



### **Project Identification**

- 1. Project Title:** New Cabbage Cultivars for Processing in SK
- 2. Project Number:** 20211040
- 3. Producer Group Sponsoring the Project:** Saskatchewan Vegetable Growers Association (SVGA)
- 4. Project Location:** Saskatchewan Conservation Learning Centre, Prince Albert  
Legal Land Location: SW-20-46-26-W2 RM 461
- 5. Project Start and End Dates:** March 2022 to February 2023
- 6. Project Contact Person and Contact Details**
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### **Objectives and Rationale**

#### **7. Project Objectives**

The purpose of this project was to provide a demonstration for local producers of the potential of growing large cabbage cultivars for processing. This project is also intended to identify cabbage cultivars that have resistance to sclerotinia and large cabbage cultivars that are resistant to splitting.

## **8. Project Rationale**

New vegetable cultivars become available every year for producers to grow, but these cultivars are bred and grown in climates with pests and diseases different from those in Saskatchewan. Producers in SK require sustainable cultivars that can be grown under SK conditions and perform on the SK market.

Saskatchewan's climate and soils are well suited for growing brassicas. The province has abundant processing market opportunities for locally grown cabbage. Current cabbage products being processed in SK include sauerkraut, kimchee, and coleslaw. The companies purchasing processing cabbage prefer larger heads as this requires less coring, but local producers typically grow smaller cultivars for the fresh market. Growing larger cultivars is then an advantage to producers as the companies buy cabbage based on weight. The issue with growing large heads of cabbage is that they are very dense and tend to split at maturity. Some cultivars are resistant to splitting and thus would provide producers with desirable processing cabbage heads.

The increasing incidence of sclerotinia in cabbage fields has producers searching for ways to reduce the risk of such fungal infections. ADOPT 20170358, Control Options for Sclerotinia in Cabbage found that some fungicides help lessen the prevalence of sclerotinia in cabbage, but no products completely eliminate the problem. This fungal infection is responsible for serious in field losses, and it only gets worse in storage where major breakdowns occur. Some cultivars are more resistant to sclerotinia than others. With a reduced risk in sclerotinia, producers will opt to grow the more resistant cultivars.

## **Methodology and Results**

### **9. Methodology**

This trial was set up as a randomized complete block design with 3 replicates (Figure 1). The treatments consisted of 10 different cultivars of cabbage (Table 1). However, only 9 cultivars are included in the report due to the cultivar Mandy having poor germination. There were only enough Mandy transplants for a single replicate (rep 1). The performance of rep 1 was so poor, no data collection occurred for Mandy. All Mandy plants were small and diseased.

The trial site was rototilled prior to transplanting. Fertilizer was broadcasted and incorporated manually with a rake. Fertilizer was applied based on soil test results (Table 3) and recommendations provided by Agvise. Nitrogen, phosphorous, and sulfur were spread at rates of 189 kg N/ha (46-0-0-0), 162 kg P<sub>2</sub>O<sub>5</sub>/ha (11-52-0), and 28 kg S /ha (21-0-0-24), respectively (formulations used).

Cabbage transplants were planted May 24<sup>th</sup>, 2022. Rows were 5 m in length and 60 cm apart. There were 15 plants per row with 30 cm spacing and two rows per plot. Data was collected from the one irrigated row per plot. Drip irrigation was installed for every other row on June 6<sup>th</sup>. Cabbage was irrigated with city water when required.



**Figure 1.** Cabbage cultivar trial layout on June 13, 2022 near Prince Albert Saskatchewan. Plots were monitored for pests and disease. Cabbage worms arrived late in 2022 and were sprayed for on Aug 24, 2022 with Coragen at a rate of 250 ml/ha. Disease symptoms were recorded for each plant during harvest. No disease control was implemented due to the desire to compare potential disease resistance across cultivars. Cabbages were hand weeded as required.

