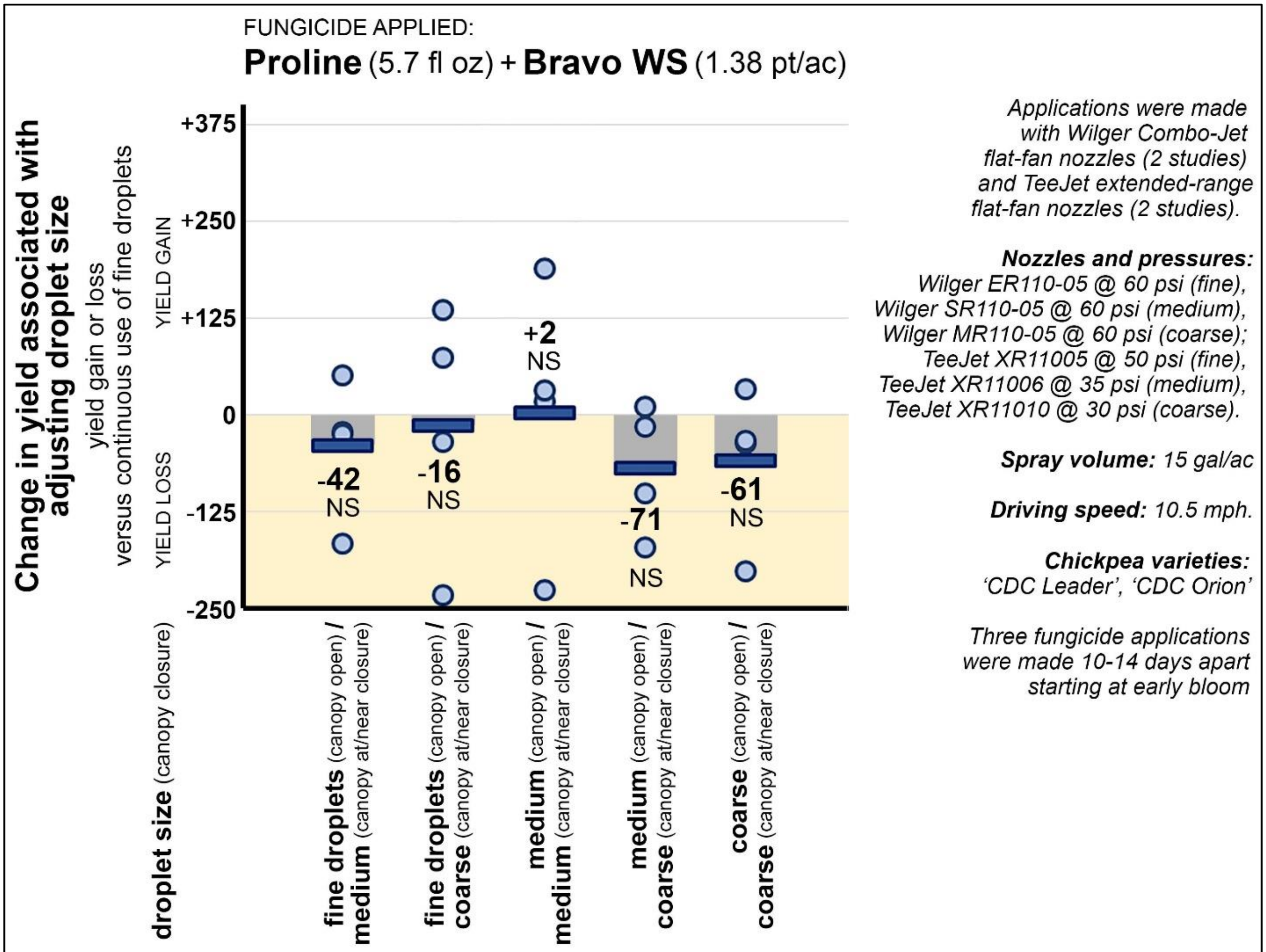

FIGURE 5. OPTIMIZING FUNGICIDE SPRAY DROPLET SIZE WHEN APPLYING FUNGICIDE TANK-MIXES WITH BRAVO WEATHERSTIK FOR ASCOCHYTA MANAGEMENT - Are fine droplets always optimal when applying locally systemic fungicides in a tank-mix with the contact fungicide Bravo WeatherStik? *Impact on yield associated with 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 $P < 0.10$.*

