PROJECT REPORT

Effect of Modifying Physiological Age of Seed Potatoes via Winter Warming or Extended Seed Cooling on Yield, Quality and Economic Value of PEI Potato Processing Varieties: Year Two

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Introduction

Genesis Crop Systems Inc. (GCS) was engaged to implement a two year trial using small replicated trials to measure the effects of modifying physiological age of seed tubers by winter warming or extended spring cooling storage temperatures on the yield, quality and overall crop value of several PEI processing potato varieties.

Results of prior research, conducted both locally and internationally, suggest that some potato varieties show positive response to a "winter warming" period during their dormant phase whereby tubers are placed in a warmer storage environment for a period of time. This winter warming treatment adds physiological age to the tubers and may result in quicker plant emergence, changes in tuber number and improvements in crop yield and value for certain potato varieties. Treated tubers are then returned to normal storage conditions for the remainder of the storage period.

Alternatively, initial trial work conducted in 2018 suggested that seed kept under refrigerated conditions up to near the time of planting produced crops with higher economic value than seed which had been maintained in a non-refrigerated storage environment for 4-5 weeks prior to planting in the Russet Burbank variety. Seed maintained in the cooler storage conditions for an extended period of time would be "physiologically younger" than seed stored under more variable temperature conditions.

Materials and Methods:

Fifty pound (50 lb) samples of several commercial French fry potato varieties were collected in October 2020. These included Alverstone Russet (AR), Clearwater Russet (CR), Dakota Russet (DR), Mountain Gem (MG), Payette Russet (PY), Prospect (PR), and Russet Burbank (RB).

A portion of the AR, CR, and RB tubers were placed in a refrigerated compartment at Cavendish Farms (CF refrigerated) research facility and held at approx. 4^{0}C for the entire storage season. The remaining AR, CR and RB tubers were placed in a commercial ventilated seed storage at MacLennan Properties (MP) in West Cape. The target storage temperature was 4^{0}C (MP conventional). In early January, one half of each of the CR, DR, MG, PY, and PR samples were removed from the seed storage and placed in a temporary storage where the temperature was set at 15^{0}C (MP winter warmed), but was generally recorded between 16 and 18^{0}C. Samples remained there for 16 days and were then returned to the seed storage. The seed was exposed to 191 degree-days (DD). An Elitech Data Logger temperature recorder was placed in close proximity to each group of seed at the MP complex to record and identify potential differences in temperature accumulation during the winter warming treatment exposure.

The MP seed was moved to the seed cutting facility in early May. All MP samples were hand cut May 6 into 2.5-3 oz seed pieces and allowed to suberize in the cut seed storage for several days. The refrigerated samples were removed from CF facility on May 19 and placed with all other samples. The CF samples were hand cut similar to above on the day of respective plot planting. There was a total of 399 degree days accumulated by the conventionally stored seed at the MP facility compared to seed stored at the CF facility until May 19th.

Plots were planted in randomized complete block design experiments in designated areas adjacent to commercial potato fields at MacLennan Properties, Springfield West and MacAulay Farms, Glenfanning on May 21 and May 25, respectively. Plot size was 1 row x 15 feet with three replications per treatment at the MP site and four replications per treatment at the MacAulay site. Note that Prospect was not planted at the MacAulay site. In-row spacing was 12 inches for AR, DR, MG, PY, PR and 15 inches for CR and RB. All crop inputs and management (fertilizer, crop protectants, etc.) were similar to the host growers' grower standard practice for that particular field (MP – Clearwater Russet; MacAulay – Ranger Russet) and would be representative of best management practices used for those varieties by the majority of Island producers. Trial locations were randomly assigned as Sites A & B for subsequent discussion purposes.

Plots were harvested with a small plot harvester on September 28 and October 4 at the MP and MF sites respectively. Tuber samples were placed in temporary storage and subsequently evaluated at the GCS grading facility on November 4th and 5th. All samples were subjected to a grading procedure similar to the one used to identify grade and quality parameters used to assign value to Cavendish contract growers. Data from the grading exercise was incorporated into an Excel spreadsheet allowing for calculation of the economic value of each plot on a crop value ($/acre) basis. Statistics were run with analysis of variance (ANOVA) to a 90% confidence interval.

Results

Growing conditions in 2021 were more conducive to producing higher tuber yields in most areas with most growers finishing planting operations in early June. June weather also featured above average rainfall and temperatures, leading to plants emerging more rapidly compared to recent years.

As noted previously, there was a 191 DD difference between the winter-warmed and conventionally stored seed; and a 399 DD difference between the conventionally stored seed and the seed stored at 4^0C at Cavendish Farms.

