HORTICULTURE AND CROP SCIENCE

Management of Ohio Winter Malting Barley

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Winter malting barley requires careful management to maximize grain yield and to maintain high quality grain for malting purposes. Here, we offer practical management recommendations.

In 2009, Dr. Eric Stockinger initiated a winter malting barley breeding program by testing different varieties obtained from outside sources for their suitability in Ohio. As winter-hardiness is the most critical parameter for successful barley cultivation in the Midwest, emphasis on winter-hardiness and developing winter-hardy barley varieties is a key breeding program goal.

Ohio farmers need to carefully consider growing winter malting barley as it may not be suitable for all farming operations. Malt quality barley must meet several criteria to avoid being rejected by the malt facility- this risk may be too high for certain farmers since there are no markets in Ohio for barley that does not meet the requirements for malt. Malting barley is not sold through traditional grain elevators like corn, soybean, and wheat, so contracts or agreements should be in place before planting. Special considerations for post-harvest handling include drying capability, grain cleaning, and delivering in totes (versus hopper trucks). Each farmer must understand the unique challenges of growing malt quality barley before contracting and purchasing seed.

Field Selection

Proper field selection is necessary for maximizing grain yield and quality. When selecting fields for winter malting barley production, consider the following:

- **Drainage**- Select a well-drained field with a low chance of ponding
- **Crop rotation-** Do not plant malting barley after corn, wheat, or other small grain crop. Be mindful of herbicides used on previous crops as some residual herbicides may injure malting barley. Also, be mindful of herbicides applied to the barley crop as residual herbicides may injure the succeeding double crop soybean. **Soil fertility-** Select a field with adequate fertility (see soil fertility section for more details)
- **Tillage-** Barley may be produced with or without tillage. No-till can help prevent soil erosion, reduce spring heaving, and lower production costs. However, tillage may be useful to control weeds, reduce the risk of diseases, and help ensure proper seed depth and uniformity.

Seed Sources

Each year, the Ohio Seed Improvement Association publishes a directory listing of Ohio seed dealers that supply Certified Seed. The 2020 directory can be found here: https://ohseed1.org/publications

Planting Date

Do not plant barley prior to the county Hessian fly-safe date (Figure 1). The fly-safe date coincides with reduced numbers of adult aphids, which transmit Barley Yellow Dwarf Virus to seedlings in the fall. The best time for seeding is the 10-day period starting the day after the fly-safe date.

Figure 1. Hessian fly-safe dates for planting winter barley or wheat in Ohio counties.

Row Width

Planting barley in 7.5-inch row width is ideal. However, wide-row barley production may also be feasible. Winter wheat grown in 15-inch row width yields 1 to 11% lower than wheat grown in 7.5-inch row width. When planting barley in wide-rows consider the following:

- Plant barley as soon as possible after the Hessian fly-safe date.
- Spring herbicide application is very important to maximize yield in wide rows.
- Changing row spacing will change the micro-climate within the barley canopy, and this could affect disease development. Scout fields for foliar diseases to determine whether disease risk is high enough to warrant a fungicide application.

Seeding Depth

Barley should be seeded at a1.0 to 1.5 inch depth.

Seeding Rate

We recommend planting barley based on the number of seeds/acre. Planting by pounds/acre or bushels/acre is inaccurate due to variability in seed size from one year to another and from one variety to another. Low seeding rates result in inadequate and uneven stand and winter injury. However, excessively high rates may increase the risk for powdery mildew. Calibrate the drill each year for each variety and seed lot planted. Use Table 1 to calibrate grain drills. **Keep in mind, barley seed is often larger (fewer seeds per pound) than winter wheat.**

The optimum seeding rate for barley is variable. In favorable growing conditions, there is a poor relationship between seeding rate and grain yield. However, in unfavorable growing conditions (saturated soils, low temperature without snow cover), higher seeding rates result in a better stand and, consequently, greater grain yield. We recommend seeding winter malting barley at ≥1.5 million seeds/acre when planting during the first two weeks following the fly-safe date (Figure 1). Seeding rate also influences grain quality. Seeding rates ≥ 1.5 million seeds/acre are associated with lower protein and lower deoxynivalenol (DON), which is ideal for malting.

