North Dakota State University
CROP & PEST REPORT

NDSU EXTENSION

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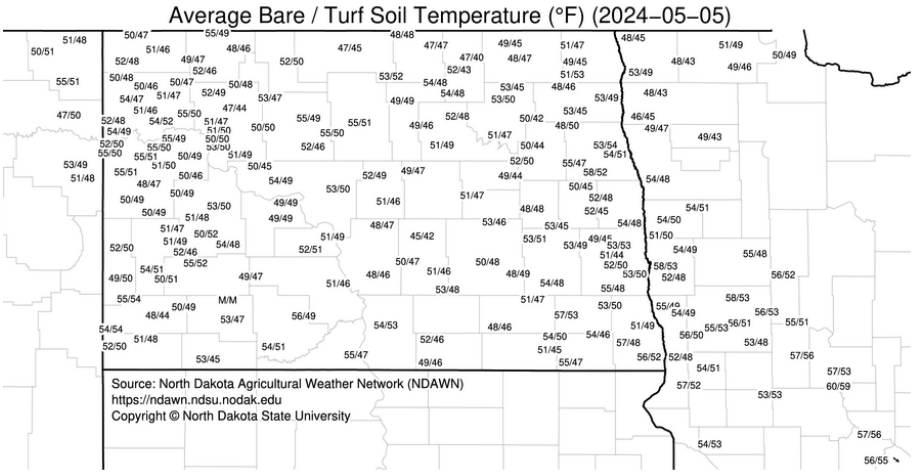
entomology

SOIL INSECT PESTS ACTIVE

WIREWORMS, the larval stage of click beetles, are active feeding on seeds, roots and tunneling through stems when soil temperatures have warmed above 50°F. With the warmer than normal spring, average soil temperatures for bare ground / turf at 4-inch depth have already reached 50°F in most of North Dakota as of May 5, 2024 (see NDAWN map below). Moisture is also important to wireworms, allowing larvae to move through the soil more readily with less mortality. Further, moisture causes any planted seeds to geminate and to emit CO_2 gas, which attracts hungry wireworms. The most susceptible stage for wireworm damage is in the seedling stage, so spring is the high-risk period for severe wireworm infestation.



Wireworm larva (on left, Patrick Beauzay, NDSU)
Wireworm feeding on untreated barley seed (on right, Kylen Kostrewski, Otto Ag)

Wireworm management depends on three factors: field history of wireworm pressure, continuous planting of cereal grain crops and environment.

- Field history – Wireworms generally have a long-life cycle (two to six years) resulting in multiple generations of wireworms present in a field. Knowing your field history can help farmers predict which fields are at higher risk due to wireworm's multiyear life cycle.
- Grass crops are a preferred host of wireworms including wheat, barley, corn and pastures or high density of grassy weeds. These fields are more likely to contain high populations of wireworms.
- Environment – Again, warm soil temperature >50°F and moist soils (not flooded soils) can favor wireworm damage in the spring.

There are no rescue treatments for wireworms. If you know that your field has a history of wireworm damage, **insecticide seed treatments** are a preventative means of reducing wireworm damage (plant stand loss through dead plants) to growing crops.

- **Systemic neonicotinoid seed treatments** (Group 4A), such as thiamethoxam, imidacloprid and clothianidin, do not cause significant long-term wireworm mortality. Rather, wireworms that ingest a neonicotinoid will become moribund (sick) and stop feeding for a while, thus giving some crop protection. In cool, wet conditions, the crop is more susceptible to wireworm attack. A seedling may live or die depending on the timing and extent of feeding injury. Seedlings that do survive wireworm injury usually have delayed growth and less vigor.
- **Broflanilide seed treatment (Terraxa, Terraxa F4)** is a newer product registered in 2022 for use in small grains. NDSU Extension Entomology trials found that Broflanilide provided the highest stand counts and resulted in significant wireworm mortality. Broflanilide is a Group 30 (meta-diamides) insecticide, and is not systemic. The idea here is that including broflanilide in the crop rotation will reduce overall wireworm populations long-term.

Soil applied insecticides also are effective in reducing plant stand damage caused by wireworms by providing a zone of root protection. Pyrethroids (Group 3A) also do not cause enough mortality to reduce overall wireworm populations. Pyrethroids repel foraging wireworm larvae away from the seed. Seedling root growth within the in-furrow application zone is protected, but a seedling is still susceptible to wireworms attacking outside the zone of root protection.

WHITE GRUBS, another soil insect pest, were observed in lawns as mature 3rd instar grubs last weekend. White grubs are a white larva with a brown head capsule and robust C-shaped body. Larvae have a long three-year life cycle and can

On left – Mature 3rd instar white grubs (Janet Knodel, NDSU) and On right – Bare patches in lawn damaged from white grub root feeding (Patrick Beauzay, NDSU)

be destructive to many field crops in North Dakota including corn, wheat, oats, barley, sugarbeets, soybeans and potatoes. White grubs are most likely to be found in crop fields with rotation from grassland, pasture, or grassy weed sites or corn following soybean. White grubs in the second year of the life cycle cause the most severe larval root feeding and cause bare patches in the lawn or crop field.

The adult stage is called May / June beetles that rest and feed on leaves of shelterbelt trees like willow and cottonwood. Adult beetles are reddish-brown beetles about ¾ inch long. At night, adult beetles are attracted and congregate near bright lights.

Adult May-June Beetle (Joseph Berger, Bugwood.org)

Again, no rescue insecticide treatment is available for white grubs. Both soil-applied insecticides and seed treatments are labeled for white grub control, however, efficacy can be inconsistent.

For insecticides registered for control of wireworms by crop in North Dakota, please refer to the 2024 North Dakota Field Crop Insect Management Guide.

Thresholds for white grubs in corn - Average of one or more white grubs per square foot using the following soil sampling protocol. Sampling in late summer or early fall, before a freeze, provides a more reliable estimate of populations than spring sampling just before planting. Larvae are typically present in the upper 6 inches of soil until a killing frost occurs in the fall. Take soil samples, 1 square foot in size to a depth of 8 inches. Begin taking samples 45 yards from shelterbelts. A total of 30 samples per field, randomly spaced along the shelterbelts, are necessary. If at least a single grub is found in less than 40% of the samples, treatment may be required only out 20 yards from the tree line. If 40% to 60% of the samples are infested, treatment is needed to this distance and maybe as far as 65 yards. If greater than 60% of the samples are infested, treatment may be needed out to 90 yards from the tree line.

Janet J. Knodel
Extension Entomologist

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State IPM Coordinator
Research Specialist, Extension Entomology

plant pathology

WAY TOO EARLY PREDICTION FOR WHEAT DISEASE IN NORTH DAKOTA

The 2024 planting season has begun and we are looking forward to another great wheat production season in North Dakota. Producers are faced with many pest challenges each year and this article will review some of the wheat disease challenges that we may see (or not see) this year.

Pythium root rot

The cool and wet conditions we see every spring will delay seed germination and can provide a favorable environment for *Pythium*. However, wheat tends to be less sensitive to *Pythium* (when compared to broadleaf crops), and a higher plant population increases wheat's ability to compensate for any early season stand loss. Also, the use of a fungicide seed treatment that includes metalaxyl, mefenoxam or ethaboxam will further reduce risk from *Pythium* in wheat. I suspect we may see some *Pythium* damage this year in wheat, but do not expect it to be a major problem.

Fungal Leaf Spots

The fungal leaf spots of tan spot and Stagonospora nodorum blotch will be found every year in North Dakota. However, prevalence of these diseases has decreased in the past five years (Figure 1) likely due to early season weather unfavorable disease (May and June), frequent use of an early season fungicide, adoption of varieties with improved genetic resistance in spring wheat, diversified crop rotations, and residue management practices. Producers are able to use several tools to manage fungal leaf spots, and if this continues, I do not foresee any major problems with fungal leaf spots this year.

