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Fertilizing Malting and Feed Barley

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Barley

has been an important cash and rotational crop in North Dakota and the region for many years. It is important as a feed grain, but by far, its economic value is linked to the malting industry.

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Barley requires adequate nitrogen (N) for good yields, but because grain protein in excess of industry limits often results in rejection of the crop as malting grade, and because excess N may lead to smaller kernel size, the line between adequate N and excessive N is fine. In addition, excessive N may result in lodging, which lowers yields and increases the incidence and severity of fusarium head blight (scab) and other diseases in some years.

Due to the irregularity of rainfall in the region, a preplant N application is important to feed the crop adequately through its short growing season. All of the N intended for the barley crop should be applied preplant. Top-dressing N after crop establishment is discouraged because it contributes more to increased grain protein than increased yield.

Once the N application is made, managing the crop for high yield is important. Although yield is most directly related to temperature, soil moisture and rainfall within a growing season, growers have a number of important management factors that influence yield in any given year.

High fertilizer application will not push yield higher than the environment and management decisions allow. Also, yield and the N rate are not related between environments, so instead, fertilizer rates are based on the rate that maximizes yield/quality in any given year, and not on yield prediction.

Feed barley rates are higher than those intended for malting contracts, which are more conservative due to the importance of lower protein.

Date of Planting

Research at NDSU has shown that seeding barley early is extremely important to achieving the highest yield for the season. Seeding before May 15 provides the greatest chance of achieving malting grade south of Highway 2; the optimum date for northern-tier county growers is May 25.

Seeding two weeks later than these dates results in almost no chance of achieving malting grade unless N rates are greatly reduced. Very low yields that result from late planting and low N rates are not economically acceptable to most growers.

Seeding Rate

An adequate seeding rate with an approved malting barley variety is important for growing and marketing the crop effectively. Current barley seeding rates are 1.5 to 2 bushels per acre (65 to 90 pounds live seed per acre).

Growers would be advised to determine the number of seeds per pound and germination percentage to provide a more accurate seeding rate. The target plant population is 1.25 million to 1.30 million plants per acre, or approximately 30 plants per square foot.

Other Management Tools

Controlling insects, weeds and diseases adequately is important for successful malting barley, or even good-quality feed barley, production. NDSU has a variety of publications to help producers with these decisions. The publications are available from NDSU Extension county offices or from the NDSU Extension publications website at *www.ag.ndsu.edu/publications/crops*.

Abandonment of Yield Goal as a Consideration of Fertilizer Rate

The most important reason for abandoning yield goal as a consideration in fertility recommendations is that the data from modern fertilizer rate trials indicate that a similar rate of nutrient results in the highest yield regardless of the maximum yield in any experiment. In other words, the rate of nutrient resulting in the highest yield in a low-yield environment was similar to the rate that resulted in the highest yield in a high-yield environment.

A logical way to explain this is that in a low-yield environment resulting from too wet or too dry conditions, nutrient use efficiency is quite low, so a greater rate of nutrient is required to produce a unit of yield. In a high-yield environment, nutrient use efficiency is quite high as release from the soil is maximized, root growth is maximized and the movement of nutrient to the root is maximized, so a lower rate of nutrient is required to produce a unit of yield.

Therefore, the recommended N-rate table values should be utilized regardless of what yield a grower believes will result from the barley cultivation.

Nitrogen Rate Adjustments

The total N requirements for 6-row barley production are indicated in **Tables 1-6**. Total N requirements are the sum of residual nitrate-N soil analysis to 2 feet in depth, previous crop credits **(Table 7)** and an adjustment for six years or more of continuous no-till/one-pass seeding.

Soil sampling usually is conducted the fall before planting, although early spring sampling also can be conducted. Neither time is superior to the other in terms of the nitrate-N values it will generate. Site-specific zone soil sampling may help reduce over- or underfertilization in areas of the field, compared with a composite soil sampling approach.

The adjustment for long-term no-till production is due to an apparent decrease in the N rate required for maximum yields in spring wheat, corn and sunflower research conducted at NDSU during the past 10 years. In fields that are transitioning to no-till or are no-till during only part of the rotation, an additional 20 pounds of N per acre would be required to overcome the tie-up of N by residue before soil microbial communities convert to a more efficient N cycling system.

The N rates for yield and to achieve malting grade protein of less than 14 percent are more conservative than for barley grown for feed. For six-row barley, the crop needs to be slightly N deficient to achieve malting grade protein. For two-row barley, N rates can be slightly greater.

In drought years, the chances of making malting grade protein are low because any beginning residual nitrate, along with the most conservative N rates, will result in higher protein barley.

