**Evaluation of Organic Fungicides to Reduce FHB and DON Infection of Barley in Vermont.**

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**ABSTRACT**

Public interest in sourcing local foods has extended into beverages leading to a rapid expansion of the northeast malting industry. This has provided farmers with new market opportunities and many of these markets are interested in purchasing certified organic barley. However, all farmers are struggling to produce barley that is not infected with FHB and DON.In Vermont during 2024 we observed the disease and yield impact of inoculation with *Fusarium graminearum*, and treatment with two organic fungicides at two timings. The ChampION and Double Nickel fungicides were applied at heading. ChampION was also applied both at heading and 4 days after heading. Finally, in combination ChampION was applied at heading with an application of Double Nickel 4 days after heading. The 2024 growing season was conducive to Fusarium infection with mild conditions and above average rainfall throughout the spring and summer. All fungicide treatments and timings, including the control and the Fusarium inoculated plots, had DON concentrations above the 1 ppm threshold recommended by the FDA. However, there were significant differences observed in DON concentrations for the fungicide treatments. The highest DON concentration was in the ChampION treatment (applied at heading) at 3.82 ppm and was significantly higher than all other treatments. The ChampION treatment applied at heading and 4 days after heading had the lowest DON concentration (1.44 ppm) but was statistically similar to ChampION applied at heading combined with Double Nickel applied 4 days after heading, the uninoculated control, and the Fusarium inoculated plots. Overall, the organic treatments did not reduce DON concentrations compared to the control; however, the application of organic fungicides at heading and 4 days after heading provided some control over just one application at heading. Additional research should be conducted to evaluate combinations of organic fungicides and timing of application.

**OBJECTIVE**

To evaluate the effects of application timings of two organic fungicides on barley yield and the management of Fusarium head blight (FHB) and deoxynivalenol (DON) in Vermont.

**INTRODUCTION**

Public interest in sourcing local foods has extended into beverages leading to a rapid expansion of the northeast malting industry. This has provided farmers with new market opportunities and many of these markets are interested in purchasing certified organic barley. However, all farmers are struggling to produce barley that is not infected with FHB and DON.Hence integrated management strategies are essential for managing yield and quality losses from FHB. Most farmers in New England have experienced significant crop loss from FHB and some farmers have already stopped growing barley. At present, few farmers are specifically selecting varieties for resistance to FHB and even fewer are combining host resistance with fungicide applications. There has been little to no research conducted to evaluate organic approved fungicides. Other regions have shown that the use of a well-timed fungicide is an important management tool when suppressing FHB in barley production. In Vermont during 2024 we observed the disease and yield impact of inoculation with *Fusarium graminearum*, and treatment with two organic fungicides at two timings.

**MATERIALS AND METHODS**

The trial was conducted in Alburgh, VT during 2024. The soil type was a Benson silt loam soil. The plot size was 5 x 20 ft including seven rows with 7-in spacing. Planting occurred April 23, 2024. The plots were sown with ‘Robust’ (susceptible) barley at 350 seeds per m2 with a Great Plains grain drill (Salinas, KS). The experiment was set up as a completely randomized block design with fungicide treatments, randomized in four replicated blocks. Fungicide treatments are shown in Table 1. The first fungicide application (with surfactant at 0.125% V/V) was applied at heading (Feekes growth stage, FGS 10.1) on June 13, 2024. After the fungicide had dried, plots were spray-inoculated with a conidial suspension of *F. graminearum* (40,000 conidia/ ml) to augment the development of FHB. The ChampION and Double Nickel fungicide was applied at heading. ChampION was also applied both at heading and 4 days after heading. Finally, in combination ChampION was applied at heading with an application of Double Nickel 4 days after heading. Fungicide and *F. graminearum* treatments were applied with a CO2 backpack sprayer with paired TJ-60 8003vs nozzles mounted at an angle (30o from horizontal) forward and backward, 20-in. apart, pressurized at 30 psi, and calibrated to deliver 20 gal/A. Grain was harvested using an Almaco plot combine (Nevada, IA). Grain moisture, plot yield, and test weight were recorded. Yield and test weight were adjusted to bushels ac-1 at 13.5% moisture. Deoxynivalenol (DON) concentrations were analyzed at the McMaster lab at Virginia Tech on an Agilent 6890N / 5975 GC/MS. This method has a detection range of from 0.025ppm – 15ppm. Treatment means were calculated, subjected to analysis of variance, and separated by Fisher’s protected LSD test (P = 0.05).

**RESULTS AND DISCUSSION**

Weather conditions in Vermont during the 2024 growing season can be characterized as moderate temperatures with excessive rain. Temperatures were at or slightly above the 30-year average. Rainfall was well above the 30-year average with 7.15 inches of precipitation more than normal from April to August. Overall, weather conditions were conducive for Fusarium infection.

All fungicide treatments and timings, including the control and the Fusarium inoculated plots, had DON concentrations above the 1 ppm threshold recommended by the FDA (Table 2). However, there were significant differences observed in DON concentrations for the fungicide treatments. The highest DON concentration was in the ChampION treatment (applied at heading) at 3.82 ppm and was significantly higher than all other treatments. The ChampION treatment applied at heading and 4 days after heading had the lowest DON concentration (1.44 ppm) but was statistically similar to ChampION applied at heading combined with Double Nickel applied 4 days after heading, the uninoculated control, and the Fusarium inoculated plots. Overall, the organic treatments did not reduce DON concentrations compared to the control; however, the application of organic fungicides at heading and 4 days after heading provided some control over just one application at heading.

Additional research should be conducted to assess the efficacy of multiple applications of organic fungicides on FHB.

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**Table 1.** Organic fungicide treatments, active ingredients and rates applied.

|  |  |  |  |
| --- | --- | --- | --- |
| **Fungicide treatments** | **Company** | **Fungicide active ingredient** | **Application**  **rates** |
| Control |  |  | Water |
| *Fusarium graminearum* |  |  | 40,000 spores/ml |
| Champ ION++ | NuFarm | Copper hydroxide | 1.5 lbs ac-1 |
| Double Nickel | Certis Biologicals | *Bacillus amyloliquefaciens strain D747* | 6.0 qts ac-1 |
|  |  |  |  |

**Table 2.** Effect of organic fungicide + timing on deoxynivalenol (DON) contamination and grain yield at Alburgh, VT, 2024.

|  |  |  |  |
| --- | --- | --- | --- |
| **Fungicide + timing** | **DON** | **Test weight** | **Yield** |
|  | **ppm** | **lb bu-1** | **bu ac-1** |
| Non-sprayed, non-inoculated control | 1.84 | 44.8 | 65.4 |
| Inoculated FGS at heading | 2.04 | 44.4 | 55.4 |
| ChampION at heading | 3.82 | 43.8 | 60.4 |
| Double Nickel at heading | 2.63 | 45.7 | 59.7 |
| ChampION at heading plus 4 days after heading | 1.44 | 44.9 | 66.9 |
| ChampION at heading plus Double Nickel 4 days after heading | 1.98 | 45.7 | 63.9 |
| LSD (p=0.05) **†** | 1.05 | 0.89 | 11.8 |

**†**LSD; least significant difference at p-value = 0.05.