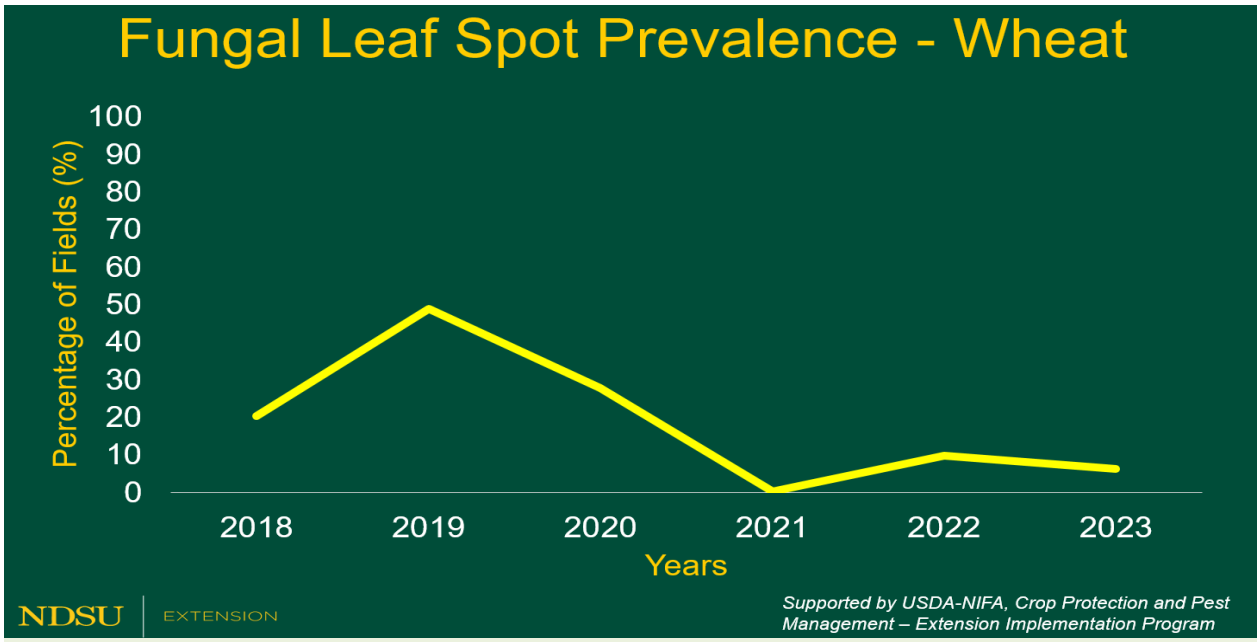

Figure 1. Percentage of wheat fields in North Dakota with at least one plant with tan spot or Stagonospora nodorum blotch. Incidence within a field and severity on a plant are not reported.

Rust Diseases

Leaf rust, stripe rust and stem rust are considered "disease wild cards" for North Dakota wheat. This is largely due to that the rust pathogens overwinter in the southern USA and rely on southerly winds to move spores along the Plains States (*Puccinia* pathway). Our best indicator of potential rust problems is gathering reports from the Southern Plain States. Observations form the southern states have indicated an earlier than normal appearance of stem rust and stripe rust in northern Kansas. I am not aware of any leaf rust reports in the southern states yet.

Our last stripe rust epidemic in ND was in 2015 and it coincided with epidemics in Kansas and Nebraska. Last year we had reports of severe stem rust (Figure 2) in a couple fields planted to a susceptible cultivar (CP3099A). The good thing is that a majority of the spring wheat varieties are resistant to stem rust with only two susceptible varieties (CP3099A and CP3188; LCS Trigger was erroneously reported as susceptible) listed in the NDSU Spring Wheat Variety Selection Guide. We will continue to monitor and track epidemics in the southern USA to help determine risk in ND. At this point, our risk for an early rust reporting in ND is elevated. The good news is that if we see rust in the lower canopy of wheat prior to flag leaf, we have excellent fungicide options that can be used to reduce economic loses.

Figure 2. Stem rust on a susceptible hard red spring wheat variety.

Bacterial Leaf Streak

I still consider bacterial leaf streak our most important foliar disease in North Dakota. Genetic resistance is our only reliable management tool, and most of the commonly grown spring wheat varieties are average (Figure 3) to below average for bacterial leaf streak resistance. Field prevalence reports (percentage of fields with at least one plant having bacterial leaf streak) have been relatively stable the last two years (approximately 8%). However, if we get average or above average humidity and rainfall in June, we will likely see an increase in bacterial leaf streak this year. As a reminder, in-season crop protection sprays have not been shown to be effective on bacterial leaf streak.

Figure 3. A hard red spring wheat variety with a BLS score of 5. Notice considerable flag leaf damage caused by BLS.

Fusarium Head Blight (Scab)

Our scab risk prediction window begins 10 to 14 days before wheat heads (mid to late June). It is always difficult to know what type of humidity and precipitation we will receive, but luckily we have prediction models in place to provide real

time estimations of scab risk. When scab risk season approaches, I will make sure to push forward regular updates on risk. In the meantime, remember that we have some great tools in place to help manage scab. First, genetic resistance is our most important tool and most of the spring wheat varieties are above average for scab resistance. However, there are a few varieties with below average scab resistance (FHB scores of 6 or higher). Second, there are several *good* fungicides on the market (50-60% suppression) and our fungicide timing window has expanded (up to seven days after early flowering has started).

Andrew Friskop
Extension Plant Pathology, Cereal Crops

THE 2024 SOYBEAN DISEASE OUTLOOK FOR NORTH DAKOTA

The two times of year that are most hopeful for me are the first week of the NFL season and the beginning of planting season. It's a blank slate and only possibilities ahead of us. As the 2024 planting season begins across North Dakota, we are almost guaranteed another year of potential challenges posed by various diseases. With the dynamic weather patterns continuing across the region, understanding the potential disease threats, and preparing effective management plans is crucial. Here's an early look and my thoughts on at what soybean diseases might be prominent this season and how farmers can tackle them effectively.

Soybean Cyst Nematode (SCN)

Due to a very warm and dry season in 2023, data from the SCN Sampling program indicated that SCN counts were extremely high across much of Eastern North Dakota (Figs. 1 and 2). This means that more fields will have a high level of eggs in 2024 which could lead to yield loss this season. As always, it's crucial to test soil and manage fields known to have SCN by rotating to non-host crops (corn, small grains, sunflowers, canola) and utilizing SCN-resistant varieties. Regular monitoring and following an integrated management plan can substantially reduce the impact of SCN. For more information about SCN, visit this link.

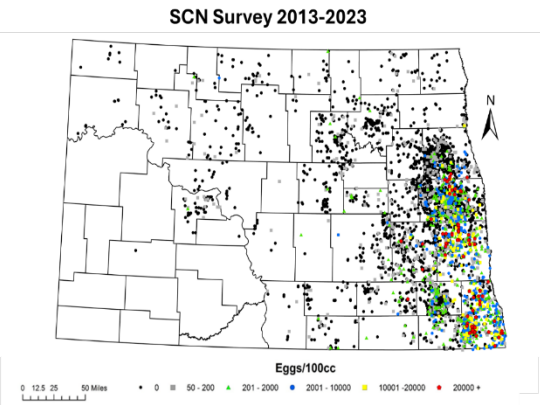

Figure 1. This map shows the spatial distribution of SCN egg counts across North Dakota from 2013 to 2023, based on soil samples collected through the North Dakota Soybean Council funded SCN Sampling Program. The data points are color-coded to represent different ranges of SCN egg counts: 0 eggs (black), 50-200 eggs (yellow), 201-2,000 eggs (blue), 2,001-10,000 eggs (green) 10,001-20,000 eggs (yellow), and over 20,000 eggs (red). The map highlights the concentration of higher infestation levels, particularly in the eastern part of the state.

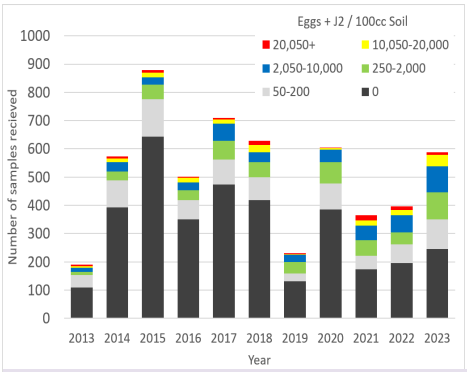

Figure 2. This graph shows the number of SCN egg counts from soil samples submitted through the NDSC funded SCN Sampling Program from 2013 to 2023. Each bar represents the total number of samples received per year, segmented by different SCN egg count ranges: 0 eggs (black), 50-200 eggs (grey), 250-2,000 eggs (blue), 2,050-10,000 eggs (green), 10,050-20,000 eggs (yellow), and over 20,050 eggs (red).