The alternative to recommended N rates applied at planting in a year with limited spring subsoil moisture is to split the N required, with perhaps applying half the N rate by seeding, then guessing on what rainfall might be received the next six weeks and Applying the other half of the recommended N. Apply less or no additional N if the outlook for rainfall during the next 30 days is bleak.

No additional N should be applied after five-leaf stage in barley because a great share of the application will produce more protein than grain.

2-Row Barley N Rate Adjustment

Recently, the malting industry has moved greatly from 6-row barley cultivars to 2-row. The 2-row cultivars tend to naturally have less protein in the grain compared to 6-row cultivars and require less N. If 2-row barley cultivars are grown, reduce N rates in Tables 1-7 by 10 percent.

All tables are on Pages 4 and 5

Table 1. Barley malting grade in **cooler, moister regions** in North Dakota in conventional tillage systems.

	Soil Test P, ppm					Soil Test K, ppm				
Total available N*	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 151+
pounds per acre	Pounds P_2O_5 per acre					Pounds K_2O per acre				
150	78	60	52	26	0	90	60	45	30	0

* Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources.

Table 2. Barley malting grade in **cooler, moister regions** in North Dakota in long-term no-till systems (6 years or more continuous no-till).

	Soil Test P, ppm					Soil Test K, ppm				
Total available N*	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 151+
pounds per acre	Pounds P_2O_5 per acre					Pounds K_2O per acre				
120	78	60	52	26	0	90	60	45	30	0

* Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources.

Table 3. Barley malting grade in **warmer, drier regions** in North Dakota in conventional tillage systems.

	Soil Test P, ppm					Soil Test K, ppm				
Total available N*	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 151+
pounds per acre	Pounds P_2O_5 per acre					Pounds K_2O per acre				
100	78	60	52	26	0	90	60	45	30	0

* Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources.

Table 4. Barley malting grade in **warmer, drier regions** in North Dakota in long-term no-till systems (6 years or more continuous no-till).

	Soil Test P, ppm					Soil Test K, ppm				
Total available N*	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 151+
pounds per acre	Pounds P_2O_5 per acre					Pounds K_2O per acre				
70	78	60	52	26	0	90	60	45	30	0

* Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources.

Table 5. Barley feed grade in North Dakota in **conventional** tillage systems.

	Soil Test P, ppm					Soil Test K, ppm				
Total available N*	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 151+
pounds per acre	Pounds P_2O_5 per acre					Pounds K_2O per acre				
150	78	60	52	26	0	90	60	45	30	0

* Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources.

Table 6. Barley feed grade in North Dakota in **no-till** systems.

	Soil Test P, ppm					Soil Test K, ppm				
Total available N*	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 151+
pounds per acre	Pounds P_2O_5 per acre					Pounds K_2O per acre				
120	78	60	52	26	0	90	60	45	30	0

* Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources.

Table 7. Previous Crop Credits

Previous crop	Credit
Soybean	40 lb. N/acre
Dry edible bean	40 lb. N/acre
Other grain legume crops (field pea, lentil, chickpea, faba bean, lupin)	40 lb. N/acre
Harvested sweet clover	40 lb. N/acre
Alfalfa that was harvested and unharvested sweet clover:	
>5 plants/sq. ft.	150 lb. N/acre
3 4 plants/sq. ft.	100 lb. N/acre
1 2 plants/sq. ft.	50 lb. N/acre
<1 plant /sq. ft.	0 lb. N/acre
Sugar beet	
Yellow leaves	0 lb. N/acre
Yellow/green leaves	30 lb. N/acre
Dark green leaves	80 lb. N/acre

Second-year N Credits

Half of the N credit indicated for the first year for sweet clover and alfalfa is recommended, but no N credit is recommended after the second year for other crops.

Table 8. Maximum N + K_2O recommended for application with the seed based on planter row spacing, planter type and seed spread. This table assumes a coarse-textured soil for the lower end of each range and a heavier texture for the upper end of the range.

For more detail, see NDSU Extension publication "Fertilizer Application With Small-grain Seed at Planting" *(www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1751.pdf).*

		Planter Spacing, inches			
Planter type	Seed Spread	6	7.5	10	12
	inches	pound N + K_2O per acre			
Double disc	1	20-30	19-28	17-23	15-20
Hoe opener	2	32-44	27-38	23-31	20-27
	3	44-58	37-48	30-40	26-34
Air seeder	4	56-72	46-58	37-48	32-42
	5	68-86	56-68	51-55	38-49
	6	80-100	66-79	58-74	44-56
	7		76-90	66-83	50-64
	8			73-92	56-71
	9			80-100	62-78
	10				68-86
	11				74-93
	12				80-100

Nitrogen Application Methods

Nitrogen can be applied with the seed at planting as long as it does not exceed the limits recommended in **Table 5**. For more detailed charts that include variation in soil texture and soil moisture, refer to the NDSU Extension publication "Fertilizer Application With Small-grain Seed at Planting" at *www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1751.pdf*.

