HIGHER VALUE BARLEY: MALT BARLEY ENHANCEMENT BY SEEDING RATE

Anna Willy and Clair Langlois
Research Department, B.C. Grain Producers Association – Dawson Creek

ABSTRACT

Growing specialty crops provides produces with a greater range of markets, as well as the opportunity to receive premium prices. Malt barley is grown across Western Canada; therefore many of the guidelines to successfully growing malt barley have been established. However, the Peace River region has unique attributes, which may require a modification of such techniques. It is the goal of this study to look at one aspect that may influence the optimal conditions for producing malt grade barley: seeding rate. At the 2 - 2.25 bushels per acre seeding rate, about a day earlier in maturation is gained, which could translate to 3-5 days earlier by harvest. Results also show that there appears to be a near linear drop in both seed size and seed weight, as you increase seeding rate from 1.5 bushels per acre. Protein is non-responsive to seeding rate. The optimal seeding rate, as indicated by these results, is between 1.5 and 2 bushels per acre as adjusted for the bushel weight.

INTRODUCTION

Malting barley is a crop that will produce high quality malt. Domestic maltsters and exporters pay a premium price for this specialty crop. The quality requirements for malting barley are directly related to the processing efficiency and product quality in the malting and brewing industries, and are therefore reasonably strict. The producer has the capability to control many of these characteristics while others are influenced by weather conditions during the growing and harvesting season. A few of the characteristics required for high quality malting barley includes: a pure lot of an acceptable variety, germination of 95 percent or higher, protein content of 11-12.5 percent, moisture content of 13.5 percent maximum, plump kernel of uniform size and full maturity (bmbri, 2005).

The first step to successfully produce and market malting barley is variety selection; there are markets that prefer only one or two varieties of a particular type. The next step to starting malting barley production is by planting Certified Seed: this should be true to variety, plump, free of weed seeds and diseases as well as have a high germination (Mclelland et al., 1999). The seeding rate, fertilizer application and disease control are just as important and are components that the producer has control over.

The BC Peace River region has two unique attributes, which should allow high value malt barley to be grown. These include the long day-length and the usually good moisture. In order to ensure consistently good malting barley, proper management

techniques must be practiced. In the spring of 2002, the BC Grain Producers Association initiated agronomic trials to determine the best method of stabilizing malt barely characteristics. Fertility and disease control were looked at together in a separate study, while the seeding rate was looked at separately to reduce the number of variables and therefore the number of possible interactions. This trial was designed to study the yield and grain quality response of malting barely as the seeding rate was increased.

After the initial year's work had been undertaken in 2002, work of a similar nature had been initiated in Alberta on non-malt barley which brought attention to a possible influence seeding rate might have on maturity (O'Donovan et al., 2004). Thanks to the Alberta work, maturity data was also included in this study's data assessment package from 2003 onward.

MATERIALS AND METHODS

Two farm sites are used to collect data: the first is located in the South Peace at Dawson Creek (DC) the other is in the North Peace at Fort St. John (FSJ). The sites are kept as identical as possible and are treated equally throughout the season. Plots are planted, maintained, analyzed and harvested according to proper research protocol.

Each plot has a total area of 8.4 meters squared at planting, six rows wide each at 20 cm spacing (eight inches) by seven metres long, which are trimmed back in season to ensure plot length, avoid treatment overlaps while providing a pathway between replicates for viewing and assessments. Fertility levels were maintained to represent levels expected for malt barley production in the Peace Region and guided by spring soil sampling results taken each spring prior to planting. Weeds were controlled with common herbicides used for malt grade barley in the Peace River area.

Physiological maturity was determined through the collection of whole-head dry-down samples that are weighed in-laboratory as soon after collection as possible, dried down completely using heated air, and re-weighted immediately upon completion of heated drying. Harvest is done as soon as conditions allow using a small-plot research combine. The yield samples are air-dried with ambient air in house to equalize grain moisture content before final analysis occurs.

