

# Guide to Malting Barley Production in the Northeast



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## NORTHWEST CROPS & SOILS PROGRAM



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# Malting Barley Quality Standards

Since the revival of the small grains industry in the Northeast, due in no small part to the burgeoning locavore movement, demand for malting barley has grown exponentially. Vermont has 72 breweries according to Vermont Brewer's Association, up from 41 breweries in 2013. Vermont also has 20 distilleries according to Distilled Spirits Council of Vermont. The growth of this industry is driving demand for local barley.

Malting barley must meet specific quality characteristics such as low protein content and high germination. Craft breweries and distilleries have expressed an interest in sourcing locally produced malting barley, and this guide is intended to help farmers in the Northeast learn how to produce high quality barley for this expanding local market.

In its most basic definition, the malting process is a controlled partial germination. Barley is soaked in hot water until it begins to germinate and then it is quickly dried (generally in a kiln) to stop germination. Enzymes activated during the germination process break down proteins and starches into a sugar-rich malt that can be used to brew beer or can be distilled into liquor. Uniform, high-quality malt production depends on uniform, high-quality barley seed.

Maltsters have specific barley quality requirements to produce high quality malts. The parameters used to measure quality for barley for malt include test weight, protein content, plumpness, germination rates, and concentration of deoxynivalenol (DON) vomitoxin.

**Test weight** is a measurement of grain density. It is measured by weighing a known volume of grain at harvest. Barley users require grain that weighs more than 48 pounds per bushel.

**Protein concentrations** need to be between 9% and 11%. Higher levels of protein can produce hazy beer. Generally, six-row barley can have higher protein concentrations (up to 12.5%) than two-row because they have higher enzymatic activity.

**Grain plumpness** is measured by sieving grain with a mesh size of 6/64" (2.38 mm). Plumpness is a proxy for starch content and also general quality. Brewers and maltsters desire barley with over 90% of kernels larger in diameter than 6/64".



Image 1. Barley being sorted for plumpness at NWCS Quality Testing Laboratory, Burlington, Vermont.

## Malting Barley Quality Standards

**Germination rate** (also called germination energy) is critical to successful malt. Barley maltsters require 95% or higher germination rate.

**Deoxynivalenol (DON)** is a toxin produced by the fungus *Fusarium graminearum*. *F. graminearum* is spread by spores that can overwinter in soil. Barley is susceptible to *fusarium* infection at seed-fill and heading. Cool, wet weather during the heading stage tends to promote growth of the fungus and higher levels of DON in the grain. FDA standards require that DON concentrations in products for human consumption are 1 part per million or less in the final product. *Fusarium* produces other compounds that can interfere with the brewing process, and malts made with infected grain can lead to problems with gushing and off-flavors.



Image 2. *Fusarium* head blight on barley. Image credit: University of Idaho Extension.

**Falling number** is a measure of enzymatic activity in grains. Falling number is not universally recognized as a standard for malting quality, but a few studies suggest that a falling number greater than 250 indicates minimal sprouting damage (pre-germination of barley seed) and sound malting quality.

It is also important to evaluate **moisture content** at harvest. Barley needs to have moisture content below 14% for long-term storage so that the grain does not mold or prematurely germinate. Barley that is over 14% moisture should be dried down for storage.

## Varietal Selection

Selecting suitable varieties of barley to grow is crucial to success. Growers should select varieties that have good yields, produce high quality grain, and are disease-resistant. Farmers can consult results from local or regional variety evaluation programs to select varieties that are adapted to their region. The University of Vermont, Cornell University, the University of Maine, and the Eastern Barley Testing Network publish varietal trial information. Whenever possible, consult with the malting house or brewer who will be purchasing the barley crop to ensure that the variety grown is desired by the end-user.

