

Sequential Cropping Romaine Lettuce

The objective was to determine yield and quality potential for sequential planted crops of direct seeded and transplanted romaine lettuce under Saskatchewan growing conditions.

The project was conducted at the University of Saskatchewan - Horticulture Field Research Station in Saskatoon. The site features a Sutherland Series clay loam soil (pH 7.8, E.C.< 1.0dS/m). Establishing a small seeded crop like lettuce from seed can be challenging in clay soils – however once the crop is established, clay soils can readily supply the nutrients and moisture required to produce a vigorous lettuce crop. As the site has a long history of vegetable production, the soil tests very high for most required nutrients (> 400 kg P₂O₅/ha and > 1000 kg K₂O/ha) and only limited applications of N fertilizer are required in each year. Every 4 years about 10 T/ha of composted cattle manure is added to the site in an effort to enhance the soil organic matter content. This manuring adds to the already abundant nutrient supply at the test site. The site is protected by a well-established shelter-belt system.

The specific area used in the 2015 romaine lettuce production project had been cropped to cauliflower in 2014. In spring of 2015 the plot area was fertilized by broadcasting sufficient 46-0-0 (urea) to raise total soil N levels (residual + applied) to 125 kg N/ha. The field was then rotovated to a depth of 15 cm in order to incorporate the fertilizer and prepare a suitable seedbed.

The romaine crop was established by either direct seeding or by transplanting. Two days before the crop was direct seeded the plot area was lightly rotovated to prepare a smooth uniform seedbed. A disc-type small plot seeder was used to drop the lettuce seeds ½” deep into the soil. The crop was seeded in twin rows spaced 30 cm apart – with 1m between each pair of rows. Transplants were grown in 72 cell transplant trays filled with standard peat-based soilless media. Lettuce seed is small and light – making seed singulation difficult. Greenhouse conditions during transplant production were 24C day/18C night with 10 h/day of supplemental light (100 umol) supplied by HPS lights. It took about 5 days for most seedlings to emerge. The plants were thinned to 2 seedlings/cell once the plants were at the 1 true leaf stage. From week 3 onwards the seedlings were fertigated daily with 400 ppm N coming from 20-20-20 fertilizer. It took 4weeks to get the transplants to the size suitable for transplanting into the field. A waterwheel transplanter was used to place the lettuce seedlings into the field. Seedlings were spaced 30 cm apart within the row (closest spacing available on the transplanter) in twin rows spaced 30 cm apart – with 1.25m between twin rows to allow tractor access. The transplants were watered in with dilute 10-52-10 and the plot was overhead irrigated within a couple of hours of transplanting.

There are very few herbicides approved for use in lettuce – so the weeds were controlled in the test plot by rotovating between rows and hand weeding within the rows. Consistent attention to weed control was required as the romaine plants are relatively small and slow growing.

Once or twice weekly an overhead irrigation system was used to maintain near optimum soil moisture levels throughout the growing season.

No disease or insect problems were observed in the romaine crop and no pest control measures were employed.

The romaine cultivars tested in 2015 were selected for ease of seed availability – and none have been tested previously by the U of S. Many more cultivars of romaine lettuce are available.

2015 Growing Season - an early spring melt followed by several weeks of dry weather allowed early access to the fields in 2015. Field preparation for the initial planting was completed by the 2nd week of May. Warm weather prevailed for the remainder of the month – except on May 29 temperatures dropped to -3C. Any romaine crops present at this time would have been damaged by the frost. June and July were exceptionally warm and windy, with next to no rain. August was also warm with slightly above average rainfall. By the first week of September, night time temperatures were dropping into the single digits. On Sept. 9 temperatures dropped to -1C and some frost damage was observed on cold sensitive crops – but no damage was observed on the romaine crops present at that time. On Oct. 4 night time temperatures dropped to -5C, resulting in extensive damage to all cold sensitive crops – and some chilling injury was observed in the romaine trials. Temperatures did not go below -5C through early November.

Crop Timeline

Directed Seed Crop

1st Crop

Seeded : 3rd week of May
Emerged : 2nd week of June
Ready for harvest : 4th week of July

2nd Crop

Seeded : 4th week of June
Emerged : 2nd week of July
Ready for harvest : 4th week of August

Transplanted Crop

1st Crop

Seeded : 3rd week of April
Transplanted into the field : 3rd week of May
Ready for harvest : 4th week of June

2nd Crop

Seeded : 4th week of May
Transplanted into the field : 4th week of June
Ready for harvest : 4th week of July

3rd Crop

Seeded : 4th week of June
Transplanted into the field : 4th week of July
Ready for harvest : eaten by deer

