

Project Title: Effects of seeding rate and fertilizer rate on dryland malt barley

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Objectives: To determine the planting rate for optimum, dryland malt barley yield and quality; and to evaluate the effects of nitrogen (N) and sulfur (S) fertilization on yield and quality of malt barley.

Results: Grain yield, kernel plumpness, grain protein, and grain S content data are tabulated in Tables 2 thru 5, respectively. Site characteristics and soil test results are shown in Table 1. Average grain yields ranged from 58 bu/ac to 88 bu/ac, and grain plumpness at all locations, except Joplin, exceeded 75%. The Joplin location experienced severe drought conditions this year. Increasing planting rate increased grain yields all locations except Cut Bank, Ethridge, and Joplin. Kernel plumpness declined with increasing planting rate at all locations except Cut Bank. Nitrogen fertilization increased yields at all locations except Conrad (WTARC). Kernel plumpness declined with increasing N at Joplin, Sunburst, and Conrad (WTARC). Plump was unaffected by N at Cut Bank and Knees, and plump increased with increasing N at Ethridge. Grain yield at Cut Bank declined with increasing fertilizer S; however, yield was not significantly affected at the other locations. Kernel plumpness and grain protein content was unaffected by S. Grain protein content increased with N at all locations. Also grain protein generally declined with increasing planting rate, but grain protein contents were all less than 11.5 %.

2006 Summary: Grain yields were exceptionally high this year (except for Joplin) as shown by many individual treatments that had yields that exceeded 90 bu/acre. All fertilizer and planting rate treatments had percent plump kernels that exceeded 75 % and protein contents less than 11.5 %; however, the highest plump occurred when planting rate was 10 seeds per square foot with out N fertilizer. Sulfur fertilization did not affect plump or protein content, but one location had a yield reduction due to S. Counting the data from 2004 and 2005, S fertilization has reduced yields in five out of 17 locations.

Three year summary: Under dryland conditions and typical starter fertilizer programs of 60 lbs of 11-52-0, most fallow fields will have enough N for malt barley production. Fields should be soil tested for nitrate N and additional N fertilizer added to correspond to 1 to 1.2 lbs N/bu yield goal. Optimum seeding rate for yield, plump, and protein content appears to be around 15 pure live seeds per square foot. Sulfur fertilizers should not be used.

Future Plans: None

Table 1. Site characteristics and soil test results by location. Western Triangle Ag. Research Center. 2006.

Site Characteristics						
Character	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
Planting Date	4/25	4/18	4/14	4/28	4/20	4/19
Harvest Date	8/21	8/8	8/1	8/7	8/14	8/16
Previous Crop	Chem. Fallow	Chem. Fallow	Chem. Fallow	Chem. Fallow	Chem. Fallow	Conv. Fallow
Growing Season Precipitation (inches)	4.10	4.27	3.64	4.00	6.05	6.89
Spray Date	6/6	6/7	6/6	None	ND	6/2
Soil Test Results						
Test	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
pH	8.8	8.0	8.0	8.0	7.9	7.9
O.M. (%)	0.7	1.8	2.0	2.7	1.7	2.4
P (ppm)	5	24	21	11	14	22
K (ppm)	174	540	369	621	271	376
EC (mmhos/cm)	0.42	0.41	0.33	0.51	0.40	0.28
NO ₃ -N (0-3', lb/ac)	67.5	67.3	125.2	97.5	41.5	62.5
SO ₄ -S (0-3', lb/ac)	94	152	352.8	125	82	319

ND=Not determined. **=Bronate Advanced @ 1.6 pt/a tank mixed with Achieve SC @ 8oz/a. *=Soil sample to two feet depth.

Table 2. Effect of nitrogen, sulfur, and planting rate on yield of dryland malt barley. Western Triangle Ag. Research Center. 2006.