Seedling Diseases

Seedling diseases in soybeans, such as those caused by *Pythium*, *Phytophthora*, *Fusarium*, and *Rhizoctonia*, present significant threats to germinating seedlings and early soybean stands. *Pythiums* and *Phytophthora*, often referred to as water molds, are particularly problematic, thriving under conditions of high soil moisture. With the recent widespread rainfall across the state, there is an elevated risk of these pathogens affecting soybeans. During the early planting season, cooler soil temperatures can increase the impact of *Pythium*, making it a major concern for emerging seedlings. As the season progresses into late May and June, and if rainfall remains consistent, *Phytophthora* may emerge as a more significant threat, given its preference for slightly warmer conditions.

Effective management of these diseases involves a combination of cultural practices and chemical treatments. Enhancing soil drainage through cultural techniques or drain tillage can help manage moisture levels and reduce the risk of infection. Additionally, chemical seed treatments are highly recommended as they protect the seeds and seedlings during their most vulnerable stages. However, it's crucial to select the right type of seed treatment; not all products are equally effective against all pathogens. Some treatments are specifically designed to combat water molds like *Pythium* and *Phytophthora*, while others are more effective against true fungi such as *Fusarium* and *Rhizoctonia*. For comprehensive protection, it is essential to use products that offer a broad spectrum of control, safeguarding young soybean plants from a variety of pathogens that could compromise their health and vigor in the critical early weeks of development. Further resources are available: 1) North Dakota Field Crop Plant Disease Management Guide, 2) Fungicide Efficacy on Soybean Seedling Diseases, 3) What's on Your Seed.

White Mold

White mold consistently threatens soybean production in North Dakota. No varieties are truly resistant, and the disease flourishes under cool and moist conditions. Very dense canopies are particularly favorable for white mold infection due to the cool and wet microclimate.

This year, the NOAA Prediction Center forecasts a shift from El Niño, which brought a warmer winter, to La Niña by early summer. This transition is expected to result in average temperatures but slightly drier conditions, particularly on the western side of the state. While this might suggest a lower risk for white mold in those areas during the July to August flowering window, any occurrence of timely rains could still increase the risk. It is important to remember that we are still a long way from this critical period, and these predictions may change drastically by the time we reach July. For white mold, we can help prevent disease by managing the environment by reducing canopy density through widening row spacing and dropping planting populations in problematic fields. Additionally, deploying fungicides during flowering under conducive conditions can further mitigate the risk of white mold.

Emerging Threats: Frogeye Leaf Spot

Although traditionally more common in southern states, frogeye leaf spot has been moving northward and could become more prevalent in North Dakota as climates shift. I do not personally think this disease will show up at economically important levels in 2024, but due to a very mild winter, the pathogen may have been able to survive in crop residue. So, I will be keeping my eye out for early reports of frogeye leaf spot. More information on this disease can be found here.

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plant science

2023 NATIONAL SCREENING OF COMMERCIALLY AVAILABLE BIOLOGICAL SEED TREATMENT FOR SOYBEAN

There are many biological seed treatment products on the market in the US, and soybean growers are interested in understanding the benefits of applying biological products to the seed. In many cases, there is little or no third-party evidence regarding the ability of these biological seed treatments to improve soybean yield and profitability. Therefore, the objective of this study was to evaluate soybean yield when nine biological seed treatments were used.

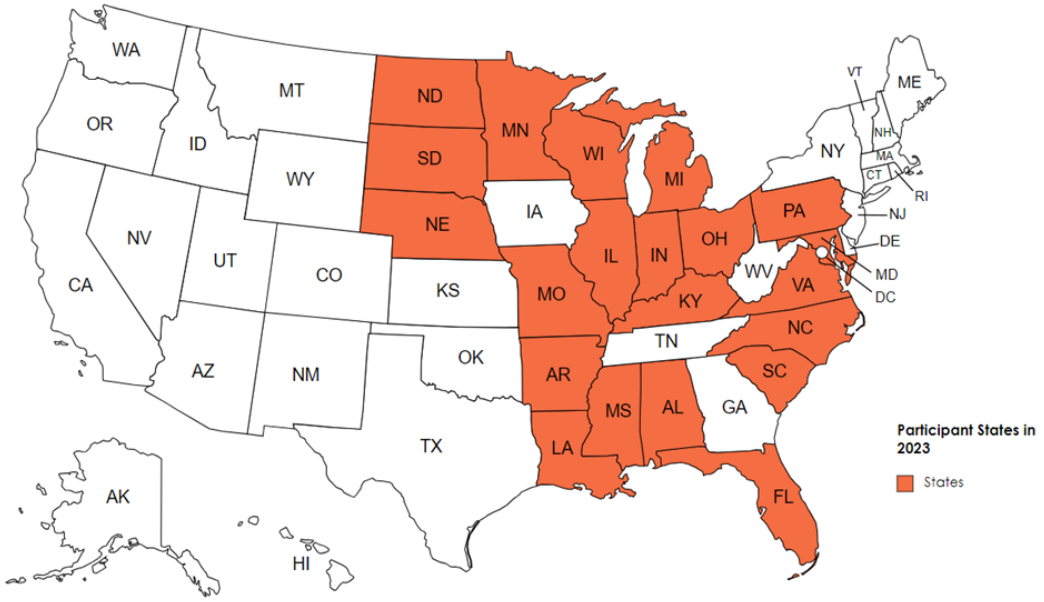


Figure 1. Map of state participants in this project in 2023 (in red).

Methodology

In 2023, the science for success partnership, consisting of extension agronomists from land-grant institutions, established small plot trials in twenty-five locations across the US (Figure 1), including two environments in North Dakota. Selected fields had soybean in the crop rotation. In each location, the researchers evaluated the influence of nine biological soybean seed treatments and one untreated control on grain yield. The experiment design was a randomized complete block design with six to eight replications at all sites. Biological seed treatments were applied to the seeds before planting, and the application protocol used was according to each product's recommendations (labels). Each state collaborator obtained the soybean variety recommended for their region. All soybean seed came treated with fungicide to represent practices adopted by farmers. Soybean yield was adjusted to 13% moisture concentration prior to data analysis.

Table 1. List of treatments (products) and active ingredients in each biological product, 2023.

Treatment (product)	Active ingredients
1	*Azospirillum brasilense, Bacillus licheniformis, Bacillus amyloliquefaciens, Bacillus subtillis, Pseudomonas fluorescens, Rhizobium*
2	*Kosakonia cowanii strain SYM00028*
3	*Bradyrhizobium spp.*
4	*Bacillus subtillis + Bradyrhizobium japonicum*
5	*Bacillus amyloliquefaciens Strain PTA-4838*
6	*Methylobacterium hispanicum*
7	*Bradyrhizobium elkanii, Delftia acidovorans + Bacillus velezensis*
8	*Bacillus velezensis*
9	*Glomus intraradices, Glomus mosseae, Glomus aggregatum, Glomus etunicatum*
10	Untreated Control

Results

A summary of the average grain yield (in bu/acre) by product across 25 sites is shown in Figure 1. There were no significant soybean yield differences between products. The untreated control is indicated in red. The experiment was also conducted in 2022 and no significant yield differences were found in that year (Thanks to Fabiano Colet and Laura E. Lindsey from The Ohio State University, who coordinated this multi-year research project).