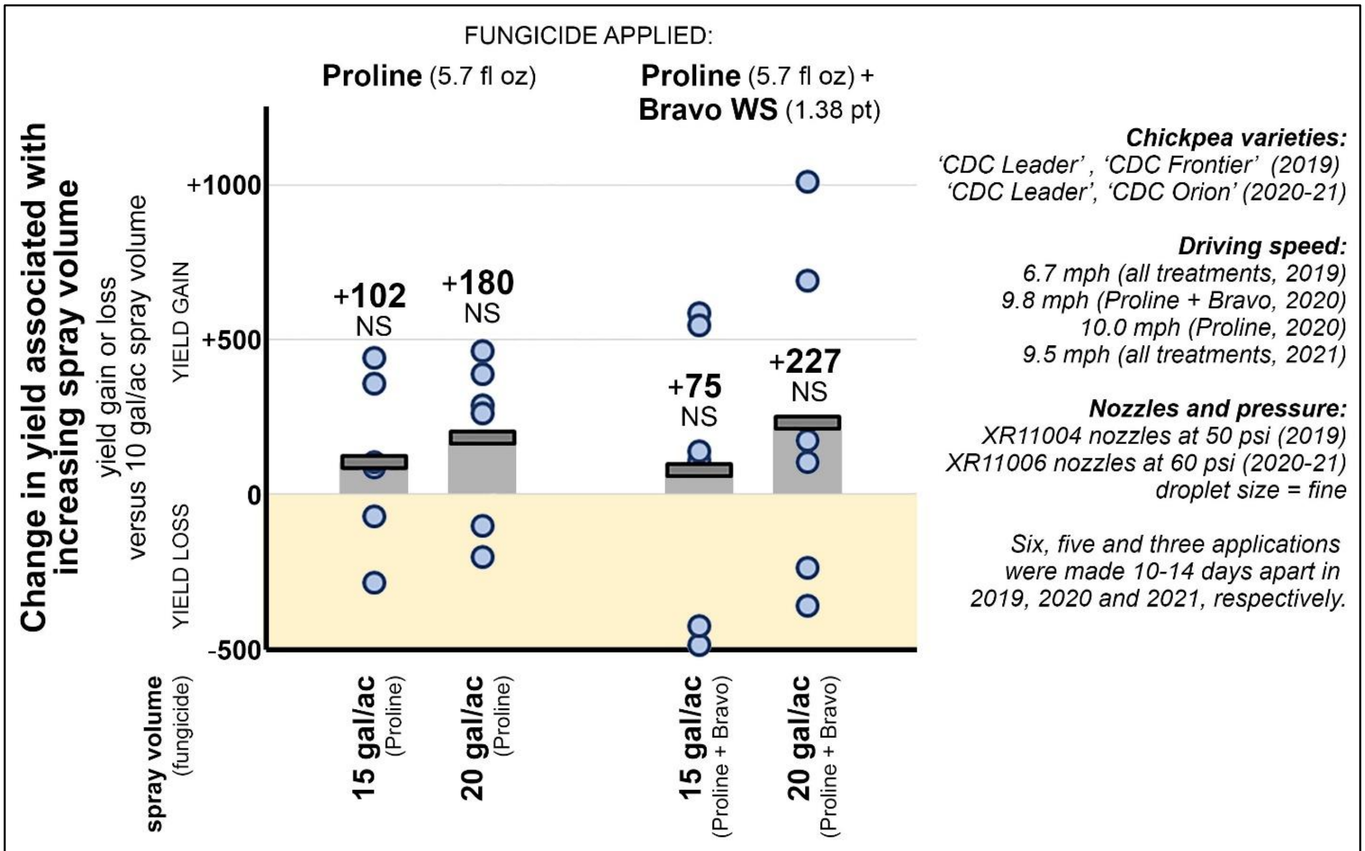

FIGURE 6. Impact of increasing spray volume from 10 gal/ac to either 15 or 20 gal/ac on Ascochyta management and chickpea yield; Carrington, ND (2019, 2020, 2021). *Dots represent results from individual studies; bars represent average values. 'NS' indicates no statistically significant difference relative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

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OPTIMIZING FUNGICIDE APPLICATION TIMING FOR IMPROVED MANAGEMENT OF WHITE MOLD IN DRY BEANS

Across the dry bean producing regions of North Dakota and Minnesota, the growth stage at which fungicides are applied to dry beans targeting white mold differs widely across producers and across production regions. When conditions favor white mold as dry beans enter bloom, fungicides are applied as early as initial bloom (10 to 20% of plants with an open blossom) to as late as initial pod (50 to 75% of plants with initial pin-shaped pods). Research evaluating fungicide application timing for white mold in dry beans has been lacking, and the application timing utilized has been largely driven by tradition.

To generate data for rigorous research-based recommendations for optimizing fungicide application timing targeting white mold in dry beans, field studies were conducted at the NDSU Carrington Research Extension Center and at the NDSU Robert Titus Irrigation Research Farm in Oakes in 2017, 2020 and 2021. Parallel studies were conducted in pinto, dark-red kidney, navy and black beans. Overhead irrigation was applied as needed to facilitate disease pressure. The goal of this project was to identify when fungicides should be applied when risk of white mold is elevated as dry beans enter bloom.