Cabbage harvest occurred from August 16 to October 7. A plot was harvested when the cultivar reached maturity. Two cultivars were harvested before full maturity due to forecasted freezing temperatures. During harvest, the first few outer leaves were removed, stem trimmed, cabbage inspected for sclerotinia and other diseases, weighed, and circumference measured.

**Table 1.** Cabbage cultivars used in the “New Cabbage Cultivars for Processing in SK” trial.

<b>Treatment #</b>	<b>Cultivar</b>
1	Extreme Vantage
2	Adaptor
3	Grand Vantage
4	Multikeeper
5	Mucsuma RZ
6	Acclaim
7	Expect
8	Bronco
9	Cheers
10	Mandy*

\*Mandy was not included in final data collection due to poor germination

Data analysis was completed by ANOVA using Statistix 10 software. Any non-parametric data was analyzed using the Kruskal-Wallis test. Post-hoc tests used were Tukey for parametric data and Dunn’s multiple comparisons test for non-parametric data.

## 10. Results

### Weather

The growing season of 2022 at the CLC started off cooler than the long-term average but ended warmer (Table 2). Compared to the 8-year averages, the mean temperature of May 2022 was 0.9°C cooler while October had a mean temperature double the long-term average. Average temperature for this growing season was just 0.8°C warmer than the historical average. This year was drier compared to past years, but not as dry as 2021. All months of 2022 received less precipitation than the historical averages; there was a total of 66.5 mm less precipitation this year. While the trial was irrigated, Rep 1 was closest to a mature shelterbelt and it is likely responsible for the poor performance of rep 1 that downgraded the mean size and yields of cabbage in 2022. Following multiple moisture deficit years, shelterbelt effects have been more enhanced than previously. The first light frost occurred on September 10 (-0.4°C), prior to harvest of all cabbage cultivars. The first heavy frost occurred October 5 (-4°C). Mucsuma RZ, Expect and Multikeeper were harvested October 5-7<sup>th</sup> following the frost. Complete monthly weather summaries can be viewed/downloaded at [src.sk.ca/download-weather-summaries](http://src.sk.ca/download-weather-summaries).

**Table 2.** Weather conditions from 2022 growing season at the CLC, near Prince Albert SK from onsite SRC weather station.

Year	May	June	July	August	September	October	Average/Total
--- Mean Temperature (°C) ---							
2022	10.5	15.5	18.3	18.5	13.3	6.2	13.7
2012-2021	17.1	16.2	18.7	17.1	11.6	3.1	14.0
--- Precipitation (mm) ---							
2022	17.9	75.7	63.7	37.8	26.3	11.5	232.9
2012-2021	38.3	77.6	75	43	28.3	20	282.2
--- Growing Degree Days (base 5°C) ---							
2022	173.1	314.7	413.6	419.6	248.6	79.8	1649.4
2012-2021	172.1	326.6	416.8	352.4	211.1	36.3	1515.4

### Soil Test Results

A composite soil sample was collected May 9, 2022 from the trial area and sent to Agvise Laboratories for analysis. Soil test results (Table 3) indicated low levels of available nitrogen, sulfur, and salts. Organic matter levels were moderate while phosphorous and potassium levels were high.

**Table 3.** May 2022 soil test results.

Depth (cm)	N (lb/ac)	P (ppm)	K (ppm)	S (lb/ac)	OM (%)	pH	Salts (mmho/cm)
0-15	10	15	241	10	4	5.8	0.12
15-30	11			12		6.0	0.11
0-30	21						

### Plant Counts and Harvest Timing

There was a large range of maturity across the cabbage cultivars. Harvest occurred from August 5 – October 7, 2022. Rep 3 was often harvested earlier than reps 1 and 2. The whole plot was harvested when most heads were mature, but due to uneven maturity, some heads would be very large and at risk of splitting, while other heads were small. Few plants were lost prior to harvest, as the maximum

plant count possible was 45 (Table 4). Each cultivar lost only 1-3 plants. Plants removed and not included in remaining data analysis included plants with multiple heads, heads that were too rotten due to disease, or plants that had not formed a compact head. Multiple heads per plant likely resulted due to windy conditions immediately after transplanting causing excessive plant whipping, which likely damaged the growing point. Acclaim, Bronco and Cheers were the earliest maturing cultivars and were harvested close to their expected date of maturity ( $p < 0.0001$ ). Mucsuma, Adaptor, Multikeeper, and Expect were the latest maturing. The later maturing cultivars were harvested due to forecasted freezing temperatures and may not have reached maximum yields.

