

Code Name: Top Shelf

Oregon State University to release a new winter habit, GN0, malting barley targeted to the distilling industry — and more are in the offering

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In the first chapter of this story, we provided an in-depth history of glycosidic nitrile (GN), ethyl carbamate (EC), and the serendipitous introduction of the GN-null (GN0) allele into malting barley varieties (Artisan Spirit, Winter 2023) (1). In the United Kingdom tight regulation of the EC content in spirits and the overall industry dominance of single malt whisky has encouraged breeders there to provide malting barleys to the industry that are non-producers of GN. Currently all distilling malt varieties recommended by the Maltsters Association of Great Britain's Malting Barley Committee are required to be GN0 and there are a plethora of options for British maltsters and distillers (2). While research and innovation around GN has progressed significantly in the thirty-plus years since the discovery of the root cause of EC, it has only recently become a hot topic in the North American craft distilling community. An informal poll by the *Society of Spirit* shows that

Read the first
chapter of this story
*Glycosidic nitrile
and ethyl carbamate
in malting barley*



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Figure 1. Top Shelf nearing harvest at the OSU Hyslop Crop Science Research Lab in Corvallis, Oregon.

many craft distillers are aware of the issue and have at least some level of concern about the impact that regulation of GN and/or EC may have on their products and business.

While there are options for GN0 malt for North American distillers, these are

relatively limited due to a lack of domestically bred and grown barley varieties to meet the industry demand. Our previous article provided a glimmer of hope as the collective North American industry has encouraged breeders to introgress the GN0 allele into their breeding lines

with steady progress being made. The Barley Project at Oregon State University (OSU) is on the cusp of releasing one, and possibly two, winter-habit, two-row, GN0 varieties specifically selected for the distilling industry. This article's focus is on the barley line DH162310 (code name: Top Shelf), which is still awaiting formal approval of the name and release of the variety by OSU. More information on the second potential new variety will be available in a future story. Top Shelf has already garnered support from a large national maltster interested in diversifying their offerings of GN0 malt. While not the first domestically bred GN0 barley, nor even the first from the Barley Project (Full Pint and Oregon Promise are both unabashedly GN0), Top Shelf is slated to be the first winter GN0 barley in North America and the first mainstream release with the potential to fit the needs of distillers of all styles of whiskey.

Agronomics and Malting Quality

Bred for the Pacific Northwest, Top Shelf is adaptable to both traditional malt barley growing regions (southern Idaho and the Palouse in eastern Washington/north-central Idaho) and emerging regions (the western valleys of Oregon and Washington). Broader environmental adaptation is being evaluated in the winter malting barley trials with cooperators nation-wide in Minnesota, New York, Virginia, and other locations. Evaluation has found that it has high yields and test weights, good lodging resistance, and resistance to the common barley diseases of stripe rust and scald. Detailed agronomic comparisons to contemporary check-varieties¹ can be found in Tables 1 and 2. Despite a tough winter in southern Idaho, seed increases are underway and extensive pure seed production and seed for commercial-scale assessment is planned

¹ Check-varieties are well established, malting varieties of the same growth habit (winter or spring) and row type (two or six) with broad environmental adaptation. These are used for agronomic comparisons in trials nation-wide. The current winter check varieties are all GN+.

Table 1. Agronomic performance of fall planted DH162310 compared to check cultivars. Average of 2019-2022 OSU trials at two locations in the Willamette Valley of Oregon.

Entry	Yield (kg/ha)	Test Weight (kg/hL)	Heading (DOY)	Plant height (cm)	Lodging (%)	Stripe rust (%)	Scald (%)
Station years*	7	7	4	7	7	7	7
DH162310	10,558	69.0	111	119	1	1	2
Endeavor	7,465	66.4	113	102	26	2	47
Wintmalt	7,196	64.6	121	99	12	8	39
Thunder	7,667	64.9	114	99	16	7	36

*Station years are the multiples of location and years (i.e., location x years). Check varieties are all GN+.

for the 2024 harvest.