The varieties used include: the two-row varieties of Harrington, AC Metcalfe and CDC Bold, as well as B1602 a six-row barely. CDC Bold is a semi-dwarf feed barley for comparison purposes should an interaction occur between variety and seeding rate. The variety component of the study will be labeled as Factor A. The second variable in the trial is the rate of seeding, otherwise labeled Factor B. Five different rates were tested: 1.5, 2, 2.25, 2.5 and 2.75 bushels per acre. The correct bushel weight for each variety is determined through the collection of the percent germination and the hectolitre weights. In this fashion the same number of viable seeds per bushel per acre is planted for all varieties studied.

RESULTS & DISCUSSION

Table 1. Yield response to seeding rate

	Yield - Bu/Ac												
	2006		2005		2004		2003		2002				
Seeding Rate	DC	FSJ	DC	FSJ	DC	FSJ	DC	FSJ	DC	FSJ	Average	DC Avg	FSJ Avg
1.5 bus/acre	18.17	70.33	110.48	110.27	102.57	90.18	111.41	105.48	74.48	87.46	88.08	83.42	92.74
1.75 bus/acre	16.25	70.88	111.40	114.12	101.41	86.43	114.09	107.06	77.30	88.25	88.72	84.09	93.35
2 bus/acre	16.70	70.75	111.22	113.21	100.24	89.62	114.00	104.21	77.49	87.88	88.53	83.93	93.13
2.25 bus/acre	16.32	71.53	110.92	113.18	100.41	92.54	114.71	107.05	78.36	85.78	89.08	84.14	94.02
2.5 bus/acre	15.92	67.97	112.28	112.61	98.56	92.23	117.77	102.29	81.74	86.10	88.75	85.25	92.24
2.75 bus/acre	15.63	71.60	112.71	112.39	93.72	89.33	117.20	106.58	78.93	88.97	88.71	83.64	93.77
CV value	13.18%	6.49%	2.80%	5.76%	5.76%	9.76%	5.39%	7.23%	5.71%	5.49%			
Factor A prob.	0.0084	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001			
Factor B prob.	0.1723	0.2956	0.4504	0.7036	0.0009	0.4096	0.0573	0.4318	0.0013	0.3799			
Factor A x B prob.	0.5244	0.9368	0.0132	0.1435	0.5707	0.5345	0.7346	0.9585	0.4014	0.4362			

Table 2. Maturity response to seeding rate

	Maturity - "Days to 20% Moisture"												
	2006		2005		2004		2003		2002				
Seeding Rate	DC	FSJ	DC	FSJ	DC	FSJ	DC	FSJ	DC	FSJ	Average	DC Avg	FSJ Avg
1.5 bus/acre	86.86	76.38	92.86	89.93	101.70	106.04	96.30	98.30			93.55	94.43	92.66
1.75 bus/acre	88.28	76.30	92.03	89.00	100.20	107.62	96.10	97.80			93.42	94.15	92.68
2 bus/acre	87.12	77.51	91.92	89.73	98.45	106.13	94.80	97.10			92.84	93.07	92.62
2.25 bus/acre	86.51	76.53	90.97	88.85	98.13	106.14	94.90	98.10			92.52	92.63	92.41
2.5 bus/acre	86.86	76.23	90.93	88.48	99.47	107.78	95.00	96.80			92.69	93.06	92.32
2.75 bus/acre	86.51	76.45	90.67	88.77	99.44	107.17	93.30	97.10			92.43	92.48	92.37
CV value	2.67%	2.15%	1.00%	3.25%	2.86%	2.24%	1.60%	1.45%					
Factor A prob.	0.8701	0.1371	0.003	0.0095	0.1457	0.0001	0.0001	0.0001					
Factor B prob.	0.4292	0.4897	0.0006	0.6916	0.0481	0.2622	0.0002	0.0464					
Factor A x B prob.	0.513	0.4924	0.1016	0.5112	0.7486	0.138	0.0412	0.1277					