### Two-Row versus Six-Row Barley

Two-row barley produces two rows of seed on each head, while six-row barley has six rows of seed on each head. The four side rows in six-row barley have smaller and more uneven kernels. The smaller kernels can be separated out and sold for livestock feed while the larger, uniform kernels can be used for malting. In addition to the botanical differences, two-row and six-row barley have somewhat different characteristics for malting. Six-row barley has higher protein and lower carbohydrates. It also has higher enzymatic activity and can more effectively break down both starches and proteins. Because of this, higher protein is acceptable for six-row barley, and six-row barley is commonly used in multi-grain mashes that include rice or corn. Two-row barley has 1-2% higher extract of malt per volume of grain, which can be significant for large breweries but has a negligible effect at smaller scales. Two-row barley may be more *fusarium*-resistant. Craft brewers tend to prefer two-row barley over six-row for its flavor and brewing quality.

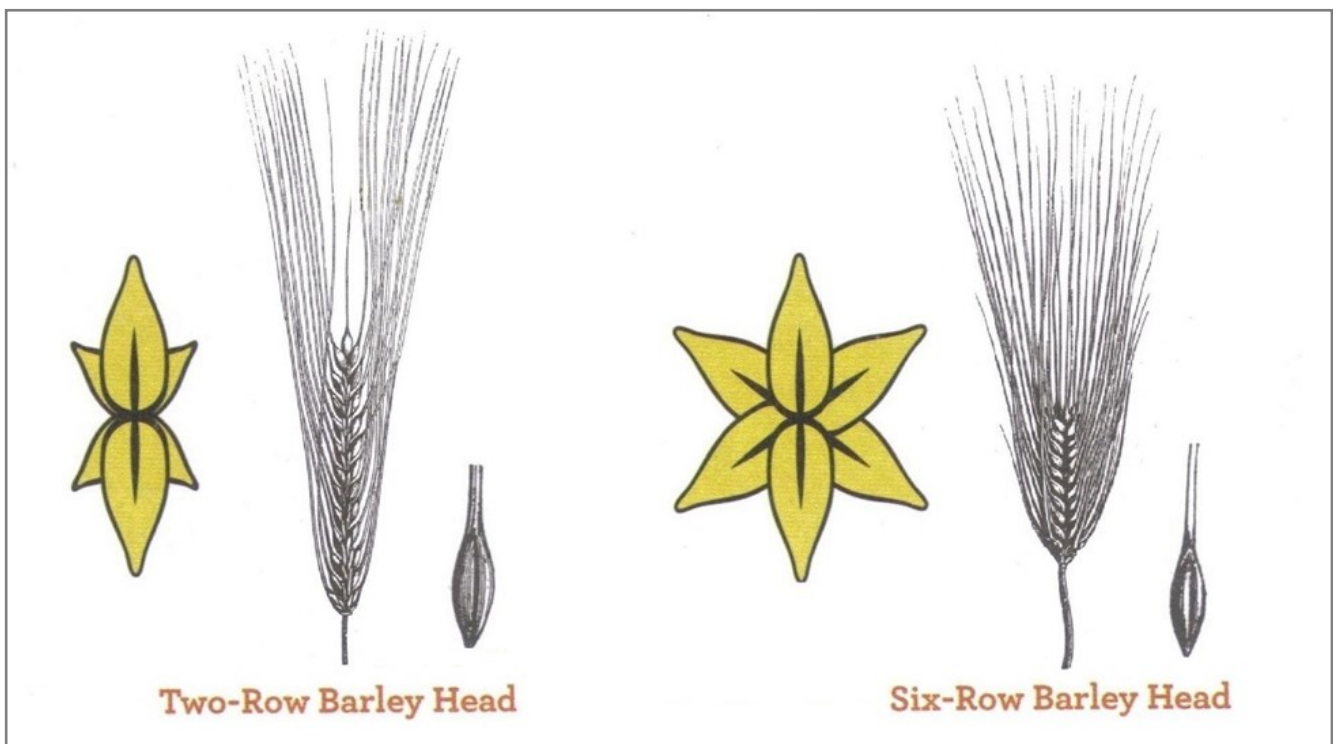


Image 3. Two-row and six-row barley. Image credit: Brulosophy.com