Testing was conducted on dry beans seeded to 14-inch or 28-inch rows at 90,000 viable seeds/ac (pinto and kidney beans) or 100,000 viable seeds/ac (navy and black beans). Testing was conducted on 'Laz Paz' (2017), 'Lariat' (Carrington, 2020), and 'Palomino' pinto beans (Oakes, 2020 and 2021; Carrington, 2021); 'Avalanche' (Carrington, 2017), 'T9905' (Carrington, 2020) or 'HMS Medalist' navy beans (Carrington, 2020); 'Eclipse' (Oakes and Carrington, 2017) and 'Black Bear' (Carrington, 2020) black beans; and 'Dynasty' dark-red kidney beans. Fungicides were applied with a hand-held 56-inch, 4-nozzle boom. When canopy closure averaged less than 90%, applications were made with TeeJet DG11015 nozzles at 30 psi (medium droplets); when canopy closure averaged 90-95%, applications were made with TeeJet AIXR11015 nozzles at 60 psi (medium-coarse droplets); and when canopy closure was >95%, applications were made with TeeJet AIXR11015 nozzles at 50 psi (coarse droplets). Testing was conducted with a single application of Topsin (30 fl oz/ac in 2017 and 2020; 40 fl oz/ac in 2021) and with sequential applications of Topsin followed by Endura (8 oz/ac) 8 to 14 days later. Studies were conducted with 6 to 14 replicates, with a large number of replicates utilized so as to mitigate spatial differences in Sclerotinia disease pressure.

The best predictors of optimum fungicide application timing were percent canopy closure and the percent of plants with one or more initial pods.

- Pinto beans: When the canopy was at or near closure (average ≥ 95% of the ground covered) when the first pin-shaped pods were developing, white mold management and pinto bean yield were optimized when fungicides were applied when approx. 15% of plants had initial pin-shaped pods (**Figure 1**). When the canopy was open (average < 95% of the ground covered) when the first pin-shaped pods were developing, white mold management and dry bean yield were optimized when fungicide applications were delayed until 50% of the plants had initial pin-shaped pods (**Figure 2**). The growth stage which optimized fungicide performance was the same irrespective of whether one fungicide application or two sequential applications were made.

- Black beans and navy beans: When the canopy was open (average < 95% closure) when the first pin-shaped pods were developing, the response to fungicides was very similar irrespective of whether applications were made at the first appearance of pin-shaped pods or delayed until 30-50% of plants had initial pods (**Figures 3 and 4**). However, yield gains in individual studies were highly variable when fungicide applications were made after 20% of plants had initial pods, indicating that making applications when more than 20% of plants had initial pods is only optimal when conditions do not favor infection by the Sclerotinia pathogen.

- Kidney beans: Only two of the field trials conducted on kidney beans had sufficient white mold disease pressure to evaluate the impact of fungicide application timing. Preliminary results suggest that the optimal application timing may be similar to navy and black beans (10 to 20% of plants with initial pin-shaped pods irrespective of canopy closure), but additional data are needed before recommendations can be developed.

Follow-up research is in progress this season to confirm these findings. The number of field studies conducted for each market class was relatively small, and statistical separation was often not achieved. Final conclusions are anticipated after a fourth year of field trials in 2022.

More research-driven recommendations on improving white mold management in dry beans and soybeans can be found at the NDSU Carrington Research Extension Center website at https://www.ndsu.edu/agriculture/ag-hub/research-extension-centers-recs/carrington-rec/research/plant-pathology. Included are data and recommendations on optimizing row spacing, seeding rate, fungicide droplet size, fungicide selection (comparative fungicide efficacy), fungicide application frequency, and fungicide application interval.

