Malting Barley

Crop Highlights

- Target pH: 6.0
- Split nitrogen (N) application to increase N-use efficiency in wheat. Apply a small amount of N (20 to 30 lb/ac) at planting or in late winter and the bulk of the N requirement in two applications in early Spring. Apply the first when growth resumes in the spring and the second at Feekes' growth stage 5.
- Use the fall soil nitrate test (FSNT) to determine whether the fall application of N can be reduced or eliminated.
- Excessive N application can result in high protein content, which causes problems during the malting process. Protein content in malting barley should be between 9.0 and 12.5%. As such, spring N rates are slightly lower for malting barley than for feed barley.
- Soil test more frequently when straw is removed from the field since soil P and K may decrease more rapidly than when straw is left behind to decompose.
- Monitor crop for manganese (Mn) deficiency, **especially** when soil test Mn is less than 3.4 lb/ac.

Yield Goal

Malting barley yields are influenced by many factors, including the cultivars selected, planting date, winter weather, soil type and water-holding capacity, nutrient and water availability, weed, insect and disease pressure, and crop management practices. **On most Delaware soils, typical malting barley yields range from 60 to 90 bu/ac in a good to average year. Typical yields range from 85 to 150 bu/ac when grown on black soils (>6% organic matter) or silt loams, or when irrigation is used.**

Delaware growers should use field history to determine the yield goal for each field and use that information to adjust management decisions and fertility programs accordingly. Delaware nutrient management law requires the use of optimal rolling average for determining the yield goal for a specific field when field history is available. To calculate the optimal rolling average yield, see University of Delaware Extension Fact Sheet ***Estimating Yield Goal for Crops***.

Soil pH and Liming

Target pH: 6.0 for most soils

Soils that are high in organic matter (e.g., "black" soils; soil organic matter >6.0%) have a lower target pH (5.6) because organic matter moderates some of the negative effects of excessive soil acidity (e.g., aluminum toxicity).

The lime recommendation for a specific field is calculated from the soil pH and Adam-Evans buffer pH measurements using the steps outlined in University of Delaware Extension Fact Sheet ***Calculating the Lime Requirement Using the Adams-Evans Soil Buffer***. Avoid over-liming to prevent deficiency of micronutrients such as manganese (Mn).

The recommended liming source is dependent upon Mehlich-3 (M3) soil test calcium (Ca) and magnesium (Mg) reported in University of Delaware fertility index value (FIV) and can be determined using Table 1.

Table 1. Recommended type of lime as a function of Mehlich-3 soil test calcium and magnesium concentrations.

Soil Test Levels	Recommended Lime Type
M3-Mg is less than 50 FIV	Dolomitic
M3-Mg between 50 and 100 FIV AND M3-Mg is less than M3-Ca	Dolomitic
M3-Mg greater than 100 FIV	Calcitic
M3-Mg is greater than 50 FIV AND M3-Mg is greater than M3-Ca	Calcitic

Nitrogen

The University of Delaware recommends a total nitrogen (N) rate of 60 to 90 lb/ac per growing season for malting barley. The higher end of the range should be used for sandy soils or for management systems where a single N application will be made to compensate for higher leaching losses. In general, increasing N rate may increase grain production, but it may also increase lodging, which can reduce harvestable and economic yield. Split N applications can increase N use-efficiency, thus requiring less total N to achieve the same grain yield. For best results, N should be split into two or more applications. Effective N management for malting barley is facilitated by soil and plant tissue sampling to ensure enough N to produce a healthy crop, but also to limit yield penalizing effects (e.g., disease and lodging) and leaching losses.

A small amount of N (up to 30 lb/ac) should be applied in the fall or in late winter to promote root growth and fall tillering. Avoid applying more than 30 lb/ac N in the fall, as plants with excessive fall growth are susceptible to disease and winter kill; fall N applications are also susceptible to leaching below the root zone. A fall soil nitrate test (FSNT) run on a 6-inch composite soil sample is recommended to determine if enough soil N remains to reduce or eliminate the fall N application as follows:

- **NO_3-N <22 lb/ac:** Apply N at 20-30 lb/ac to establish the crop
- **NO_3-N >22 lb/ac:** No N fertilizer is needed to establish the crop

Spring N requirements for malting barley are slightly lower than for feed barley to prevent grain protein content from rising above 12.5%. High protein content causes problems during the malting process and therefore, grain with high protein is likely to be rejected. The University of Delaware recommends that growers monitor protein content and adjust N fertility in subsequent growing seasons as needed.

The remainder of the total N requirement should be applied in the spring in two applications. The first application should be made at “green up”, i.e., when growth resumes (approximately Feekes’ growth stage 3) in the spring, based on tiller density measurements as described in Table 2. Do not exceed 40 lb/ac N at this stage if planning a second spring N application.

Table 2. Nitrogen rate recommendations for early spring “green up” application to malting barley at Feekes’ growth stage 2-3.

	Tiller Density (tillers/ft^2) at Feekes’ 2-3				
	<50	75	100	125	>150
lb N/ac	40	30	20	10	0

Make the second spring application just prior to the period of rapid N uptake at Feekes' growth stage 5 (stem elongation) based on results of a whole plant tissue test as described in Table 3. Cut the whole plant ½ inch above the soil line at Feekes' 5 growth stage and submit to a reputable lab for analysis. Do not exceed 80 lb/ac N at this stage, as it increases the risk of high protein content and lodging.

Table 3. Nitrogen rate recommendations for second spring application to malting barley at Feekes' growth stage 5.

	Percent N in Tissue from Whole Plant Sampled at Feekes' 5				
	<2.50	**2.75**	**3.00**	**3.25**	**>3.5**
lb N/ac	80	60	40	20	0

When planting into fields where manure has been applied, determine the plant available N (PAN) for the manure application and reduce fertilizer N rates as appropriate.