Treatment		Location					
Plant. rate	N-S	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
seed/ft ²	lb/ac	-----bu/ac-----					
10	0 - 0	71.2	70.1	41.5	67.9	41.8	72.5
15	0 - 0	83.5	70.8	41.1	71.4	48.1	79.9
20	0 - 0	86.6	75.1	36.8	74.1	51.9	73.7
10	30 - 0	83.2	73.6	39.7	75.2	50.5	73.6
15	30 - 0	94.1	76.5	34.8	73.7	49.8	81.5
20	30 - 0	94.9	74.9	42.9	76.0	57.2	82.2
10	60 - 0	93.1	75.2	38.5	76.8	50.3	74.8
15	60 - 0	98.5	73.0	40.6	79.5	59.7	79.6
20	60 - 0	103.5	78.6	40.5	76.7	59.8	79.6
10	0 - 10	79.3	65.6	39.6	68.1	45.0	69.4
15	0 - 10	81.2	73.6	39.9	75.0	50.2	71.6
20	0 - 10	83.5	70.9	40.6	77.5	52.3	74.3
10	30 - 10	88.5	70.2	41.4	70.5	50.3	78.6
15	30 - 10	92.1	75.6	44.2	76.0	55.7	80.6
20	30 - 10	93.0	78.3	40.4	77.4	64.5	80.8
10	60 - 10	90.0	70.9	38.5	78.6	57.5	76.5
15	60 - 10	100.7	77.3	41.6	81.2	64.2	81.6
20	60 - 10	102.2	75.8	40.1	80.7	63.1	80.5
10	0 - 20	71.8	69.9	44.7	67.3	42.4	75.3
15	0 - 20	79.4	67.9	44.4	73.7	46.5	75.5
20	0 - 20	84.5	72.1	40.7	73.8	51.7	70.4
10	30 - 20	80.3	74.1	43.4	77.1	49.8	77.1
15	30 - 20	85.4	79.4	40.0	79.1	55.8	78.0
20	30 - 20	95.8	76.6	40.5	77.7	56.4	83.5
10	60 - 20	85.9	66.7	37.3	72.6	59.5	71.7
15	60 - 20	91.1	78.0	38.0	77.7	61.5	78.0
20	60 - 20	97.8	73.2	39.2	78.3	61.3	81.9

Table 2. Continued						
Treatment	Location					
	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
Planting Rate Summary						
10 seeds/ft ²	82.6 a	70.7 a	40.5 a	72.7 a	49.7 a	74.4 a
15 seeds/ft ²	89.6 b	74.7 b	40.5 a	76.4 b	54.6 b	78.5 b
20 seeds/ft ²	93.5 c	75.1 b	40.2 a	76.9 b	57.6 b	78.5 b
P-value, Linear contrast	0.001	0.468	0.823	0.001	0.001	0.001
P-value, Quad. contrast	0.271	0.690	0.888	0.090	0.465	0.029
Nitrogen Summary						
0 lbs/ac	80.1 a	70.7 a	41.1 a	72.1 a	47.8 a	73.6 a
30 lbs/ac	89.7 b	75.5 b	40.8 a	75.9 b	54.4 b	79.5 b
60 lbs/ac	95.8 c	74.3 b	39.3 a	78.0 c	59.7 c	78.2 b
P-value, Linear contrast	0.001	0.019	0.224	0.001	0.001	0.001
P-value, Quad. contrast	0.213	0.026	0.595	0.388	0.589	0.001
Sulfur Summary						
0 lbs/ac	89.8 a	74.2 a	39.6 a	74.6 a	52.1 a	77.5 a
10 lbs/ac	90.1 a	73.1 a	40.7 a	76.1 a	55.9 a	77.1 a
20 lbs/ac	85.8 b	73.1 a	40.9 a	75.3 a	53.9 a	76.8 a
P-value, Linear contrast	0.011	0.468	0.350	0.532	0.260	0.530
P-value, Quad. contrast	0.099	0.690	0.709	0.206	0.036	0.956
Statistical Summary						
Mean	88.5	73.5	40.4	75.3	54.0	77.1
CV (%)	7.5	8.7	14.5	6.1	12.3	5.7
Interaction p-values						
Plt Rate x N Rate	0.999	0.922	0.576	0.314	0.608	0.113
Plt Rate x S Rate	0.322	0.511	0.809	0.575	0.928	0.489
N Rate x S Rate	0.786	0.708	0.423	0.091	0.803	0.240
N Rate x S Rate x Plt rate	0.786	0.619	0.766	0.890	0.816	0.164

Yield means with the same letter are not significantly different accord to the LSD (p=0.05).

Table 3. Effect of nitrogen, sulfur, and planting rate on kernel plumpness of dryland malt barley. Western Triangle Ag. Research Center. 2006.

