H1824 (Revised April 2023)

Interpreting the NDSU Soil Test Analysis for Managing Turfgrass

(iStock.com photo)

Alan Zuk, Associate Professor, Department of Plant Sciences
Esther McGinnis, Associate Professor, Department of Plant Sciences

Homeowners and turfgrass managers rely on the NDSU Soil Testing Lab for soil analyses to amend the soil before planting grass seed or to make soil nutrient adjustments after turf establishment.

The interpretation of the soil test report will be different for turfgrass compared to agronomic crop producers. Homeowners and turfgrass managers can use this publication to clarify the results for the purpose of establishing and maintaining a healthy lawn.

Soil Sample Preparation

To prepare a soil sample for testing, take cores (subsamples) from the upper 4 to 6 inches of soil, excluding the thatch layer. We recommend that homeowners take 7 to 10 random cores from each area to be tested. A separate set of cores would be submitted for the front yard as opposed to the backyard. For larger areas, professional turfgrass managers should take 15 to 20 cores per area.

Providing numerous cores from across the entire area is important because the composite soil sample will truly represent that area. In addition, it will provide enough soil to the laboratory to perform the requested tests and ensure accurate test results. Avoid collecting from unrepresentative areas such as dog urine spots and fertilizer spills.

You can use a core sampler or a hand trowel (Figure 1). Be sure to remove the thatch layer to avoid an inaccurate high organic matter reading (Figure 2). Place the cores or trowel samples in a clean bucket and thoroughly mix together. Send at least 1 pint of the mixed soil sample from each area to be tested. You can send soil samples in a plastic or paper bag or in sample bags provided by the lab.

Figure 1. A ¾-inch core sampler and a hand trowel; both are suitable for collecting soil samples. (W. Upham, Kansas State University)

NDSU | EXTENSION

North Dakota State University, Fargo, North Dakota

Soil pH

The first chemical analysis category listed on the soil test report is soil pH (Figure 3). The pH scale ranges from 0 to 14 and indicates the level of hydrogen ions in the soil solution. Active hydrogen ions (H+) cause soil acidity, while hydroxyl groups (-OH) cause soil alkalinity.

A soil that contains a high amount of hydrogen ions is called "acidic" (pH below 7) and a soil that contains a high amount of hydroxyl ions is referred to as "basic" or "alkaline" (pH above 7). A soil with a pH of 7 is referred to as "neutral."

The ideal soil pH for managing most turfgrasses is 6.5 because most nutrients are available at this slightly acidic level. However, various grass species may differ in their tolerance for different pH levels. Maintaining the proper pH is important because some vital nutrients become "fixed" (held tightly) by the soil and become unavailable to the turf as the soil pH extends above or below neutral.

Although a pH of 6.5 is optimal, turfgrasses will grow and, in most cases, thrive in soils above or below that ideal benchmark as long as proper cultural practices are used.

Soils in North Dakota tend to be alkaline and range as high as 8.5 to 9. At these high pH levels, turf yellowing caused by iron chlorosis is quite common because iron molecules in the soil become unavailable to turf roots. As a result, chlorophyll production in plant cells is hindered and the leaves begin to turn dull green to yellow. See the section on "Iron" to correct iron chlorosis of turf.

Soil pH is based on a logarithmic scale. Therefore, a soil with a pH of 8.0 is 10 times more alkaline than a soil with a pH of 7.0 and a soil with a pH of 9.0 is 100 times more alkaline than a soil with a pH of 7.0.

Figure 2. Thatch is an accumulation of dead and living organic matter above the soil and below the turf canopy. Remove this layer from your soil samples to avoid an incorrect soil organic matter value. (A. Zuk, NDSU)

SOIL TEST REPORT

SOIL TESTING LAB NDSU DEPT 7680 P.O. BOX 6050 FARGO, ND 58108-6050

Phone: (701) 231-8942

To:

Copy To:

Lab No.:

County:

County Agent:

Date Sampled:

Date Received:

Date Reported:

Sample Notes:

Section: T: R: SOIL TEST RESULTS Acres:

Sample Number	pH	Nitrogen N03-N lb/acre			Organic Matter %	P ppm	K ppm	Soluble Salts mmhos/cm			Zinc Zn ppm	Iron Fe ppm	Mn ppm	Copper Cu ppm	Sulfur S04-S lb/acre		Chloride Cl lb/acre	
	0-6"	0-6"	0-24"	2-4'	0-6"	0-6"	0-6"	0-6"	0-24"	24-48"	0-6"	0-6"	0-6"	0-6"	0-6"	0-24"	0-6"	0-24"

Figure 3. Soil test options as they appear on the NDSU soil test report form. Soil sample test results for turfgrass management purposes are based on a 4- to 6-inch depth.

