Northarvest
BEAN GROWER

2023 RESEARCH ISSUE AGWEEK

2023 Dry Bean Research Reports

Learn more about research on herbicides, white mold, new varieties and other important projects.

Northharvest BEAN GROWER

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Table of Contents

Featured

Plus:

On the cover:

While ALS-inhibitor-resistant Palmer amaranth hasn't been found in dry edible bean fields in North Dakota, it has been found in other crops. This stand of the weed was in Nebraska in 2017. Nick Nelson / Agweek file photo

FROM THE PRESIDENT

A spotlight on research

Eric Sameulson
President,
Northarvest
Bean Growers
Association

This is a packed issue, so I'll try to keep this letter brief. Northarvest Bean Growers Association has provided extensive funding to support research aimed at improving dry bean production for more than 40 years. In 2020-21, that amounted to $378,225 — more than 22% of the association's budget. We upped that amount in 2021-22 to $381,429 — 25% of the budget.

Supporting this research serves a vital function of helping our growers improve their yields and their overall efficiency. That's important to the bottom line for growers, as well as to the environment and to the future of our industry. We are constantly striving to best manage our fields to try to achieve the highest yields to meet the challenge of feeding a hungry world with less resources.

In this issue of BeanGrower, you'll be able to read about the research we have supported in the past year. That includes a wide range of projects, from bean varieties to disease control, herbicide use and fertilizer use. Some of these projects are looking at things that haven't been looked at before or that haven't been looked at in years. For instance, on page 27, you can read about research into how much nitrogen it takes to grow dry edible beans. That research hasn't been done in Minnesota for over 20 years. The preliminary research indicates it might be possible to reach the same yields using less nitrogen. I'm sure you've seen the volatility of that market in recent years. We sure would like to be able to trim some of those costs — and we hope research like this continues to be of use to our fellow growers.

Contained in this issue is just a snapshot of the research done this year. If you'd like to read the full reports on any of this work online, please visit **bit.ly/NBGAResearch2022.** While you're at it, please note that you can also now watch videos all of the Northarvest Bean Day 2023 panels on the NBGA YouTube channel — **bit.ly/NBGAyoutube.**

As always, thank you for helping put food on the world's table and thank you for reading. NBGA

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Cover Story

Herbicide trial studies ALS resistant pigweed

BELOW: While ALS-inhibitor-resistant Palmer amaranth hasn't been found in dry edible bean fields in North Dakota, it has been found in other crops. This stand of the weed was in Nebraska in 2017. *Nick Nelson / Agweek file photo*

By Ann Bailey | Agweek

No one has found Palmer amaranth that is resistant to acetolactate synthase — or ALS — inhibiting herbicides in North Dakota edible bean fields yet, but when it happens, Joe Ikley wants to have an herbicide program in place to control it, along with ALS-resistant waterhemp, which has been reported.

Waterhemp was one of the top three worst weeds in 2022 of the dry bean acres in the Northarvest Bean Growers Association region, according to annual edible bean growers' surveys. The resistance of waterhemp to ALS-inhibiting herbicides is especially concerning because many dry edible bean herbicide programs rely on an ALS-inhibiting herbicide, imazamox.

Meanwhile, while herbicide-resistant Palmer amaranth hasn't been found in edible beans in North Dakota, it has been found in several counties in the Northarvest region, just not in beans. The challenges of controlling the weed will be similar to controlling ALS-resistant waterhemp if it becomes established in dry edible bean fields, said Ikley, North Dakota State University Extension weed specialist.

Ikley in 2021 and 2022 conducted trials in fields near Fargo, North Dakota, and in Barnes County, North Dakota, to determine the two ALS inhibitor resistant weeds' reaction to a variety of herbicides. Data on the effectiveness of pre-plant incorporated herbicides on waterhemp and Palmer amaranth is limited.

The two weeds have longer emergence windows than redroot pigweed or Powell amaranth, so herbicides, including Eptam, Sonalan and Treflan that provide longer season residual control, were tested on the Palmer amaranth and water hemp. Spartan, Dual and Outlook were tested as pre-emergence options.

Post-emergence options were limited. Reflex is the most effective product labeled for dry beans. Single applications of full rates, and multiple applications of split rates of bentazon and fomesafen were evaluated for efficacy on ALS-resistant water hemp and Palmer amaranth.

The addition of a residual herbicide to post-emergence applications is important for controlling water hemp and Palmer amaranth in many crops, including dry beans. However, fomesafen and dimethenamid-P are the only herbicides with effective residual activity on ALS-resistant pigweeds that can be applied over the top of dry beans.

If a pigweed population is resistant to protoporphyrinogen oxidase — or PPO — inhibiting herbicides, then dimethenamid-P or S-metolachlor are the only viable options remaining.

Palmer amaranth seeds are shown on lined paper to indicate their tiny size. Though the seeds are small, the weed can grow to be massive and reproduce quickly to overtake crops.
Courtesy / University of Minnesota

Ikley applied the residual products at various dry bean growth stages to determine the optimal time to achieve residual control of late emerging pigweeds until the dry bean crop can canopy.

All field experiments were conducted on a Group 2-resistant water hemp population in Fargo, North Dakota, and on a Group 2-resistant Palmer amaranth population in eastern North Dakota.

All field experiments were conventionally tilled and were conducted in a RCBD with four replications. Experiments on water hemp were established in May 2021 and 2022 at the Fargo location.

Experiments on Palmer amaranth control were established in early June 2021 and 2022 at the research location in Barnes County. Preplant incorporated treatments were applied, then incorporated with a rototiller set to 4 inches. The North Dakota Palomino variety of pinto beans were planted at 70,000 seeds per acre in 30-inch rows, then pre-emergence treatments were applied.

Herbicide efficacy ratings were collected every two weeks after planting. Pigweed biomass was collected and the trials were terminated at eight weeks after planting.

Herbicide efficacy and crop injury ratings were collected one, two and four weeks after initial post-emergence application. Pigweed biomass was collected four weeks after initial biomass application. Yields were collected at the Fargo location for the waterhemp trial.

CONTINUED ON PAGE 6

CONTINUED FROM PAGE 5

Overall field conditions at the Palmer amaranth location were dry at trial establishment in both years, and field conditions generally were dry at the Fargo location after planting in both years.. The blanket pre-plant incorporated application of Eptam and Sonalan provided good control several weeks into the season. That led to light infestations of water hemp and Palmer amaranth for the targeted post-emergence applications in these trials. Overall, the treatments with Reflex provided the best control of both water hemp and Palmer amaranth while any treatment without Reflex did not provide adequate control.

Reflex tank-mixed with other herbicides outperformed Reflex by itself.