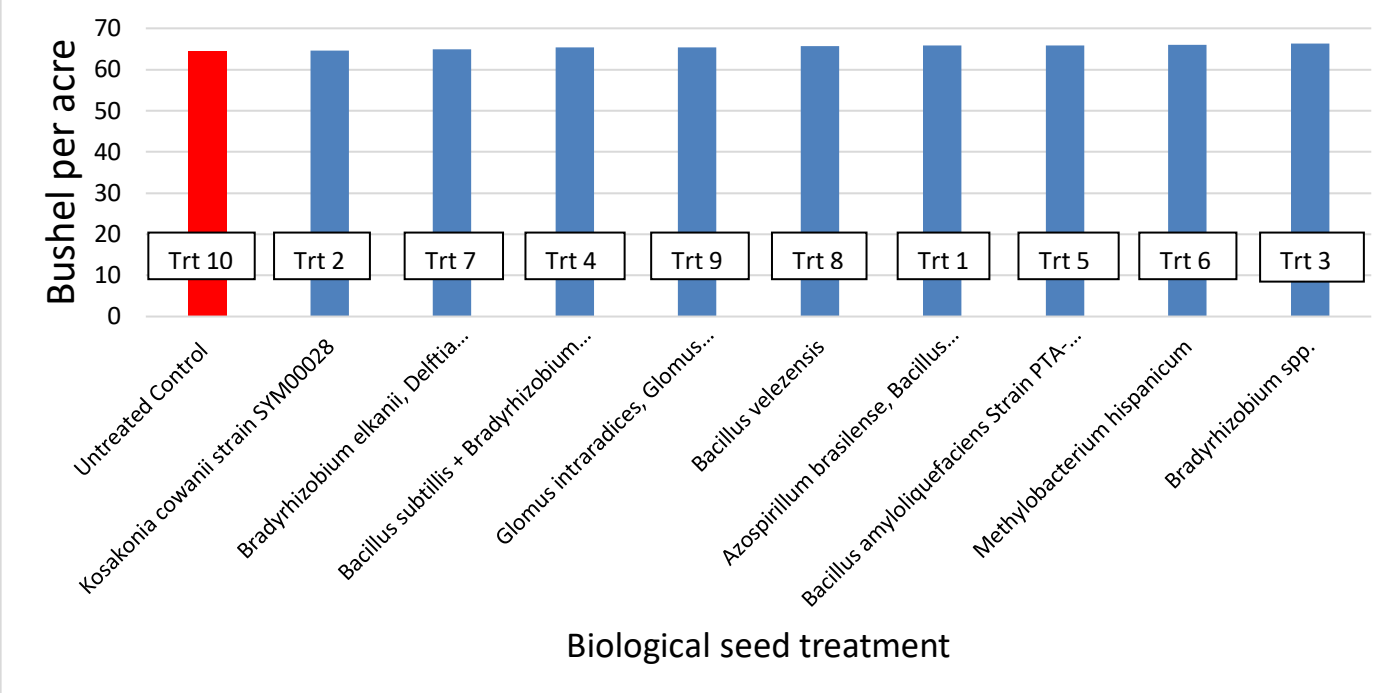


Figure 1. Average soybean yield in bushel per acre, from lowest (left) (64.6 bu/a) to highest (right) (66.4 bu/a), for biological seed treatments at 25 US environments, in 2023.

Hans Kandel,
Emeritus Extension Broadleaf Crop Agronomist

SMALL GRAIN PLANTING DATES AND IMBIBITIONAL CHILLING INJURY IN CORN

The warm and relatively dry winter allowed some farmers to get seed in the ground before the rain started in recent weeks with some planting in early to mid-April. With the rain received over the past few days, planting has stopped or slowed down, but we're about on track for where we should be with small grains. It may feel like it's getting late, but keep in mind that 2023 and 2022 plantings were unusually late due to heavy snowpack and late spring blizzards. Optimum and last recommended planting dates for small grains are in the table below (credit Ransom and Wiersma).

Location in ND	Optimum	Last Planting Date
South of Hwy 13 and 21	2nd week of April	2nd week of May
South of I-94	3rd week of April	3rd week of May
South of US Hwy 2	4th week of April	4th week of May
South of Canadian border	1st week of May	1st week of June

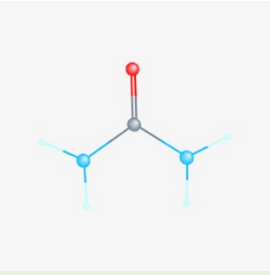
For those who were able to plant corn in April, there was some concern about imbibitional chilling injury. Imbibition is the process of the seed absorbing water in the first 24-48 hours after being planted into moist soil. Imbibitional chilling injury can occur in corn when soil temperatures are below 50°F with lower temperatures posing higher risk. There is no well-established threshold for what soil temperature and for how long will cause imbibitional chilling injury, but a single day of cold soils is less risky than multiple consecutive days of cold soils. Now that many are waiting for fields to dry out before they can continue planting, I don't foresee much risk of chilling injury with the majority of the corn crop. NDAWN soil temperatures are in the mid- to upper-40's and low to mid-50's across the state. Combined with the 10-day weather forecast with highs in the 60's and 70's, we should quickly be out of the risk window.

Clair Keene
Extension Agronomist Small Grains and Corn

soils

UREA ON TOP

It is common for farmers to apply urea to the soil surface or near the soil surface. The formula for urea is $(NH_2)_2CO$, and it is shaped like a triangle, with the 'C' in the middle, the 'O' shooting off the top, and the 'NH_2' groups shooting off each side below the 'C'.



Urea molecule, red O, grey C, blue NH_2 groups. From PubChem, open access.

In the soil, an enzyme that came originally was made by a plant or bacteria, urease, is very resistant to decay, so when the rest of its creator is gone, the urease persists. When it contacts a urea molecule, it draws it into its triangular space (see Performance of Selected Commercially Available Asymbiotic N-fixing Products in the North Central Region for more detailed information) and splits it into its component parts of ammonia and carbon dioxide. Since ammonia is a gas, it can be lost, or 'volatilized'. The urease inhibitor NBPT (or a relative NPPT if it is still sold) completely locks up the urease enzyme for about 10 days after application. After 10 days, the urease activity ramps up. Soil

with pH greater than 7 is at great risk of ammonia volatilization after this date, as is urea in soil with residue at the surface. Soils with acidic pH and no residue are at far less risk of loss.

Water is very attracted to urea pellets. During a humid night, urea pellets applied the day before will attract water and the pellet will slake and 'disappear'. This shocks some growers when they see it; but the urea has not gone away and the ammonia is not lost at this point. It takes urease enzyme activity to make ammonia volatilization happen. The pellet has just melted, that's all. The following are general guidelines for urea use:

1. If the urea is placed at least 2 inches deep, no NBPT is required.
2. If the urea is surface applied or placed within the top 1 inch or so with tillage, and soil pH is greater than 7, and/or there is a lot of residue, use of NBPT would be very wise.
   - Applicators impregnating with NBPT would best do it later in the AM to afternoon when humidity is lower. Mixing the fertilizer with humidity high will increase the chance of pneumatic spreader plugging.
3. If it rains at least 1/10 of an inch in a few-hour period, this has been enough in my research to protect the urea whether or not it is protected with NBPT.
4. Urea applied to fields with residue covering the soil surface may need 1/2 inch or more of rain to move the urea to the soil and off the residue.

Use of urea with NBPT at the soil surface is a convenience. Some research has shown that the most efficient urea application is made with urea application at least 2 inches deep.

BIOLOGICALS

I classify biologicals into 2 categories; living organisms; isolates from living organisms including signal molecules, enzymes, biologically- or soil-derived compounds that may act like hormones, such as fulvic or humic acids among others.

When farmers are interested in any biological it is wonderful that they are curious. However, it is important that they are also skeptical. My advice to any farmer with interest in any new product or management practice is to test it on their farms using replicated strip trials, ideally on multiple fields, before using it on everything.

North Dakota State University currently does not have an official program to support on-farm research; however, I think with the new hires in the SNRS-Soils Department an official program may soon be forthcoming. For now, the best website that I know of to help farmers establish and analyze on-farm replicated strip trials is out of the University of Nebraska, Lincoln https://on-farm-research.unl.edu/ . Within this site are excellent tutorials on setting up replicated strip trials, and also an easy-to-use statistics program that will provide farmers with these trials the means to objectively determine if what they are testing is worthwhile with confidence.

The most common biological marketed to farmers may be the commercial asymbiotic (non-symbiotic, meaning they are not attached to plants, like the rhizobia for soybeans, field peas and other legumes) N-fixing bacteria.