Parameters reported include total yield, marketable yield (tubers greater than 1.875 inches in diameter), percentage of small tubers less than 1.875 inches in diameter, percentages of tubers greater than 10 ounces, tuber specific gravity and overall crop value in $/acre. All data is provided in the attached Appendix (Appendix A). Yield values were calculated using a 1 lb/15 ft = 9.6 cwt/acre formula. Note that the values presented in this report would be higher than those observed by the grower at harvest time, but are reflective of the potential yield and any potential difference in crop performance due to the treatment effects.

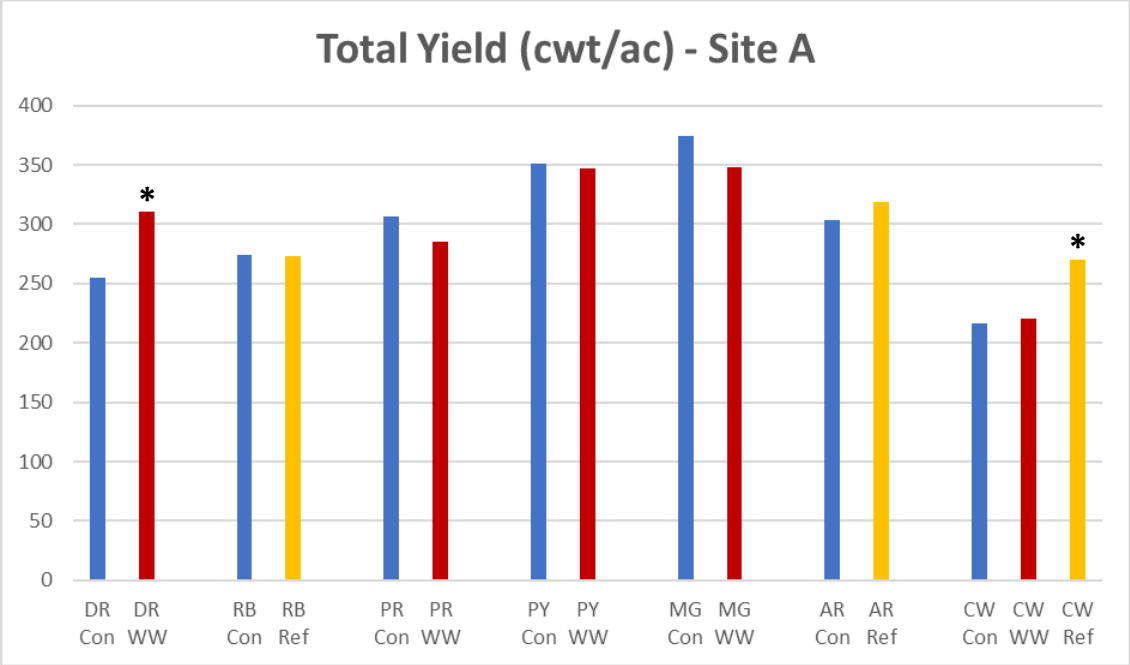

Fig. 1. Comparison of total yields at Site A. Statistical differences significant at $p < 0.1$ are denoted with an asterisk (*).