CONTINUED ON PAGE 8

Joe Ikley, North Dakota State University Extension weed specialist, urges farmers to get on top of Palmer amaranth weeds to avoid bigger expenses later on. Photo taken Feb. 12, 2019, in Fargo, North Dakota. *Mikkel Pates / Agweek file photo*

Herbicide-resistant weeds are becoming a growing problem for farmers in North Dakota and Minnesota. Waterhemp, pictured here, is one of the weeds now resistant to glyphosate, the active ingredient in Roundup.
Courtesy / Richard Zollinger, NDSU Extension weed specialist

CONTINUED FROM PAGE 6

Control of waterhemp with treatments containing Reflex varied between 62% and 96%, while Palmer amaranth control ranged from 36% to 69% with the same treatments.

Ikley knew from earlier research in soybeans that many post-emergence herbicides had failed to control both of those weeds.

His research trials in 2021 and 2022 showed that there were even fewer to control the weeds in edible beans. In fact, Raptor, Pursuit and Permit, the three options, don't control weeds in edible bean fields with ALS-resistant Palmer amaranth and water hemp.

Reflex herbicide will control ALS-resistant weeds when the plants are in the recommended growth stage of 2 to 3 inches high.

"We basically have that one chemical," Ikley said.

That means farmers in counties where or near where waterhemp has been reported should

> *We basically have that one chemical.*
>
> **Joe Ikley, speaking about weed control for ALS-resistant weeds**

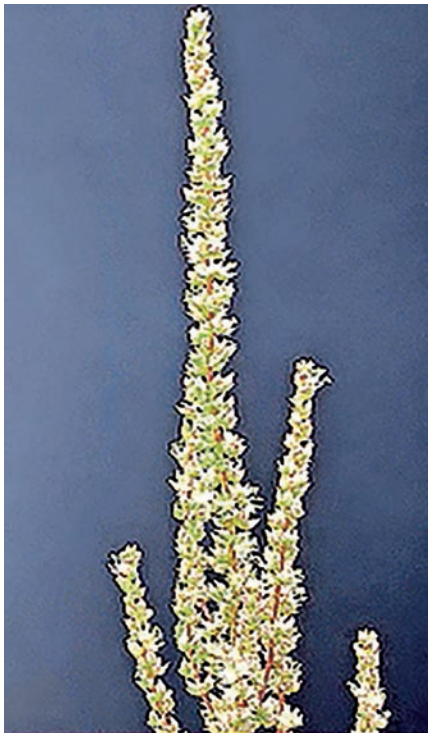
scout their fields early in the growing season for the weed.

Though there only is a single option to control the ALS-resistant waterhemp and Palmer amaranth post-emergence, Ikley's research trials showed that there are plentiful pre-plant incorporated and pre-emergence herbicides available for control of the weeds.

Pre-plant emergence herbicides are activated by water and pre-planting incorporated herbicides are activated by tillage.

Group 3 herbicides Treflan, Sonalan and Prowl, commonly called the "yellow" herbicides, had a rate of 90% control of ALS inhibitor-resistant waterhemp and ALS inhibitor-resistant Palmer amaranth, Ikley said.

For the most effective control, he suggests edible bean farmers in or near counties where water hemp has been reported use pre-plant emergence or pre-plant incorporated herbicides at planting, followed by a post-emergence treatment if the weeds are found in fields. NBGA



A waterhemp seed head.
Courtesy / NDSU Extension

Timing, droplet size of fungicide help control white mold in dry edible beans

By Jenny Schlecht | Agweek

Sclerotinia stem rot, also known as white mold, is a problem in both dry edible beans and soybeans.

Michael Wunsch, North Dakota State University plant pathologist at the Carrington Research Extension Center, has worked on finding new solutions to controlling the disease in both crops and is finding similar solutions.

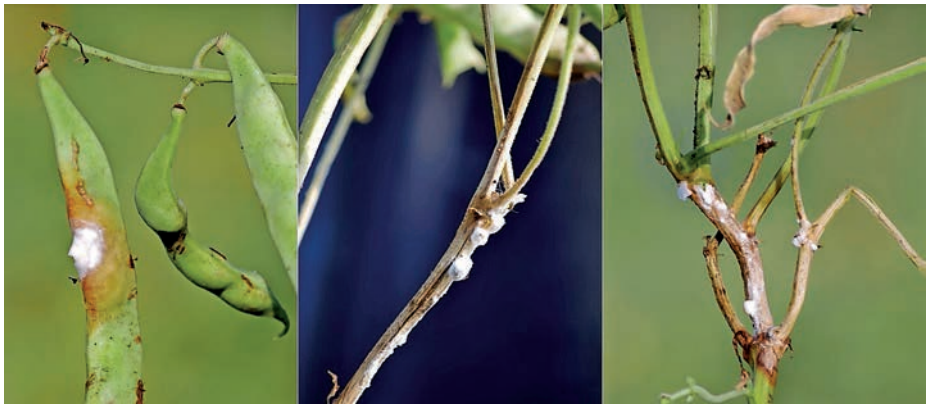
Wunsch, speaking at Bean Day in Fargo on Jan. 20, 2023, said there's no one solution for white mold in dry edible beans. But after three years of row spacing and seeding rate work on pinto and kidney beans, he has figured out the simplest management technique.

"The easiest thing that you can do from our research to manage white mold is, on your problem fields, be at the lower end of that normal seeding rate," he said.

But the research Wunsch has done, along with co-principal investigator NDSU agronomist Kelly Cooper at the NDSU Robert Titus Irrigation Research Site, also has looked at both the timing of fungicide and the types of droplets used in spraying.

The droplet size has been the "real game changer" for soybeans and dry beans, Wunsch said. Using a fine mist had been the established way to apply fungicides, but that doesn't work for white mold, which does not appear at the top of the canopy like other fungal infections. Fine droplets don't get through to where the disease lives when the canopy is significantly closed.

The researchers conducted field trials in Carrington and Oakes in 2020 and 2022 and found white mold management and dry bean yield were optimized by increasing spray droplet size between application one and application two as the canopy became denser.



White mold can be a significant problem in dry edible beans.
Courtesy / Michael Wunsch, NDSU

In four of eight pinto bean studies, fine droplets in the first application and coarse droplets at the second application provided the best management, while in the other four studies, medium droplets in the first application followed by coarse application in the second was best. Additional research is needed to identify the canopy characteristics when fine droplets versus medium droplets are optimal in the first application.

When the canopy was moderately open to nearing closure (80-95% of the ground covered) at the first fungicide application and at or near closure (88-99% of the ground covered) at the second fungicide application, kidney bean yield under white mold pressure was optimized by applying fungicides with medium droplets in the first application and coarse droplets in the second application.