Table 3. Percent Kernel Protein response to seeding rate

	Percent Kernel Protein												
	2006		2005		2004		2003		2002				
Seeding Rate	DC	FSJ	DC	FSJ	DC	FSJ	DC	FSJ	DC	FSJ	Average	DC Avg	FSJ Avg
1.5 bus/acre	16.75	14.07	10.53	11.83	13.28	11.09	13.89	11.56	14.52	11.35	12.89	13.79	11.98
1.75 bus/acre	16.69	14.12	10.44	11.75	13.24	11.02	13.80	11.28	14.35	11.22	12.79	13.70	11.88
2 bus/acre	16.61	14.13	10.44	11.81	13.40	11.05	13.82	10.79	14.35	11.48	12.79	13.72	11.85
2.25 bus/acre	16.51	14.01	10.32	11.45	13.39	11.12	13.76	10.79	14.27	11.23	12.69	13.65	11.72
2.5 bus/acre	16.65	14.00	10.33	11.55	13.45	11.18	13.75	10.96	14.28	11.43	12.76	13.69	11.82
2.75 bus/acre	15.48	14.06	10.38	11.53	13.46	11.30	13.75	10.86	14.27	11.30	12.64	13.47	11.81
CV value	11.62%	2.11%	3.26%	6.35%	1.25%	3.94%	1.17%	4.57%	*Pooled	*Pooled			
Factor A prob.	0.0027	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001	*Pooled	*Pooled			
Factor B prob.	0.391	0.6617	0.6313	0.6994	0.0009	0.5146	0.2319	0.0017	*Pooled	*Pooled			
Factor A x B prob.	0.3084	0.2869	0.2342	0.2543	0.5313	0.976	0.6504	0.1111	*Pooled	*Pooled			

*****Pooled - one composite sample was collected per treatment by mixing small samples from each replicate.

Table 4. Thousand Kernel Weight response to seeding rate

	TKW												
	2006		2005		2004		2003		2002				
Seeding Rate	DC	FSJ	DC	FSJ	DC	FSJ	DC	FSJ	DC	FSJ	Average	DC Avg	FSJ Avg
1.5 bus/acre	37.03	42.26	46.75	48.05	47.08	49.12	44.38	42.82	47.06	47.02	45.16	44.46	45.85
1.75 bus/acre	35.66	42.15	46.40	46.58	47.17	48.71	43.63	43.30	47.15	47.29	44.80	44.00	45.61
2 bus/acre	35.24	41.69	45.50	46.73	46.13	48.64	43.92	42.14	46.45	46.94	44.34	43.45	45.23
2.25 bus/acre	34.93	42.03	45.30	46.00	46.51	48.19	43.58	41.94	46.27	46.20	44.09	43.32	44.87
2.5 bus/acre	34.70	41.23	45.43	45.88	46.05	46.69	43.65	42.17	46.24	45.42	43.74	43.21	44.28
2.75 bus/acre	34.14	41.76	44.40	46.10	45.43	47.58	42.94	40.92	45.99	45.47	43.47	42.58	44.37
CV value	3.03%	2.24%	2.11%	3.27%	3.87%	3.60%	3.12%	5.06%	2.35%	2.35%			
Factor A prob.	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001			
Factor B prob.	0.0001	0.0485	0.0005	0.0003	0.0669	0.0022	0.1033	0.0523	0.0168	0.0001			
Factor A x B prob.	0.4676	0.0814	0.0494	0.7686	0.9464	0.8533	0.2925	0.1146	0.8302	0.1994			