Turf managers can attempt to adjust the soil pH downward (more acidic) by incorporating a sulfur amendment into the soil.

However, the soil has the ability to withstand chemical change and the sulfur amendment may not be effective if the soil pH is high, and if large amounts of calcium carbonate are present. If the soil test lists a pH of 7.5 or higher, a follow-up calcium carbonate test can be conducted at home using a simple process. Place 2 tablespoons of household vinegar in a one-cup disposable container. Then add approximately 1 tablespoon of soil. As the soil absorbs the vinegar, listen for a fizzing sound. If the mixture fizzes, then calcium carbonate is present in high quantities and a sulfur amendment would not be advised.

If the vinegar-soil mixture does not fizz, then a sulfur amendment can be incorporated into the high pH soil. Refer to Table 1 for directions in using sulfur to acidify the soil.

Table 1. Approximate amounts of elemental sulfur needed to lower pH for various soil textures.

	Pounds sulfur/1,000 sq. ft.		
Change in pH desired	**Sand**	**Loam**	**Clay**
8.5 to 6.5	46	57	69
8.0 to 6.5	28	34	46
7.5 to 6.5	11	18	23
7.0 to 6.5	2	4	7

Do not attempt to add sulfur to lower the soil pH if high amounts of calcium carbonate are present. In addition, irrigation water containing high levels of dissolved carbonates can also raise the soil pH and nullify the effects of a sulfur soil amendment.

Before planting a new lawn, incorporate the sulfur amendment into soil to a depth of 6 inches before planting. For established turfgrasses, reduce the rate by half and apply only during spring or fall in conjunction with core aeration, and do not apply more than 5 pounds per 1,000 square feet at any one time.

If applying elemental sulfur to bentgrass putting greens, do not apply more than 2 pounds per 1,000 square feet at any one time. If applying to annual bluegrass putting greens, do not apply more than 0.8 pound per 1,000 square feet at any one time. (Fagerness et al., 1998).

Soil pH can also be adjusted upward with lime if the soil is acidic. Because soils in North Dakota are predominantly alkaline, the necessity to lime the soil to adjust the pH upward is extremely uncommon. Do not use lime to treat dog urine damage in lawns.

Nitrogen

The next box on the soil test report notes (NO_3-N lbs./A), which is pounds of nitrogen (N) per acre in the nitrate form. Although nitrate is immediately available for plant uptake, this number is not really significant to turf managers because nitrate is very mobile in the soil and can move to deeper depths quickly, for example, after a heavy rain. The nitrate value reported represents available nitrogen when the soil samples were taken, and because it's a fluid number, the soil nitrate level can change by the time you get the report back from the lab. Evidence of this would be a yellowing (chlorosis) of older turf blades even though the lab reported an adequate soil nitrate level.

To ensure adequate nitrogen availability for your lawn, we recommend that homeowners apply 1pound N per 1,000 square feet around the summer holidays of Memorial Day, the Fourth of July and Labor Day for a total of 3 pounds of nitrogen per 1,000 square feet per year. The Fourth of July application should be omitted if the lawn is not irrigated or is under drought stress. Furthermore, fertilizer application should not be applied when day temperatures are 85 F or above.

Golf course superintendents often apply as much as 5 to 6 pounds N per 1,000 square feet per year to their greens and fairways because their turf is constantly under stress from foot and vehicular traffic and is maintained at a low mowing height.

Make sure your spreader is calibrated to apply the proper amount of fertilizer per 1,000 square feet. To apply nitrogen, note the first number of the analysis (the three numbers on the front of the fertilizer package represent the percent bag weight of nitrogen, phosphorus and potassium in that order). For example, a 50-pound bag of 29-3-5 fertilizer contains 14.5 pounds of nitrogen per bag (.29 x 50 pounds = 14.5 pounds N). That's enough nitrogen to fertilize 14,500 square feet of turfgrass at 1 pound N/1000 square feet.