**Table 4.** Days to harvest for cabbage cultivars grown near Prince Albert Saskatchewan in 2022.

Cultivar	Plant count at harvest	Plants included in data collection	Days to harvest*	
			Expected	Actual
Extreme Vantage	44	41	80	106 bc
Adaptor	44	43	95	132 ab
Grand Vantage	43	37	80-85	98 c
Multikeeper	43	38	86	129 ab
Mucsuma RZ	44	37	125	136 a
Acclaim	42	35	75	80 c
Expect	42	38	100	135 ab
Bronco	42	42	90	95 c
Cheers	43	42	80-85	89 c

\*Days to harvest is calculated from date of transplanting. Expected days to harvest were provided by seed companies. Different letters indicate significance at  $p < 0.0001$ .

#### Cabbage yields

Overall total yields and mean head weights were lower than anticipated, but maximum head weights ranged from 2.05 – 2.71 kg/head indicating these cultivars can perform well (Table 5). In a 2020 CLC study, the cultivar Bronco had a mean head weight of 1.57 kg (ADOPT 20190421). In this 2022 cultivar trial mean Bronco head weight was 1.38 kg/head and had a maximum head size of 2.36 kg/head. Both Mucsuma and Expect have the smallest sized heads and were the lowest yielding cultivars (Table 5). While there was a lot of variability within plots for cabbage size and across reps, Acclaim and Cheers produced the largest heads with circumferences of 50 and 51 cm respectively and while both yielded well, Multikeeper was the highest yielding cultivar at 76.8 Mg/ha, due to a denser head weight of 1.76 kg/head.

**Table 5.** Size and yield of cabbage cultivars grown near Prince Albert Saskatchewan in 2022.

Cultivar	Circumference (cm)			Head weight (kg/head)			Yield (Mg/ha)
	Mean	Min	Max	Mean	Min	Max	
Extreme Vantage	47.1 abc	36.0	54.7	1.35 bcd	0.44abc	2.20	60.0 abc
Adaptor	42.4 bc	28.0	59.3	1.09 cd	0.23c	2.71	52.7 bc
Grand Vantage	46.3 abc	32.3	55.3	1.45 abc	0.25bc	2.39	59.7 abc
Multikeeper	49.7 ab	39.3	60.3	1.76 a	0.93a	2.47	76.8 a
Mucsuma RZ	40.6 c	30.3	52.7	1.00 d	0.32bc	2.05	42.4 c
Acclaim	50.2 a	40.3	59.2	1.58 ab	0.85ab	2.45	61.6 abc
Expect	40.6 c	30.0	51.0	1.17 cd	0.50abc	2.11	47.9 bc
Bronco	46.1 abc	31.7	56.3	1.38 abcd	0.34abc	2.36	63.5 abc
Cheers	51.0 a	37.7	62.8	1.46 abc	0.50abc	2.53	68.7 ab
P value	0.0006	0.2	0.1	0.0001	0.0058	0.1479	0.0032
Critical Value	7.8	16.9	13.4	0.38	0.60	0.79	23.7

1.0 ton/acre = 2.24 Mg/ha

1 kg = 2.21 lb

\*Different letters indicate significance at  $P < 0.05$ . Critical value shows difference between cultivars needed to be considered a significant difference.