When considering such a product, first know that these are naturally occurring organisms that have been around for over a billion years in soils and they are present in your soils. In my research, these organisms are much more productive in long-term no-till soils compared to conventional till soils, and are they likely are a substantial part of the long-term no-till N credit in NDSU N calculators for spring wheat/durum, sunflower, corn and 2-row malting barley https://www.ndsu.edu/pubweb/soils/N_calculators/ . These native organisms are also most productive in moist and warm soils and they are very sensitive to soil moisture and temperature.

I have been fortunate to visit at length with about 8 startup biological companies. Through conversations, the following are points that a farmer should ask a company agent before seriously considering such a product.

1. Is there a test or test kit that can be used to determine whether the organism is alive and functioning in the soil or plant?
2. The product probably has strict temperature requirements indicated for storage. Have these temperature restrictions been followed from the date the product left the assembly line to the field, including trucking, storage at distributors and retailer, and maybe even the farm?
3. The organisms will be introduced into a soil environment with thousands of organisms that want to kill and eat them, and others that defend their territories around the nutrient-rich roots against foreign intruders. Is the product organism competitive enough to 'win the battle'?
4. North Dakota farms have sandy soils, clay soils, droughty soils, wet soils, salty soils, not-so-salty soils, very acidic soils and very high pH soils. Some quarter-sections have all of the above in the same field. How adapted are the organisms to these wide-ranging conditions?

Farmers again should remain curious, but skeptical. Farmers have GPS on tractors, applicators and yield monitors, so replicated strips with and without products or management are certainly possible and practical. Ask lots of questions of company representatives and conduct replicated trials before committing the whole farm to a new product or practice.

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NEW GENETIC TESTS PROVIDE RAPID CONFIRMATION OF HERBICIDE-RESISTANT KOCHIA AND PIGWEEDS

Herbicide-resistant kochia is problematic for farmers in North Dakota. NDSU Weed Scientists first confirmed resistance to PPO-inhibiting (Group 14) herbicides in kochia in 2022. In a collaborative effort, BASF scientists discovered a target-site mutation in kochia that provided resistance to Group 14 herbicides. Once the target-site was identified, the National Agricultural Genotyping Center (NAGC), located on NDSU's campus, developed a rapid test to detect the mutation from DNA extracted from leaves. We are happy to announce that this DNA-based test is now available for public submissions of kochia samples.

In addition to testing for Group 14 resistance in kochia, the NAGC offers DNA tests for resistance to Group 14 herbicides in waterhemp and Palmer amaranth, as well as Glyphosate (Group 9) and ALS-inhibitors (Group 2) in kochia, waterhemp, and Palmer amaranth. The NAGC can also test for Group 2 resistance in any pigweed species. Standard turnaround time for results will be 7 days from arrival at NAGC.

Thanks to sponsorships from the North Dakota Corn Utilization Council, North Dakota Soybean Council, North Dakota Specialty Crop Block Grant, and Minor Crop Utilization Grants, funding is available to test the first 1,000 North Dakota pigweed or kochia samples for no charge. Each county Extension office will have testing kits on hand with instructions on how to collect and send samples. Once kits run out at county offices, samples can be submitted following the self-mailing instructions and submission form: https://genotypingcenter.com/product/kochia/. Free testing is currently

limited to 4 samples per farming operation. Additional tests, as well as samples originating from outside of North Dakota, will have charges listed in Table 1. Please use the non-ND submission form also provided at NAGC's website.

Table 1. Cost DNA test for herbicide resistance in pigweeds and kochia.

Marker	Pigweed-Indiv Test	Kochia-Indiv Test	All three tests (Pigweed or Kochia)
ALS	$ 75	$ 75	$ 195
EPSPS	$ 75	$ 75	
PPO	$ 75	$ 135	

To get the most impactful information from these DNA tests, leaves should be collected from plants that survive the herbicide in question. The application will remove susceptible plants and increase confidence of the resistance determination.

Individual sample results will remain confidential. Test results will be sent directly from the NAGC to the e-mail provided on the submission form. The NAGC will aggregate results to provide data at the county-level, but no individual information will be released. The attached map (Figure 1) highlights counties where populations of Group 14 resistant kochia have been confirmed.

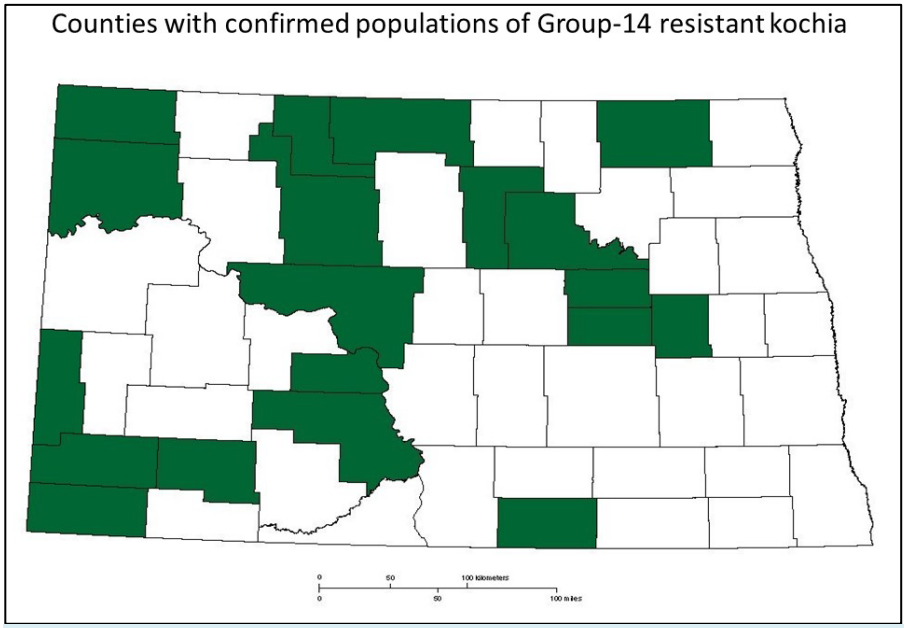


Figure 1. Counties in green contain at least one population of kochia resistant to Group 14 herbicides.

This sampling program using DNA testing began in the Fall of 2023. To date, the NAGC has received 51 kochia samples from 21 counties in North Dakota. Results found 33% of samples contained a mutation that confers resistance to Group 14 herbicides, 82% of samples contained a mutation that confers resistance to glyphosate, and 51% of samples contained mutations that confer resistance to Group 2 herbicides. It is important to note that DNA testing can only detect known target-site mutations that confer resistance. There could be unknown mutations, or other mechanisms of resistance that these tests cannot detect.

Collection Instructions

1. Locate pigweeds or kochia in the field. Proper ID is important before collecting leaf samples.

2. Collect two leaves near the top of the plant (leaves must be larger than a standard hole-punch to allow for adequate DNA extraction). Place two (2) leaves from a single plant into one (1) zipper bag or small envelope. **DO NOT mix leaves** from multiple plants.

3. With a marker, label the outside of the collection bag with a unique Sample ID. The Sample ID can be in the following format: **Year-Month-County-Personal Field ID** (Example: 24-05-Cass-SE4). Make sure to also write the Sample ID on the submission form.

4. Sample additional weeds in fields of your choice by following Steps 1-3. **Send a max of four (4) total plants for testing.** Keep samples dry and at room temperature before shipping.

5. Mail the submission form and individually-packaged samples in a large business envelope to:

   National Ag Genotyping Center
   1616 Albrecht Blvd N
   Fargo, ND 58102

For an example of results, see Charlie Lim's article in the Around the State section, page 16-18.