Some growers also use a midrow band application of anhydrous ammonia, urea or nitrogen solutions successfully. As long as seed and fertilizer are separated by at least 1½ inches for urea and nitrogen solutions, and separated laterally by at least 3 inches for anhydrous ammonia, reasonable rates of nitrogen can be applied safely.

Fall application has been used successfully when the application is made after Oct. 1, and only when soil temperatures have dropped below 50 F in the morning at the 4-inch depth. Fall application should not be made to sandy soils, nor should it be made to heavier soils that are prone to early spring saturation.

Nitrapyrin and DCD are the two chemistries that have nitrification-inhibiting properties in NDSU research. For a full description of the chemistry and properties of nitrification inhibitors, see the NDSU Extension publication "Nitrogen Extenders and Additives for Field Crops" at *www.ag.ndsu.edu/publications/crops/nitrogen-extenders-and-additives-for-field-crops/sf1581.pdf*.

Surface application of urea is not generally desirable unless the urea will be incorporated within 48 to 72 hours, depending on weather conditions. Adequately incorporating urea in low-residue situations requires a steady ½ to ¾ inch of rainfall. Under no-till, more rainfall may be needed to incorporate the urea.

Under no-till, subsurface application at a 2-inch depth of more urea or nitrogen solutions containing urea is strongly recommended because the conversion from urea to free ammonia is very fast when residues are present. Some evidence shows that shallow (1 inch) incorporation of urea may be worse than no incorporation.

A urease inhibitor containing an effective rate of NBPT or NBPT/NPPT essentially will inhibit ammonia volatility for about 10 days. For more information regarding urease inhibitors, refer to "Nitrogen Extenders and Additives for Field Crops" *(www.ag.ndsu.edu/publications/crops/nitrogen-extenders-and-additives-for-field-crops/sf1581.pdf)*.

Phosphorus Application

Banding phosphorus (P) with or near the seed in barley at planting is very important for highest yield and P use efficiency. If the rate of P recommended exceeds the $N+K_2O$ limit recommended in **Table 8**, the P fertilizer may be split, with some applied as a band and some as a broadcast application.

Phosphorus application is most efficient and results in the highest yield and economic returns if banded near or with the seed. If phosphorus is banded near or with the seed, rates at the VL and L level soil test P levels can be reduced by one-third, compared with chart rates in **Tables 1-4**.

Limits have been placed on the amount of fertilizer that can be applied safely with the seed. The restrictions have more to do with the ammonium-N content of the fertilizer than with the salt-index, although fertilizer salt still needs to be considered.

For an abbreviated chart of the maximum urea-N fertilizer rates recommended with barley seed at planting, see **Table 5**. For a more detailed chart that includes variation in soil texture and soil moisture, refer to the NDSU Extension publication "Fertilizer Application With Small-grain Seed at Planting" *(www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1751.pdf)*.

Potassium/Chloride Application

Potassium may be required for some sandy soils, but the main reason for its application is as a carrier for chloride. Potassium chloride is approximately 50 percent chloride (Cl). The indicator for the need of chloride is a soil test from 0 to 2 feet in depth. If soil levels are below 30 pounds per acre Cl, then an application of 10 to 20 pounds of Cl per acre might result in an increase in yield and some additional tolerance to certain soil and leaf diseases.

This will not be a substitute for a needed fungicide application later in the season. Banding the Cl is not necessary, but if the other fertilizer is being banded, and the addition of the fertilizer does not result in exceeding the $N+K_2O$ limit in **Table 6** or the NDSU Extension publication "Fertilizer Application With Small-grain Seed at Planting" *(www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1751.pdf)*, then banding may provide convenience to the grower.

Research in North Dakota has shown a yield increase, mostly due to larger kernel size, about half of the time when soil levels are low. Increased kernel size is important in malting barley because kernel "plump" is a category considered by the malting industry for contract acceptance of grain.

Sulfur and Micronutrient Requirements

Sulfur (S) deficiencies are more common throughout North Dakota than in the past due to higher crop demand from higher yield, increased rainfall in many years and low S deposition from rainfall. No soil test is diagnostic for S availability.

Sulfur deficiency also has been observed on higher organic-matter soils in addition to lower organic-matter soils, and in higher clay soils as well as sandy soils. If a field going to barley was wet the fall before, and/or snowfall has been normal to high and/or pre-seeding spring rainfall has been high, producers should consider applying 10 pounds per acre of S as a sulfate or thiosulfate form before or at seeding.