### Splitting

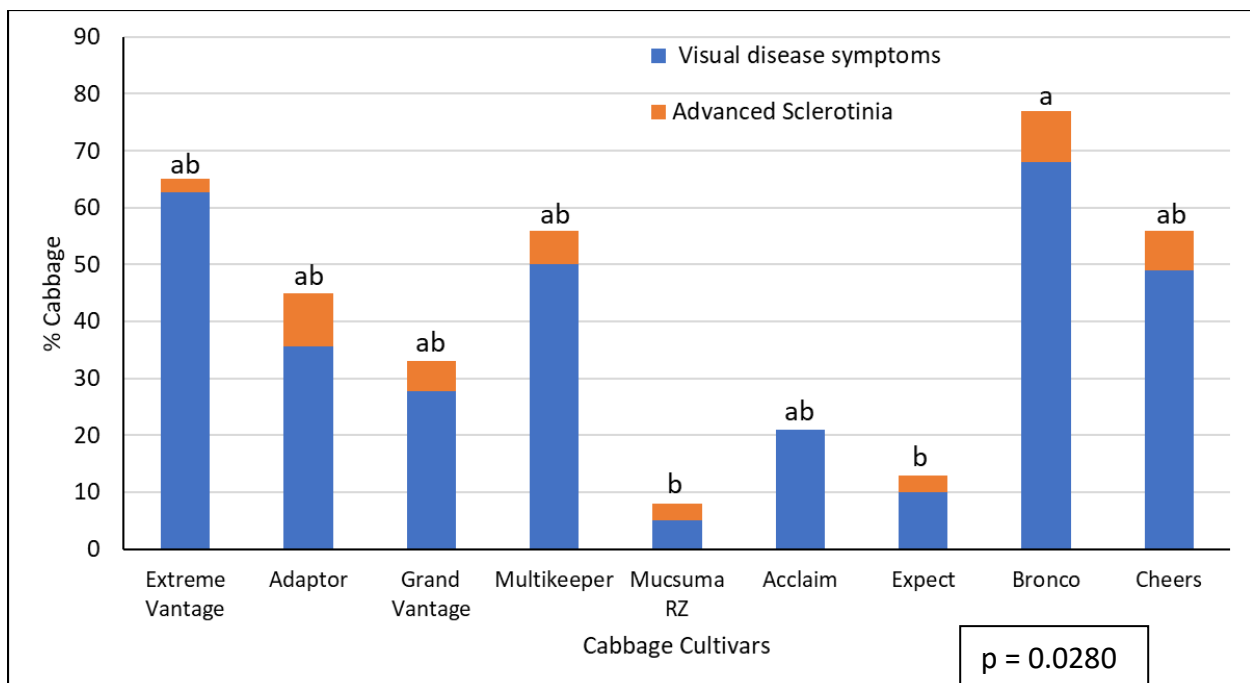
No splitting occurred in rep 1 due to poor growth and small plants. Rep 3 had the greatest sized cabbages and the most splitting. This rep provides the best indication of which cultivars were more prone to splitting. Three cultivars had evidence of splitting within rep 3 and include Acclaim (17%), Multikeeper (20%), and Cheers (57%). Acclaim was the only cultivar to split in rep 2, with splitting evident in 60% of harvested cabbage heads within rep 2. However, Acclaim was the earliest maturing cabbage and a later than desired harvest date may have exacerbated splitting.

### Disease

As the growing season progressed disease became more evident. The earliest harvested cultivar had no evidence of disease. Disease presence was visually more noticeable in rep 1 where plants were stressed. Disease symptoms described may not all be a result of sclerotinia, and could indicate the presence of other diseases like black leg (Table A1 and Figure A1 in appendix). However, ratings of advanced sclerotinia (Figure 2) indicate the percentage of heads that were observed to be rotten with sclerotia present. Advanced sclerotinia infected cabbage was present in 9, 6, and 0 heads in reps 1, 2, and 3 respectively. Bronco was rated the worst for disease symptoms, while Mucsuma RZ and Expect had the least disease symptoms (Figure 3;  $p=0.0280$ ). Mucsuma and Expect were both later maturing cultivars. Both cultivars did not form tight heads until later in the growing season. Mucsuma also had a different growth habit of being more upright. Perhaps greater airflow reduced disease incidence in these cultivars. Acclaim was the only cultivar to not have any advanced sclerotinia at time of harvest.