4th Crop

Seeded : 4th week of July
Transplanted into the field : 4th week of August
Ready for harvest : failed to mature due to deer damage and cold damage

Crop Performance - getting the direct seeded lettuce to emerge uniformly was a problem at both seeding dates – with the average stand count being only 35-37%. Some cultivars were clearly more vigorous than others – but none of the cultivars tested consistently produced a quality stand when direct seeded. Problems with emergence could be attributed to; a) use of a poor quality seeder, b) the clay soil at the site is tough to seed into and c) there was next to no rain though July of 2015 – so all moisture required to get the crop established had to be applied via irrigation – and we struggled to get enough moisture onto the plots without washing out the shallow planted seed. It took about 8 weeks for the direct seeded crop to reach harvest maturity – and the harvest period for most cultivars stretched over a 7-10 day period.

Getting the lettuce crop established using transplants was easier than direct seeding. It took about 4 weeks to grow the seedlings to the size that was ready to go to the field (ca. 10 cm tall). Larger seedlings were more prone to transplant shock, particularly if they are transplanted out during hot/windy weather. The transplanted crop was ready for harvest after about 4 weeks in the field. The transplanted crop was more consistent in head size and time to head maturity than the direct seeded crop.

Tipburn of lettuce is caused by an interruption in calcium uptake due to uneven temperatures and/or soil moisture (Fig. 1). Tipburn was a major problem in the 1st Crop of both direct seeded and transplanted romaine, but few problems were seen in the later crops. The difference in severity of tipburn between the crops could have reflected differences in growing conditions – however it was more likely due to differences in crop management practices. In the 1st Crop P1 we opted to hold off harvesting as long as possible in the hope of increasing over-all yields – as lettuce plants are known to grow very quickly in last few days prior to harvest. However, rapid growth also triggers the onset of tip-burn. Due to extensive losses to tip-burn in the 1st Crop, we opted to harvest the 2nd Crop a few days earlier. This resulted in a dramatic reduction in grade out to tip-burn and a corresponding increase in marketable yields – however the average size of the heads was smaller in 2nd Crop than for the 1st Crop. Some cultivars were clearly more resistant to tipburn than others.



Fig. 1. Tipburn of lettuce.

While aster yellows can be a serious problem in lettuce, very few signs of this disease were observed in the 2015 romaine trial. For unknown reasons the incidence and severity of aster yellows vary greatly from year to year. The leaf hoppers which transmit the aster yellows viroid were definitely present in the lettuce plots in 2015.

Deer browsing was a major problem, especially as they tended to preferentially eat just the tender growing point. As a consequence, just a few feeding sessions resulted in 100% loss of the 3rd and 4th transplanted crops.

Yields (see tables for detailed yield breakdown)

Due to problems with tip-burn, marketable yields in the 1st transplanted crop were low. Earlier harvesting resulted in over 90% of the 2nd transplanted crop being marketable. Average marketable yields for 1st and 2nd direct seeded crop were identical (11.4 T/ha). The earlier harvest used for the 2nd direct seeded crop reduced the average head weight but increased the % of heads that were marketable (free from tipburn).

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|---------------------------|--|
| Transplanted Crop | <ul style="list-style-type: none">- 20,000 heads/ha (8000 heads/a) in 2015 trial- Plant population could easily be increased by 30% by reducing the between row spacing.- Average head size was large (0.7 kg)- Crops planted from late May through to mid-Aug took 4 weeks to mature in the field. Earlier or later plantings will take longer |
| Direct seeded Crop | <ul style="list-style-type: none">- 30,000 heads/ha (12,000/a)- Higher plant populations are possible in direct seeded crops as in-row and between row spacing can be narrower than when using transplants.- Higher plant populations lead to increased total yields – but smaller average head size. |

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- Average head size for direct seeded romaine in 2015 was 0.5 kg
- It took on average 7.5 weeks to take a direct seeded crop to maturity when the crop was planted in May or June. A similar rate of development could be anticipated for crops planted through until early August – but after that, shorter days and declining temperatures will extend the required growth period.

Quality - as previously mentioned, the quality of the 1st Crop in both the direct seeded and transplanted trials was compromised by both external and internal tipburn. The quality of the 2nd Crop was far better. This reflects changes in growing conditions – but also we learned to not let the lettuce become too mature before harvest – as problems with tipburn seemed to arise within the last week or so of crop development. Some cultivars bolted, especially in the early planting, which coincided with the longest days of the year. Deer wiped out 3rd and 4th transplanted crops.

The appearance of most of the cultivars was good – although few formed the classic elongated shape associated with “hearts of romaine”. This shape could be achieved in some cultivars by trimming away some of the framing leaves – with Early’s Romaine, Little Caesar and Paris White being the best suited to this use. In other varieties, (ie; Jericho) the more open heads were not well suited to trimming for sale as a heart of romaine.