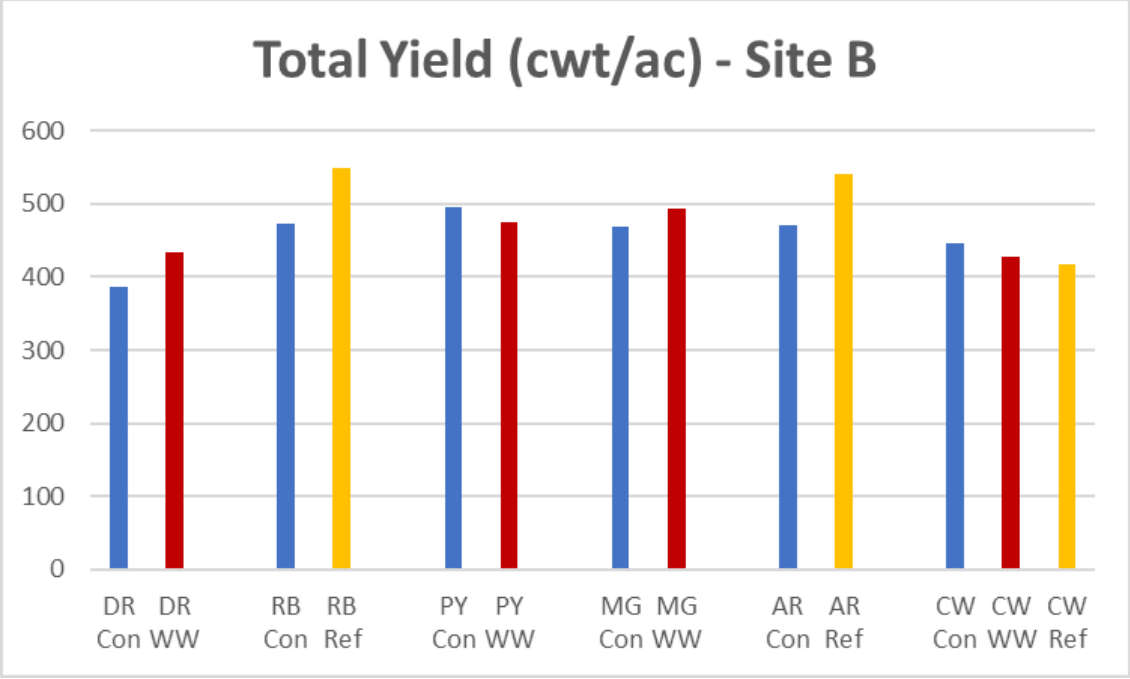

Fig. 2. Comparison of total yields at Site B.

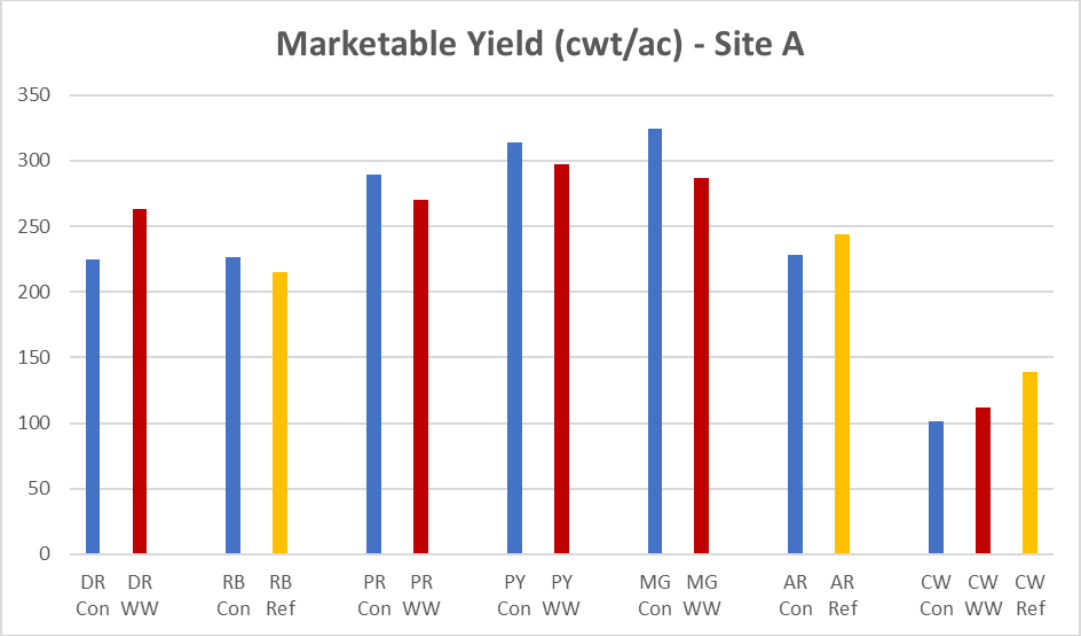

Fig. 3. Comparison of marketable yields at Site A.