Table 1. Pounds of seed needed to plant from 1.2 to 2.0 million seeds/acre with seed of varying size.

	Millions of Seeds/Acre				
Seeds/lb	1.2	1.4	1.6	1.8	2.0
10,000	120	140	160	180	200
11,000	109	127	145	164	182
12,000	100	116	133	150	167
13,000	92	108	123	138	154
14,000	85	100	114	129	143
15,000	80	93	107	120	133
16,000	75	88	100	113	125
17,000	71	82	94	106	118
18,000	66	77	89	100	111

Soil Sampling

Recent soil test results should be used to guide lime and fertilizer applications. See the Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat, and Alfalfa (Extension Bulletin E-2567) available at: https://stepupsoy.osu.edu/soybean-production/soybean-fertility/tri-state-soil-fertility-guidelines

Soil pH

Soil pH should be between 6.3 and 6.8. When proper soil pH is maintained, micronutrients should be available at adequate levels. The lime test index or buffer pH on the soil test report should be used for lime recommendations for mineral soils with adequate drainage containing 1 to 5 percent organic matter.

Phosphorus (P)

Phosphorus is important for early tiller development and should be applied prior to planting when the soil test level is below 30 ppm (60 lb/acre) Mehlich-3 P. At soil test levels of 60 ppm (120 lb/acre) or greater, additional P fertilizer is not recommended. Table 2 show P recommendations for barley.

Table 2. Phosphorus fertilizer recommendations based on Mehlich-3 P soil test values (ppm). Fertilizer rates are based on yields of 75 and 100 bushels per acre.

Soil Test P	P Recommendation (lb P_2O_5/ acre)	
Mehlich-3 (ppm)	75 (bu/acre)	100 (bu/acre)
10	140	150
20	90	100
30-50	40	50
>50	0	0

Potassium (K)

Potassium fertilizer recommendations are based on Mehlich-3 K soil test values (ppm). Table 3 has K guidelines for soils with cation exchange capacity (CEC) greater than 6 meq/100 g.

Table 3. Potassium fertilizer recommendations based on Mehlich-3 K soil test values (ppm). Fertilizer rates are based on yields of 75 and 100 bushels per acre and for soils with CECs greater than 6 meq/100 g.

Soil Test K	K Recommendation (lbs K_2O/ acre)	
Mehlich-3 (ppm)	75 (bu/acre)	100 (bu/acre)
50	160	170
75	120	125
100	75	80
120-170	40	45
>170	0	0

Sulfur (S)

Barley grown in sandy soils and/or soils low in organic matter (<2%) is most likely to respond to S fertilizer. If applied in the fall, elemental S is recommended to minimize loss. In the spring, suitable S fertilizer include ammonium sulfate, ammonium thiosulfate, and gypsum. In our research trials, S fertilizer did not influence grain protein concentration.

Nitrogen (N)

Nitrogen management is extremely important as grain protein increases with increasing N application (Figure 2). Low grain protein (≤ 12.5% on a dry weight basis) is desirable for the malting industry.

