RESULTS OF CROPPING SYSTEMS RESEARCH CONDUCTED IN SOUTH CENTRAL MONTANA-2016

Southern Agricultural Research Center, Huntley, MT

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1. Project Name: Nitrogen management and variety comparisons of Moravian malt barley.

2. Investigators:
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3. Justification: We have tested several Moravian varieties over the past 3 years for response to nitrogen fertilizer. Last year it appeared that Moravian 150 had a slightly higher requirement for N per bushel. So a study was designed to get a more accurate measure of total N needed for optimum production of this variety. Additionally several Moravian varieties were added to the regional off-station variety trials to continue to compare their performance with other varieties currently grown by area producers.

4. Objectives: A nitrogen rate fertility study was located at the Research Center in Huntley and was managed under flood irrigation. Fertilizer nitrogen rates starting at 50 lbs/A and increasing at 15 lb/a increments up to 210 lbs/a were used to zero in on the optimum rate necessary for production. A second study included five Moravian varieties in the off-station variety trials conducted at four locations in the area. There were two irrigated sites, Fromberg and Hysham, and dryland sites near Broadview and Musselshell. All fertility and weed control at the off-station locations was managed by the cooperating producers.

5. Methods: The nitrogen study was arranged as a randomized complete block with 4 replications. Each plot was approximately 5 feet wide by 15 feet long planted with border plots (same dimension) between each pass of treatments. This allowed the urea fertilizer to be hand broadcast from the center of one border plot across the treated plot to the center of the border plot on the opposite side. This method avoids creating edge effects on small plot research which can be significant especially with fertilizer studies. The rates were 0, 50, 65, 80, 95, 110, 125, 140, 155, 170, 185, and 210 lbs N/acre. Fertilizer was spread on March 16 and immediately incorporated using a spring-toothed harrow. Moravian 150 barley was planted on March 17 at a population of 900,000 plants/acre. Soil residual nitrate was 45 lbs nitrate-N in a 4 foot profile. Plots were harvested on July 20. The variety trial studies consisted of 25 varieties arranged in a 5x5 lattice with 3 replications. Two of these were managed under flood irrigation. The other two were managed under dryland conditions. All were on local producer farms where fertility and weed control were managed by the producers. Results are presented in a separate report that compiles all of our off-station barley variety trials.

6. Results: The nitrogen study produced a very clean response curve for yield with yields optimized (95% of maximum yield) at 137 bu/a (Table 1). The total nitrogen needed to attain this yield was

179 lbs N/acre which computes to 1.3 lbs N/bushel of yield goal. This is in agreement with the average across several varieties for the past 2 years. Test weight, moisture, plump, and thins were unaffected by N rates used in this study. Plant height increased with increased nitrogen applied. Protein significantly responded to additions of N rising from 9.5 to 12.1 % across the same range of N rates.

Soil was sampled directly after harvest to determine residual nitrate. The majority of nitrate was found in the top foot for all treatments measured (Table 2) with only the highest treatment (210 lbs N/a) having a greater amount of residual N than the other treatments and this was in the top 0-12" depth. The difference in the top foot carried over to the total for the profile where the 210 lb N/acre rate resulted in significantly higher total nitrate than the lesser N treatments. The majority of this mineral N was most likely mineralized after plant uptake as the crop matured and the grain dried down. Deeper soil profiles for all treatments showed very little residual N in the subsoil layers.

The yield response to applied nitrogen dataset was very clean which provided an opportunity to determine the number of treatments needed to estimate an optimum N rate for malt barley yield. For the analysis above all the data points (12) were used to fit a regression equation. The fit was excellent with an R^2 of 0.99 (Table 3). By reducing the total number of points used to conduct regression analysis the estimate for optimum N rate was largely unaffected. Adding the maximum N rate (210 lbs N/a) to the original proposed rates did not improve the estimate for optimum N rate and neither did the estimate improve by including the check (0 N rate). In fact across all analysis using 3, 4, 7, or 12 points the estimate for optimum N rate ranged from 1.27 to 1.31 lbs N/bushel of yield goal.

Table 1. Malt barley grain yield and quality across various nitrogen fertilizer rates, Huntley 2016

N Rate	Grain Yield	Test Wt	Moist	Plump	Thin	Height	Protein
lbs N/a	bu/a	lbs/bu	%	%	%	inches	%
0	60.7	51.4	10.3	94.1	1.0	23.2	10.4
50	96.8	50.9	10.3	93.5	1.0	27.7	9.5
65	113.0	51.2	10.3	94.9	0.8	28.4	9.6
80	117.9	51.2	10.4	94.4	1.0	29.3	9.6
95	123.9	51.1	10.3	94.8	0.7	28.5	9.9
110	129.6	51.5	10.3	95.2	0.9	29.8	10.1
125	130.0	51.3	10.4	94.5	1.0	28.8	10.3
140	137.2	51.5	10.3	94.4	1.0	30.4	10.8
155	142.4	52.1	10.4	94.3	1.0	30.9	11.2
170	140.8	50.4	10.3	94.1	1.0	30.3	11.2
185	141.4	51.7	10.3	94.5	0.8	31.1	11.9
210	143.3	52.0	10.5	94.4	1.0	31.5	12.1
Average	123.1	51.4	10.3	94.4	0.9	29.2	10.5
CV%	4.2	1.5	1.3	1.1	27.9	3.5	2.9
LSD(.05)	7.5	NS	NS	NS	NS	1.5	0.4

Means separation by Fisher's protected LSD at 5% confidence level. NS = non significant.