Joe Ikley
Assistant Professor/Extension Weed Specialist
Kirk Howatt
Associate Professor, Plant Sciences
Brian Jenks
Weed Scientist, North Central REC
Zack Bateson
Research Scientist, National Agricultural Genotyping Center

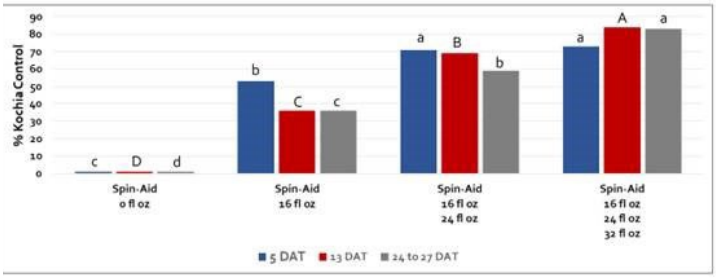
KOCHIA CONTROL IN SUGARBEET

Sugarbeet growers continue to make substantial progress on 2024 sugarbeet plant. Early plant means some kochia may not have been removed with spring tillage. Further, strip-tillers need to carefully scout for kochia in the undisturbed areas between sugarbeet rows. Finally, we have observed less predictability on emergence patterns with herbicide resistant kochia. We have observed some populations emerging in May and in some cases June.

Ethofumesate (Nortron, Ethotron, Ethofumesate 4SC) is our best choice for soil residual control of glyphosate resistant kochia. Apply ethofumesate products at 6 pint per acre. We leave it to the discretion of the grower if ethofumesate should be incorporated by tillage into the ground. Keep the tillage shallow if you elect to incorporate. I prefer rainfall, mother natures' incorporation. However, rainfall is not always timely and ethofumesate on the surface while kochia emerges has very little value.

Kochia control from Spin-Aid, 21 DAT, greenhouse, December/January 22023/24

Kochia control from 1-time, 2-time, and 3-time Spin-Aid, across greenhouse runs, 2023-24.[ab]



[a]Treatment includes ethofumesate at 4 fl oz/A plus MSO at 1 pt/A.
[b]Means within a rating timing that do not share any letter are significantly different by the LSD at the 5% level of significance.

What about emerged glyphosate resistant kochia? Extension Sugarbeet has been evaluating Spin-Aid (phenmedipham) for kochia control. Phenmedipham was sold using the trade name 'Betanal' until 1982. Spin-Aid can be applied using a 24(c) local needs label once sugarbeet are at the cotyledon stage. However, sugarbeet are extremely sensitive to application at the early 2-lf stage, especially when maximum daily air temperature is greater than 80F. Spin-Aid rate should be commensurate with sugarbeet stage and environmental conditions. We have found that kochia control is best when Spin-Aid is mixed with ethofumesate at 4 fl oz per acre and when one or two repeat applications are made on 5- to 7-day intervals. PowerMax3 may also be added to the mixture but 2-times PowerMax3 applications must be made on 10-day spray intervals. Consult your Agriculturalist or your Belchim USA product representative for more information.

SPIN-AID 24(C) LOCAL NEEDS LABEL FOR KOCHIA, COMMON LAMBSQUARTERS, AND COMMON RAGWEED CONTROL IN SUGARBEET

North Dakota and Minnesota Department of Agriculture recently approved/updated the 24(c) local needs label for Spin-Aid application in sugarbeet. Spin-Aid rate is dependent on sugarbeet size and environmental conditions at application. Spin-Aid can be applied on cotyledon sugarbeet for early season kochia control but 2-lf sugarbeet, especially early stage 2-lf sugarbeet (see image) are most sensitive to Spin-Aid, particularly when maximum daytime air temperature is greater than 80F. The updated local needs label approves the use of Spin-Aid mixed with Stinger HL for common ragweed control, specifically common ragweed greater than 2-inch in size.

Spin-Aid is a group 5, photosystem II inhibitor herbicide. Photosystems II inhibitors disrupt food production in susceptible plants by binding to specific sites in plant chloroplasts. PS II inhibitors affect older leaves first; the growing point may remain green in less susceptible plants (see image). Tolerant broadleaf species including sugarbeet rapidly metabolize Spin-Aid to less toxic compounds.

We are targeting kochia control with Spin-Aid. Consult your agriculturalist or your Belchim USA representative for more information.

Sugarbeet at the early 2-lf are more susceptible to Spin-Aid than cotyledon sugarbeet or sugarbeet with fully developed leaves

Older leaves turn brown and die while the growing point may remain green

ULTRA BLAZER SECTION 18 CONTROL IN SUGARBEET

EMERGENCY EXEMPTION FOR WATERHEMP

Sugarbeet safety from Ultra Blazer alone or Ultra Blazer mixed with Roundup PowerMax was Ms. Emma Burt's thesis research project at NDSU. Findings from the thesis were the basis for our first Section 18 Emergency Exemption in North Dakota and Minnesota in 2021. Sugarbeet growers asked that we reapply for the Section 18 EE in 2022, 2023, and again in 2024.

The 2024 Section 18 EE targets escape glyphosate resistant waterhemp control with Ultra Blazer at 16 fl oz per acre plus nonionic surfactant or Ultra Blazer mixed with PowerMax3 plus ammonium sulfate. Apply Ultra Blazer on sugarbeet greater than the 6-lf stage on days with maximum day-time temperatures less than 85F. Application should occur prior to 4 inch weed height for control of waterhemp. Section 18 EE is effective May 20, 2024 and expires July 31, 2024. Ultra Blazer is a product of UPL NA Inc.

Tom Peters
Extension Sugarbeet Agronomist
NDSU & U of MN

around the state

AROUND THE STATE

NORTHEAST ND

Rain events for the past two weeks brought in good moisture to the region. Slow and steady rains helped the dry ground to soak in the moisture and replenished the deep soil moisture levels. Rainfall totals averaged between 2- 5 inches in the past five weeks. Several farmers got a chance to get into their fields early before the rains and were able to get the tillage, fertilizer application and plantings done. Depending on the location, 20-75% of small grains were planted. A few acres of corn, soybeans and field peas were also planted. The field activities got halted with the rains and now farmers are waiting for the rain to quit.

Anitha Chirumamilla
Extension Cropping Systems Specialist
Langdon Research Extension Center

NORTHWEST ND

Now that the burndown season is ramping up, it is important to scout your fields within a week of your herbicide burndown application. Look for surviving plants, and please have the kochia from your field genetically tested for resistance! For more information and submission instructions, please see Joe Ikley and team's article in the Weed section, page 12-14.

Last week I sent kochia leaf tissue samples to the National Agricultural Genotyping Center (NAGC) for resistance testing. The leaf tissue samples came from seedlings that were grown in the grow light shelves at the Williston REC. These seedlings came from kochia seeds that were randomly collected last fall (2023) from fields in the five northwest counties where the kochia plants survived the last growing season and produced mature seeds. Each population were a composite of seeds from at least ten kochia plants no more than ten feet from each other during the seed collection. The resistance testing results came in within a week of sending the tissue samples to NAGC, and the results report looked like below.

National Agricultural Genotyping Center

1616 Albrecht Blvd N Fargo, ND 58102
TEL: (701) 239-1451
www.genotypingcenter.com

To: HR Survey
1616 Albrecht Blvd N
Fargo, ND 58102

Attn: Charlie Lim

REPORT ON THE EXAMINATION OF PHYSICAL SAMPLES

Testing Request: Herbicide Resistance Genotyping (koPPO, koEPSPS-COPY, and koALS-W574L) **Laboratory Case #:** 24-0333

Report Date: May 07, 2024

Description of Submitted Samples:

Item	Description
1	One (1) envelope labeled K#1 [redacted] containing plant tissue
2	One (1) envelope labeled K#2 [redacted] containing plant tissue
3	One (1) envelope labeled K#3 [redacted] containing plant tissue
4	One (1) envelope labeled K#4 [redacted] containing plant tissue

Results/Interpretations/Opinions:

Genotyping for herbicide resistance traits was performed on a sub-sample, as received, from Items 1 through 4. The tests detect genetic mutations associated with resistance to herbicides that include PPO-inhibitors (Group 14), EPSPS-inhibitors (Group 9), and ALS-inhibitors (Group 2). The results are reported as resistant, susceptible*, or undetermined and can be found in the table below.

Item	koPPO	koEPSPS-COPY	koALS-W574L
1	Resistant	Susceptible	Susceptible
2	Resistant	Resistant	Resistant
3	Resistant	Resistant	Susceptible
4	Resistant	Susceptible	Susceptible

*Other genetic and non-genetic mechanisms can lead to herbicide resistance in weed species. Therefore, susceptible results in this report should be considered preliminary findings that may require additional genetic testing or greenhouse work. Please contact the laboratory for more information.