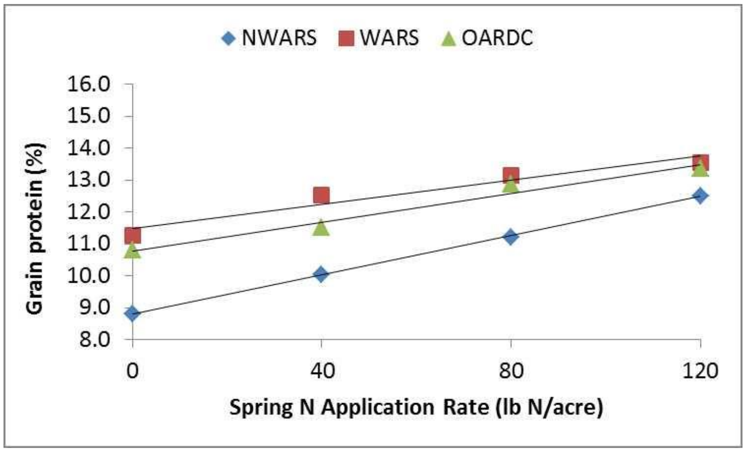

Figure 2. Relationship between grain protein and spring N application rate at three locations in Ohio: Northwest Agricultural Research Station (NWARS) in Custar, Western Agricultural Research Station (WARS) in South Charleston, and Ohio Agricultural Research and Development Center (OARDC) in Wooster.

Fall application: 20 to 30 lb N/acre of fall-applied N is recommended for early fall and spring growth.

Spring application: In the spring, great care should be taken to avoid over-fertilizing. High N application may result in grain protein levels too high for quality malt (Figure 2). Spring N application rates of 60 to 80 lb N/acre *generally* result in an acceptable grain protein concentration (≤ 12.5% protein on a dry weight basis). However, the influence of N application rate on grain protein level is extremely variable depending on the environment.

Spring N application timing: Spring N application should occur between green-up and Feekes growth stage 6.0 (first node visible) as this timing coincides with rapid N uptake by the plant (Figure 3). Nitrogen fertilizer applied prior to green-up is subject to loss by leaching or denitrification.

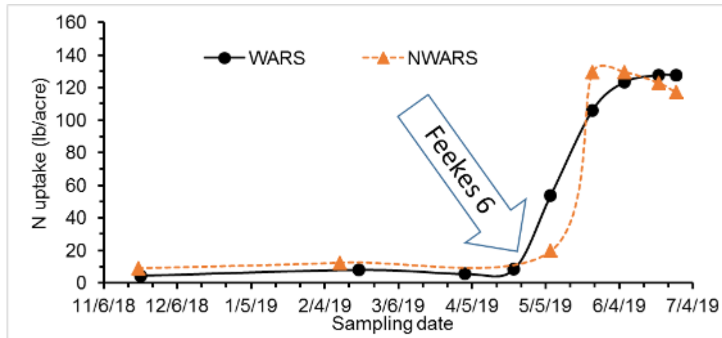

Figure 3. Nitrogen uptake by barley by calendar date at the Western Agricultural Research Station (WARS) in South Charleston and Northwest Agricultural Research Station (NWARS) in Custar.

Nitrogen source: Commercial fertilizer source is not a concern unless conditions are conducive to N loss. In general, urea-ammonium nitrate solutions have the greatest potential for loss, then urea, and ammonium sulfate the least. However, be aware of seed contamination when purchasing granular fertilizer. Talk with your dealer prior to purchasing to ensure no small grain seeds have been mixed with the fertilizer.

Release of plant-available N (ammonium and nitrate) from animal manure is unpredictable. Organic N is converted to ammonium and nitrate by microorganisms in a process called mineralization. The rate of which mineralization occurs depends on the amount of carbon and nitrogen in the manure (C:N ratio), soil moisture, and soil temperature. Due to this unpredictability and the low grain protein required by the malting industry, we do not recommend applying manure to winter malting barley.

Weed Management

Effective weed control is important to maintain barley yield and quality, and to ensure control in any following crop of double crop soybean. A healthy barley crop completes well with weeds, especially when production techniques result in an initial uniform stand and when loss of stand due to winter injury is minimal. Effective weed control and prevention of weed seed production in prior crops will reduce the severity of weed problems in barley. Barley should be planted into a weed-free seedbed through the use of tillage or burndown herbicides. Some barley fields can benefit greatly from herbicide application in late fall or spring, and failure to scout and take the appropriate measures can result in loss of yield or quality, and harvesting problems. The weeds that appear above the barley canopy late in the season, such as giant ragweed and Canada thistle, can often be easily controlled or suppressed with a spring herbicide treatment.