Thiosulfate forms should not be placed with the seed. Ammonium sulfate may be applied as long as the limits outlined in **Table 5** are considered. No micronutrients other than chloride need to be considered for barley production in North Dakota.

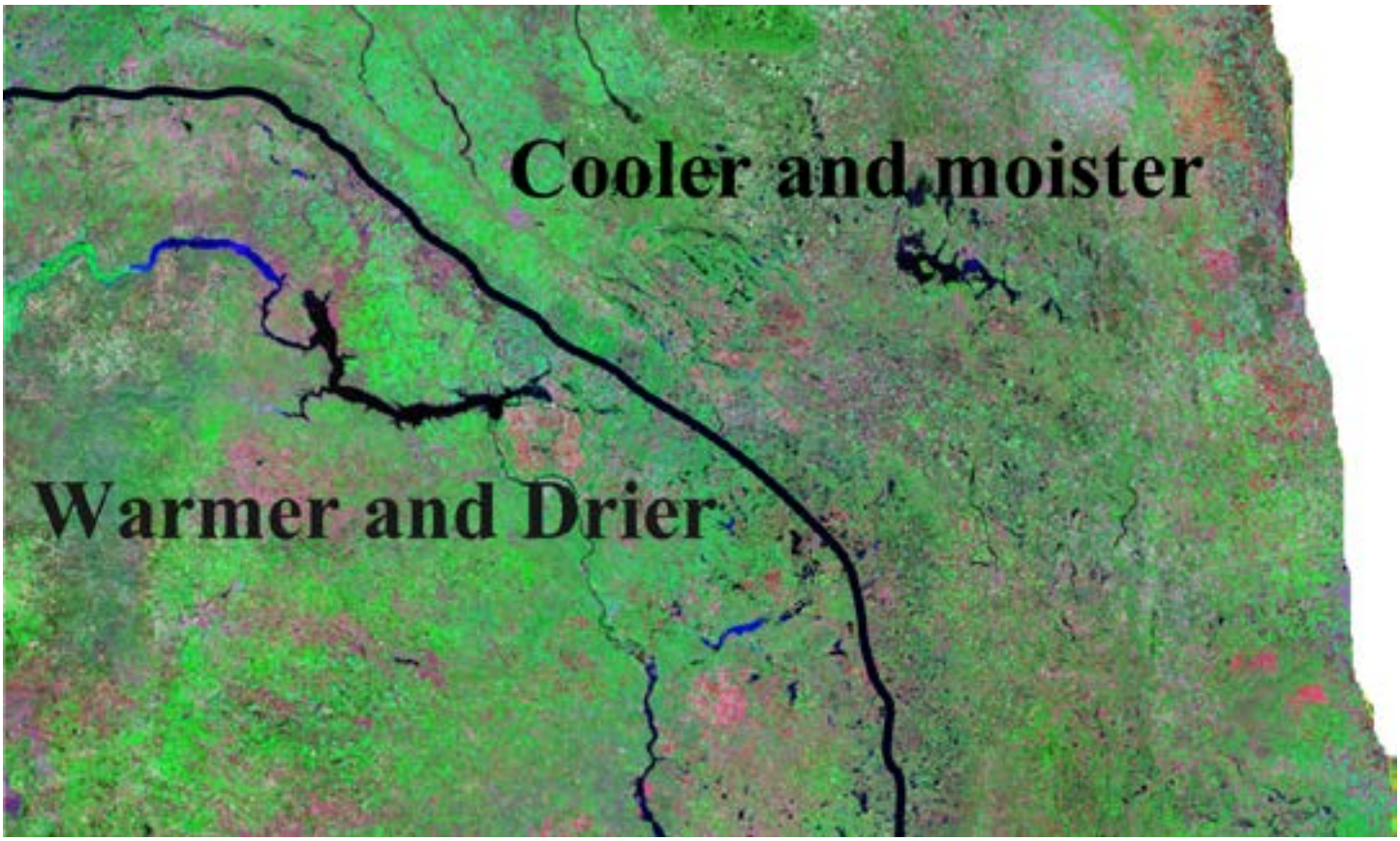

Figure 1. General climatic delineation between cooler and moister areas and warmer and drier areas in North Dakota. In a given year, the line separating the two regions may move considerably east or west.

For use with Tables 1-4. (Image courtesy of NASA, Angela King, image compiler, and Hobart King/Geology.com, publisher).

All photos courtesy of Richard Horsley, NDSU Barley Breeding Program

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

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