Table 5. Percent plumps response to seeding rate

	% Plumps												
	2006		2005		2004		2003*		2002*				
Seeding Rate	**DC**	**FSJ**	**DC**	**FSJ**	**DC**	**FSJ**	**DC**	**FSJ**	**DC**	**FSJ**	**Average**	**DC Avg**	**FSJ Avg**
1.5 bus/acre	77.38	87.27	93.90	89.33	92.86	91.48					88.70	88.05	89.36
1.75 bus/acre	72.18	87.64	93.64	89.19	91.97	91.68					87.72	85.93	89.51
2 bus/acre	69.26	86.64	93.10	88.70	93.24	91.35					87.05	85.20	88.90
2.25 bus/acre	69.33	85.74	92.79	83.18	93.05	90.64					85.79	85.06	86.52
2.5 bus/acre	64.67	85.21	92.87	88.26	92.86	89.82					85.62	83.47	87.76
2.75 bus/acre	64.80	86.25	92.48	88.13	93.11	90.80					85.93	83.46	88.39
CV value	12.44%	4.21%	1.25%	9.55%	2.36%	2.46%							
Factor A prob.	0.0001	0.0001	0.0414	0.1836	0.0001	0.0001							
Factor B prob.	0.0407	0.488	0.0186	0.4352	0.6312	0.198							
Factor A x B prob.	0.0302	0.5292	0.4546	0.4114	0.6961	0.6222							

***No Data Collected**

Note: the results displayed above do not show values for Factor A, variety, on its own, this is because there was no interaction seen to exist between the variety type and the seeding rate.

Overall Yield Response

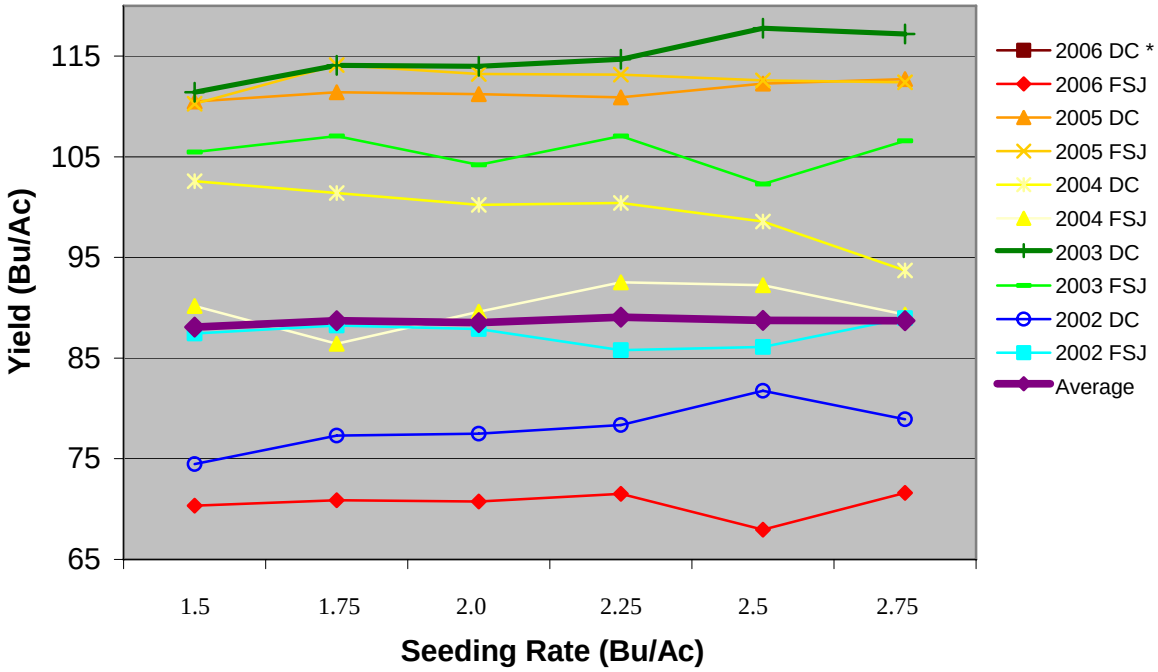

Figure 1. Yield response of malt barley to seeding rate in Dawson Creek and Fort St. John
* 2006 DC cannot be seen on this graph, as the yields are small, the data can be found in Table 1.