# Varietal Selection

## Winter Barley versus Spring Barley

Winter barley is planted in the fall and overwinters under snow cover. Winter barley tends to produce higher yields and test weight compared to spring barley. The potential benefits have to be weighed against the risk of losing the whole crop in particularly cold winters or when there is inadequate snow cover to insulate young barley through the winter. “Conventional wisdom” suggests that spring barley is more prone to fungal infections. However, in over a decade of barley trials at Borderview Research Farm in northern Vermont, DON levels for winter barley have averaged higher than those of spring barley. Winter barley trials at Borderview Research Farm have frequently been terminated due to poor winter survival (out of eight winter barley trials that were planted, only five were harvested; a 37.5% failure rate). Winter barley is best adapted to parts of the Northeast with milder winter conditions.

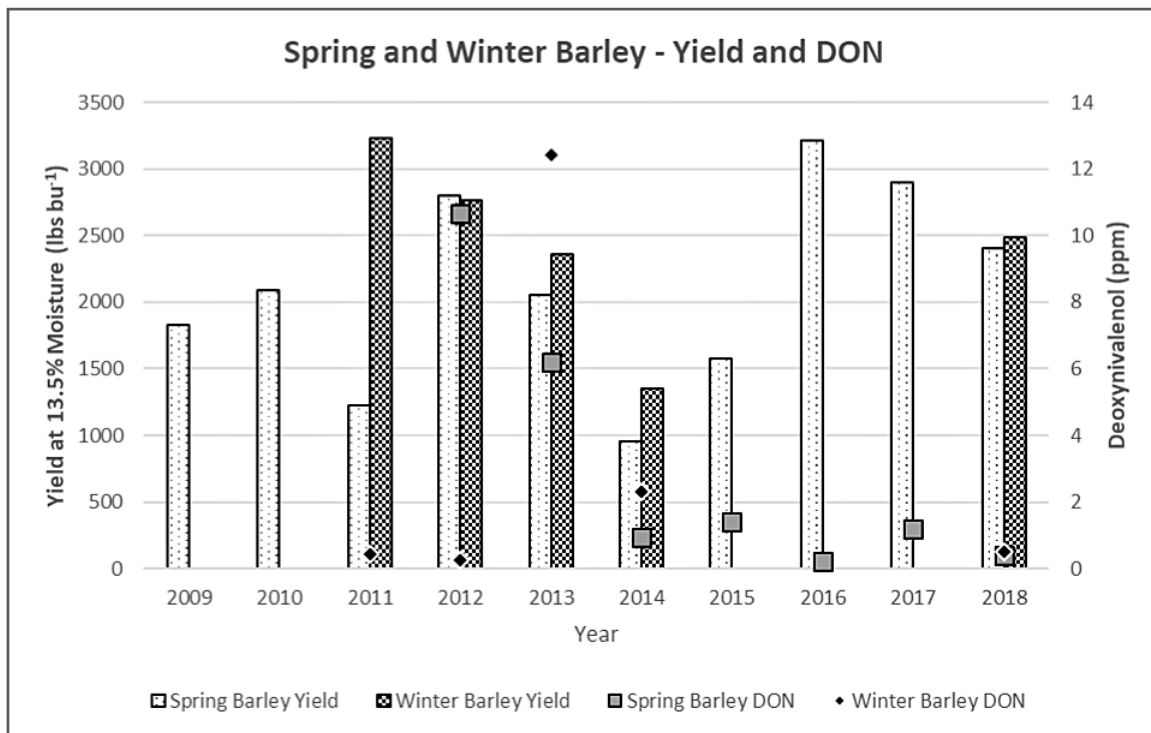


Image 4. Yield and DON concentrations for spring and winter barley variety trials at Borderview Research Farm 2009-2018. Winter barley was not planted in 2009 or 2010. DON testing did not begin until 2011.