**Figure 2.** Advanced sclerotinia on a cabbage head on Aug 16, 2022 near Prince Albert, SK.



**Figure 3.** Disease symptoms for each cabbage cultivar grown near Prince Albert, SK in 2022.

This cultivar trial is particularly useful and fills a gap of information for Saskatchewan growers. While the University of Saskatchewan previously conducted cultivar trials from 1989-2016 the recommendations are becoming outdated. The previous U of S cultivar recommendations suggest Cheers as a short season and Multikeeper as a late season cultivar (University of Saskatchewan, 2023). These two cultivars were top performers in the 2022 CLC cabbage cultivar trial. The U of S suggests growers consider the North Dakota State University Gardener Cultivar Trials for recommendations as they share similar prairie climate and soils. None of the cultivars included in the most recent “Vegetable Cultivars for North Dakota: 2023” include the cultivars used in the CLC’s 2022 cultivar trial that were selected based on interest from local growers (Kalb, 2022). There is also limited data available on performance of many of the cultivars investigated at the CLC in 2022.

An older North Dakota trial identified Bronco as a suitable cultivar for both the fresh and processing markets and Cheers as a suitable cultivar for the processing market. These two cultivars must be longstanding cultivars as the study took place from 1993-1997 (Greenland et al., 2000). None of the other cultivars included in the CLC trial had been investigated in this older study.

## **11. Conclusions and Recommendations**

This trial provided useful information of the performance of 9 different cabbage cultivars under Saskatchewan growing conditions. Mucsuma and Expect were the latest maturing and lowest yielding cultivars, which suggests they may not be appropriate for the Prince Albert region short growing season. However, both cultivars had the lowest disease incidence and maximum head weights were not significantly different from other cultivars (Table 5;  $p=0.1479$ ). There may be value in including these cultivars in an additional year of data collection. Acclaim and Cheers produced the largest heads and were high yielders, but Multikeeper was the highest yielding cultivar (Table 5). Acclaim, the earliest maturing cabbage (Table 4), was the only cultivar that did not have any heads affected by advanced sclerotinia. There was minimal splitting likely due to the overall small head size, but splitting did occur in the top 3 yielding cultivars Acclaim, Cheers and Multikeeper.

An additional year would be beneficial to better optimize growing conditions to reduce variability. It is not good practice to base recommendations off one single site year worth of data. While the CLC had good precipitation in June and July, conditions were quite dry for the remainder of the growing season. Max size recorded indicates there is a greater potential for these cultivars. Better site selection, farther away from a shelterbelt, coupled with increased irrigation should aid this trial if 2023 were to be another dry year. Better growth would allow for better determination of cultivars likelihood of splitting, which was not very evident in cabbage grown in 2022. Additionally, more in depth observations and records of disease incidence would be beneficial to more accurately determine if certain cultivars appear to have better resistance than others. During data collection in 2022, it was easy to diagnose advanced sclerotinia, but other documented symptoms may have been signs of early onset of sclerotinia or an alternative disease.

### References:

Greenland, R.G., Lee, C.W., Holm, E.T. and L.E. Besemann. 2000. Cabbage Hybrid Trials in North Dakota. Hort Technology. 10(4):806-811.



Kalb, Tom. 2022. Vegetable Cultivars for North Dakota: 2023. Retrieved February 7, 2023 from <https://www.ag.ndsu.edu/homegardencultivartrials/documents/recommendations2023.pdf>.

University of Saskatchewan. 2023. Gardening at USask: Cabbage: Growing Outdoors. Retrieved February 7, 2023 from <https://gardening.usask.ca/gardening-advice/gardenline-nested-pages/food-plant-pages/vegetables/cabbage.php#Growingoutdoors>.