Organic Matter

Organic matter is reported as a percent of total soil. The ideal amount of soil organic matter for turf management ranges from 2% to 4%.

About 95% of soil nitrogen is found in the soil organic matter (Soltanpour and Follett, 2007).

Much of this nitrogen, which is part of the organic matter, needs to be mineralized (to nitrate) by soil microorganisms to be available to the grass plants.

About 30 pounds of nitrogen per acre (approximately .7 pound per /1,000 square feet) will be released (mineralized to nitrate) during the growing season from each 1% of organic matter present (Soltanpour and Follett, 2007).

Organic matter also increases the water-holding capacity and the cation-exchange capacity (CEC) of soils. The CEC is a measurement of the soil's ability to hold cations in place and to prevent their loss from leaching and runoff.

Some examples of organic matter that can be incorporated to amend the soil are compost, sphagnum peat moss, leaves, cow manure and green manures. If the soil test reveals that organic matter is low, spread 2 to 4 inches of organic matter on the soil surface and incorporate into the top 6 inches of soil before planting turfgrass seed.

Phosphorus

Phosphorus is reported in parts per million (ppm). In North Dakota, the Olsen test method is used because it is more accurate for alkaline soils.

Phosphorus (P) is essential for healthy turfgrass root development. Unlike nitrogen, phosphorus is relatively immobile in the soil. Movement of phosphorus deeper into the soil profile is extremely slow. Consequently, the risk of overapplication exists and less phosphorus needs to be applied to established lawns.

Overapplication of phosphorus can lead to runoff into rivers, lakes and sloughs, which may promote the rapid growth of dense algal blooms. Large blooms often deplete the oxygen in the water because sunlight cannot reach oxygen-producing aquatic plant life below the water surface. As a result, large numbers of fish may die.

The states of Minnesota and Wisconsin passed laws that restrict the application of phosphorus in lawns. While no such law exists in North Dakota, phosphorus should be used at lower rates.

For established lawns, the addition of phosphorus is usually not necessary unless a soil test shows that it is deficient (Table 2). Lawn fertilizers that are phosphorus-free or have lower concentrations of phosphorus are readily available in North Dakota. Avoid using balanced fertilizers such as 10-10-10 because they contain too much phosphorus. The middle number in the three-number sequence represents phosphorus.

In contrast to established lawns, new lawns benefit from phosphorus fertilization. A soil test is recommended before seeding or sodding to determine if the soil is deficient in phosphorus (Table 3). If no soil test is conducted, a standard rate for new lawns would be 1.0 pound of actual P per 1000 square feet. Starter lawn fertilizers usually contain phosphorus and should be worked into the top 4 to 6 inches of soil before seeding or sodding.

Table 2. Phosphorus fertilizer recommendations for established lawns based on soil test results.

Olsen-P Method (ppm)	Pounds of P_2O_5/1000 sq. ft.
0-7	1.0
8-18	0.5
Over 18	0.0

From University of Minnesota Extension publication, Soil Test Interpretations and Fertilizer Management for Lawns, Turf, Gardens, and Landscape Plants, 2008.

Table 3. Phosphorus fertilizer recommendations for new lawns based on soil test results.

Olsen-P Method (ppm)	Pounds of P_2O_5/1000 sq. ft.
0-7	5.0
8-18	2.0
Over 18	1.0

Incorporate the phosphorus into the top 4-6 inches of soil before seeding or laying sod. From University of Minnesota Extension publication, Soil Test Interpretations and Fertilizer Management for Lawns, Turf, Gardens, and Landscape Plants, 2008.

Potassium

Potassium (K) is reported in parts per million (ppm) and is an essential component in regulating cellular electrical and water balance and controlling stomatal closure. It's also used as a catalyst in many chemical reactions inside and outside of the plant cells. As with phosphorus, the amount required varies among soil types and maintenance regimes (Table 4).

Table 4. Potassium fertilizer recommendations for established turfgrass based on soil test results.

Soil Test Available K (ppm)[b]		Pounds K_2O/1,000 sq. ft./year[a]		
		General Turf[c]	High Maintenance Turf[d]	New Lawns[e]
0-50	Low	3	4	6
51-100	Medium	2	3	4
101-150	High	1	2	2
Over 150	Very High	0	0	0

Modified from University of Minnesota Extension publication, Soil Test Interpretations and Fertilizer Management for Lawns, Turf, Gardens, and Landscape Plants, 2008.