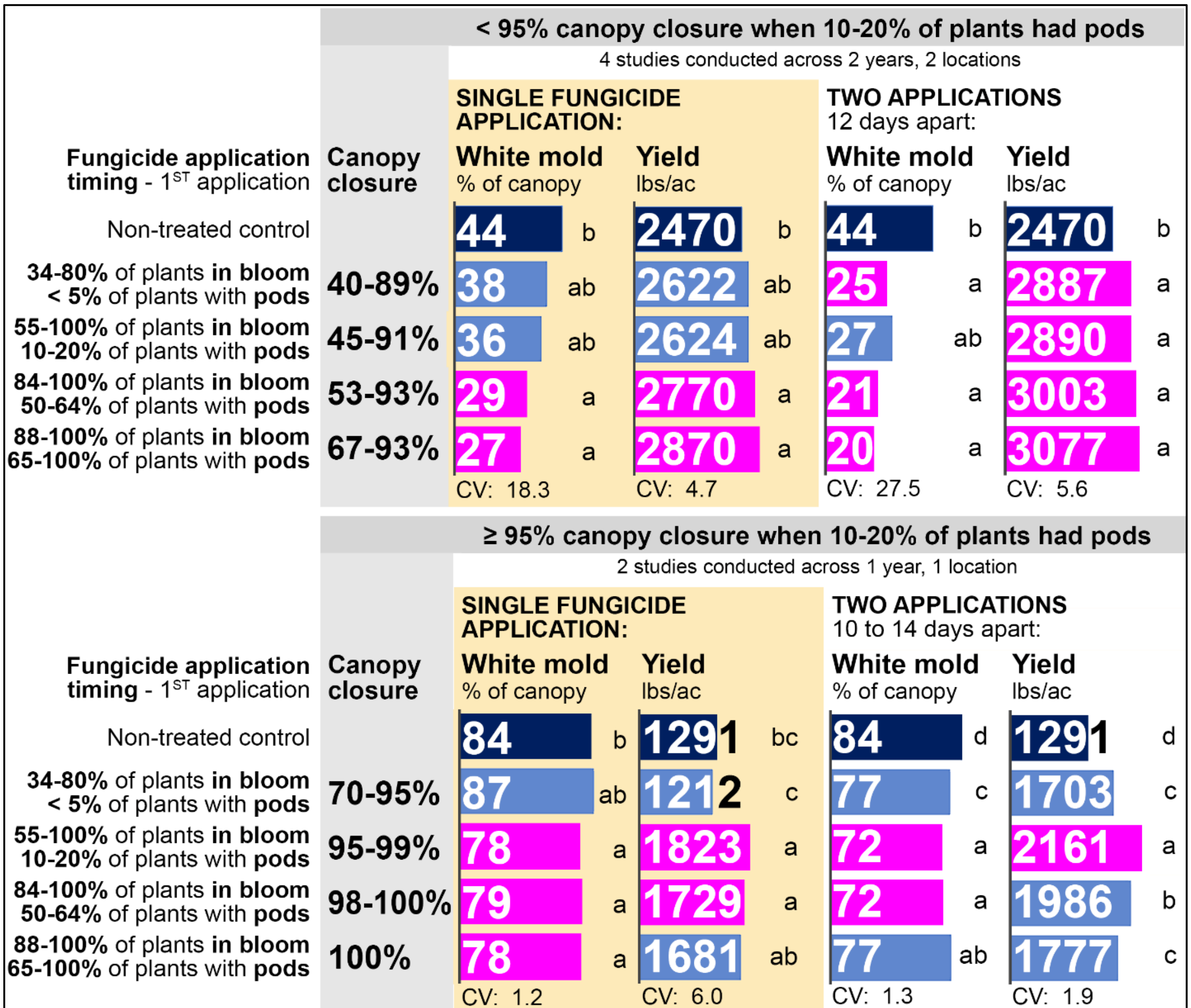

FIGURE 1. Impact of fungicide application timing on white mold management in pinto beans; Carrington and Oakes, ND (2017, 2020, 2021). *Treatment means followed by different letters are significantly different (P < 0.05).*