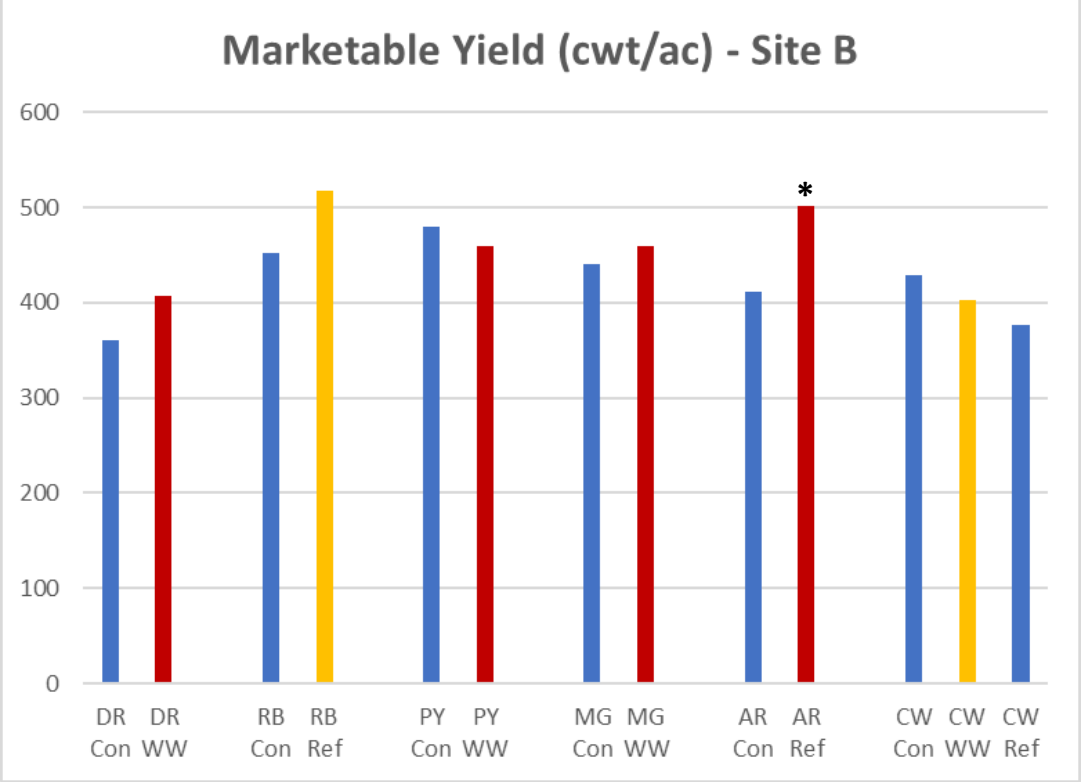

Fig. 4. Comparison of total yields at Site B. Statistical differences significant at $p < 0.1$ are denoted with an asterisk (*).

Table 1: Observed results at Site A

Treatment	Total Yield (cwt/ac)	% Smalls	% 10 oz	Specific Gravity	Marketable Yield (cwt/ac)	Value ($/acre)	Tubers/ Plot
Dakota WW	311 b	15.4	10.0	1.088	263	3262	106 b
Dakota Control	255 a	11.8	16.1	1.084	225	2633	79 a
Difference	**56**	3.6	-6.1	0.004	38	629	**27**
Clearwater WW	220	49.1	0.9	1.082	112	1682	134
Clearwater Control	216	53.2	0.0	1.091	101	1687	125
Difference	4	-4.1	0.9	-0.009	11	-5	9
Clearwater Refrig.	270 b	48.5	0.0	1.089	139	2199	156 b
Clearwater Control	216 a	53.2	0.0	1.091	101	1687	125 a
Difference	54	-4.7	0.0	-0.002	38	512	**31**
Prospect WW	285	5.3	31.9 b	1.064	270	2694	80
Prospect Control	307	5.9	17.3 a	1.066	289	2823	92
Difference	-22	-0.6	**14.6**	-0.002	-19	-129	-12
M. Gem WW	348	11.8	4.0	1.085	287	3422	149
M. Gem Control	374	13.4	5.9	1.087	324	3977	155
Difference	-26	-1.6	-1.9	-0.002	-37	-555	-6
Payette WW	347	14.4 b	4.0	1.095	297	3664	177
Payette Control	351	10.0 a	6.0	1.091	314	3794	209
Difference	-4	**4.4**	-2.0	0.004	-17	-130	-32
R. Burbank Cold	273	20.9	3.7	1.090	215	2631	132
R. Burbank Control	274	17.5	6.2	1.090	226	2746	123
Difference	-1	3.4	-2.5	0.000	-11	-115	9
Alverstone Cold	319	23.5	3.8	1.082	244	2943	166
Alverstone Control	303	24.8	3.0	1.080	228	2750	163
Difference	16	-1.3	0.8	0.002	16	193	3

Note: WW= Winter Warmed, Cold= Refrigerated.