[a] Do not apply more than 1.5 pounds K^2O per 1,000 square feet to established turf at any one time.

[b] Ammonium acetate test method

[c] Assumes that lawn clippings are not removed

[d] Assumes that lawn clippings are removed

[e] Incorporate potassium into the soil before seeding or sodding new lawns

Soluble Salts

Electrical conductivity (EC), reported in millimhos per centimeter (mmhos/cm), is a unit of conductivity and indicates the amount of water-soluble salts in the soil extract. Soil EC can range from 0 to 50 mmhos/cm (seawater). An increase in EC or mmhos/cm represents an increase in soil salt content. Table 5 provides the EC threshold number for various turfgrass species managed in North Dakota.

Table 5. Electrical conductivity threshold numbers for various turfgrasses managed in North Dakota.

Turfgrasses	Soluble Salts (EC or mmhos/cm)
Annual bluegrass	<3
Kentucky bluegrass	<4
Crested wheatgrass	<4
Red fescue	<4
Alkaligrass	3 to 4
Fairway wheatgrass	4 to 8
Tall wheatgrass	4 to 8
Tall fescue	4 to 8
Perennial ryegrass	4 to 8
Creeping bentgrass	3 to 16*

*Salt-tolerance varies widely among creeping bentgrass cultivars.

**The EC levels are determined by the saturated paste extract.

Soil salinity in eastern North Dakota can be caused by poor-quality irrigation water, lack of precipitation and capillary wicking from a high water table. Soils in western North Dakota tend to be saline because of low precipitation and because the local soil parent materials are of old marine origin. Not enough rain water is available to leach the salts from the surface soil (commonly 0 to 12 inches) to the deeper depths where most plant roots do not grow.

Upward (capillary) wicking of groundwater is the primary cause of soil salinity in eastern North Dakota. The eastern part of the state has a high water table; in some areas, it is as shallow as 3 feet below the soil surface. The shallow water table rises during heavy rain events, bringing salts up to the soil surface. After the rain stops, the water table recedes, but the salts remain at or below the soil surface due to water evaporation from the surface. Soils high in clay can wick water from water tables up to 6 feet below the soil surface.

Irrigation with water containing salts also can cause soil salinity. Many groundwater irrigation sources are saline, and excessive irrigation with these water sources can create salinity problems.

The easiest way to remediate a saline soil is to leach it with good-quality water (low in dissolved salts and sodium). However, this simple remedy may not be possible if good-quality water is not available at the problem site. Refer to Table 6 for the amount of good-quality water required to leach a saline soil of accumulated salt.

Do not incorporate gypsum to remediate soil salinity. Gypsum is a salt of low solubility and should be used only to remediate sodic or saline-sodic soil conditions. Please contact your local NDSU Extension agent for more information on sodic soils.

Table 6. The amount of good quality water needed to leach salt through 1 foot of saline soil.

Amount of good-quality water needed	Reduction in salt content*
6 inches	50%
12 inches	80%
25 inches	90%

*Although accumulated salts can be leached from the soil with good-quality water, saline conditions will return quickly after a heavy rain if wicking of salt from a high water table is the usual cause.

Zinc

Zinc, reported in parts per million (ppm), is rarely deficient in turf. A number below 1 ppm is considered low. If a deficiency occurs, elemental zinc (Zn^{2+}) can be applied as a minor nutrient application. Minors consist of the following essential nutrients: boron (B), chlorine (Cl), copper (Cu), iron (Fe), nickel (Ni), manganese (Mn), molybdenum (Mo) and zinc (Zn). They are required by the plant in lesser amounts. If a minor nutrient is added to a plant fertilizer, it is listed as a fourth number in the analysis and often followed by the element's symbol in parenthesis.

Zinc excess or toxicity on turf is more common than deficiencies, especially if sewage sludge composts containing high levels of zinc are applied as a fertilizer.

Iron

Iron, reported in parts per million (ppm), is plentiful in our soil but often deficient in turfgrass and other ornamental plants because it often becomes unavailable in alkaline soil.