Winter annual weeds: Winter annual weeds, such as common chickweed, marestail, purple deadnettle, shepherd's purse, and field pennycress, become established in late summer and fall along with the barley, and can interfere with early development of barley in spring. Gramoxone, glyphosate, and Sharpen are labeled for burndown application any time prior to barley emergence. Low rates of dicamba can be applied at least 15 days before planting, but 2,4-D is not labeled for preplant burndown in small grains. Sharpen can control emerged marestail and provide residual control following planting, but should be mixed with glyphosate or Gramoxone for control of most other emerged weeds. Sharpen rates of 1.5 to 2 oz/acre also provide residual control of broadleaf weeds for several weeks following application. No-till fields not treated with burndown herbicides at time of planting can be treated with postemergence herbicides later in the fall to control winter annual weeds, marestail, and dandelion as necessary. Options include Huskie, Quelex, and mixtures of dicamba (2 to 4 oz of 4L) with products that contain tribenuron or tribenuron + thifensulfron. Late fall-applied herbicides can be more effective for control of these weeds and safer to the crop than spring-applied herbicides. Where spring applications are necessary to control winter annual weeds, Huskie, Quelex, or mixtures of 2,4-D or MCPA with products that contain tribenuron + thifensulfuron are among the more broadly effective treatments.

Wild garlic: Wild garlic bulbets can contaminate harvested grain making it unsuitable for malting. Herbicides containing thifensulfron are effective when applied in the spring after garlic has several inches of new growth.

Canada thistle: Canada thistle can greatly suppress barley growth due to its tendency to occur in dense patches. Many spring-applied barley herbicides have at least some activity on thistle, and can suppress it adequately through harvest if not applied too early in spring.

Dandelion: Dandelion can interfere with barley establishment in the fall and barley growth in the spring. Emerged dandelion should be controlled prior to barley planting with tillage or glyphosate, or at least by late fall with postemergence herbicides. The combination of dicamba (4 oz of 4L) and tribenuron (Express, etc) applied in early November has been effective in OSU research.

Summer annual broadleaf weeds: Summer annual broadleaf weeds, such as common and giant ragweed, can begin to emerge in late March. A healthy barley crop can adequately suppress these weeds, but a spring application is occasionally warranted. There are a number of effective options for summer annual weeds – consult small grain herbicide ratings in the *Weed Control Guide for Ohio, Indiana, and Illinois.*

Herbicides must be registered for use on barley, and label guidelines followed to minimize the risk of crop injury, including application at the appropriate stages of barley growth. When barley has not yet reach the jointing stage, any approved herbicide can be safely applied. As barley growth stage advances past jointing and approaches the boot stage, herbicide choices become much more limited. Most herbicides can be applied in UAN when barley is top-dressed. This may increase crop injury somewhat, and some labels recommend adjusting surfactant rates to minimize injury. Information on herbicides and specific weed problems can be found in the current edition of the *Weed Control Guide for Ohio, Indiana, and Illinois*, Extension Bulletin 789, available at OSU County Extension offices and online at CFAES publications: http://estore.osu-extension.org/.

Disease Management

Barley is affected by several leaf, spike, and root diseases that have the potential to negatively impact grain yield and quality by reducing stand and grain-fill, and contaminating grain with mycotoxins. Disease management is critical for the production of high malting quality barley, and this should begin in the fall in order to prevent early disease establishment and reduce risk.

- Avoid planting highly susceptible varieties.
- Avoid planting barley after corn or wheat, as both crops are hosts for *Fusarium graminearum*, the fungus that causes head scab and contaminates grain with vomitoxin.
- Avoid planting barley without tillage after barley or other related grass species. Till and/or rotate with soybean. Several of the leaf and root diseases of barley are caused by pathogens that overwinter in stubble left in the field after harvest.
- Avoid planting barley too early. Rusts, viruses, and leaf blotching disease may become established in early-planted barley, getting a head-start in the spring.
- Plant treated seeds. This will reduce stand loss due to seed and seedling diseases; help to control smuts; and prevent early establishment of leaf diseases.
- Control weeds in and around barley fields, as some weed species are hosts for viruses that affect barley and the insect vectors that transmit them.
- Avoid excessive N fertilization and high planting density.