Treatment		Location					
Plant. rate	N-S	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
seed/ft ²	lb/ac	-----%-----					
10	0 – 0	93.9	91.8	18.2	95.0	95.5	96.0
15	0 – 0	95.7	90.6	23.0	94.0	95.7	96.3
20	0 – 0	95.2	91.4	13.3	90.2	94.8	94.9
10	30 – 0	94.0	90.7	14.6	92.2	95.4	97.0
15	30 – 0	93.9	83.2	6.2	89.3	95.1	96.6
20	30 – 0	95.1	76.9	15.5	88.7	94.4	94.3
10	60 – 0	93.2	89.2	8.1	86.6	94.7	95.0
15	60 – 0	94.4	73.4	11.6	85.2	94.7	95.1
20	60 – 0	94.0	74.9	13.5	80.3	93.7	93.8
10	0 – 10	95.4	95.9	16.3	92.6	93.9	97.0
15	0 – 10	94.4	92.2	27.4	94.9	94.9	96.3
20	0 – 10	95.5	89.3	20.2	90.1	95.3	94.8
10	30 – 10	94.8	90.4	18.4	94.7	95.0	97.1
15	30 – 10	95.1	88.5	20.2	92.4	95.3	96.0
20	30 – 10	96.0	82.5	12.2	88.3	93.9	95.0
10	60 – 10	93.9	90.8	11.3	88.4	96.0	96.4
15	60 – 10	94.5	77.7	15.1	83.3	95.3	94.1
20	60 – 10	94.7	78.3	9.9	78.2	94.6	92.5
10	0 – 20	95.9	93.1	30.0	96.2	95.4	95.4
15	0 – 20	95.4	91.9	28.3	92.9	94.9	94.4
20	0 – 20	95.0	93.3	20.9	89.5	94.2	94.2
10	30 – 20	94.6	89.6	20.6	93.1	95.7	96.2
15	30 – 20	95.3	84.8	15.7	91.8	94.8	94.6
20	30 – 20	94.3	89.0	11.3	88.8	94.0	94.1
10	60 – 20	93.6	87.4	9.3	89.0	95.8	95.4
15	60 – 20	93.4	82.1	7.7	83.5	95.3	94.3
20	60 – 20	93.8	71.6	8	81.3	94.8	92.2

Table 3. Continued						
Treatment	Location					
	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
Planting Rate Summary						
10 seeds/ft ²	94.4 a	91.0 a	16.3 a	92.0 a	95.3 a	96.2 a
15 seeds/ft ²	94.7 a	84.9 b	17.2 a	89.7 b	95.1 a	95.3 a
20 seeds/ft ²	94.8 a	83.0 b	13.9 a	86.2 c	94.4 b	94.0 b
P-value, Linear contrast	0.146	0.159	0.349	0.001	0.003	0.001
P-value, Quad. contrast	0.789	0.310	0.324	0.568	0.336	0.455
Nitrogen Summary						
0 lbs/ac	95.1 a	92.2 a	22.0 a	92.8 a	94.9 a	95.5 a
30 lbs/ac	94.8 a	86.2 b	15.0 b	91.0 a	94.8 a	95.6 a
60 lbs/ac	93.9 b	80.6 c	10.5 b	84.0 b	95.0 a	94.3 b
P-value, Linear contrast	0.001	0.001	0.001	0.001	0.922	0.005
P-value, Quad. contrast	0.399	0.848	0.576	0.010	0.691	0.099
Sulfur Summary						
0 lbs/ac	94.4 a	84.7 a	13.8 a	89.0 a	94.9 a	95.4 a
10 lbs/ac	94.9 a	87.3 a	16.8 a	89.2 a	94.9 a	95.4 a
20 lbs/ac	94.6 a	87.0 a	16.8 a	89.6 a	95.0 a	94.5 a
P-value, Linear contrast	0.457	0.159	0.250	0.563	0.768	0.048
P-value, Quad. contrast	0.118	0.310	0.514	0.956	0.955	0.176
Statistical Summary						
Mean	94.6	86.3	15.8	89.3	94.9	95.1
CV (%)	1.4	7.8	68.7	5.4	1.2	2.1
Interaction p-values						
Plt Rate x N Rate	0.943	0.036	0.555	0.645	0.543	0.846
Plt Rate x S Rate	0.293	0.762	0.555	0.926	0.652	0.730
N Rate x S Rate	0.593	0.892	0.453	0.893	0.152	0.941
N Rate x S Rate x Plt rate	0.647	0.341	0.936	0.951	0.762	0.971

Yield means with the same letter are not significantly different accord to the LSD (p=0.05).

Table 4. Effect of nitrogen, sulfur, and planting rate on grain protein content of dryland malt barley. Western Triangle Ag. Research Center. 2006.

