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Evaluation of Florida-grown barley for brewing applications: yield and fermentability

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Introduction

Barley is an annual, cool-season grass that provides the requisite fermentable sugars for brewing and distilling operations. The state of Florida ranks 4th in the United States in beer production by volume yet does not boast a commercially viable barley crop of its own, presenting a potential market for Florida-grown barley. Despite similarities in the USDA Plant Hardiness Zones of Florida and traditional barley-growing regions (Figure 1), the length of day in Florida, coupled with the inveterate seasonality of cash crops already being grown in the region and a general lack of crop management guidance for the successful cultivation of barley in Florida present ongoing challenges to the establishment of this emerging crop.

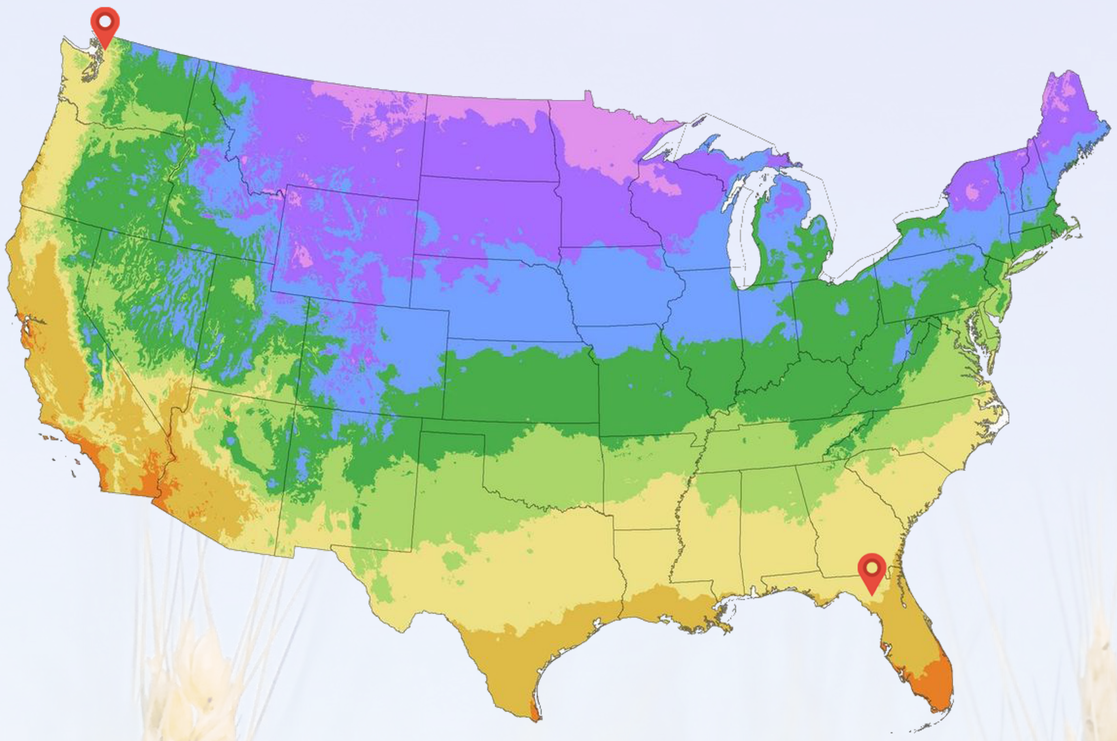

Figure 1. USDA Plant Hardiness Zones and markers to pinpoint Live Oak, Florida and Skagit Valley, Washington. Plant hardiness zone 8b is characterized by a maximum low temperature range of -12.2 to -6.7 °C.

Objective

The specific objective of this experiment was to assess the potential viability of eight different barley varieties grown in USDA climate zone 8b in Florida to support brewing and distilling operations in Florida by evaluating plot yield and soluble solids content/extract of each.

Methods and Materials

The eight barley varieties selected for this study were evaluated using heading date, potential yield, plant height, stem breakage at maturity, and susceptibility to diseases at single planting date (Barrett et al. 2021).

Table 1. Barley varieties and sources.

