Grain yield and malting indices of brewing barley as affected by time of planting and nitrogen management in the Northeastern USA

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Introduction: In response to increasing demand from local craft brewers for locally grown barley grains, a comprehensive research project was conducted to optimize date of planting and fertility management for growing contributing to yield and malt-quality barley in Massachusetts.

Design:

- 3 dates of planting (DOP); September 5, 15, and 25, in 2015 and 2016
- Within each DOP each of six nitrogen (N) regimes were replicated in a RCB
- 6 N regimes were either 50 or 0 kg ha^{-1} N at planting, followed by either (28, 50, or 73 kg ha^{-1}) N/ac in the spring.
- Data were analyses using SAS Proc GLM, followed by either orthogonal polynomial comparisons or Tukey's HSD as appropriate. ** indicates $p<0.01$, * indicates $p<0.005$.

Measurements:

Field data and sample collections were performed in accordance with industry standards and included winter survival, heading date, foliar disease level, grain yield, test weight, germination test, whole plant and kernel protein content, falling number, and deoxynivalenol (DON) levels.

Results:

- Fall N applications had no meaningful impact on any of the measured indices, with the exception of a negative impact on the agronomic NUE.
- Larger application of N in the spring resulted in increased yields, and only increased foliar disease at the highest rate. While higher protein was observed in the high N levels, all were in the acceptable range for malting
- Earlier planting dates had higher yields than the late planting date in the first year of the trial, but suffered appreciably higher rates of foliar diseases, primarily powdery mildew. While lower protein was observed in the later planting dates, all were in the acceptable malting range.
- In the second year of the trial, the earlier planting date suffered significant winter kill, reducing yield as compared to the early planting dates
- In contrast to foliar disease rates, which increased with earlier planting dates, DON levels increased with later planting dates.
- Agronomic NUE significantly decreased with any given fall N treatment.

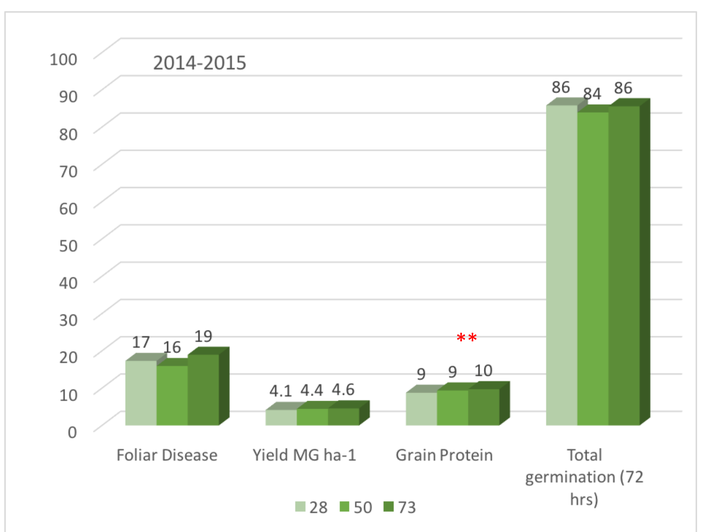

Figure 1. Yield and growth parameters of winter barley influenced by spring fertility management.

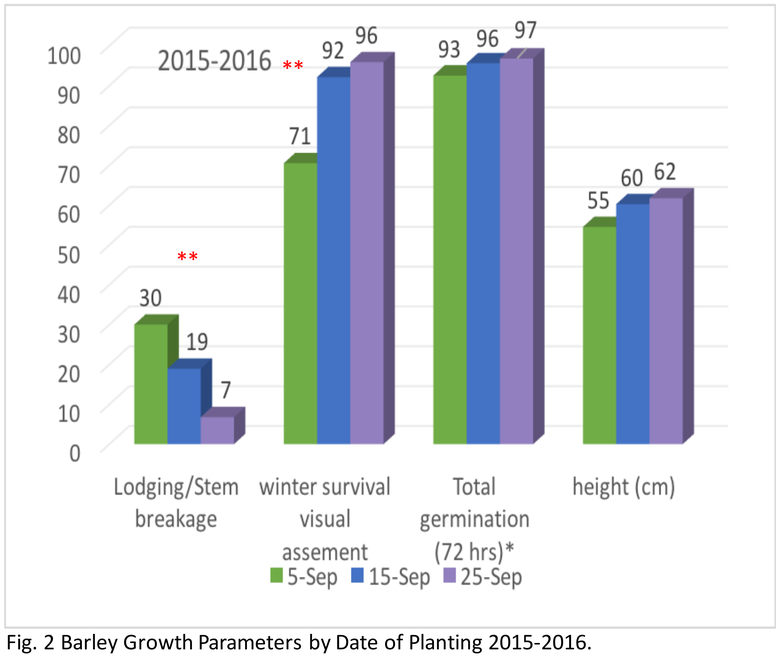

Fig. 2 Barley Growth Parameters by Date of Planting 2015-2016.