Wunsch said using the least coarse droplet possible is important, as coverage area decreases the coarser the droplets get.

However, increased canopy closure requires increased size of droplets.

"You have to get a coarser droplet as your canopy gets denser," he said.

A surprising piece of the research was that increasing spray volume from 10 gallons per acre to 25 gallons per acre had no impact on white mold severity or dry bean yield. Wunsch said follow-up research is planned.

When it comes to timing of spraying, Wunsch said the mantra always has been to spray before infection. But spraying too early also may have a penalty, he said.

"What we have learned is, when you apply too early before there is any significant risk of infection, you can actually really hurt yourself," he told the crowd at Bean Day.

The reason, he explained, is that fungicides do not "translocate" into new growth, which happens fast at early bloom.

"Remember that any additional vegetative growth after you apply your fungicide is not protected," he said.

Researchers conducted field studies under overhead irrigation in Carrington and Oakes in 2017, 2020, 2021 and 2022 to evaluate the growth stage at which fungicides should be applied when weather conditions favor white mold. Four application timings were evaluated. The first application was made at early bloom (target 10-50% of plants with an open blossom) and subsequent timings were spaced two to four days apart. Testing was conducted with a single fungicide application of Topsin (30 or 40 fluid ounces per acre) or with sequential applications of Topsin followed by Endura (8 ounces per acre) 10-14 days apart. Irrigation was managed to create conditions favorable for white mold.

The percent of plants with initial pin-shaped pods was utilized to characterize fungicide

CONTINUED ON PAGE 12

White mold

CONTINUED FROM PAGE 11

application timing. Dry beans produce small pin-shaped pods as soon as blossoms deteriorate with age. Nearly all white mold infections are initiated on dead blossoms, and the percent of plants with dead blossoms is a better predictor of susceptibility to white mold than the percent of plants with open blossoms, research has found.

In pinto beans, optimum fungicide application timing differed by canopy closure and daytime temperatures. When the canopy was open and temperatures reached the mid- to upper 80F range many days, fungicide performance was maximized by delaying applications until 50-85% of plants had pin-pods (when two sequential fungicide applications were made 10-14 days apart) or until 70-85% of plants had pin-pods (single application). When the canopy was at or near closure and daytime highs were predominantly in the mid-70 to low 80F range, fungicide performance was maximized with

Michael Wunsch, a plant pathologist with North Dakota State University, presents at the 2019 Carrington Research Extension Center Field Day.
Jenny Schlecht / Agweek file photo

applications made when 10-20% of plants had pin-pods (two sequential applications) or 60-85% of plants had pin-pods (single application).

In black beans, optimum fungicide application timing differed by canopy closure. When the canopy was open, fungicide performance was maximized when 1-20% of plants had initial pin-pods and two sequential fungicide applications were made 10-12 days apart. When a single application was made, disease management was poor, and no difference was observed across application timings. When the canopy was at or near closure, fungicide performance was maximized with applications made when 30-50% of plants had pin-pods (two sequential applications) or 60-100% of plants had pin-pods (single application).

In navy beans, optimum fungicide application timing was influenced by daytime high temperatures. When daytime high temperatures were predominantly in the mid- 80 to low 90F range, fungicide performance was maximized when the first application of a two-application sequence was made when 21-50% of plants had initial pin-pods. When a single application was made, fungicide performance was optimized when 65-96% of plants had pin-pods. When daytime high temperatures were predominantly in the mid- 70 to low 80F range, fungicide performance was maximized when the first application of a two-application sequence was made when 3-20% of plants had initial pin-pods. When a single application was made in cool weather, white mold overwhelmed the fungicide, and no difference was observed across application timings.

In kidney beans, when a single fungicide application was made, fungicide performance was maximized by delaying applications until 55-80% of plants had initial pin-shaped pods. A variable response to application timing was observed when two sequential applications were made, and additional studies are needed to reach conclusions. Only four field studies were conducted with kidney beans (versus six to eight studies with the other market classes).

Optimum fungicide application timing was generally two to three days earlier for the first application of a two-application sequence (10-14 days apart) versus a single application. A single fungicide application does not confer sufficient residual to protect dry beans for the entire bloom period. The results indicate that when a single fungicide application is made, it is best to delay the application slightly in order to extend protection through more of the critical full bloom when dry beans are at their height of susceptibility to white mold.

The results suggest that when rainfall or irrigation patterns are favorable for white mold as dry beans enter bloom, fungicide application timing can be optimized on the basis of forecasted daytime high temperatures, average canopy closure, and the percent of plants with initial pin-shaped pods.

"We have to be very very good producers and we have to be very timely with our applications," Wunsch said. NBGA

NDSU Extension dry been breeder introduces new varieties

By Ann Bailey | Agweek

Farmers soon will have new edible bean varieties to plant that were developed by a North Dakota State University Extension dry bean plant breeder.

Juan Osorno introduced North Dakota Rodeo, a slow-darkening pinto bean variety, and North Dakota dark red kidney variety, North Dakota Red Barn, to farmers at Northarvest Bean Day in Fargo on Jan. 20, 2023.

North Dakota Red Barn has a shape similar to Montcalm, a variety released in 1973, that still is the industry standard for kidney bean shape. The Red Barn variety, though developed in North Dakota, also will be planted in Minnesota, the largest kidney bean state in the U.S. More than 50% of the kidney beans in the country are grown in Minnesota, Osorno said.

Juan Osorno, a North Dakota State University Extension dry edible bean breeder, spoke to farmers at Northarvest Bean Day, held Jan. 20, 2023 in Fargo, North Dakota, about edible bean varietal trials. ***Ann Bailey / Agweek***

Besides a superior seed shape, trials conducted from 2012 to 2021 showed that Red Barn had good yields — 300 pounds per acre higher than Montcalm — and white mold tolerance and intermediate resistance to common bacterial blight and the root rot complex, Osorno said.

Osorno also talked about North Dakota Rodeo, a new pinto bean variety, at Northarvest Bean Day.

"I think it's going to be another good option for farmers, especially those who are dealing with slow-darkening pintos," Osorno said. Farmers appear to have definite opinions on planting slow-darkening pinto beans, either loving them or hating them, he said.

North Dakota Rodeo has potential because it is high yielding, something that has been an issue with earlier slow-darkening varieties. For example, NDSU Extension edible bean trials conducted between 2017 and 2022 showed that North Dakota Rodeo yielded an average of 22.7 hundredweight per acre, 3.9 hundredweight higher than North Dakota Palomino and 5.6 hundredweight higher than Vibrant, two other slow-darkening pinto varieties. North Dakota Rodeo also yielded 1.6 hundredweight and 1 hundredweight per acre, respectively, more than the conventional pinto bean varieties of Monterey and LaPaz, Osorno said.