There is not a notable response in yield to the seeding rate as can be seen in Figure 1. The average shows a relatively flat line, with 2.25 bushels per acre being the highest point at 89.08 bushels per acre. The average for FSJ also shows a flat line with the highest point at 2.25 bushels per acre. DC however has the highest yield at 2.5 bushels per acre. This can be explained by that fact that DC has been the drier site with a deficit in available soil moisture. Figure 1, however clearly shows that there is no advantage to increasing the malt barley seeding rates in order to increase the yield.

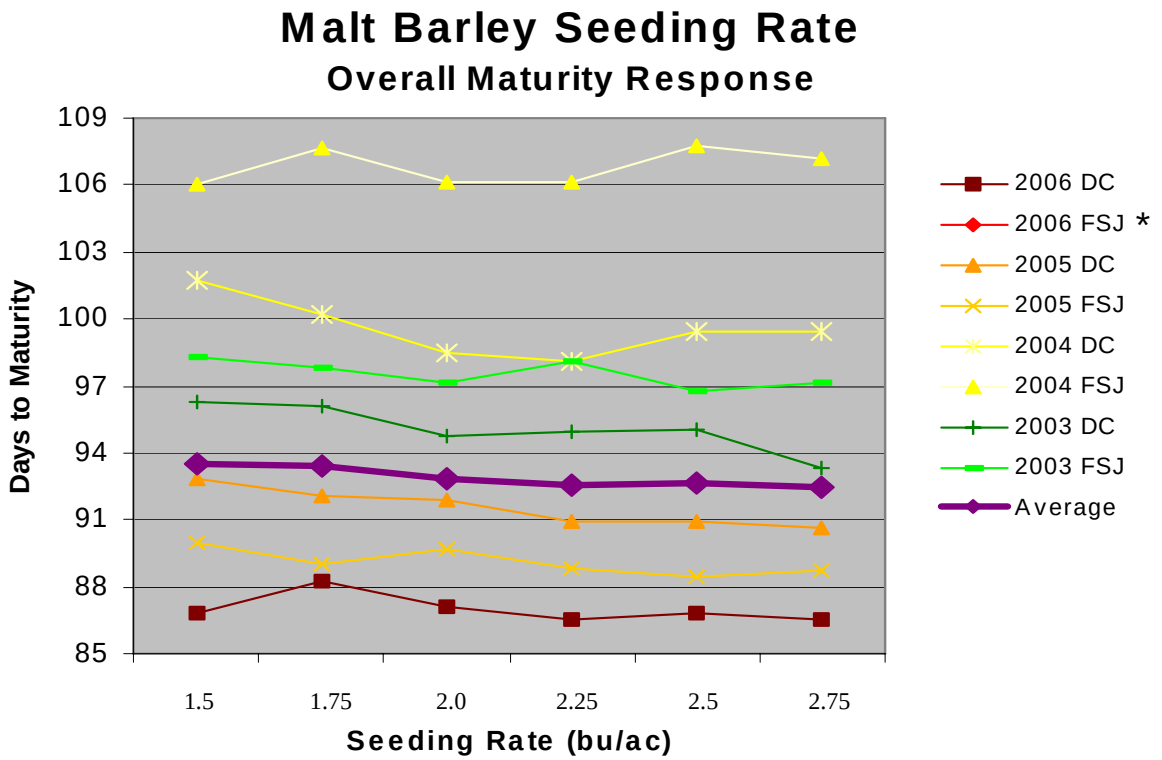

Figure 2. Maturity response of malt barley to seeding rate in Dawson Creek and Fort St. John
* 2006 FSJ cannot be seen on this graph, as the maturity's are to low, the data can be found in Table 2.

The average indicates a slight decrease in the days to maturity as the seeding rate increases, with the lowest occurring at 92.52 days and 2.25 bushels per acre. That is a full day early than what is seen at 1.5 bushels per acre. It is possible that this would result in the crop being harvested a week early, which would be beneficial in the years of early frost or snow. This figure indicates that the higher seeding rates are optimal.