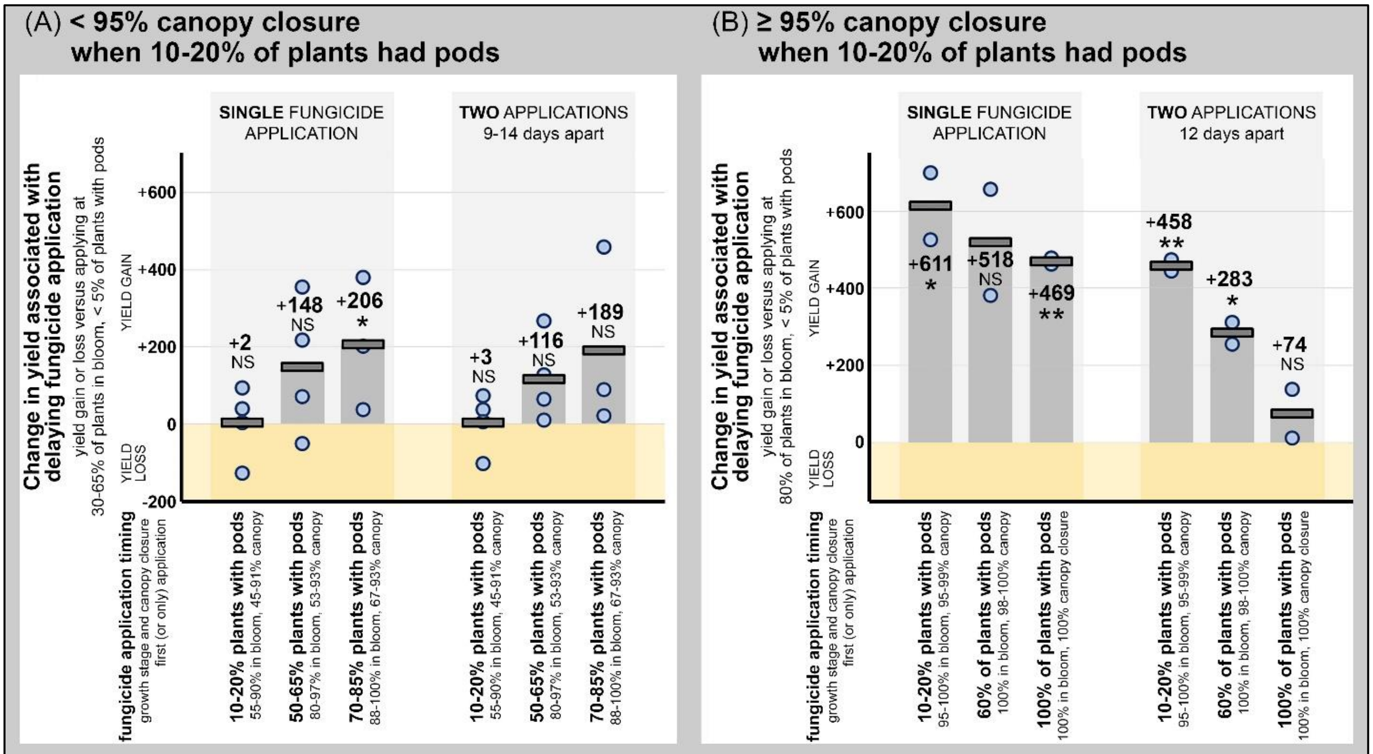

FIGURE 2. Impact on pinto bean yield associated with delaying white mold fungicide applications from initial bloom (30-65% of plants with an open blossom, <5% plants with initial pods) to initial pod development (10-20%, 30-65%, or 70-85% of plants with initial pin-shaped pods). *When the canopy was open when 10-20% of plants had initial pods (figure A on the left side), delaying fungicides until 30-85% of plants had initial pods optimizing fungicide performance. When the canopy was at or near closure when 10-20% of plants had initial pods (figure B on the right side), applying fungicides when 10-20% of plants had initial pods was optimal. Applying at early bloom (<5% of plants with initial pods) was never optimal. (Dots denote responses observed in individual field studies; bars represent average values.)*

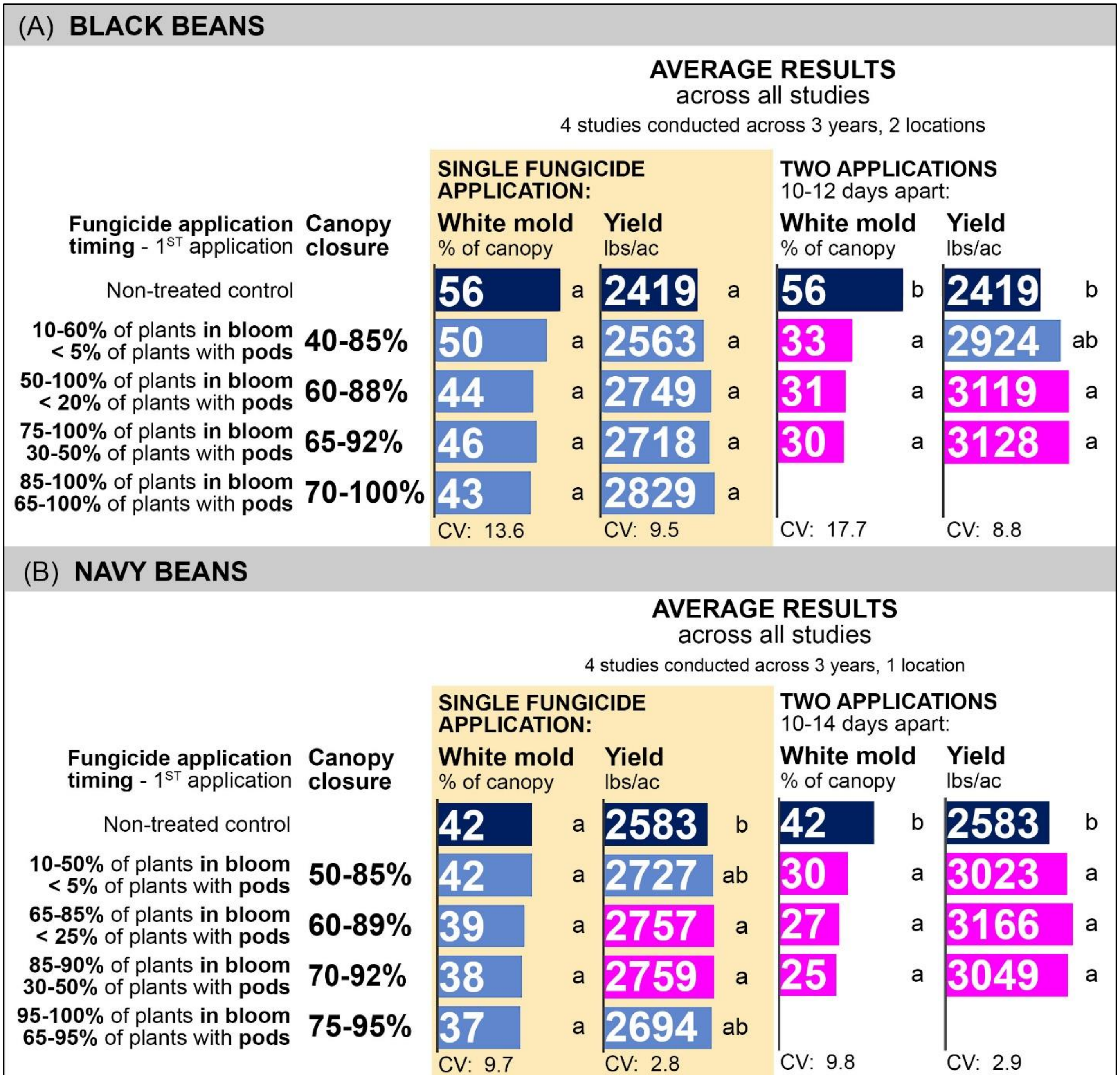

FIGURE 3. Impact of fungicide application timing on white mold management in black and navy beans; Carrington and Oakes, ND (2017, 2020, 2021). *Treatment means followed by different letters are significantly different (P < 0.05).*