"Criticism was, slow-darkening pintos don't yield as well as conventional varieties. I think we're finally being able to break that barrier," he said.

CONTINUED ON PAGE 16

A skin check is performed on kidney beans at Chippewa Valley Beans in Menomonie, Wisconsin, on Dec. 15, 2022. Minnesota leads the nation in kidney bean production, and a new variety produced by North Dakota State University — North Dakota Red Barn — is expected to be grown in Minnesota and North Dakota. ***Noah Fish / Agweek***

CONTINUED FROM PAGE 15

The hope is that North Dakota Rodeo will be an improved version of Lariat, an older pinto bean variety that farmers liked, he said.

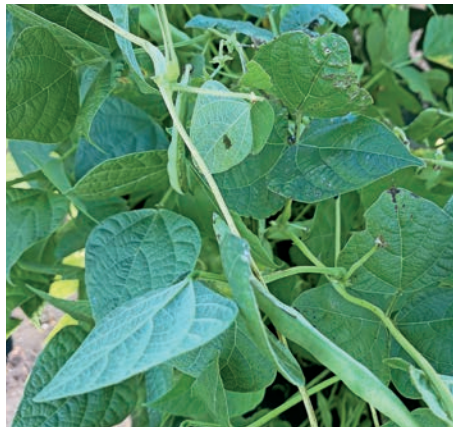
Besides consistently above average yields in research trials, North Dakota Rodeo also stands up well and has good tolerance to bacterial blight, Osorno said.

Foundation seed of Red Barn and Rodeo will be available for the 2023 growing season.

In 2022, Osorno announced the release of North Dakota Polar, the newest navy bean variety in about 10 years. The navy bean variety offers higher seed yield than other navy bean varieties commonly grown in the region. In addition, it offers a good agronomic package for the rest of the traits of economic importance.

> *I think it's going to be another good option for farmers, especially those who are dealing with slow-darkening pinto.*
>
> **Juan Osorno, talking about North Dakota Rodeo**

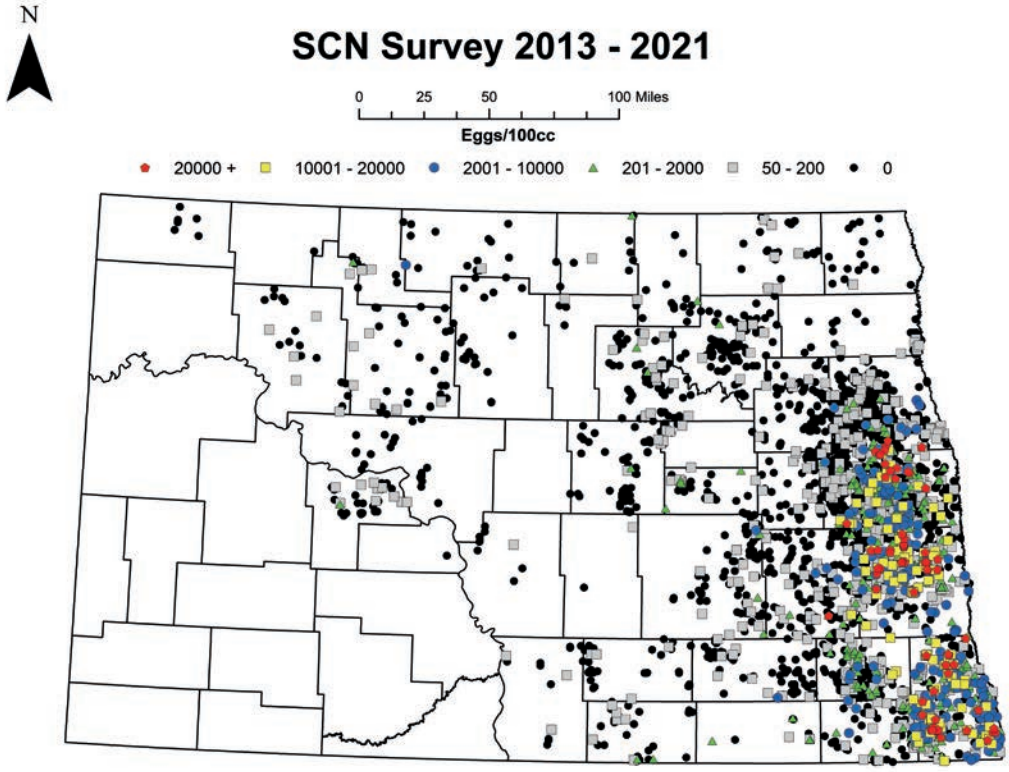
The foundation North Dakota Polar navy bean seed was made available to certified seed producers in 2022 and will be available to farmers in the 2023 growing season. NBGA



New varieties of pinto and kidney beans produced by North Dakota State University appear to have increased tolerance to common bean diseases. This photo of a pinto bean plant was taken Aug. 23, 2022.
Ann Bailey / Agweek

What to know about Soybean Cyst Nematode in dry edible beans

Evaluation of Dry Bean Varieties and Breeding Lines for Resistance to Soybean Cyst Nematode



Egg levels identified in soil samples submitted through NDSC/NDSU Extension sampling program from 2013-2021. *Sam Markell / NDSU*

By Dr. Guiping Yan, plant nematologist; Dr. Juan M. Osorno, dry bean breeder; and Harkamal Kaur, graduate student, North Dakota State University

Research shows that soybean cyst nematode, a soybean pathogen, has potential to cause yield losses in dry edible beans.

Earlier research conducted by Berlin Nelson demonstrated that soybean cyst nematode, which is widespread in soybean counties across the state, has potential to reduce dry bean yields by 50% and that reproduction levels of SCN varied among the classes of dry beans.

Other projects carried out by Guiping Yan, NDSU Extension plant nematologist, have led to successful characterization of different populations of SCN across North Dakota.

NDSU plant breeder Juan Osorno provided the varieties and breeding lines. The Barnes soybean variety also was germinated for use as the susceptible check.

The 37 commercial varieties belonged to seven different market classes including pinto, navy, and black. The cultivars were tested for resistance to HG type 0, the least virulent SCN population, — but most common — that does not attack the major soybean resistance source PI 88788.

Female index values ranged from a minimum of 20.8% on variety North Dakota Falcon to a maximum of 76.7% on the variety Talon.. By market class, the average FI ranged from

CONTINUED ON PAGE 18

Soybean Cyst Nematode

CONTINUED FROM PAGE 17

41.6% for pinto beans to 65.1% for small red/pink beans.