Speckled/Septoria leaf blotch:

Speckled/Septoria leaf blotch (*Septoria passerinii*) is **not** the same Septoria that affects winter wheat. It is a different species.

Speckled/Septoria leaf blotch:

- Characterized by light brown, rectangular lesions with small black dots (pycnidia) primarily on leaves and leaf sheaths.
- Thrives under cool conditions (50-68°F) with extended wet periods.
- Survives in crop stubble and remains viable in straw for at least two seasons, buried or on the surface.
- Disseminated by splash within the canopy, and by wind-blown rain at longer distances.

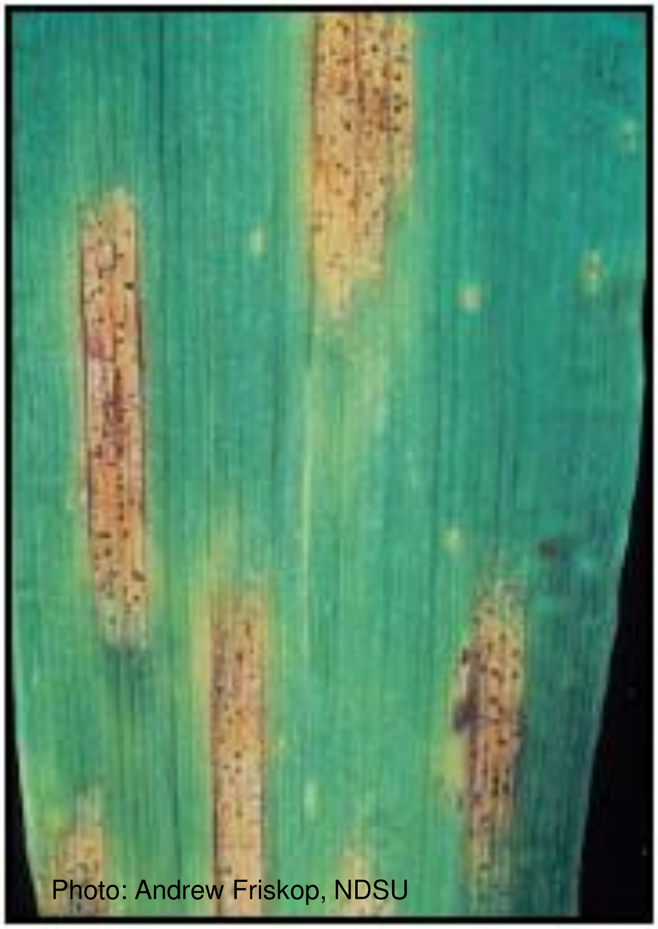

Figure 4. Speckled/Septoria leaf blotch (*Septoria passerinii*)

Stagonospora blotch:

Stagonospora leaf blotch (*Parastagonospora nodorum*) is **not** the same Stagonospora found on wheat **but** barley may also be infected by some isolates of the wheat biotype.

Stagonospora leaf and glume blotch:

- Characterized by brown to grayish irregular spots on leaf blades and sheaths. Spots may also develop on glumes and awns of the spike.
- Thrives under warm conditions (59-77°F) with extended wet periods.
- Disseminated by splashing rain.
- Survives in crop straw for up to three years if not buried or disturbed.
- Also survives in seeds for several years.

Figure 5. Stagonospora leaf blotch *(Parastagonospora nodorum)*

Net blotch:

Net blotch (*Pyrenophora teres*) is **not** the same as tan spot on wheat; it is a different species of the same genus.

- Characterized by brown spots that develop in a net-like pattern on leaf blades and sheaths and glumes.
- Thrives under warm conditions (59-77°F) with extended wet periods.
- Seedborne and survives in crop stubble.
- Excessive N fertilizer increases disease severity.
- Disseminated by wind.