Disposition of Samples:

Items 1 through 4 will be retained and stored by the laboratory for thirty days before final disposition according to NAGC policy.

In total, 20 kochia populations were sent to NAGC and tested for resistance to PPO-inhibitor (koPPO), glyphosate (koEPSPS-COPY), and ALS-inhibitor (koALS-W574L) through genetic testing. In the report above, **ko** is just to denote the weed species tested was kochia. Below are the compiled results report of the resistance testing by NAGC.

No.	Kochia Population	koPPO	koEPSPS-COPY	koALS-W574L
1	K #1	Resistant	Susceptible	Susceptible
2	K #2	Resistant	Resistant	Resistant
3	K #3	Resistant	Resistant	Susceptible
4	K #4	Resistant	Susceptible	Susceptible
5	K #5	Resistant	Susceptible	Susceptible
6	K #6	Resistant	Susceptible	Susceptible
7	K #7	Resistant	Resistant	Susceptible
8	K #8	Resistant	Resistant	Susceptible
9	K #9	Resistant	Resistant	Resistant
10	K #12	Susceptible	Susceptible	Susceptible
11	K #13	Resistant	Resistant	Susceptible
12	K #14	Resistant	Resistant	Resistant
13	K #17	Resistant	Resistant	Susceptible
14	K #18	Resistant	Resistant	Susceptible
15	K #19	Susceptible	Susceptible	Resistant
16	K #20	Susceptible	Resistant	Resistant
17	K #21	Susceptible	Resistant	Susceptible
18	K #22	Susceptible	Resistant	Susceptible
19	K #23	Resistant	Resistant	Susceptible
20	K #24	Resistant	Resistant	Resistant

Results showed that 75% (15 out of 20) of the kochia populations tested are resistant to Group 14 (PPO-inhibitor), 70% (16 out of 20) are resistant to Group 9 (glyphosate), and surprisingly only 30% (6 out of 20) are resistant to Group 2 (ALS-inhibitor). The resistance to Group 2 in this case is conferred by the specific mutation, the tryptophan (W) to lysine (K) amino acid substitution at the position 574 in the ALS enzyme configuration, hence, koALS-W574L, specifically detected by genetic test. Additionally, 20% (4 out of 20) have multiple resistance to all 3 modes of action, namely populations K#2, K#9, K#14 and K#20. Almost all or 95% (19 out of 20) have multiple resistance to 2 modes of action. Only one population namely K#12 was detected as susceptible to all three types of tests. It is alarming the 75% of these randomly collected populations have resistance to Group 14 (PPO-inhibitor).

Will write a follow up to elaborate more on this on the next CPR issue.

Charlemagne "Charlie" Lim
Extension Cropping Systems Specialist
NDSU Williston Research Extension Center

weather

THE MAY 9 TO MAY 15, 2024 WEATHER SUMMARY AND OUTLOOK

Typical of the Northern Plains climate, the region has gone from dry to wet in the past few weeks. The one big exception to getting the recent rains has been southwestern North Dakota (Figure 1). The pattern looks to become a bit drier in the next couple of weeks. Does that mean zero precipitation? No, but less frequent rain systems and the ones that do move through will probably be more hit and miss. As of this writing, the next, more widespread, precipitation threat will come in next Tuesday/Wednesday (May 14/15) time frame.

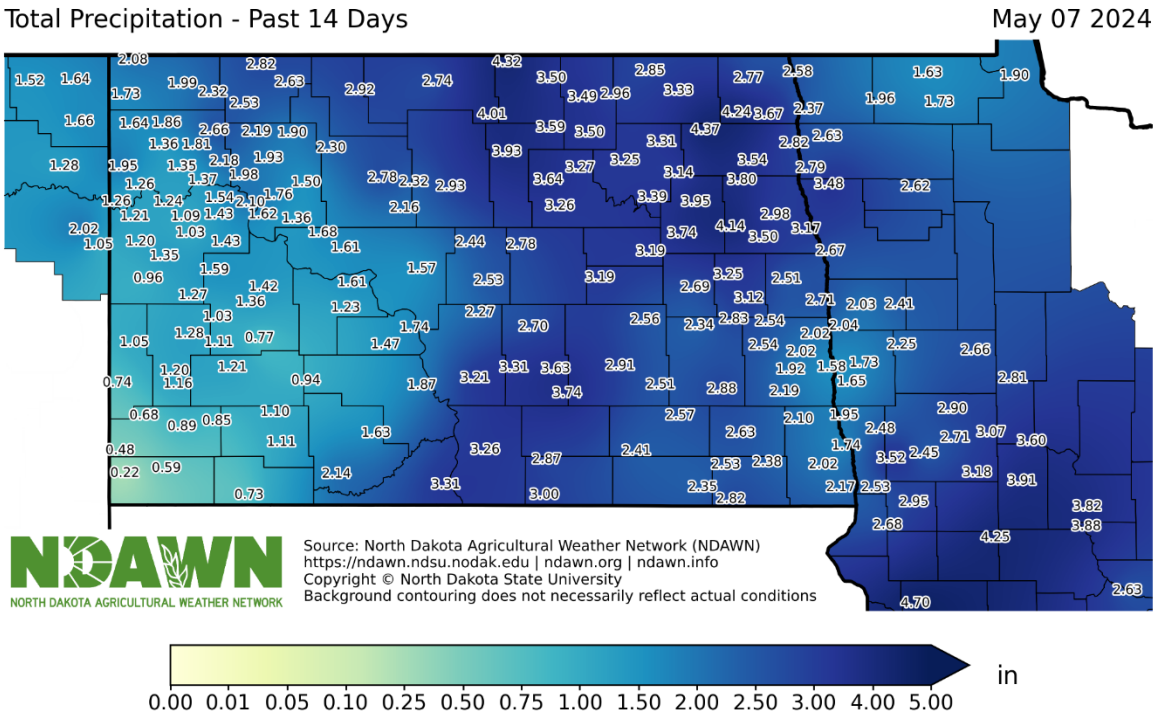


Figure 1. Two-week rain totals ending May 7, 2024 at NDAWN Weather Stations.

April finished warmer than average across the region (Figure 2). Even with the recent rains the temperature so far in May has been running a bit above average in eastern North Dakota, but a bit below average in the western part of the state. Odds favor May finishing at least near average for temperatures, if not a bit above average. In turn, no where near as warm as May 2023, yet, it still looks to be a good temperature start to the 2024 growing season.

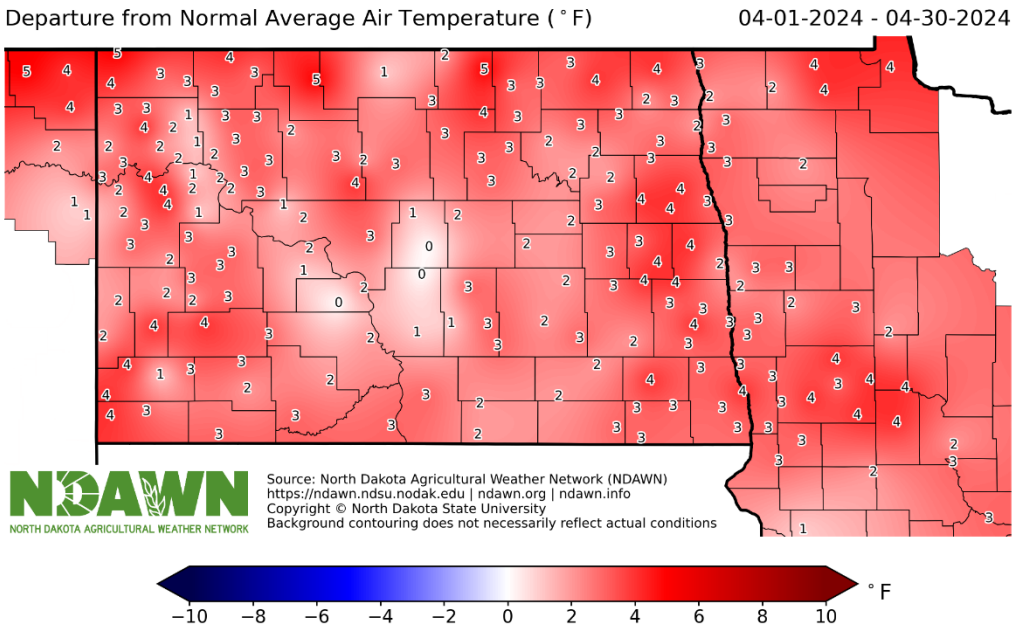


Figure 2. Departure from Average Air Temperature at NDAWN stations during April 2024

Figures 3 and 4 below are forecasted growing degree Days (GDDs) base 32° (wheat and small grains) and 50° (corn and soybeans) for this forecast period. This period is expected to produce near to slightly above average temperatures which will produce higher than normal GDDs, plus, aid in drying the top soil in areas that are currently too wet to plant.