North Dakota Falcon had a FI of 20.8%, so it was classified as moderately resistant (MR) according to the resistance rating scale. All the remaining varieties were classified as either moderately susceptible or susceptible.

Soybean cyst nematode reproduction was observed in all the varieties tested, although the average number of females developed on each variety was less than the susceptible soybean check Barnes.

The 69 breeding lines from advanced yield trials belonged to black, navy and slow darkening pinto classes All the breeding lines were tested for resistance to HG type 2.5.7, a more virulent SCN population that can attack the major soybean resistance source PI 88788.

Yellowish-white SCN females on dry bean roots observed under a microscope. ***Guiping Yan***

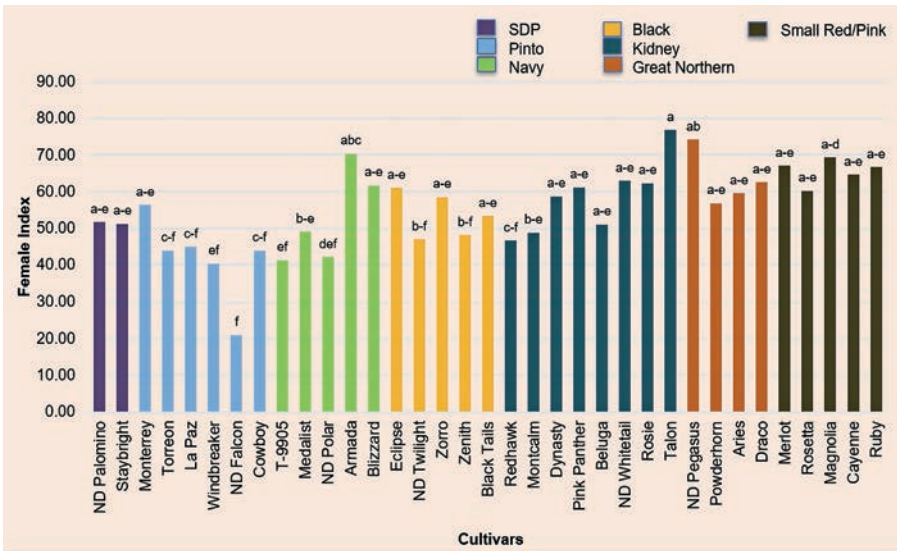
The average FI for black, navy, and SDP were 69.2%, 73.0%, and 67.1%, respectively. The results from the experiment showed that SCN reproduced on all the breeding lines tested, with FI ranging from 44.5% to 99.2% as compared to the susceptible check Barnes. They were classified as either susceptible (S) or moderately susceptible (MS). Breeding lines on other market classes are being tested against SCN.

The experiments will be repeated to confirm the reactions of these varieties and breeding lines to SCN infection.

Major SCN management strategies for growers include crop rotation, planting resistant varieties (or least susceptible varieties), and seed treatments.

Growers should also sample soil to detect SCN in the field to determine the egg levels and risk. Sampling for soybean cyst nematodes can be done in the spring or most commonly in the fall. If the pathogen is present in the field, crop rotation, planting resistant varieties and seed treatments can reduce the egg levels in the soil.

Growers also consult the NDSU dry bean production guide for more information on soybean cyst nematode management. NBGA



Female index of each of the 35 varieties tested for resistance to SCN HG type 0 where x-axis and y-axis depict the variety names and female index (%) values, respectively. Varieties sharing the same letter are not significantly different (P < 0.05) for the means from four replicates for each of the varieties tested.
Contributed / NDSU Extension

Is dicamba a viable option for pinto bean weed control?

Pinto Bean Crop Tolerance to Preplant, Low-dose Application of Dicamba

Principal Investigator: Greg Endres, Extension cropping systems specialist, NDSU Carrington Research Extension Center. Co-Investigators: Joe Ikley, North Dakota Extension weed specialist; Brian Jenks, North Central Region Extension Center Weed scientist and Mike Ostlie, CREC director and research agronomist

North Dakota State University Extension researchers conducted research in 2021 and 2022 to determine if pinto beans will tolerate a low-dose pre-plant application of dicamba with a limited waiting period or after a major rainfall.

That would give farmers another herbicide option to control herbicide resistant weeds including horseweed, kochia and pigweed species. Meanwhile, it could also be used to control other broadleaf weeds, including common lambsquarter and wild buckwheat.

There are a limited number of preplant burndown herbicides, potentially available for pinto bean and other broadleaf row crops that are effective on herbicide-resistant broadleaf weeds, provide initial soil residual, and low cost. Although low rates of dicamba do that, waiting periods between dicamba application and row-crop planting generally restrict use of the herbicide because of the potential for crop injury.

The research trials were conducted so pinto bean farmers and crop advisors would have access to a database that would help them make decisions about the level of risk of injury to pinto beans when low doses

of pre-plant herbicides were used for burndown and short-term residual control.

Researchers conducted the trials in the 2021 and 2022 growing seasons on irrigated fields near Carrington, Minot and Prosper. Dicamba was applied at the sites between May 7-13, 2021, and May 27-June 3, 2022.

Pinto beans were planted two to seven days and 14 to 20 days after the dicamba was applied. Rainfall during those periods ranged from none to 0.08 inches between the dicamba application and the first planting dates. Total precipitation during the second planting dates were from 0.62 to 0.74 inches in Prosper, 2.16 to 3.01 in Carrington and 0.84 to 0.96 in Prosper.

Across six trials, visual evaluation of pinto bean plant injury, which would manifest as reduced biomass and abnormal growth, one to two weeks after emergence in dicamba-treated soil ranged from 23-91% with first planting dates and 0-46% with the second dates. Injury generally declined over time with evaluations three to four and six to eight weeks after plant emergence.

Early season plant stands in dicamba-treated soil compared to untreated checks were reduced 0-73% with the first planting dates and 0-19% with the second planting dates.

CONTINUED ON PAGE 22

A pinto bean plant shows slight evidence of injury from dicamba.
Courtesy / NDSU

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Pinto bean seed yields were statistically similar between untreated checks and dicamba-treated soil at Carrington in 2021 and 2022 and Minot in 2022. Dicamba reduced yield at Prosper by 30% with the first planting dates, while no yield reduction occurred with dicamba with the second planting dates.

Averaged across the four site-years, untreated check seed yield with the first planting dates averaged 25 hundredweight per acre, compared to 21.8 hundredweight with dicamba. Yields were similar with the second planting dates between the untreated check and dicamba. Pinto beans grown in dicamba-treated soil had moderate to severe plant injury with the first planting dates and low to moderate injury with the second planting dates.