Treatment		Location					
Plant. rate	N-S	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
seed/ft ²	lb/ac	-----%-----					
10	0 – 0	10.00	10.31	ND	10.78	8.90	8.59
15	0 – 0	9.84	10.47	ND	11.09	7.97	9.38
20	0 – 0	9.84	10.31	ND	10.78	8.13	9.06
10	30 – 0	9.53	11.41	ND	11.09	9.06	9.69
15	30 – 0	9.53	10.63	ND	10.78	8.28	9.53
20	30 – 0	9.38	10.94	ND	11.09	7.81	9.53
10	60 – 0	10.31	10.94	ND	11.41	8.75	10.00
15	60 – 0	10.16	10.94	ND	10.94	8.44	9.69
20	60 – 0	10.00	10.94	ND	11.72	8.28	9.84
10	0 – 10	9.84	10.47	ND	11.09	9.69	8.28
15	0 – 10	9.53	10.31	ND	10.94	7.81	8.44
20	0 – 10	9.38	10.00	ND	11.25	7.50	8.28
10	30 – 10	9.53	10.78	ND	10.63	8.44	9.69
15	30 – 10	9.69	10.31	ND	10.78	7.97	9.38
20	30 – 10	9.69	10.47	ND	10.78	8.13	9.06
10	60 – 10	10.94	10.94	ND	11.25	9.38	10.16
15	60 – 10	10.31	10.78	ND	11.25	8.44	9.84
20	60 – 10	10.00	10.78	ND	11.56	8.59	9.53
10	0 – 20	9.38	10.16	ND	11.25	8.13	8.75
15	0 – 20	9.22	10.16	ND	10.78	8.13	8.44
20	0 – 20	9.22	9.53	ND	10.78	7.66	8.75
10	30 – 20	9.69	10.78	ND	11.41	8.28	9.38
15	30 – 20	9.38	10.16	ND	11.09	7.97	9.22
20	30 – 20	10.00	9.69	ND	11.56	7.97	8.91
10	60 – 20	10.94	10.94	ND	11.41	8.75	10.00
15	60 – 20	9.38	10.94	ND	11.09	8.59	9.84
20	60 - 20	10.00	10.31	ND	11.09	8.13	10.16

Table 4. Continued						
Treatment	Location					
	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
Planting Rate Summary						
10 seeds/ft ²	10.02 a	10.75 a	ND	11.15 a	8.82 a	9.39 a
15 seeds/ft ²	9.67 b	10.52 ab	ND	10.97 a	8.18 b	9.31 a
20 seeds/ft ²	9.72 b	10.33 b	ND	11.18 a	8.02 b	9.24 a
P-value, Linear contrast	0.283	0.002	ND	0.843	0.001	0.319
P-value, Quad. contrast	0.375	0.914	ND	0.088	0.098	0.942
Nitrogen Summary						
0 lbs/ac	9.58 b	10.19 b	ND	10.97 b	8.21 b	8.66 c
30 lbs/ac	9.60 b	10.57 a	ND	11.02 b	8.21 b	9.38 b
60 lbs/ac	10.23 a	10.83 a	ND	11.30 a	8.59 a	9.90 a
P-value, Linear contrast	0.001	0.001	ND	0.011	0.019	0.001
P-value, Quad. contrast	0.016	0.620	ND	0.286	0.170	0.439
Sulfur Summary						
0 lbs/ac	9.84 a	10.76 a	ND	11.08 a	8.40 a	9.48 a
10 lbs/ac	9.88 a	10.54 ab	ND	11.06 a	8.44 a	9.27 a
20 lbs/ac	9.69 a	10.30 b	ND	11.16 a	8.18 a	9.18 a
P-value, Linear contrast	0.283	0.002	ND	0.508	0.176	0.176
P-value, Quad. contrast	0.375	0.914	ND	0.593	0.302	0.148
Statistical Summary						
Mean	9.80	10.53	ND	11.10	8.34	9.31
CV (%)	6.32	5.91	ND	4.76	8.35	6.93
Interaction p-values						
Plt Rate x N Rate	0.150	0.426	ND	0.807	0.624	0.527
Plt Rate x S Rate	0.391	0.349	ND	0.667	0.236	0.686
N Rate x S Rate	0.167	0.569	ND	0.062	0.719	0.241
N Rate x S Rate x Plt rate	0.817	0.998	ND	0.688	0.399	0.922

Yield means with the same letter are not significantly different accord to the LSD (p=0.05).

ND=Not Determined.

Table 5. Effect of nitrogen, sulfur, and planting rate on grain sulfur content of dryland malt barley. Western Triangle Ag. Research Center. 2006.