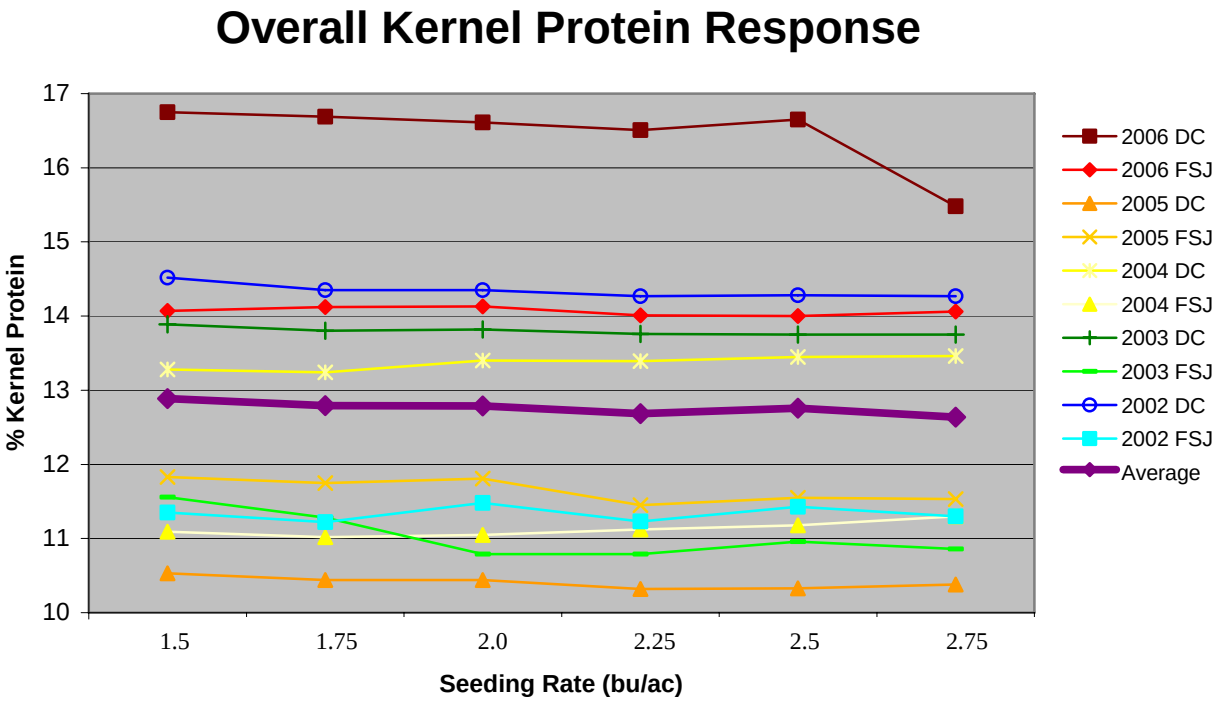

Figure 3. Protein response of malt barley to seeding rate in Dawson Creek and Fort St. John

Once again the average is a relatively flat line, Table 3 shows the lowest percent protein to be 12.64 and the highest at 12.89. Therefore there is not a great advantage for kernel protein with an increased seeding rate. It is believed that as yield increases the protein content drops; this is seen to be true as Fort St. John has the highest yields and the lowest protein content, whereas Dawson Creek has the lower yields and the higher protein contents. Again this could be related to environmental factors, as DC has experienced the most severe drought conditions. The requirement for malt grade is a protein between 11 and 12.5 percent, producing high protein is a common problem in this area. Table 3 shows the average for DC and FSJ; FSJ proteins were perfect whereas those from DC were are high.