Pinto beans plants grown in dicamba-treated soil were moderately or severely damaged when the dicamba was applied one week or less after planting and no rain fell. Injury to the plants was low to moderate when the dicamba was applied two to three weeks after planting and received 0.6 to 3 inches of water.

Stand reduction with dicamba was variable with the first planting dates and generally low with the second planting dates.

Based on study data, loss of seed yields are likely with no rain and prompt planting after application of dicamba. However, yields should be preserved with bean planting delayed two weeks or more, and with more than 0.5 inches of water after application of dicamba. NBGA

Kochia is among the weeds that could be better controlled with proper use of dicamba. *Courtesy / NDSU*

How prevalent were dry bean diseases in 2022?

2022 Dry Edible Bean Disease Research Report

Principal Investigators: Malaika Ebert, North Dakota State University Extension, dry bean and pulse crop pathologist, Upinder Gill, NDSU rust pathologist; Sam Markell, NDSU Extension plant pathologist, and Jack Rasmussen, NDSU plant pathologist

Various diseases and pests are limiting dry bean production in the Northarvest region.

Common pathogens that infect above ground plant parts, for example, are fungi such as uromyces appendiculatus, the causal agent of bean rust, colletotrichum lindemuthianum, which causes anthracnose and sclerotinia sclerotiorum, the white mold pathogen.

CONTINUED ON PAGE 24

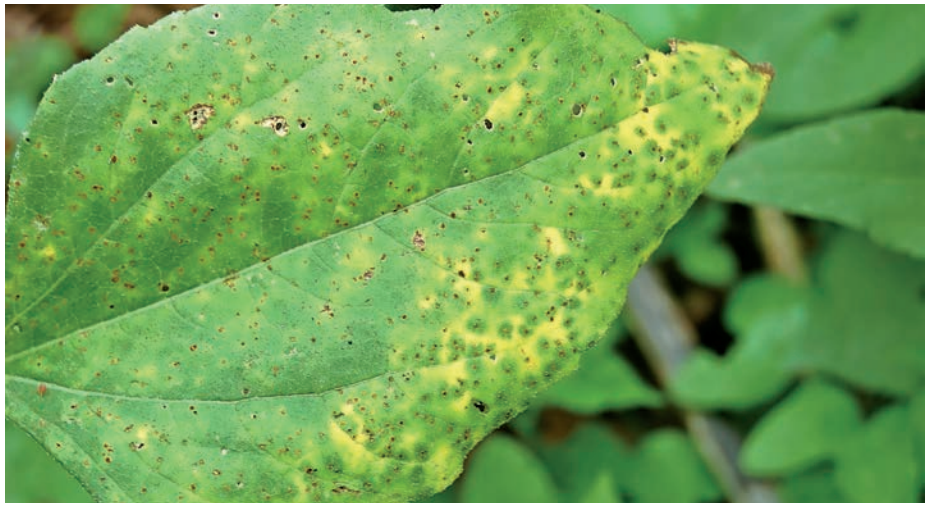
Small, brown, necrotic lesions characteristic of early bacterial brown spot infection.
Courtesy / University of Nebraska-Lincoln

CONTINUED FROM PAGE 23

Other pathogens infect the plants from the roots and depending on the severity of the infection, can cause the plants to die. Rhizoctonia solani, fusarium spp. and pythium spp.are known causal agents of root rot and can pose major threats to dry bean health.

For many years, the NDSU Department of Plant Pathology has conducted annual surveys to monitor dry bean diseases in the fields. For the dry bean monitoring survey in 2022, researchers went to a total of 30 fields in the North Dakota counties of Grand Forks, Steele, Traill, and Walsh and the Minnesota counties of Hubbard, Otter Tail, and Wadena.

Researchers observed nine pinto beans, five navies and a total of eight light red kidneys



Rust pustules (reddish-brown spots) developing on volunteer sunflower leaves. Each dark spot on leaf contains thousands of spores. *Courtesy / University of Nebraska-Lincoln*

and dark red kidney fields. To cover different diseases as best as possible, the surveys were conducted three times throughout the growing season — between July 6-8 for root rot, Aug. 15-18 for bacterial blight, and Sept. 6-9 for rust and white mold.

Similar to previous years, in 2022, researchers observed common bacterial blight in all of the fields evaluated.

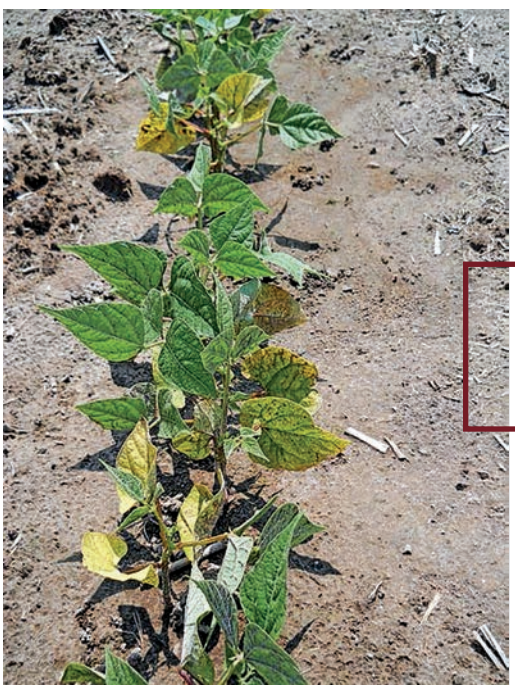
Halo blight lesions from field-grown dry beans consisting of a broad yellow-green halo surrounding necrotic center.
Courtesy / University of Nebraska-Lincoln

Observation of brown spot also was comparably high — in 28 of 30 fields or 93%. In 2021 brown spot was observed in about 5% of the fields; in 2019, it was observed in 33% of the fields; and in 2018, it was in slightly more than 30% of the fields.

Researchers also noticed an increase in halo blight from slightly more than 2% in 2021 to slightly more than 25% in 2022.

Some white mold was observed in one field in Grand Forks County, North Dakota, and two fields in Otter Tail County, Minnesota, for a total of 20% total in the Northarvest region.

Four fields in Walsh County, North Dakota, had rust. Generally, rust has been appearing late in the season and can be explosive under conducive conditions. Throughout the last years, root rot always has been present in the fields. Researchers observed root rot in all of the surveyed fields in 2022. NBGA



Late-planted black beans with root rot symptoms.
Jim Isleib / Michigan State University Extension

How pinto, navy and black bean varieties matched up in 2022

North Dakota Statewide Dry Bean Variety Trial

By Justin Jacobs and Tyler Tjelde

The North Dakota State University Extension dry bean program — led by Juan Osorno, NDSU Extension edible bean breeder and six branch research stations — conducted dry bean variety trials across North Dakota in 2022.