## FHB Resistance

*Fusarium* head blight (FHB), also called scab, is a primary concern for northern grain growers. Infection with the *fusarium graminearum* fungus can produce toxins, including the vomitoxin deoxynivalenol. The FDA has set a limit for human consumption of 1 part per million of the DON vomitoxin in the final product. There are other associated effects on brewing quality from *fusarium* infection, including unpleasant flavors, uneven malting, and gushing. Researchers are engaged in ongoing efforts to identify effective fungicides. It is important to select a *fusarium* resistant variety. Two-row varieties may be more resistant to *fusarium* infection than six-row varieties. Barley should be rotated with a non-grass crop to avoid accumulation of *fusarium* in soil. The U.S. Wheat and Barley Scab Initiative maintains up-to-date information on FHB severity in different regions of the U.S., varietal selection, and effective treatments at <https://scabusa.org/>.

## Site Preparation and Planting

Barley prefers moderately basic soils (ideal pH range is between 6.2 and 6.8) and can grow in soils that are quite alkaline. Barley performs best when planted on well-drained soils.

Barley is most commonly produced using conventional tillage methods. Some New England farmers are having success with reduced tillage or no-till grain systems. Winter barley is typically planted in mid to late September and spring barley in mid to late April. Barley is cold tolerant and spring barley can be planted as early in the season as the ground can be worked. Barley is typically planted at 300-350 live seeds per square meter, or around 125 pounds of seed per acre. The seeding rate in pounds per acre can be adjusted to specific varieties based on thousand kernel weights and germination rates to achieve the desired plant population/stand density. Barley should be planted with a grain drill at a depth between one and one and a half inches. Typical row spacing is six inches.



Image 5. Grain drill.



Image 6. Tillering barley.

### Weed Control

Seeding rates and good establishment are important for barley stands to outcompete weeds. Some pre-planting herbicides can be applied prior to planting barley to reduce initial weed pressure. Herbicide application is not typically a cost effective approach to weed management in barley unless fields are very weedy. Carefully check labels to make sure the herbicide is appropriate to use with barley and how long to wait after application before planting barley. Barley can be mechanically cultivated. Mechanical cultivation is more effective prior to tillering; after tillering it is more likely to damage barley.

## Fertility Management

It is important not to over-fertilize barley. Barley yields improve with application of nitrogen; however, too much nitrogen can result in higher crude protein levels than optimal and can also lead to lodging. Lodging occurs when the seed head grows too heavy for the stalk and the plant falls over, leading to quality issues and difficulty with mechanical harvesting. Winter barley benefits from fall nitrogen applications that can help produce strong stands that can successfully overwinter. Spring nitrogen application should not exceed 50 pounds of nitrogen per acre. Over-application of phosphorus in fertilizers contributes to water quality issues. Soils should be tested, and phosphorus and potassium applied accordingly. If lime is required, it should be applied at least 12 months before planting barley.

## Monitoring

Barley should be monitored through the growing season to check for good establishment and evaluate if interventions are needed for pests or disease management.

### Emergence and Staging

If desired, check germination rates and populations post-emergence prior to tillering. Heading date should be monitored as barley is most susceptible to *fusarium* infection at heading. Farmers may want to consider fungicide treatment to keep *fusarium* infection to a minimum, particularly if weather conditions at heading are wet. Fungicides must be applied at heading or shortly afterwards to be effective against *fusarium*. By the time blighted heads appear, it is too late to apply fungicide.

### Disease

Barley should be monitored for disease infection through the growing season. While *fusarium* is the disease of greatest concern for Northeastern growers, other diseases can be problematic as well.

Smut in barley is caused by the fungus *Ustilago nuda* and can affect yield and quality. Smut appears on grains as “smutted grain heads”, which are filled with spores that appear black or brown. The spores take the place of the grain heads, so that less or none is left to be harvested. Smut is a seed-borne disease, and grain from smut infected fields should NOT be saved as seed.