Spot blotch:

Spot blotch *(Bipolaris sorokiniana*)*:*

- Characterized by chocolate-brown round to elongated spots on leaf blades and sheaths.
- May also affect spikes and kernels under favorable weather conditions.
- Thrives under warm conditions (60-82°F) with extended wet periods.
- Seedborne and survives in crop stubble, soil, and on grasses.
- Disseminated by wind.

Figure 6. Net blotch (*Pyrenophora teres*)

Figure 7. Spot blotch (*Bipolaris sorokiniana*)

Scald:

Scald (*Rhynchosporium seralis*):

- Characterized by oval spots with a water-soaked appearance, later becoming bleached or straw-colored, on the leaf and spike.
- Thrives under cool temperatures (59-68°F) with extended wet periods.
- Seedborne and survives in crop stubble.
- Disseminated predominately by splashing rain.

Rusts- stripe, leaf, and stem:

Rusts (*Puccinia spp.*):

- Differentiated based on types, color, arrangement, and location of pustules on the plant.
- Stripe rust develops best under cool conditions (50-59 F), whereas leaf and stem rusts thrive under warmer conditions (68 F). They are all favored by wet, rainy conditions.
- They all need a live host to survives, so will not overwinter in crop residue.
- Disseminated over long distance by wind and spread rapidly within and between fields.

Figure 8. Scald (*Rynchosporium seralis*)

Figure 9. Stripe (left) and leaf (right) rust (*Puccinia spp)*

Managing Foliar Diseases

A variety of strategies should be used to manage foliar disease beginning with selecting resistant varieties and cultural practices that take into account disease survival and dissemination. Then, consider the application of foliar fungicides.

Net blotch, spot blotch, scale, Septoria, and Stagonospora are residue-borne. This means residue management is a critical component to managing these diseases including crop rotation and/or tillage. Leaf rust and stripe rust are not residue born and travel long distances by wind.

When timed correctly (between flag leaf emergence and heading, depending on the disease), foliar diseases have been adequately controlled by fungicides including

- tebuconazole
- propiconzole
- propiconazole + trifloxystrobin
- azoxystrobin
- prothioconazole + tebuconazole
- prothioconazole
- metconazole
- fluoxastrobin
- fluoxastrobin + flutriafol

Read labels carefully and follow guidelines when making a fungicide application.

Fusarium Head Blight (Scab)

Fusarium head blight (FHB) or scab (*Fusarium graminearum*) is probably the biggest disease concern in winter malting barley. FHB reduces grain yield and malting quality by contaminating the grain with mycotoxins (vomitoxin). **Vomitoxin levels in malting barley must be ≤ 1 ppm.**

At best, winter malting barley varieties are moderately resistant to FHB. Two-row barley tends to be more resistant than six-row barley. Fungicide efficacy is good (not great) with application timing being extremely important.

Figure 10. Fusarium head blight (*Fusarium graminearum*) on malting barley.

Management of Fusarium Head Blight

Conditions: FHB prefers temperatures of 65-80°F and wet conditions.

Crop rotation: Planting barley after soybean will reduce the risk of FHB. Do not plant barley after barley, wheat, corn, or any other grasses.

Timing of fungicide application: Fungicides have the greatest efficacy against FHB when applied at or within the first 5 days after heading. This is different from what is recommended for wheat as anthesis generally occurs *before* anthers are extruded. Once anthers are extruded, fungicide efficacy greatly decreases.

Integrated management: The highest levels of scab and vomitoxin reduction are achieved when the most resistant varieties are combined with the best fungicides (metconazole or prothioconazole + tebuconazole).

Fungicide selection: Strobiliurin fungicides have been found to increase vomitoxin contamination of grain. Check fungicide labels and avoid applying those containing a strobiliurin such as pyraclostrobin, trifloxystrobin, or azoxystrobin.