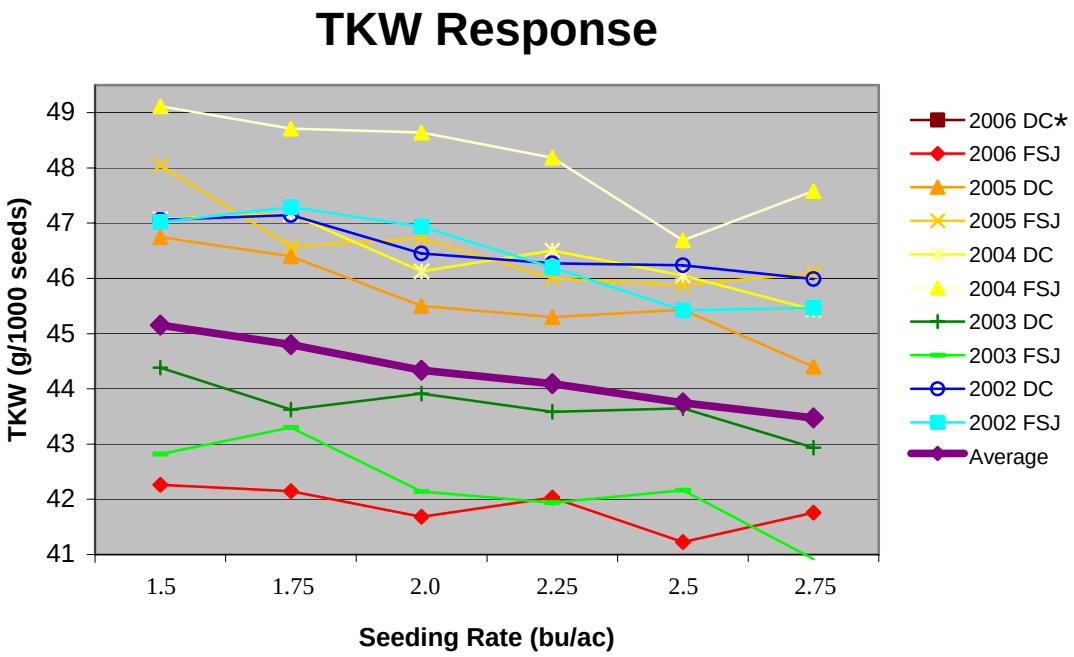

Figure 4. Thousand Kernel Weight response of malt barley to seeding rate in Dawson Creek and Fort St. John

* 2006 DC cannot be seen on this graph, as the TKW's are to small, the data can be found in Table 4.

The average seed weight, as described by the thousand-kernel weight, is seen to decrease slightly. A 1.69-gram per thousand seed difference occurs between 1.5 and 2.75 bushels per acre. A requirement of the malt grade is a relatively large seed size, therefore, this decreasing trend is of concern. The optimal range for malt grade would be the seeding rate of 1.5 or 1.75 bushels per acre.