In addition to its potential for mainstream adoption, Top Shelf is a winter-habit variety, which sets it apart from nearly all of the current GN0 varieties available in North America, the UK, and the EU. Winter barley is planted in the fall and harvested in the early summer whereas spring barley is planted in spring and harvested that same summer. Winter barley has advantages, most notably increased yield over spring barley. Additionally, there are inherent ecosystem benefits of winter habit barley relative to spring barley, such as lower water requirements and reduced weed pressure and thus lower herbicide use. This drives more interest in the release of additional winter lines. Historically, malting barley was nearly all spring habit, but over the last 20 years breeders have developed winter barley varieties that meet contemporary malt quality expectations. The downside to winter barley is potential for winter kill and varieties will vary in their cold tolerance. Top Shelf's winter survival has been assessed in regional trials throughout the U.S., and thus far performed well. It looks great in western Oregon and Washington, and it pulled through in a tough

southern Idaho winter, while less cold-tolerant varieties succumbed.

Top Shelf was selected out of an aptly named project: *Distiller's Delight Trials*. This work was a survey of elite lines from within the Barley Project that, based on parentage, were likely to be non-producers of GN. Previously, much of the breeding material within the OSU program had not been phenotyped for its GN status. However, given this trait is inherited along simple Mendelian segregation, a parental survey of crosses using known GN0 barleys provided a pool of likely candidates. Full Pint (an earlier OSU variety) was known to be GN0 and it was essentially as simple as following the family tree, looking for Full Pint's children and grandchildren.

A unique feature of Top Shelf is that it has potential as a dual-purpose malting variety suitable for all-malt or grain distilling depending on growing environment and agronomic management practices. As part of the Distiller's Delight project, these lines were grown under differing fertilizer rates to evaluate their response to field nitrogen. The goal of the management trial was to help select a line with a high nitrogen response; that is, it

Table 2. Agronomic performance of fall planted DH162310 compared to check cultivars. Average of the 2022 University of Idaho Extension Trials (Aberdeen and Rupert, Idaho).

Entry	Yield (kg/ha)	Test Weight (kg/hL)	Heading (DOY)	Plant height (cm)	Lodging (%)	Spring Stand (%)
DH162310	11,030	65.1	148	104	18	100
Endeavor	10,424	63.3	154	109	32	100
Wintmalt	11,365	62.2	154	102	7	100
Thunder	12,778	65.3	152	102	24	100
Charles	10,491	59.0	153	104	67	100

Check varieties are all GN+.



Figure 2. A grower walks through rows of Top Shelf at an on-farm trial near Boistfort in Western Washington.

would produce quality, low-protein malt for all-malt distilling when grown using minimal fertilizer but conversely take up nitrogen efficiently when available in order to drive up grain protein and produce a high-enzyme

grain distilling malt (often referred to as distillers malt). As shown in Table 3, malt quality at differing protein levels is benchmarked against the American Malting Barley (AMBA) guidelines for all-malt and grain

distilling respectively (3). When managed for low-grain protein, Top Shelf shows exceptional extract but still a robust enzyme and FAN package. As growers turn the nitrogen up to 11, the enzymes follow suit, providing the starch degradation needed for grain distilling, and even then the extract is no slouch. Top Shelf also has a solid PSY that exceeds that of Thunder when malted under standard protocols, and is greater than the AMBA recommendation of 400 LAA/tonne (Table 4). Unlike the UK where Scotch whisky is so dominant, PSY is not regularly measured on lines from North American breeding programs, making greater comparisons difficult for now.

Table 3. Malt quality of DH162310 at increasing protein levels, grown in Corvallis, Oregon, in 2021. Micro-malted and analyzed at the USDA-ARS CCRU.