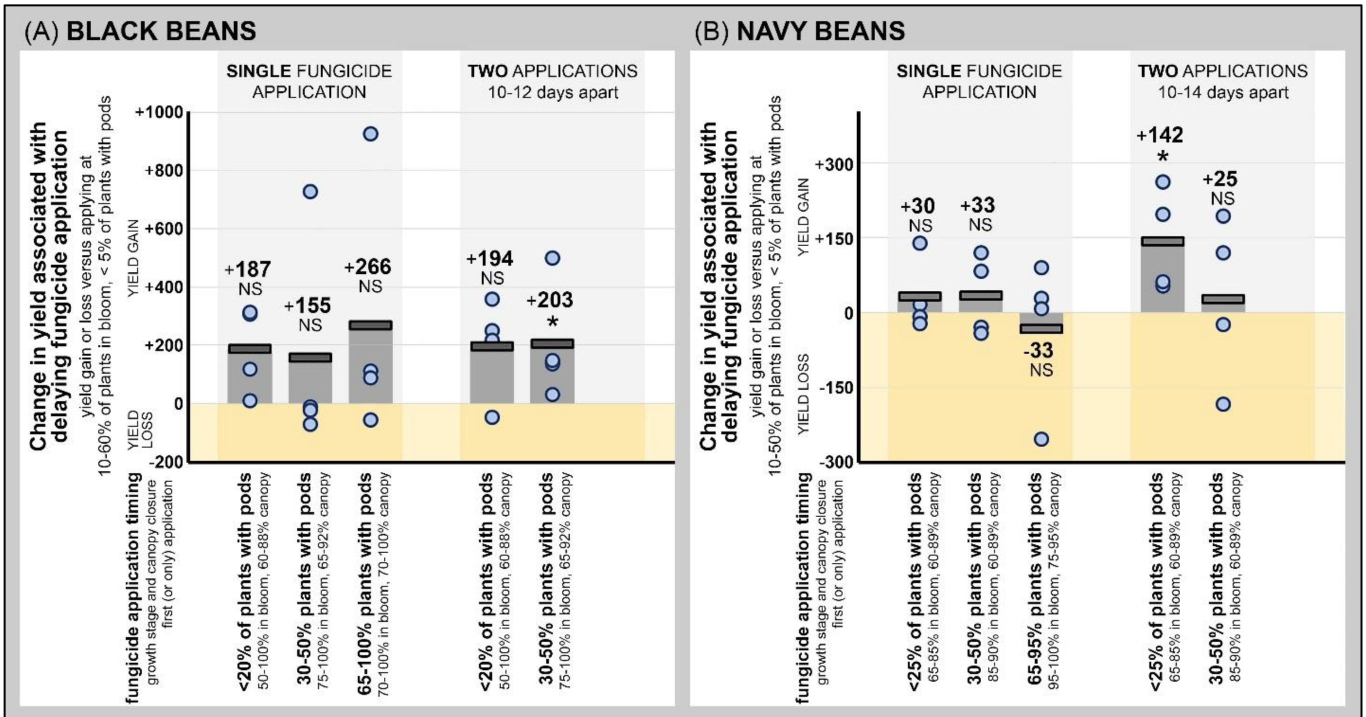

FIGURE 4. ***Impact on black and navy bean yield associated with delaying white mold fungicide applications from initial bloom (10-60% of plants with an open blossom, <5% plants with initial pods) to initial pod development (5-20%, 30-50%, or 65-100% of plants with initial pin-shaped pods).*** *The average yield gain from the fungicide was similar across fungicide application timings but results from individual studies were highly variable when more than 20% of plants had initial pods. The results suggest that when conditions are highly favorable for white mold, fungicide applications should be made when 10-20% of plants have initial pods. Fungicide applications should be delayed to 30-100% of plants with initial pods only when conditions do not favor white mold.* (*Dots denote responses observed in individual field studies; bars represent average values.)*

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plant science

NITROGEN AND SOYBEAN NODULATION

Soybean is a legume and plant roots are able to form a symbiotic relationship with specific bacteria (*Bradyrhizobium japonicum*) to fix atmospheric nitrogen (N) and transform it into an available form for plant growth. Soybean grown in North Dakota and northwest Minnesota normally do not require N fertilizer because of this relationship with beneficial bacteria. The N-fixing bacteria colonize host roots and form nodules (small swellings) on the root system (Figure 1). The formation of nodules and N fixation can start as early as the V2 (two trifoliolate leaves) growth stage and it peaks at the reproductive stages. Nodules that are actively fixing N should have a pink to red color on the inside.

Figure 1. Nodules on soybean plant roots early during the season.

Due to the late planting season, some fields intended for corn and wheat and already fertilized for these crops, were planted with soybean. High N content in the soil reduces the ability of the bacteria to form nodules and fix N (Figure 2).