Ergot is caused by the fungus *Claviceps purpurea*. Infected heads produce blackened, misshapen kernels known as sclerotia. Ergot produces alkaloid toxins that cause a syndrome known as ergotism or St. Anthony’s Fire, which can include severe pain, hallucinations, and convulsions. While ergot is more common in rye, it can also infect barley. There is no effective treatment for ergot, but barley should be monitored for the presence of tell-tale sclerotia.

# Monitoring

Foliar diseases reduce photosynthetic leaf area, use nutrients, and increase respiration and transpiration within colonized host tissues. The diseased barley typically exhibits reduced vigor, growth and seed fill. Earlier occurrence, greater degree of host susceptibility, and longer duration of conditions favorable for disease development will increase the yield loss. Foliar diseases of concern include rust, mildew, septoria, stagonospora, and other leaf blotches. Powdery mildew, caused by the fungus *blumeria graminis*, is one of the most common and problematic foliar diseases in barley. It is easily identified by white, fluffy growth on the leaves, stems or heads. Powdery mildew can reduce yields (typical losses are less than 10%, but yield loss as high as 40% has been recorded) and lead to shriveled heads with poor malting quality. As with *fusarium*, it is important to select resistant varieties. Spraying with fungicides is usually not economical for powdery mildew.

## Other Pests

The most commonly seen arthropod pests are mites and thrips. These pests rarely cause enough damage to affect growth and yields, but can be disease vectors. Other insects that damage barley in the Northeast include leaf miner and cereal leaf beetle. In the Northeast, insect pests rarely cause enough damage to require spraying insecticides.

The most damaging pests to barley crops are birds. Birds can cause significant loss in a barley crop in a very short period of time, and this can happen any time between heading and harvest. There are many different ways to battle birds, including chemical bird repellent, bird cannons, squawk boxes, “scary eyes”, metallic tape/other mirrored deterrents, or facsimiles of birds of prey (crows, owls, hawks, etc). Each method generally only works for a short period of time before birds learn that there is no actual threat. Rotating between different deterrents is more effective than use of a single deterrent.



Image 7. Scouting barley for disease and pest damage.



## Harvest and Storage

Winter barley is harvested in early to mid July, while spring barley is harvested in late July to early August in the Northeast. The timing of barley harvest will depend on grain maturity and weather. Barley that is ready to harvest is gold in color and the heads have begun to nod.



Image 8. Ripening barley heads. Image credit: Cornell University.

Mature grain will not dent when pressed with a fingernail and will crack when bitten. Mature or near mature barley that is rained on can develop pre-harvest sprouting, leading to low malting quality. As barley approaches maturity, growers need to closely monitor both the grain maturity and the weather forecast.

## Harvest and Storage

Barley is typically harvested using a combine that both harvests and threshes the grain. All makes and models of combines can be used to harvest barley.

Following harvest, barley should be cleaned to remove weed seed and damaged or diseased kernels. Conventional seed cleaners use screens to sieve out material that is larger or smaller than the desired barley seed. Gravity tables may be more effective at removed diseased kernels than standard seed cleaners.

Test weight and harvest moisture should be measured at harvest. If barley tests greater than 14% moisture content, it needs to be dried for storage to below 14% so it does not mold or pre-germinate. If barley is being sent out for quality testing, the sample should be below 14% moisture content. The drying temperature should not exceed 110° F to avoid damaging grain.

Store barley safe from pests (particularly rodents and insects such as meal moths). Barley should be stored in cool, dry conditions. Proper ventilation in storage bins is useful in maintaining grain quality and reducing insect infestations. Check on stored barley at least once a month to make sure barley is safe from pests and moisture.



Image 9. Barley being harvested with a combine.



Image 10. Barley being cleaned with a screen cleaner.

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