Phosphorus

Table 4. Broadcast phosphorus application rates for malting barley.

	M3-P (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb P_2O_5/ac	140	120	100	80	60	40	30	30	30	20	20

1. If M3 soil test phosphorus (M3-P) is "Low" (e.g., 25 FIVs or less), broadcast and plow down the recommended rate of phosphate prior to planting in the fall.
2. If M3 soil test P is "Medium or "Optimum" (e.g., 26 to 100 FIVs), phosphate can topdressed in the fall or the spring.
3. If M3 soil test P is "Excessive" (e.g., greater than 100 FIVs), the application of phosphorus in fertilizers or manures is NOT RECOMMENDED.
4. Soil test P may decline more rapidly when straw is removed than when straw is left behind as stubble since P removal from the site is greater. Growers may wish to soil test more frequently to monitor changes in soil test P when straw is removed.

Potassium

Table 5. Recommended potassium application rates for malting barley.

	M3-K (FIV)										
	0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
lb K_2O /ac	140	120	100	80	60	40	30	30	30	20	20

1. Broadcast and incorporate or band potash prior to planting.
2. For banded applications, reduce the rates in Table 5 by one-half.
3. To avoid salt injury to seedlings, do not band more than 75 lb K_2O/ac at planting. When N and K_2O are banded together, the sum of the N rate and the K_2O rate should not exceed 75 lb/ac.
4. Soil test K may decline more rapidly when straw is removed than when straw is left behind as stubble since K removal from the site is greater. Growers may wish to soil test more frequently to monitor changes in soil test K when straw is removed.

Magnesium

Table 6. Recommended application rates of soluble magnesium as a function of soil test magnesium.

Soluble Mg	M3-Mg (FIV)								
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**
lb soluble Mg/ac	80	70	60	50	40	30	20	10	0

1. Magnesium (Mg) is recommended when M3 soil test Mg is less than 40 FIV.
2. If M3 soil test Mg is less than 40 FIVs and lime is recommended, use dolomitic limestone.
3. If M3 soil test Mg is less than 40 FIVs and lime is not needed, apply soluble Mg according to the rates in Table 6.

Manganese

Manganese (Mn) needs are predicted by an availability index that includes M3 soil test Mn and soil pH. Interpretation is crop specific.

$$\text{MnAI} = 101.7 - (15.2 \times \text{soil pH}) + (2.11 \times \text{M3-Mn})$$

Where:

MnAI = Mn availability index
Soil pH = Soil pH measured in water (1:1 V:V)
M3-Mn = Mehlich 3 soil test Mn in lb/ac

Table 7. Interpretation of manganese availability index.

Mn Availability Index	Interpretation
Less than 25	Mn deficiency is likely at this soil pH and soil test Mn concentration
25 to 35	Mn deficiency is possible at this soil pH and soil test Mn concentration. Monitor the crop for symptoms, especially if liming has been recommended.
Greater than 35	Mn deficiency is unlikely.

1. If Mn deficiency is predicted or was observed in the previous growing season, broadcast 20 to 30 lb/ac elemental Mn.
2. In some cases, broadcast applications of acid forming fertilizers may correct Mn deficiency without the application of Mn; however, acid-forming fertilizers may be less effective than Mn fertilizers.
3. If Mn deficiency symptoms appear during the growing season or after an application of lime, a foliar application of Mn sulfate or Mn oxide at a rate of 1.0 to 2.0 lb/ac elemental Mn or chelated Mn (Mn-EDTA) at a rate of 0.5 to 1.0 lb/ac elemental Mn can alleviate the symptoms and restore yield potential. **Apply only when adequate growth is present to aid absorption of foliar Mn.**

Zinc

Zinc (Zn) deficiency is predicted by an availability index that includes M3 soil test Zn, soil pH, and M3 soil test P. It is most common on soils with a pH of 6.5 or higher and high soil test P concentrations but may also be induced by environmental conditions such as cold, wet soils that may limit root growth.

Table 8. Interpretation of zinc availability index.

Soil Test Criteria	Interpretation
M3-Zn is less than 1.9 lb/ac	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is higher than 7.0	Zn deficiency is predicted
M3-Zn is less than 3.1 lb/ac **AND** soil pH is 6.6 or higher **AND** M3-P is 100 FIV or higher	Zn deficiency is predicted
M3-Zn is 3.2 lb/ac or higher	Zn deficiency is unlikely

If zinc deficiency is predicted by the availability index or was observed the previous year, one of the following treatments can be applied:

1. Broadcast Zn sulfate or Zn oxide at a rate of 10 to 12 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 2 to 3 lb/ac elemental Zn. Broadcast applications should correct Zn deficiency for several years.
2. Foliar application of Zn sulfate or Zn oxide at a rate of 1 lb/ac elemental Zn or Zn chelate (Zn-EDTA) at a rate of 0.5 lb/ac elemental Zn in 20 to 50 gallons of water. **Apply only when adequate growth is present to aid in the adsorption of foliar Zn.** Foliar Zn application should be repeated if symptoms re-appear.

Sulfur

Sulfur (S) deficiency is occasionally observed in malting barley grown on Delaware soils. Symptoms include reduced growth and a general yellowing of the plant. To confirm diagnosis, have a tissue test run. Cut the whole plant ½ inch above the soil line at Feekes' 5 growth stage and submit to a reputable lab for analysis.

1. If the N:S ratio is greater than 15:1, apply 25 to 35 lb/ac of S with the first N application in the spring.

Boron

Boron (B) deficiency is not usually observed in this crop. If B deficiency symptoms appear, contact your county agent for assistance with diagnosis and corrective recommendations.