Variety	Source
Copeland Control	Skagit Valley Malt
CDC Copeland Barley	Johnny's Selected Seeds
Genie Barley	Limagrain Cereal Seeds
ND Genesis Barley	Albert Lea Seeds
Conlon Barley	Johnny's/Albert Lea Seeds
Esma Barley	North Dakota State University
Odyssey Barley	Limagrain Cereal Seeds
Pinnacle Barley	Johnny's Selected Seeds
Opera Barley	Limagrain Cereal Seeds

The plot yield of each barley variety was measured using the USDA-NASS "Estimating Small Grain Yields" procedure.

Barley was sifted through a 0.7 x 0.7 cm mesh followed by a 0.3 x 0.3 cm mesh for final removal of stems and other unwanted constituents (Figure 2). EBC Method 4.5.1, Congress Mash, was performed on the unmalted Florida barley varieties. The method was modified by adding 0.114 grams of alpha-amylase to the ground unmalted barley to provide the necessary enzyme for starch to sugar conversion. The malted Copeland served as the control for the fermentation and did not receive an addition of enzyme because it was commercially malted. The finished wort for each variety was assessed using an Anton Paar densitometer to record the extracted sugars and total weight was recorded.

Barley Yield

Across all five planting dates, November 2020 planting dates (11/10 and 11/24) produced significantly more barley bushels per acre in all varieties compared to the earlier planting date in October. Barley prefers dry conditions with high sun; Therefore, the smaller difference in barley yield between November and December may be attributed to differences in dryness and sun exposure as late December saw more rainfall and less sunlight during the day (Climate Summary for Florida - December 2020 - Florida Climate Center).

A late November planting date saw Genie, ND Genesis, Esma, Odyssey, and Opera barley varieties produce significantly higher yield than Copeland, Conlon, and Pinnacle varieties, with yields ranging from 44.1 to 65.3 bushels per acre.

Figure 2. (left) Hand sifted barley (ASBC Malt 4); (right) Finely ground, sifted barley (ASBC Malt 4).

Table 2. Average Florida barley yield at different planting times analyzed with Tukey test among Florida varieties at each planting date. Different letters indicate significant difference ($p < 0.05$). Capitalized letters are used to compare across planting dates. Lower-case letters are used to compare across varieties. All measurements were done in triplicate except when the value has *.

	Barley Yield (bu/ac)				
Variety	**10/21/2020**	**11/10/2020**	**11/24/2020**	**12/9/2020**	**12/22/2020**
Copeland	3.4 ± 2.9 C a	27.0 ± 10.7 B ab	34.9 ± 9.6 B b	34.0 ± 11.8 B a	34.6 ± 7.8 B a
Genie	9.6 ± 7.1 C a	28.4 ± 11.2 B ab	45.2 ± 10.2 B ab	-	-
ND Genesis	6.1 ± 4.1C a	29.0 ± 8.7 B ab	47.3 ± 6.6* A ab	33.9 ± 13.8 AB a	28.0 ± 6.5 B a
Conlon	3.3 ± 2.6 C a	28.0 ± 11.5 B ab	31.2 ± 11.3 B b	33.2 ± 7.9 B a	22.5 ± 4.9 B a
Esma	9.4 ± 2.2 C a	36.6 ± 7.2 B ab	44.1 ± 16.2 B ab	32.4 ± 19.9 BC a	33.4 ± 7.5 B a
Odyssey	7.9 ± 3.4 C a	37.3 ± 8.6 B ab	65.3 ± 14.0* A a	-	-
Pinnacle	4.5 ± 2.9 C a	22.7 ± 9.0 B b	27.7 ± 12.9 B b	30.4 ± 7.7 B a	23.5 ± 5.1 B a
Opera	10.0 ± 3.6 C a	43.2 ± 7.1 B a	47.7 ± 9.3* B ab	-	-