These trial test lines were ones that Osorno developed and also commercial varieties that already were available.

Trials were conducted at NDSU Extension research stations in Carrington, Hettinger, Langdon, Minot, Oakes and Williston. The Carrington, Oakes and Williston trials were tested under irrigation, and the dryland trials were conducted at Carrington, Hettinger, Langdon, and Minot. Three different variety trials were grown at each location in 2022. The three trials were made up of pinto, black, and navy beans with 10, four and five commercial varieties in each trial, respectively.

On average, the trials were planted around May 30 — Williston was the earliest planted on May 25, 2022, and Oakes was the latest planted on June 4, 2022. The average harvest date of the trials was Sept. 18.

The pinto bean trials had the highest average yield across the state at 2,547 pounds per acre. Monterrey had the highest yield of 2,837 pounds per acre.

The North Dakota Polar navy bean had the highest yield at 2,635 pounds per acre.

The black bean trial yields averaged 2,088 pounds per acre. North Dakota Twilight had the highest yield of 2,252 pounds per acre.

The irrigated pinto bean trial averaged 3,221 pounds per acre across the irrigated locations.

Dry bean variety trials at North Dakota State University have produced some new varieties that are showing promise. *Courtesy / Greg Endres, NDSU*

Monterrey had the highest irrigated yield of 3,570 pounds per acre and the dryland yield of 2,287 also was the highest. Dryland locations averaged 2,040 pounds per acre.

The black bean trial averaged 2,577 pounds per acre across the irrigated locations. North Dakota Twilight had the highest yield of 2,873 pounds per acre. Dryland locations averaged 1,720 pounds per acre. Eclipse had the highest yield of 1,890 pounds per acre.

The navy bean trial averaged 2,872 pounds per acre across the irrigated locations North Dakota Polar had the highest yield at 3,169 pounds per acre. The dryland locations averaged 2,031 pounds per acre. The variety

The North Dakota State University dry bean program in 2022 tested trial bean lines as well as commercially available varieties. *Erin Ehnle Brown / Grand Vale Creative LLC*

T9905 had the highest yield of 2,172 pounds per acre. NBGA

How much nitrogen do dry edible beans really need?

Taking another look at nitrogen requirements for dry bean production in Minnesota

Daniel Kaiser of University of Minnesota, and Hannah Swartzentruber of Central Lakes College Ag and Energy Center

Research on the nitrogen requirements for dry beans grown in Minnesota was conducted in 2022, for the first time in nearly 20 years.

Daniel Kaiser, a University of Minnesota Extension soil scientist and Hannah Swartzentruber, Central Lakes College Ag and Energy Center research coordinator in Brainerd, conducted the research Northarvest Bean Growers Association funded research to

CONTINUED ON PAGE 28

Research in Minnesota is investigating how much nitrogen fertilizer is necessary for dry edible beans, including pinto beans. *Erin Ehnle Brown / Grand Vale Creative LLC*

CONTINUED FROM PAGE 27

reevaluate the dry bean fertilizer guidelines, which are yield goal-based.

A major goal of the research was to gather as much information about present and past nitrogen potential as possible into a larger nitrogen response database. The 2022 research is the beginning of work in Minnesota and may vary from one site to the next.

Preliminary results from the first trial was made up of a series of nitrogen rate trials conducted on small plots that compared the nitrogen requirements of kidney, pinto and navy beans to black beans. The trials were in three farmers' fields — two were dryland south of Wilmar and one was irrigated near St. Cloud. The researchers' goal was to evaluate yield response to various nitrogen rates up to 150 pounds.

The three site-average of the two fields planted to black beans and one to navy beans showed greater yields up to 90 pounds per acre.

A second trial was established in a field near Staples to look at reduced nitrogen rates for dry beans grown under irrigation. Treatments were applied in large block areas (60 feet wide by 450 feet long) comparing various N rates applied around the V5 growth stage.

Research is studying how much nitrogen really is needed to produce dry edible beans, including pinto beans. *Ann Bailey / Agweek*

Analysis of the trial, which compared three rates, showed that there was no statistical difference between the standard practice and the two reduced fertilizer rates. Actual yield values were within 35 pounds of one another, which represents a 1.5% variation in yield among the treatments. NBGA

How drain spacing can reduce edible bean crop damage from water

Impact of drainage and fungicide treatment on Rhizoctonia root rot in navy bean in 2022

Principal Investigators: Jeff Strock, University of Minnesota project leader and soil scientist; Lindsay Pease, co-investigator and U of M Extension specialist in nutrient and water management; Ashok Chanda, Ph.D. co-investigator and U of M Extension sugarbeet pathologist

University of Minnesota researchers in 2022 studied how drain spacing can reduce edible bean crop damage that results from waterlogging.

The goal of agricultural drainage is to provide an optimal balance of water and air in the soil to create a hospitable environment for plant growth.

For farmers, often the differences between poor, average and record yields is attributed to the amount and timing of precipitation and available soil water. A well-designed drainage system may result in benefits including better soil aeration, timely field operations, less flooding in low areas and better root development.

Excess water stress to plants not only has potential to reduce productivity, it can also increase their disease susceptibility, making them vulnerable to damage by pathogens, especially in the early stages of plant development.

Too much water often results in development of dry edible bean root diseases, including Rhizoctonia solani, which typically thrives in low soil temperatures and moderate to high moisture.

Despite the connection between soil moisture and root disease, the interactions between subsurface drainage spacing and traditional disease management options have never been studied in the Red River Basin. Without this information, growers cannot fully evaluate the costs of subsurface drainage systems against its potential benefits for crop production. This information is essential as only about 10.4% Northarvest Bean Growers Association-reported acres were tile-drained as of 2019.

University of Minnesota researchers in 2022 studied how drain spacing can reduce edible bean crop damage that results from waterlogging. ***Mikkel Pates / Agweek***

The goal of the research project at the Northwest Research and Extension Outreach Center in Crookston, Minnesota, was to develop and evaluate drain spacing and fungicide application in a corn-bean-wheat-sugarbeet cropping system. Researchers conducted the project on a site of about four acres, with five drain spacings: 15, 25, 40 and 60 feet, plus a control which represented an undrained condition.

Soil samples were collected at the site but soil health information has not been returned.

The data suggests that the undrained condition retains more water than at the 60-foot spacing.

Root sample data also showed that, in general, the fungicide treatments contained numerically more roots than the untreated dry bean plants for the undrained and 25-foot drain spacing. The data show the opposite trend for the 40-foot spacing for the shallow depths of 5, 15 and 30 centimeters. NBGA

What varieties work on the sand plains of Minnesota?