Table 2. Residual soil nitrate following malt barley harvest, Huntley 2016.

N Rate	0 to 12 in	12 to 24 in	24 to 36 in	36 to 48 in	Total Profile
Lbs N/acre	---------- lbs NO_3-N ----------				
0	17.5	6.5	5.5	6.0	35.5
80	16.0	4.0	5.0	5.0	30.0
140	19.5	4.5	8.0	6.5	38.5
170	19.5	5.0	6.5	5.5	36.5
210	34.5	7.0	6.5	8.0	56.0
LSD(.05)	6.4	NS	NS	NS	10.4

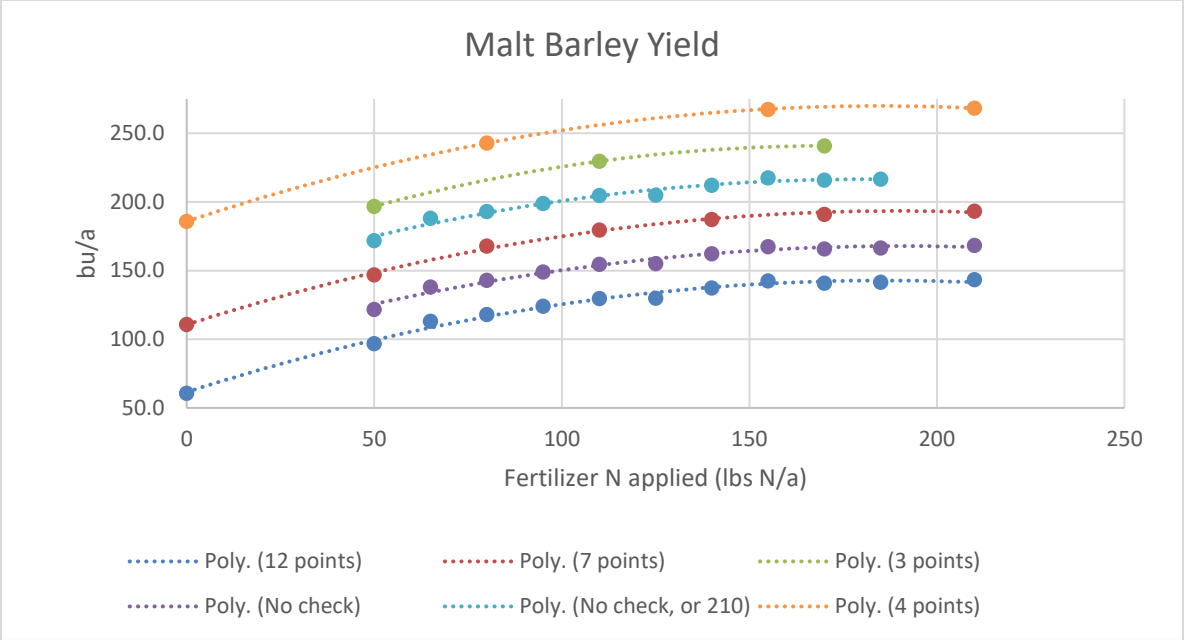

Figure 1. The actual yield (12 points) is represented by the bottom blue dots which is fitted to a 2nd order polynomial equation. To separate the curves (for display and clarity only) 25 bu/a increments were added to each data point. Second order polynomials were fit to each set (See Table 3 below). It is apparent that three data points provided as good an estimate of yield and optimum Nitrogen rate as using twelve points. Additionally excluding the check point and the highest N rate (210 lbs/a) did not significantly reduce the accuracy of the estimates for optimum N rate (Table 3).

Table 3. Regression equations in the form Yield (bu/a) = ax^2+bx+c, where x = fertilizer N rate plus 45 (lbs of residual N in the 0 to 24" profile prior to planting) were conducted with the entire data set (12 points) and with specific treatments excluded. Each yield data point was an average of 4 replications. Optimum N rate is the total N needed to attain 95% of maximum yield.

Coefficient	12 points	7 points	4 points	3 points	No check	No check or 210 rate
a	-0.002	-0.002	-0.003	-0.003	-0.002	-0.002
b	0.873	0.874	0.909	1.026	0.813	0.880
c	61.6	60.6	60.7	53.0	65.2	62.2
R^2	0.991	0.998	1.000	1.000	0.975	0.974
Optimum N/bushel	1.30	1.31	1.27	1.29	1.32	1.28