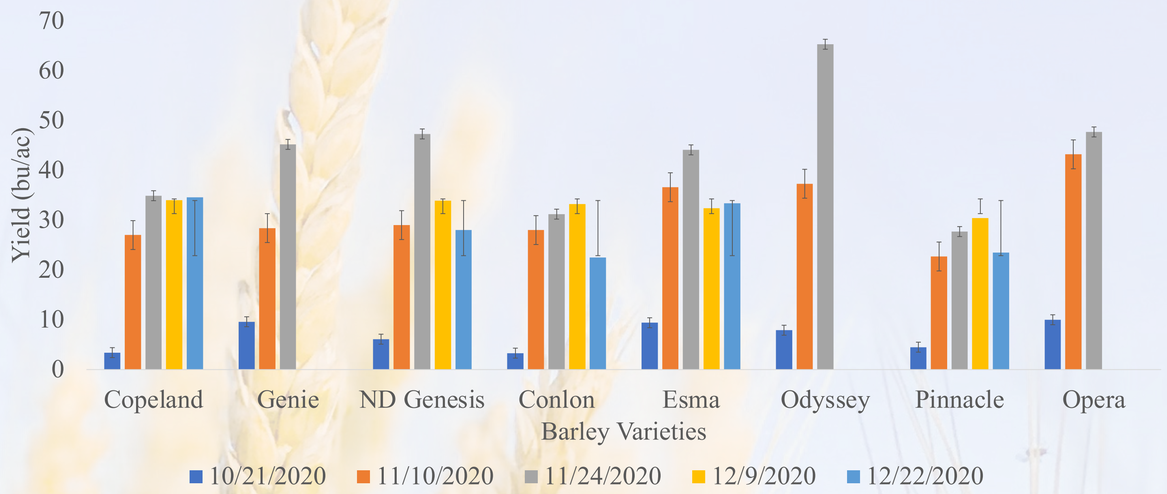

Figure 2. Average yield of barley varieties grown in Florida at different planting dates.

Extract

Table 3. Average initial sugar concentration of wort after Congress Mash (post-autoclave) for each barley variety. Data were analyzed using a Tukey test. Different letters indicate significant difference ($p < 0.05$).

Variety	Sugar Content Post-mash (°Plato)	Extract, f.g., as-is %	Extract, f.g., d.b %
Copeland (control)	12.6 ± 0.1 a	77.7 ± 0.6	81.8 ± 0.7
Copeland	10.4 ± 0.1 b	64.0 ± 0.4	73.6 ± 0.4
Esma	10.4 ± 0.1 b	63.8 ± 0.9	73.3 ± 1.1
ND Genesis	9.9 ± 0.5 bc	60.2 ± 3.2	69.2 ± 3.7
Conlon	9.8 ± 0.1 bd	59.5 ± 0.5	68.4 ± 0.5
Pinnacle	9.8 ± 0.4 bd	59.5 ± 2.3	68.4 ± 2.7
Opera	9.8 ± 0.8 bd	59.5 ± 5.1	68.4 ± 5.9
Genie	9.4 ± 0.1 cd	57.2 ± 0.9	65.8 ± 1.1
Odyssey	9.0 ± 0.3 d	54.8 ± 1.9	64.3 ± 2.1

From this data, Copeland, Esma, Pinnacle, and Opera are expected to be the most likely to result in successful fermentations with respect to sugar consumption and yeast growth, while Odyssey and ND Genesis will be less likely to produce a comparable fermentation performance to the control.

Conclusions

In Florida, a planting date in late fall produced a greater barley yield than any other planting date and saw the most variability in yield among varieties planted at that time.

Fermentable sugar concentrations were highest in Copeland, Esma, Pinnacle, and Opera barley varieties, with extracts (f.g., d.b. %) ranging from 68.4 to 73.6. From these results, it can be inferred that Esma and Opera barley varieties stand to benefit local brewing and distilling operations most as Florida-grown crops with respect to yield and sugar content.

The results of this study support the viability of Florida-grown barley for use in local brewing and distilling operations, which would have the additional benefit of supporting Florida economies and satisfying consumer demand for locally sourced ingredients for craft food and beverage products.

Future Work

More research is needed to evaluate the yield results of a December planting date in Florida, despite the increased rainfall reported between November and December.

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