## **Supporting Information**

### **12. Acknowledgments**

The Conservation Learning Centre graciously acknowledged the Ministry's and the Saskatchewan Vegetable Growers Association support through signage directly in field with the project. This trial was showcased at the annual CLC Field Day held July 28, 2022 with 60 visitors. A crop walk video was made in collaboration with the Saskatchewan Ministry of Agriculture and has had 140 views. The trial was also toured by many school groups.

### 13. Appendices

**Table A1.** Description of disease symptoms observed at time of harvest for different cabbage cultivars grown at the Conservation Learning Centre in 2022. The number indicates the quantity of heads exhibiting the described symptom.

<b>Cultivar</b>	<b>Rep 1</b>	<b>Rep 2</b>	<b>Rep 3</b>
Extreme Vantage	11-Black specks 1-very rotten core 1-rotten leaf spot	7-white fuzz 1-black specks 1-big black spot	4-white fuzz 1-round concentric rings
Adaptor	1-large water marks 2-moldy to core, with a water spot with orange mold 1-white mold 1-black specks	4-black specks 2-rotten 4-watermark with mold	4-watermarks and concentric black and pink rings
Grand Vantage	2- black specks 1- rotten 1- Lg water marks and orange mold	1-black specks 1-black splotch with grey mold	1-black stem 4-white fuzz 1-watermark
Multikeeper	1-rotten 3-black specks 2-black splotches	3-black specks 1-rotten 3-dime-loonie sized black spot	6-black specks 2-loonie sized grey/yellow patch
Mucsuma RZ	1-watermark concentric rings 1-rotten	-	1-watermark with mold
Acclaim	1-black specks		4-white fuzz 1-black specks 1-black mark
Expect	1-black specks 1-large brown spot 1-loonie sized yellow/grey spot	1-rotten	1-loonie sized grey/yellow spot
Bronco	2-rotten 11-black specks	2-rotten 12-black specks	1-verticillium stripe? 2-white fuzz 1-white crystallized mold 1-black specks 1-water mark
Cheers	11-black specks (some turning moldy) 3-rotten	9-white fuzz	1-white fuzz



**Figure A1.** Photos of various disease symptoms.



**Figure A2.** Cabbage cultivar trial at the Conservation Learning Centre July 13, 2022 showing cultivars Grand Vantage, Multikeeper and Mucsuma RZ.



**Figure A3.** Cabbage cultivar trial at the Conservation Learning Centre July 13, 2022 showing cultivars Expect, Bronco and Cheers.



**Figure A4.** Cabbage cultivar trial at the Conservation Learning Centre July 13, 2022 showing cultivars Extreme Vantage and Adaptor.

## **Abstract**

### **14. Abstract/Summary**

This trial evaluated 9 cabbage cultivars of interest to Saskatchewan vegetable growers. The purpose was to identify suitable large headed cultivars for processing purposes. Ideal cultivars would be high yielding, and resistant to splitting and disease. Unfortunately, due to site selection, and dry conditions, there was a lot of variability within plots and across reps. Smaller than anticipated head size limited the ability to evaluate splitting in the selected cultivars. The only cultivars that had splitting include Cheers, Acclaim and Mulltikeeper. Disease was most prevalent in rep 1 where plants were stressed. Bronco was rated the worst for disease symptoms. Mucsuma and Expect were the latest maturing and the lowest yielding. However, they did have low disease incidence and the maximum head weights were not significantly different from other cultivars. Maximum head weights across cultivars ranged from 2.05-2.71 kg/head with mean weights > 1kg/head. Acclaim was a top producing cultivar as it had the largest heads, high yields, early maturity, and no advanced sclerotinia. Better site selection and increased irrigation would aid this trial in the future. Another site year would be beneficial and allow for better determination of likelihood of splitting, disease resistance and yield potential. This trial was showcased at the annual CLC Field Day held on July 28, 2022 with 60 visitors and is featured as a 2022 crop walk video with the Ministry of Agriculture.