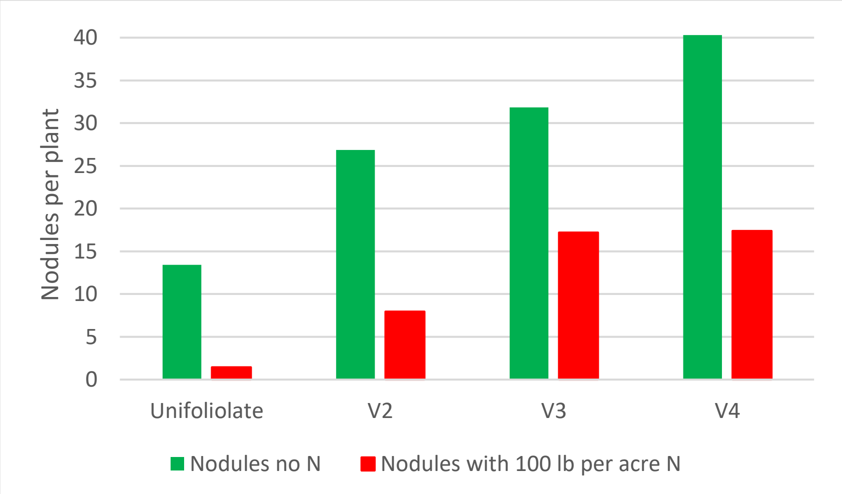

Figure 2. Nodules per plant in a replicated pot experiment with and without Nitrogen applied.

The number of nodules per root will increase as the plant develops, but at all growth stages the number of nodules will be lower when N fertilizer was applied. In addition, the size of the nodules will be smaller with the application of N (Figure 3). However, instead of developing many nodules, the soybean plant will take up the required N for plant development from the available N in previously fertilized fields. The soybean yield will be similar or marginally higher than fields not fertilized with N.

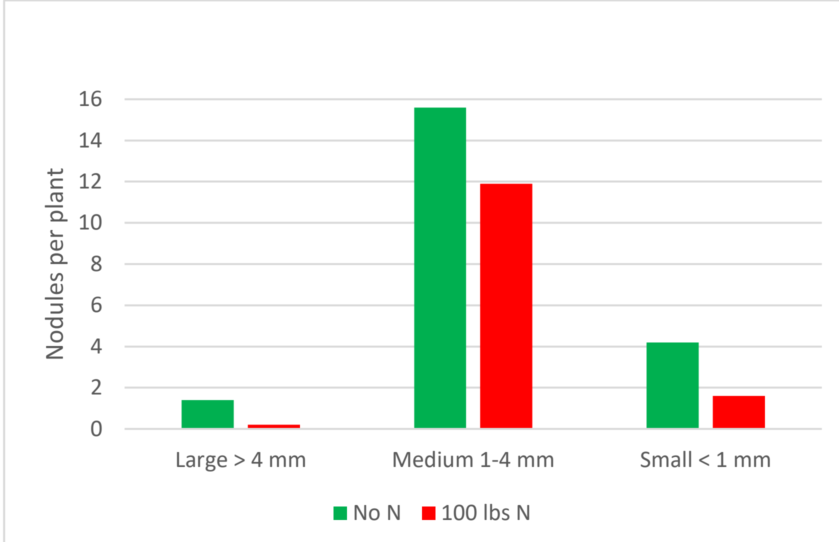

Figure 3. Nodules per soybean plant and size of the nodules without N and with 100 lbs fertilizer N applied in a field study, 2021 near Fargo

Limited nodulation may also occur in fields where there is no previous soybean cropping history. Other factors that may reduce nodulation are wet conditions early in the season, dry soil conditions, soil salinity and other plant stressing conditions. The presence of root rots, soybean cyst nematode and iron deficiency chlorosis may also inhibit the ability of the bacteria to form nodules. It is recommended to check roots for nodules. Carefully dig up plants to avoid sloughing off the nodules and wash them in a bucket of water. Check several locations in each field. If the plant has good nodulation and healthy nodules, the plant can fulfill the N need from the symbiotic relationship with the beneficial bacteria and uptake from the soil mineralization. If no nodules are present and the plants show a yellowing (not caused by IDC), a rescue N application may be warranted. With no or low nodulation, seed inoculation with *Bradyrhizobium japonicum* is recommended the next time soybean is planted in the same field.

For more details about nodulation and N needs in soybean see the Nitrogen section in the Extension publication Soybean Soil Fertility.

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weeds

CLARIFICATION ON PURPOSE AND USE OF PLANT-BACK INTERVALS

Herbicide applications have been in full swing the past several weeks as we all try to stay ahead of weeds after our wet spring. I have received several questions about applying herbicides prior to planting cover crops in Prevent Plant ground. The answer to that question may depend on: what is the end use of the crop being planted. Last week, the Weed Science Society of America, in conjunction with the EPA, sent out a Press Release and fact sheet focusing on the intended use of plant-back restrictions on herbicide labels.

In short, the main reason for plant-back restrictions on herbicide labels is related to illegal residues in subsequent crops. These restrictions are not intended to address adverse effects on crops themselves. However, companies can and will add additional restrictions to address phytotoxicity concerns. For most annual crop rotations, we are largely focused on preventing phytotoxicity to subsequent crops, and the labels reflect this. However, when it comes to planting cover crops, the waters become a little murky.