Iron (Fe) is an element found in several primary plant molecules, including chloroplasts and hemoglobin, which are responsible for photosynthesis and oxygen transport respectively. The NDSU Soil Testing Lab uses the diethylenetriaminepentaacetic acid (DTPA) extraction method. According to that method, a test result at or less than 2.5 ppm is considered to be low, 2.6 to 5 ppm is considered medium and greater than 5 ppm is high (sufficient) (Carrow et al., 2001a).

Iron-deficient turfgrass has a mottled, yellowish/greenish (chlorotic) appearance, compared with a nitrogen-deficient turf, which is uniformly yellowish/greenish across the turf canopy.

For iron-deficient turf, a foliar application of actual iron is inexpensive and will be absorbed by the turf blades. It can be applied at 0.012 to 0.024 pound per /1,000 square feet in 1 to 5 gallons of water as often as needed (Carrow et. al, 2001b). Apply foliar iron applications when the weather is cooler and avoid applications when the turf is under heat or drought stress because the grass can burn.

Also avoid foliar applications if rain is imminent. Do not irrigate for three to four hours afterward to allow the leaves to absorb the iron.

You also can use iron sulfate granules at 0.25 pound iron per 1,000 square feet. Green-up should occur in 24 to 48 hours and last about two weeks.

If liquid or granular iron products are applied to concrete or paved surfaces, staining may occur. If accidental contact occurs, immediately rinse the pavement with water to prevent staining.

If the soil pH is greater than 7.2, use an iron chelate product with the Fe-EDDHA formulation. Several EDDHA [ethylenediamine-N,N'-bis (2-hydroxyphenylacetic acid)]-based products such as Sequestar 6% are available at garden centers and online outlets and can be applied by homeowners to treat iron-deficient turf.

The only method to remediate the primary causes of an iron-deficient soil is to acidify it with sulfur. Refer to the sulfur section and Table 1 of this publication for rates.

Kentucky bluegrass can appear to be chlorotic after green-up in early spring in North Dakota because the roots are too cold to absorb an adequate amount of iron. You don't need to apply iron at that time. The turf will green up uniformly once the soil warms to 50 to 55 F.

Manganese

Manganese is reported in parts per million. The optimal soil range is 1 to 2+ ppm. Manganese deficiencies are rarely observed in North Dakota.

Like iron, manganese (Mn) is an element involved in the synthesis of chlorophyll. Turfgrass will become chlorotic while subjected to a Mn deficiency because it will cause a disruption of the photosynthetic process, which leads to yellowing of the leaf tissue. Deficiencies can occur on alkaline soils with a high pH.

Manganese can be applied as a granular fertilizer or a fertilizer minor. Manganese also can be applied in a liquid foliar formulation. Apply manganese sulfate monohydrate ($MnSO_4$-H_2O) at 0.025 pound actual Mn per 1,000 square feet in 1 to 3 gallons of water (Carrow et. al, 2001c).

Copper

Copper is reported in ppm. Most soils typically contain between 1 and 40 ppm of total copper. The NDSU Soil Testing Lab uses the DTPA extraction method to detect copper micronutrient availability. If the amount of available copper in the soil is less than 0.2, it is considered low; if it is 0.2 to 0.4, it is considered medium; and if it is greater than 0.4, it is high.

If a deficiency is detected, apply a foliar application at 0.13 pound per acre or 0.003 pound per/1,000 square feet.

Copper is used for chlorophyll formation and also catalyzes several chemical reactions. Deficiencies are uncommon but can occur on heavily leached sands and organic soils because of strong binding sites that fix the copper molecules, making them unavailable for root uptake (Carrow et. al, 2001d).

To avoid toxic levels, do not apply copper unless a true deficiency has been identified. Copper toxicity can hinder the turf's ability to absorb iron and cause chlorotic conditions. Apply a foliar treatment to a small area and observe the response for a week before treating the entire site.

Sulfur

The NDSU Soil Testing Lab reports sulfur in pounds of sulfur per acre in the sulfate (SO_4) form. The lab uses calcium phosphate ($Ca(H_2PO_4)_2$) to extract sulfate from the soil. Therefore, a moderate range would be 20 to 40 pounds per acre (.46 to .92 pound per 1,000 square feet) (Carrow and Duncan, 2011).

Sulfur's primary role in plants is in the formation of cysteine and methionine, two amino acids that are required in many physiological functions and chemical reactions.