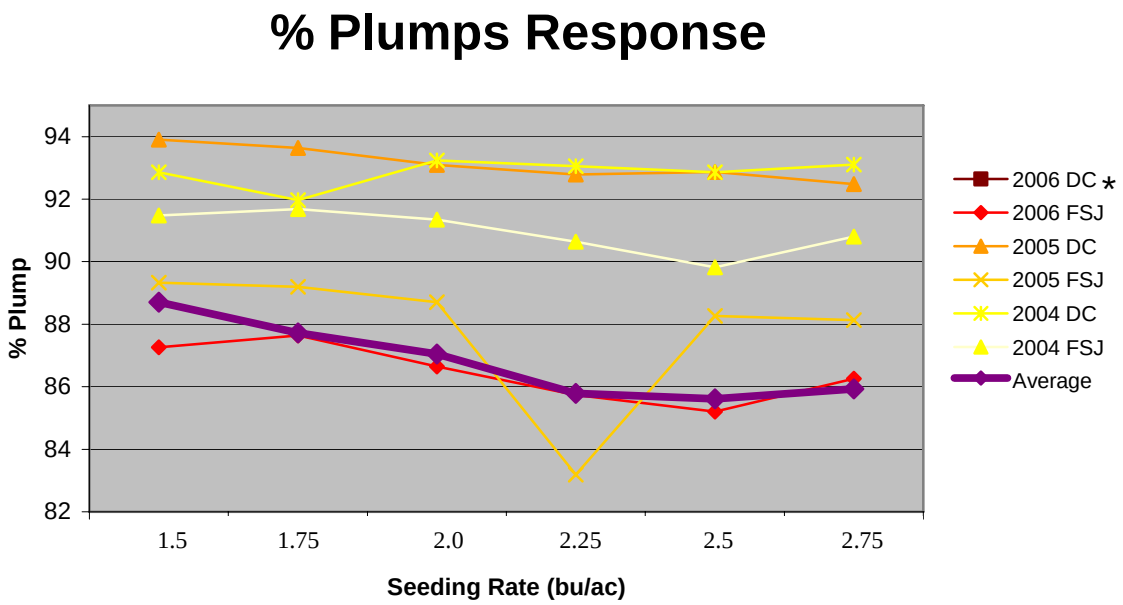

Figure 5. Percent Plumps response of malt barley to seeding rate in Dawson Creek and Fort St. John

* 2006 DC cannot be seen on this graph, as the plump percents are to small, the data can be found in Table 5.

This parameter was not collected in 2002 and 2003. The average shows a decrease in the percent of plumps as the seeding rate is increased, there is a difference of 3.08 percent between 1.5 and 2.5 bushels per acre. This parameter is also an important trait in meeting the malt grade, a high percentage of uniform plump seeds are required. Therefore, according to this graph the optimum rate would be in the 1.5 to 2 bushel per acre range.

CONCLUSION

This results shows that neither the yield nor the percent proteins are affected by the seeding rate. Leaving maturity, thousand kernel weights and percent plumps to determine the optimal rate. Maturity experienced an advantage along with the increased seeding rate, resulting in early maturity be it minimal, which in a region that often receives early frost and/or snowfalls is of significant relevance. However, this is not true for the thousand kernel weights or the plumps. In fact they experienced the opposite effect: as the seeding rates were increased, both the seed weight and the percentage of plumps decreased slightly. The level of drop is less than 4 percent for thousand kernel weights when using the 2.75 bushel per acre seeding rate, but only 2.4 percent loss at the 2.25 bushel per acre seeding rate, the apparent optimum rate for maturity gains. Similarly there is only a 3.3 percent drop in percent kernel plumps for using the 2.25 bushels per acre seeding rate over the 1.5 bushels seeding rate, but this area is more of a concern as the malt grade requires a plump, uniform seed. As it turns out, the seed size is more important then the risk of having a slightly later maturing crop.

It should be noted that the data presented in this report are contradictory to the interim conclusions made after three years of the project were completed. It is possible that higher seeding rates may have other attributes, which are not covered in this study, however, there does not seem to be any real yield advantage, drop in protein or improvements to reducing the maturation period as witnessed over the entire five-year length of the project. Therefore, the final conclusions state that the optimal seeding rate for malt barley production in the BC Peace River region lies in the lower range between 1.5 and 2 bushels per acre.

LITERATURE CITED

bmbri. 2005. Quality Factors in Malting Barley. Brewing and Malting Barley Research Institute. http://www.bmbri.ca. 11/04/07

McLelland, M., K. Panchuk, B. Green, D. Campbell, J. Foster, Dr. B. Harvey, Dr. B. Rossnagel and Dr. N. Kendall. 1999. Malting Barley. Agriculture and Food: Alberta Government.http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex98?opendocument. 11/04/07

O'Donovan, J.T [a]., G.W. Clayton [b], K.N. Harker [b] and T.K. Turkington [b]. 2004. Estimating Barley Plant Density and Yield as a Funcion of Seeding Rate in Alberta Canada. Disscussion. Agriculture and Agri-Food Canada. Beaverlodge [a] and Lacombe[b], Alberta, Canada.