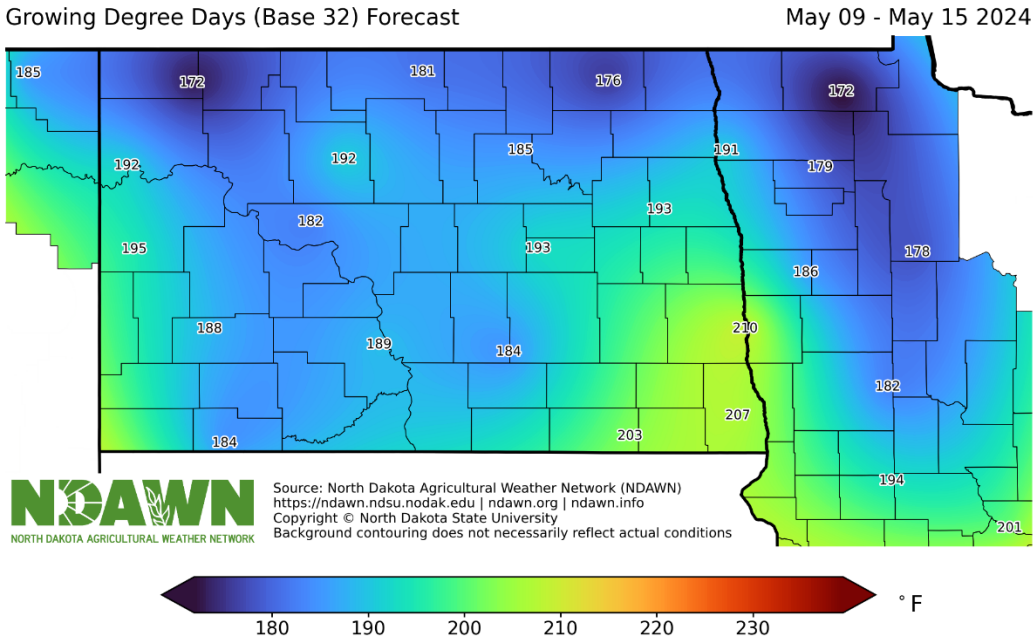


Figure 3. Estimated growing degree days base 32° for the period of May 9 to May 15, 2024.

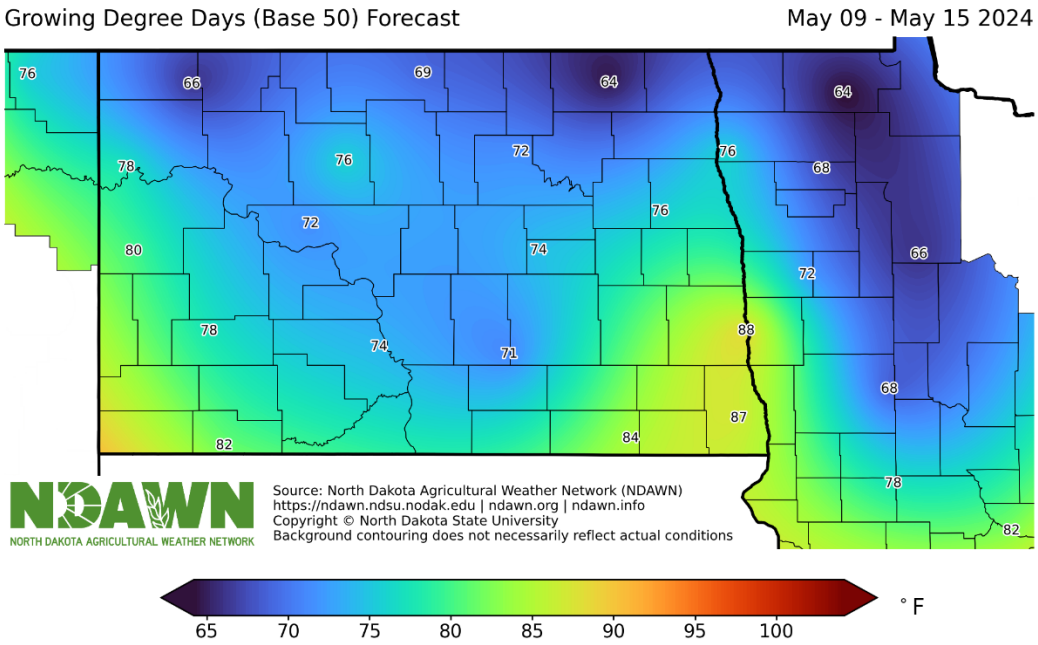


Figure 4. Estimated growing degree days base 50° for the period of May 9 to May 15, 2024.

The four-inch bare soil temperatures have now gotten close to or exceeded 50° in much of the region. Afternoon soil temperatures have been consistently above 50° with morning readings (Figure 5) or daily averages closer to 50°. With temperatures near or above average during the next couple of weeks, soil temperatures should continue to slow warm up

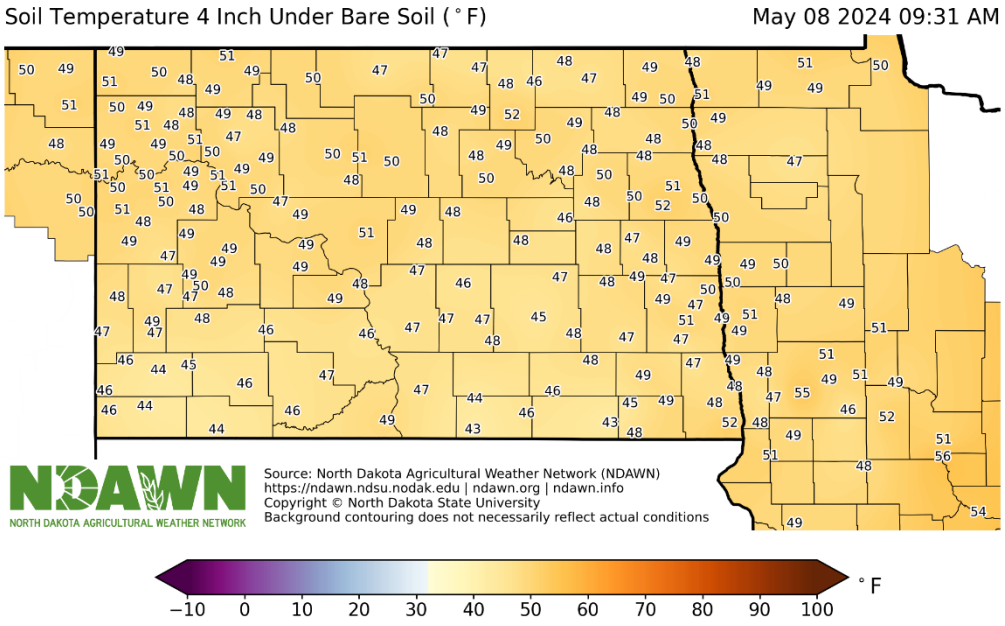


Figure 5. Four-inch bare soil temperatures at NDAWN stations at 9:30 AM on May 8, 2024.

If there are any requests for what you would like in this report during the 2024 growing season, please reach out to me.

Daryl Ritchison
Meteorologist
Director of the North Dakota Agricultural Weather Network (NDAWN)

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Fargo, ND 58108-6050

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