(iStock.com photo)

The Clean Air Act and subsequent amendments to that law imposed reductions on sulfur dioxide (SO_2) emissions. Prior to the Clean Air Act, soil sulfur deficiencies were considered rare in the U.S. except on sandy soils.

At that time, many industries in the U.S. burned high-sulfur fossil fuels, especially in coal-burning power plants and smelting plants. The heavy sulfur dioxide emissions from these industries settled to the Earth's surface during rainfall in amounts that exceeded the demands of turfgrass (Christians, 2011).

The new federal regulations require fossil fuel-burning industries to reduce sulfur dioxide emissions by employing a number of strategies, including the installation of more efficient lime scrubbers in their smokestacks to reduce ozone-depleting gas emissions, including sulfate and sulfur dioxide, into the atmosphere.

Sulfur dioxide deposition in North Dakota within recent years has ranged as low as 0.036 to 0.045 pound per 1,000 square feet (National Atmospheric Deposition Program, 2016). Therefore, sulfur applications may be required in North Dakota to prevent deficiencies.

Elemental and other reduced forms of sulfur must be oxidized by soil microbes into sulfate before it is available for root uptake. This oxidation may take a year or more. Therefore, sulfate fertilizers such as ammonium sulfate ($(NH_4)_2SO_4$), potassium sulfate (K_2SO_4) or magnesium sulfate ($MgSO_4$) should be applied to treat a sulfur deficiency because they are immediately available to the turf.

An application of 0.5 to 2 pounds of granular sulfur per year per 1,000 square feet is usually sufficient. A foliar application of 0.05-pound S (as K_2SO_4) in 3 to 5 gallons of water per 1,000 square feet also may be used. The application of sulfur should provide a greening response within one to three days if it is deficient (Carrow et al, 2001e).

Chloride

The NDSU soil test analysis reports chloride (Cl) in pounds per acre. Chloride is involved in cell multiplication in leaf tissue and water splitting during the photosynthetic process.

It is required in concentrations 100 ppm (microgram/ kilogram) or less in plant dry weight tissue. Because the required levels are so low, deficiencies in turf are almost nonexistent. The required amount is typically provided by rain.

Draining chlorinated swimming pool water on your lawn is unlikely to damage turfgrass or provide any beneficial effects.

Reference Sources

Carrow, R.N., and R. Duncan. 2011. Best management practices for saline and sodic turfgrass soils: Assessment and reclamation. p. 79. CRC Press, Boca Raton, Fla.

Carrow, R.N., D.V. Waddington and P.E. Rieke. 2001a. Turfgrass soil fertility and chemical problems. p. 251. Wiley, Hoboken, N.J.

Carrow, R.N., D.V. Waddington and P.E. Rieke. 2001b. Turfgrass soil fertility and chemical problems. pp. 354-355. Wiley, Hoboken, N.J.

Carrow, R.N., D.V. Waddington and P.E. Rieke. 2001c. Turfgrass soil fertility and chemical problems. p. 253. Wiley, Hoboken, N.J.

Carrow, R.N., D.V. Waddington and P.E. Rieke. 2001d. Turfgrass soil fertility and chemical problems. p. 251. Wiley, Hoboken, N.J.

Carrow, R.N., D.V. Waddington and P.E. Rieke. 2001e. Turfgrass soil fertility and chemical problems. p. 242. Wiley, Hoboken, N.J.

Christians, N.E. 2011. Fundamentals of turfgrass management. p. 163. Wiley, Hoboken, N.J.

Fagerness, M., S. Keeley and D. Whitney. 1998. A guide to turfgrass nutrient recommendations. Kansas State University Cooperative Extension bulletin MF-2311.

National Atmospheric Deposition Program. 2016. http://nadp.sws.uiuc.edu/data/NTN/

Rosen, C.J., P.M. Bierman, and R.D. Eliason. 2008. University of Minnesota Extension. https://conservancy.umn.edu/handle/11299/49265

Soltanpour, P.N., and R.H. Follett. 2007. Soil test explanation. Colorado State University Cooperative Extension Service. http://extension.colostate.edu/topic-areas/ agriculture/soil-test-explanation-0-502/

(NDSU photo)

Homeowners and turfgrass managers can use this publication to clarify the soil test results for the purpose of establishing and maintaining a healthy lawn.

Published with support from the
NDSU Extension Master Gardener program.

For more information on this and other topics, see www.ag.ndsu.edu