I'll use 2,4-D as an example. Most 2,4-D labels will state that any crop not listed on the label can be planted 30 days after application. This means that if we wait 30 days after application, there is no risk of 2,4-D residue being detected in subsequent crops. However, under extreme conditions there could still be injury if a sensitive crop is planted after 30 days. Here is the exact label language from a common 2,4-D label:

"Other Crops: All other crops may be planted 30 or more days after application without concern for illegal residues in the planted crop. However, under certain conditions, there may be a risk of injury to susceptible crops. Degradation factors described below should be considered in weighing this risk. Under normal conditions, any crop may be planted without risk of injury if at least 90 days of soil temperatures above freezing have elapsed since application."

So what does this mean for cover crops on Prevent Plant ground this year? Again, the answer depends on the **end use** of that cover crop. If it is being used purely as a cover crop, and will not be hayed or grazed, then plant-back restrictions, as it relates to residues, do not apply. However, we do know that we can elicit injury in some instance (for example, dicamba applied shortly before planting some small grains and grass crops). So, some fields may be a case-by-case basis on level of injury one is willing to accept in order to control weeds and establish specific cover crops. **However**, If that cover crop is going to be grazed or hayed, then we must follow plant-back restrictions to avoid illegal residues entering the human food chain.

Please see these following resources for more information on this topic:

WSSA Press Release:
https://www.prweb.com/releases/new_wssa_backgrounder_clarifies_purpose_and_use_of_plant_back_intervals/prweb18710171.htm

WSSA backgrounder:
https://wssa.net/wp-content/uploads/PBI-BACKGROUNDER-6-17-22-FINAL.pdf

Joe Ikley
Extension Weed Specialist

around the state

AROUND THE STATE

NORTH CENTRAL ND

Hit and miss storm chances brought localized precipitation to the area. Moderate temperatures and some chances of precipitation appear to be part of next week's forecast before a possible drying pattern. At the NCREC, 0.41" of rain was observed since last Monday (June 27th). The following are precipitation observations across the area as noted by local NDAWN stations from June 27th through July 5th: Bottineau: 0.23"; Garrison: 2.37"; Karlsruhe: 0.39"; Mohall: 0.34"; Plaza: 0.74"; and Rugby: 0.11".

As noted in previous editions of the *Crop & Pest Report*, some crop samples have arrived at the Extension Crop Protection Office showing signs of abiotic stress due to environmental factors from the past few weeks. However, weather conditions may allow for some disease development over the next few weeks. Please include disease scouting in your IPM protocols. Grasshopper control is still being utilized in some locations, especially near the field border. As reported previously, continue to scout, and make applications should economic thresholds be met; this could be as simple as a border treatment.

Figure 1. From the top left clockwise: soybean field; soybean plant from the same field; field pea; canola; corn; sunflower.

Crops in the region are growing well, considering the planting conditions we faced this year. Spray for scab in spring wheat already started in the region. We observed nitrogen (N) and sulfur (S - plus heat stress) in spring wheat under sandy soils. However, some farmers in clay soils also reported N/S deficiency as well. Weeds are still an issue, with a fair amount of fields with weed control issues, possible the inability to do the preemergence application due to the soil conditions (too wet) for traffic. Spring wheat in the region is found in stages ranging from 5 leaf to heading. Corn is found from V4-V8. Soybeans is found from V2 to V9. Canola is found from 2.5 to flowering. Flax is found from stage 5 to 6 (very few in stage 7). Field pea is found from V5 to pre R1. Sunflower is found from stage V4 to V6.

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NORTHEAST ND

Crops in the NE region look good ranging from fair to good and excellent. Most of the region received showers in the last week amounting to a low of 0.02 inches to a high of 1.2 inches. Majority of the small grains are beginning to head out this week. Producers should be checking the small grain disease forecasting model for Fusarium Head Blight (Scab) risk on NDAWN website for their respective locations. So far, the risk of scab affecting small grains in the NE region remained low to moderate up to July 4th. Soybeans are V1 to V3 stages with lots of open space between rows. Iron deficiency chlorosis is showing up in many areas in soybeans. Corn is reaching knee high and above in some areas whereas struggling below knee high in some areas. There is so much variability in canola growth stages too across the area. The early seeded canola is at bolting to flowering while late seeded and reseeded canola are at 4-6 leaf stage. Edible beans and sunflowers are growing well. Sugarbeet planting continued up to July 1st in Walsh County making it a new record! Grasshopper nymphs continue to increase in numbers and feeding damage is being reported along field borders. Haying has started in many areas. Blister beetles are being reported heavily in alfalfa in Pembina and Pierce counties.

Figure 1: Soybeans showing IDC symptoms (Venkataramana Chapara, LREC)

Figure 2: Variability in canola field growth stages in Cavalier County; A field in vegetative stage and another one at flowering stage (Venkataramana Chapara, LREC)

Figure 3: Sunflower field in Cavalier County (Venkataramana Chapara, LREC)

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EXTENDING KNOWLEDGE ❯❯ CHANGING LIVES

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