Table 2: Observed results at Site B

Treatment	Total Yield (cwt/ac)	% Smalls	% 10 oz	Specific Gravity	Marketable Yield (cwt/ac)	Value ($/acre)	Tubers/ Plot
Dakota WW	433	6.0	25.4	1.086	407	4911	106
Dakota Control	387	7.0	31.0	1.083	360	4179	103
Difference	46	-1.0	-5.6	0.003	47	732	3
Clearwater WW	427	5.6	24.1	1.091	403	4847	119
Clearwater Control	447	4.0	23.5	1.088	429	5126	122
Difference	-20	1.6	0.6	0.003	-26	-279	-3
Clearwater Refrig.	418	10.0	12.0 a	1.092	376	4690	128
Clearwater Control	447	4.0	23.5 b	1.088	429	5126	122
Difference	-29	6.0	**-11.5**	0.004	-53	-436	6
Mountain Gem WW	494	7.1	26.1	1.087	460	5590	151
Mountain Gem Control	468	5.8	26.1	1.088	440	5318	137
Difference	26	1.3	0	-0.01	20	272	14
Payette WW	475	3.2	30.3	1.089	460	5555	129
Payette Control	496	3.2	32.7	1.084	480	5615	126
Difference	-19	0	-2.4	0.005	-20	-60	3
Russet Burbank Cold	549	5.8	23.5	1.091	518	6254	156
Russet Burbank Control	473	4.4	26.2	1.086	452	5471	141
Difference	76	1.4	-2.7	0.005	66	783	15
Alverstone Cold	540	7.2 a	15.6	1.083	502 b	5637	181
Alverstone Control	470	12.3 b	13.6	1.087	412 a	5032	172
Difference	70	**-5.1**	2.0	-0.004	**90**	635	9

Note: WW= Winter Warmed, Cold= Refrigerated.

Discussion:

There was a considerable difference in yields observed between Site A and Site B in 2021.

	Ave. Total Yield cwt/ac	**Ave. Marketable Yield** cwt/ac
Site A	297	236
Site B	467	438

Site A had a notably lighter soil type than Site B, and also received less favourable timed rainfall. In addition, there was significant weed pressure at Site A (and a resultant post-emergence herbicide application), which may have impacted yields.

At Site A, there were significant differences ($p < 0.1$) for total yield for the Dakota Russet and Clearwater Russet varieties. At this site, the winter warmed Dakota treatment out-yielded the conventionally stored treatment. There was also a significantly higher number of tubers per plot in favour of the winter warmed treatment. There was not a significant difference in marketable yield, as the winter warmed treatment appears to have a slightly higher level of small tubers.

For the Clearwater variety at Site A, there was no difference in yield or quality between the winter warmed and conventional treatments; however, there was a significant difference between the refrigerated treatment and the other two treatments for total yield and tuber number in favour of the refrigerated treatment.

At Site B, none of the varieties showed significant differences in total yield; however, there were 70+ cwt/acre differences for between the refrigerated and conventional treatments for Russet Burbank and Alverstone Russet. For Alverstone, the difference in marketable yield and percentage of smalls was statistically significant. When looking at the refrigerated treatment for Clearwater Russet, an opposite trend was observed, in contrast to the results at Site A.

There is also a trend toward increased yield and crop value for the Dakota Russet variety for the winter warmed treatment at Site B; however, it is not statistically significant. Nonetheless, the trend is very similar between Sites A and B for this variety.

Variety by Variety Results:

When examining the differences between treatments for each variety:

	Total Yield (cwt/ac)		Market. Yield (cwt/ac)		Crop Value ($/ac)	
	Site A	**Site B**	**Site A**	**Site B**	**Site A**	**Site B**
Dakota (WW – Control)	56	46	28	47	629	732
Clearwater (WW – Control)	4	-20	11	-26	-5	-279
Mountain Gem (WW – Control)	-26	26	-37	20	-555	272
Prospect (WW – Control)	-22	--	-19	--	-129	--
Payette (WW – Control)	-4	-19	-17	-20	-130	-60
Clearwater (Refrig – Control)	54	-29	38	-53	512	-436
R Burbank (Refrig – Control)	-1	76	-11	66	-115	783
Alverstone (Refrig – Control)	16	70	16	90	193	635

Dakota Russet: The trend in 2021 appears to favour the winter warming treatment. In 2020, with a winter warming treatment of 145 degree-days, there was no significant difference between treatment and control.

Clearwater Russet: Winter warming does not appear to have a positive effect on yield or quality for this variety. Over four site-years, yield and crop value was noticeably negative three out of four times. Comparison of refrigeration compared with the control for Clearwater (only done in 2021) produced contrasting results between the two sites.

Mountain Gem: Differences in 2021 for yield and quality were not statistically significant. In 2020, there was a significant increase in yield favouring winter warming for this variety at one site.

Payette Russet: Over three site years, there was no difference in yield or quality between the winter warming and control treatments.

Russet Burbank: There is quite a difference in response between the two sites, with Site B showing a significant increase in total yield with seed refrigeration. Over three site years, the trend continues to be positive in favour of refrigeration.

Alverstone Russet: Marketable yield was significant higher for the refrigerated Alverstone in 2021 at Site B, with no statistical difference observed at Site A. This contrasts with the results from 2020, where the refrigerated treatment had statistically lower yield and crop value than the control. More research is recommended for this variety to better understand the recommended seed management program.

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