Harvest Date

Clean all equipment and bins prior to harvest to avoid contamination. Barley is harvested between mid-June and early July approximately two weeks before wheat. It is important to realize that the quality of the grain is of utmost importance to meet malting standards- damaged grain or grain that has poor germinability is not suitable for malting because **malting *is* the germination process.** Kernels should not be broken or damaged and the husk should remain tightly-adhered to the grain.

Barley is physiologically mature at approximately 35% grain moisture content. However, harvesting at moisture levels of 20% or greater makes the kernel highly prone to damage during combining, which can make it unusable for malting.

Weather-related factors will usually dictate when the actual harvest can take place. Mature grain that remains in the field for an extended period of time, especially if grain is re-wetted, is prone to shattering, pre-harvest sprouting, lodging, and increased vomitoxin levels. These factors will reduce grain yield and grain may be unsuitable for malting.

Grain Drying

Following harvest, the grain should be dried to 13.5% moisture content at 70°F and 60% relative humidity. Using natural air or low temperature drying gives the highest quality grain. If heat is used, it should be less than 90°F. Desiccants should never be used for drying malting barley. Barley dried with the use of desiccants will be rejected by the malting and brewing industry

Grain Storage

Grain to be held in long-term storage should be clean, intact, and dry. Grain that is contaminated with foreign material or with broken kernels is susceptible to attack by fungi, insects, and mites. Ideal grain moisture content is 13.5%. Higher grain moisture content is acceptable if low temperatures are used to dry. If grain is stored for a long time, grain may need to be drier (12%).

Grain bins and all equipment that comes in contact with newly-harvested material should be clean and free of residual material. Grain may be stored in bins that have been treated with Chlorpyrifos-methyl and Cyfluthrin (Storcide), but the grain itself cannot be directly treated.

Grain should be stored in a well ventilated area, under a water-tight roof, and be proofed against birds and rodents. Shatter proof light covers and shatter-resistant bulbs should be used.

Grain also needs to be protected against growth of insect, mite, and fungal populations. The most effective means, is through temperature and moisture level control. Grain weevils and Indian meal moths are the greatest insect threats to stored grain. Grain weevils will bore into barley and render it unable to germinate; therefore, it cannot be malted. These insects reproduce much more rapidly at warmer temperatures than at cooler temperatures. Temperatures below 60°F slow their growth. Nonetheless grain weevils are still capable of completing their life cycle down to about 54°F. Two months at ≤30°F will kill grain weevils and meal moths, as will four days at -4°F. Any insecticides applied to malting barley before or during storage must be food-grade. Fungi are still capable of growth at or near freezing temperatures and are best controlled by keeping the grain moisture content at ≤14.5%.

Temperature and humidity should be regularly monitored at locations in the bin that are distal from the source of where control is applied. Insects are best monitored through the use of traps.

Grain Quality

After drying the barley, a composite sample should be created by taking an equal volume of material from multiple locations in the bin, and combining these. The composite sample should be sent to a barley quality lab for testing. Several quality labs exist to test barley- University of Vermont, Michigan State University Extension, Hartwick College, and others. Samples should be taken from each variety grown and from each field. Malting facilities require a test report for each crop to determine if it meets malting quality standards. Additionally, the grain should be clean and free of insects, ergot, and foreign material.

A typical two-row barley test profile will include:

- **Test weight-** Should be 48 lb/bu or higher
- **Moisture-** Should be less than 13.5%
- **Percent plump (vs. thin kernels)-** Plump kernels on a 6/64 screen should be greater than 90%; Thin kernels through a 5/64 screen should be less than 3%
- **Germination tests-** Germination should be 95% or higher
- **Pre-harvest sprout-** Should have no evidence of
- **Deoxynivalenol (DON)/Vomitoxin-** ≤ 1 ppm
- **Protein-** 9.5 to 12.5% on a dry basis

NORTH CENTRAL EXTENSION RISK MANAGEMENT EDUCATION

USDA United States Department of Agriculture National Institute of Food and Agriculture

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Ohio Corn&Wheat

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