Grain Protein	Malt Extract	S/T	DP	α -amylase	β -glucan	FAN
%	%	%	°ASBC	20°DU	mg/L	mg/L
9.4*	85.1**	62.6 [#]	193	115 [#]	69*	309 [#]
12.5 [#]	83.4**	55.6 [#]	259 [#]	120 [#]	82*	349 [#]
12.9 [#]	82.9**	54.2 [#]	256 [#]	119 [#]	117*	346 [#]
13.2 [#]	82.4**	53.6 [#]	279 [#]	109 [#]	87*	355 [#]

Extract — fine grind, dry basis; DP, diastatic power; FAN, free amino nitrogen.

*Meets AMBA guidelines for all-malt distilling. #Meets AMBA guidelines for grain distilling.

Table 4. Malt quality of DH162310 and Thunder grown in Oregon 2021. Micro-malted at OSU under standard protocols and analyzed at Hartwick College.

Entry	Malt Extract	Malt protein	S/T	DP	α -amylase	β -glucan	FAN	PSY
	%	%	%	°ASBC	20°DU	mg/L	mg/L	(LAA/Tonne)
DH162310	84.0**	10.5*	51.0 [#]	141*	65*	88*	251 [#]	405*
Thunder	82.8**	9.7*	55.5 [#]	120*	77 [#]	52*	266 [#]	398

Extract — fine grind, dry basis; DP, diastatic power; FAN, free amino nitrogen; PSY (predicted spirit yield).

*Meets AMBA guidelines for all-malt distilling. #Meets AMBA guidelines for grain distilling.

Thunder is GN+ and used as a check variety.

Industry Evaluation

The next step on the variety's release journey is a migration through the AMBA evaluation pipeline. The organization's member maltsters, brewers, and distillers review elite barley lines submitted by breeding programs to audit the next generation of malting barley varieties (4). While growers and maltsters are not bound by the AMBA list, these recommendations provide a pool of vetted malting barleys to choose from and can make grain contracting easier to manage. This process can take up to six years and Top Shelf just successfully passed its first year of assessment in pilot-scale evaluation. In the next year Top Shelf will be put through another round of pilot-scale trials. Thankfully, the flexible AMBA system allows exciting new varieties to be fast-tracked for commercial release even while testing is ongoing. OSU has scheduled Top Shelf's release for the fall of 2023 with a non-exclusive license and foundation seed will be available to licensees for 2024 planting.

In concert with AMBA evaluation, Top Shelf is already being put through the paces in the distillery. The Barley Project is collaborating on distillation and sensory trials with the James B. Beam Institute at the

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University of Kentucky. While brewing trials are common in the AMBA variety evaluation process, published distillation trials for experimental lines are harder to come by in North America. Developing a pipeline for relatively high throughput distillation evaluations could be a key step in improving public breeding of GN0 varieties that meet the processing expectations of distillers. This initial work focused on all-malt, batch-distilled whiskey in the style of single-malt, but future work will include bourbon-type distillation trials. An additional goal of these trials is to evaluate the sensory profile of the new GN0 variety relative to a control and another GN0 line with potential for release. This research group has spent the last decade investigating the role that barley variety plays in beer flavor, and thus, this begged the question as to whether the specific barley variety contributes to spirit flavor. Full details of the distillation trials and outcomes of the sensory work will be reported in a future manuscript.

Conclusion

Increasing interest in GN0 barley from the North American distilling community has encouraged breeders to include this trait as a focus in their efforts. Steady progress has already been made with a handful of spring varieties that have been primarily embraced by the craft malting sector. With the release of Top Shelf, there will now be a more mainstream selection with a wider growing location adaptation and the potential to produce grain for both all-malt and grain whiskey production. As a winter variety it also fits the broader industry's interest in building resiliency into the supply chain. It will take a few more years for Top Shelf to undergo sufficient seed increases to plant on meaningful acreage, but it will soon enough make its way into mash-tuns and cereal cookers. Continued efforts by breeding programs will result in even more GN0 offerings for distillers, and Top Shelf is just the first offering in the way of GN0 varieties — a second selection may also be released by OSU in the fall of 2023, and there are many more GN0s in the breeding pipeline. Collaborations between breeders and research groups such as the James B. Beam Institute will lead to further advancement in distilling malt availability and quality. 

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