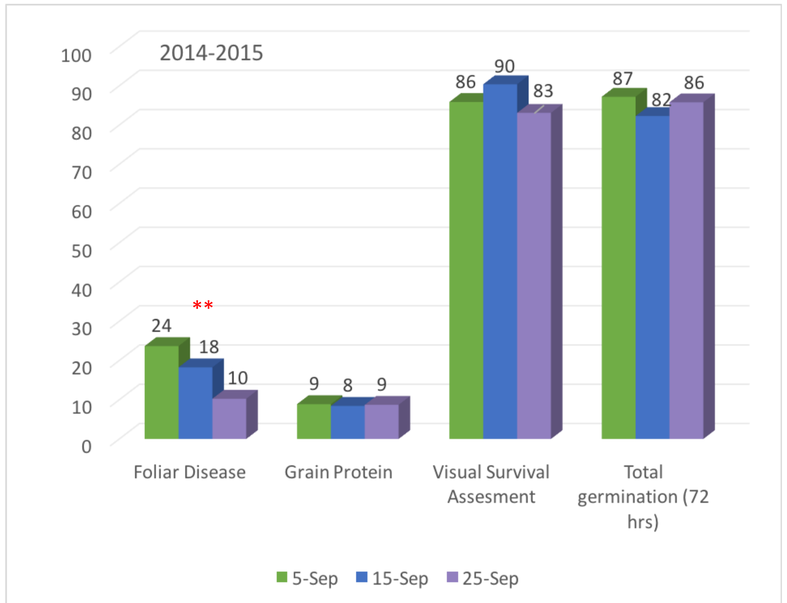

Fig. 3 Barley Yield and Growth Parameters by Date of Planting 2015-2016.

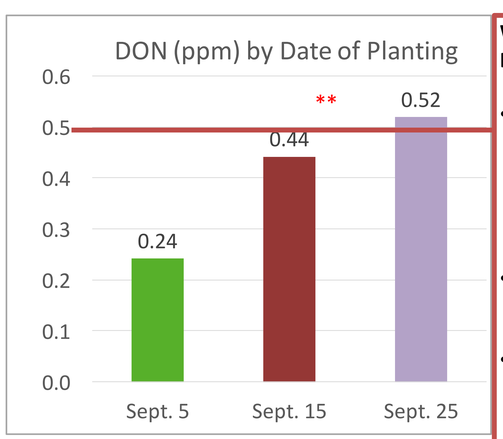

Figure 4. DON levels increased significantly with later planting dates.

What is the importance of Deoxynivalenol (DON) in malt barley?

- DON (aka 'vomitoxin') is a mycotoxin produced by fungi within the *Fusarium* genus, which infect small grains at anthesis. *F. graminearum* is of greatest concern in the Northeast.
- FDA guidelines set DON limits at 1ppm for finished wheat products for human consumption.
- Many maltsters will reject barley with DON levels of 0.5 ppm (or even lower) as the fungi can grow during steeping and some of the mycotoxin can withstand the brewing process to cause 'gushing' in finished beer.

Conclusions:

- Nitrogen applied in the fall represents a fertilizer expenditure for growers and the potential N loss to the environment with no measureable benefit at harvest.
- The decreasing NUE in relationship to increasing spring N applications is to be expected, however, is counterbalanced by numerically increasing total yields. Appropriate application of spring N to winter barley should be informed by this relationship, and also by the cost of N fertilizer, expected market price of malt barley and input costs specific to the grower.
- While foliar disease at plant maturity has limited impact on yield, the presence of DON due to *Fusarium* infestation can render the crop unsuitable for malting, significantly reducing or eliminating the market value of the crop.

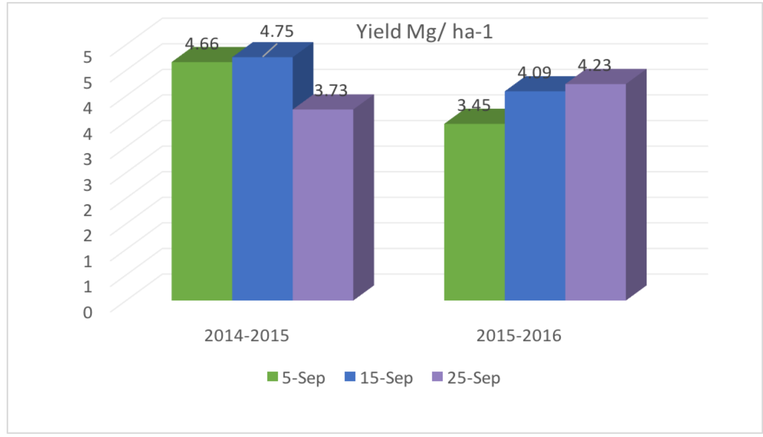

Figure 5 Yield by date of planting throughout the trial.

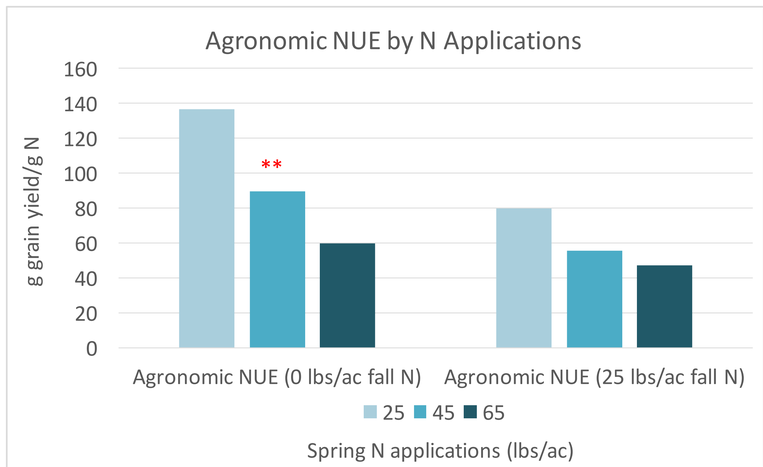

Figure 6. Agronomic NUE decreased significantly with the overall application of fall N and with increasing applications of spring N when N was applied in the fall. Agronomic NUE was calculated as calculated as grams grain/ g total N applied .

A fine ale rendered undrinkable due to gushing. A truly tragic waste of barley.

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