Collaborative Dry Bean Trials on the Sand Plains of Minnesota

By Hannah Swartzentruber

North Dakota State University Extension and Central Lakes College Ag and Energy Center researchers teamed up in 2022 to establish irrigated kidney bean trials on the sand plains of Minnesota.

It was the third straight year that Juan Osorno, NDSU dry edible bean plant breeder, and Hannah Swartzentruber, research coordinator at CLC Ag and Energy Center in Brainerd, Minnesota, collaborated on the irrigated kidney bean trials near Staples, Minnesota, with funding from Northarvest Bean Growers Association.

The researchers conducted three kidney bean preliminary yield trials, which had 38 entries of dark red kidney bean breeding lines, 28 of light red kidney beans lines and 20 of white kidney beans from the NDSU dry bean breeding program at intermediate stages of testing and selection.

The lines have not yet been released as public cultivars, so the seed and results from the trials were returned to the NDSU dry bean breeding program for internal use only.

All of the kidney beans were planted on June 8, 2022.

A July 13 hailstorm, which damaged the beans right before they were in the flowering stage, set back the pod stage, and later in the growing season, an outbreak of common bacterial blight reduced yields.

Yields were reduced by 15 hundredweight per acre because of those issues. Despite the reduced yields, research showed that there were differences in yields among breeding lines, especially when compared with commercial check beans. The findings will allow the NDSU breeding program to consider making selections for 2023. NBGA

Dry edible bean variety trials in Minnesota in 2022 showed decreased yields because of an ill-time hail storm and a bacterial blight. ***Central Lakes College Ag and Energy Center***

What's happening in dry bean breeding at NDSU?

Dry Bean Improvement for the Northern Plains

Juan M. Osorno, Ph.D., Project Leader

Research Specialists: Jody Vander Wal (Ret. April 2022) and Makenson Maisonneuve

Research Assistants: Mohammad Erfatpour Ph.D.

Graduate Students: Oscar Rodriguez, Maria Mazala, Jose C. Figueroa-Cerna, Maria de Oliveira, Ali Aizaz, and Eduardo Melgar

NDSU Extension's dry bean breeding program strives to develop high yielding, high quality dry bean cultivars adapted to the northern Great Plains using genetics and breeding. The program seeks to develop improved varieties that are well adapted to the Min-Dak region — the largest dry bean producing region.

Based on the 2021 annual dry bean grower's survey in the Northarvest region, NDSU dry bean varieties represented about 48% of the area grown to black beans, about 50% of the area grown to great northern beans and about 15% of the area grown to pinto beans. At an average price of $45 per hundredweight, the 2020 harvest of NDSU dry bean varieties contributed about $133 million to dry bean growers in the region, which represents a net return of $887 per dollar invested in the NDSU dry bean breeding program, plus economic impact to the rest of the food chain.

Here are a few highlights from 2022:

- A new navy bean variety released for 2022, ND Polar, offers higher seed yield than other navy bean varieties commonly grown in the region. It also offers a good agronomic package for the rest of the traits of economic importance.

- The North Dakota Twilight black bean variety continued to show either superior or similar performance when compared with other common black bean cultivars such as Eclipse or Zorro. North Dakota Twilight also is resistant to bean common mosaic virus and rust and has intermediate resistance to soybean cyst nematode.

- Other varieties released by NDSU such as ND Falcon pinto, ND Pegasus great northern, and ND Whitetail white kidney continued showing either competitive or superior seed yields in 2022. These varieties also offer interesting disease resistance packages such as rust (ND Falcon), white mold (ND Pegasus and ND Whitetail), soybean cyst nematode (ND Falcon), bacterial blights (ND Whitetail), and root rots (ND Whitetail). These are all important traits included in the current list of "areas of interest" developed by Northarvest Bean Growers Association.

- Most of the varieties mentioned above have been classified as sold out for 2022 — a good indication of the interest that the bean industry has in utilizing the varieties released by the NDSU dry bean breeding program.

- Recent research results are showing different market classes of dry beans show variable reactions to dicamba drift/exposure, which suggests some varieties may offer some tolerance while others may be highly susceptible.

- Collaborative research continues to identify new sources of resistance to soybean cyst nematodes in dry beans across different SCN types/populations in order to obtain durable and broad resistance.

- As a way to increase efficiency, the dry bean breeding program is using unmanned aerial vehicles to attempt to measure some of the agronomic traits normally measured in the field manually. This is known in plant breeding as high throughput phenotyping and allows recording and measuring hundreds or thousands of genotypes in a short period of time and with high accuracy.

- Additional research is being focused on disease resistance, including white mold, rust, common bacterial blight, anthracnose, plant architecture, bruchid/weevil resistance, seed quality and seed yield gain.

During the 2022 growing season, the varieties released by NDSU continued to show either similar or superior performance compared with other varieties commonly grown in the region. Most varieties were above the average of the trials in which they were grown and, in many cases, they were among the top three varieties for seed yield. NBGA

How do different fertilizers impact pinto bean yield?

Evaluation of Selected Plant Nutrition Inputs in Pinto Beans

Principal Investigator: Greg Endres, Extension cropping systems specialist, NDSU Carrington Research Extension Center. co-investigator: Mike Ostlie, CREC director and research agronomist

Carrington Research Extension center researchers studied in 2022 the response of pinto beans to zinc, sulfur and specialty fertilizers applied as preplant incorporated, starter and foliar treatments.

The 2022 trial was established on conventional-tilled loam soil with 2.8% organic matter, 8.2 pH, 5 ppm (Olsen test; low) phosphorus, and 0.56 ppm (low) zinc.

Preplant fertilizer was applied and incorporated on May 26, 2022.

North Dakota Falcon was planted in 30-inch rows on June 8 and starter fertilizer was in-furrow applied.

Foliar fertilizer was applied on July 13 when pods were 2- to 3-inches long, with seeds discernible.

Plants were hand-pulled at maturity on Sept. 27, and the seed was harvested with a plot combine on Sept. 29.

Fertilizer treatments included:

- Untreated check.
- In furrow 10-34-0 at 2.75 gpa (fertilizer check).
- Preplant incorporated zinc at 2 lb (actual Zn) per acre.
- In furrow 10-34-0 plus chelated zinc at 0.25 gpa (Ammend; CHS).
- In furrow 10-34-0 followed by foliar zinc.

Carrington Research Extension center researchers studied in 2022 the response of pinto beans to zinc, sulfur and specialty fertilizers applied as preplant incorporated, starter and foliar treatments. ***Courtesy / NDSU Extension***

Trial seed yields averaged 20.8 hundredweight per acre with statistically no difference among treatments. NBGA