Treatment		Location					
Plant. rate	N-S	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
seed/ft ²	lb/ac	-----%-----					
10	0 – 0	0.110	0.115	ND	0.115	0.108	0.113
15	0 – 0	0.103	0.118	ND	0.115	0.100	0.113
20	0 – 0	0.105	0.115	ND	0.118	0.105	0.108
10	30 – 0	0.108	0.128	ND	0.118	0.108	0.118
15	30 – 0	0.110	0.120	ND	0.120	0.103	0.115
20	30 – 0	0.103	0.125	ND	0.118	0.100	0.113
10	60 – 0	0.113	0.120	ND	0.125	0.113	0.120
15	60 – 0	0.113	0.123	ND	0.120	0.105	0.125
20	60 – 0	0.108	0.123	ND	0.123	0.103	0.120
10	0 – 10	0.105	0.110	ND	0.125	0.105	0.113
15	0 – 10	0.105	0.115	ND	0.118	0.103	0.115
20	0 – 10	0.105	0.115	ND	0.120	0.103	0.108
10	30 – 10	0.110	0.113	ND	0.123	0.113	0.118
15	30 – 10	0.100	0.118	ND	0.120	0.103	0.113
20	30 – 10	0.108	0.113	ND	0.118	0.100	0.115
10	60 – 10	0.115	0.118	ND	0.125	0.110	0.120
15	60 – 10	0.108	0.118	ND	0.123	0.110	0.120
20	60 – 10	0.110	0.120	ND	0.123	0.108	0.120
10	0 – 20	0.108	0.110	ND	0.120	0.108	0.113
15	0 – 20	0.105	0.118	ND	0.120	0.108	0.110
20	0 – 20	0.108	0.113	ND	0.118	0.105	0.110
10	30 – 20	0.113	0.120	ND	0.120	0.105	0.115
15	30 – 20	0.103	0.123	ND	0.118	0.100	0.118
20	30 – 20	0.108	0.110	ND	0.118	0.105	0.113
10	60 – 20	0.115	0.123	ND	0.123	0.115	0.123
15	60 – 20	0.110	0.120	ND	0.115	0.105	0.120
20	60 – 20	0.110	0.120	ND	0.118	0.103	0.125

Table 5. Continued						
Treatment	Location					
	Cut Bank	Ethridge	Joplin	Knees	Sunburst	WTARC
Planting Rate Summary						
10 seeds/ft ²	0.111 a	0.117 a	ND	0.121 a	0.109 a	0.117 a
15 seeds/ft ²	0.106 b	0.119 a	ND	0.119 b	0.104 b	0.116 a
20 seeds/ft ²	0.107 b	0.117 a	ND	0.119 b	0.103 b	0.114 a
P-value, Linear contrast	0.616	0.038	ND	0.066	0.001	0.097
P-value, Quad. contrast	0.499	0.010	ND	0.193	0.082	0.469
Nitrogen Summary						
0 lbs/ac	0.106 b	0.114 b	ND	0.119 a	0.105 ab	0.111 c
30 lbs/ac	0.107 b	0.119 a	ND	0.119 a	0.104 b	0.115 b
60 lbs/ac	0.111 a	0.120 a	ND	0.121 b	0.108 a	0.121 a
P-value, Linear contrast	0.002	0.001	ND	0.042	0.052	0.001
P-value, Quad. contrast	0.211	0.313	ND	0.342	0.082	0.278
Sulfur Summary						
0 lbs/ac	0.108 a	0.121 a	ND	0.119 a	0.105 a	0.116 a
10 lbs/ac	0.107 a	0.115 b	ND	0.121 a	0.106 a	0.115 a
20 lbs/ac	0.109 a	0.117 b	ND	0.119 b	0.106 a	0.116 a
P-value, Linear contrast	0.616	0.038	ND	0.837	0.475	0.834
P-value, Quad. contrast	0.499	0.010	ND	0.026	0.679	0.717
Statistical Summary						
Mean	0.108	0.118	ND	0.120	0.105	0.116
CV (%)	6.51	5.69	ND	4.76	6.22	4.84
Interaction	Interaction p-values					
Plt Rate x N Rate	0.895	0.318	ND	0.736	0.595	0.505
Plt Rate x S Rate	0.506	0.346	ND	0.736	0.962	0.778
N Rate x S Rate	0.999	0.281	ND	0.243	0.662	0.871
N Rate x S Rate x Plt rate	0.646	0.608	ND	0.883	0.382	0.609

Yield means with the same letter are not significantly different accord to the LSD (p=0.05).

ND=Not Determined.