There were a range of leaf colors to choose from. Jericho produces an attractive bright green head. Early’s Romaine is a more classic dark green. A number of red cultivars were tested – but none had outstanding yields/quality. Breen (red on the outside, green at the center) and Red Heart (green on the outside and red at the center) were excellent bi-color varieties.



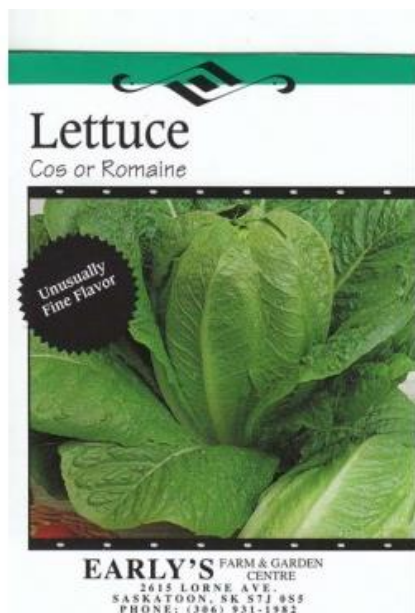
Fig. 2. Heart of Romaine

The flavour of romaine involves a balance of sweet against some bitter. Juiciness is also important. Breen was consistently rated as the best tasting cultivar in the trial, followed by Jericho and Darlene. While Early’s Romaine produced superior yields and looked good – its flavour was only average.

Although the CFIA Grade standards do not deal with romaine lettuce– they mention a number of defects commonly seen in romaine. Of particular note is the degree of tolerance for variability in head size. Canada No. 1 grade romaine lettuce is very uniform in size. It was much easier to achieve the required uniform size distribution using transplants than growing the crop from seed. Another concern will be damage to the framing leaves that occurs during harvest and post-harvest handling. The framing leaves are prone to damage – and must be trimmed away prior to sale – but trimming these leaves away opens up the next layer of leaves to damage.

Variety Assessment – Early’s Romaine produced excellent yields with a high marketable % in both transplanted and direct seeded crops. It also produces a classic shaped heart which can easily be trimmed to meet “hearts of romaine” specs. Its flavour was average. Jericho produced excellent tasting bright green attractive heads. Its yields were superior in both direct seeded trials and it also yielded well when transplanted. However Jericho appears quite susceptible to tipburn and its open head does not conform to traditional market expectations, especially for a ‘hearts of romaine’ trim.

See the tables on the next pages for details on cultivar performance



Jericho romaine lettuce

Conclusion - Romaine lettuce is a fairly straight forward crop to produce under Saskatchewan growing conditions. Transplants of romaine are easy to grow – and allow for more predictable production of a uniform high quality crop. Direct seeding of romaine is less costly than transplanting but results in a less uniform crop in terms of head size and time to heat maturity. A direct seeded crop takes more labor to thin and will also require more careful attention to weed control than if the crop is transplanted. As romaine lettuce can only handle 1-2°C of frost it would be risky to count on establishing the crop earlier than mid-May or leaving the crop in the field past mid-September. It took about 4 weeks to grow the transplants and a further 4 weeks were required for the transplanted crop to reach maturity in the field (total = 8 weeks). It was surprising to note that time to maturity was about the same for the direct seeded and transplanted crop. While using transplants got the crop off to a quick start, the check in growth that occurred at transplanting allowed the direct seeded crop to catch up. The rate of crop growth appeared to be fairly consistent over the period from mid-May to early September. Consequently, growers could likely generate a steady supply of product by either transplanting or direct seeding a new romaine crop every 2 weeks. Tipburn was the most important cause of crop loss observed in this trial – and as this disorder is driven by growing conditions there is little the grower can do – except to grow tipburn resistant cultivars and to harvest before the problem appears. Few insect or disease issues were observed in the 2015 trial but problems are nonetheless possible. Once-over harvest is possible in a transplanted romaine crop - but multiple harvests will be required when growing from seed. The crop is fairly easy to harvest, but as the heads are sensitive to handling injury, field packing is a common practice. While some cultivars tested were suited to packing as a “heart of romaine”, the trimming required to meet that market class will involve additional labor and trimming losses. Ideally some means would be found to capture and sell the trimmed leaves. The storage lifespan of romaine is about 2-3 weeks under optimal conditions (0°C and 95% RH).

Direct Seeded Romaine Lettuce

Cultivar	Supplier	1st Planting - Direct Seeded					2nd Planting - Direct Seeded					Flavor	Overall Rating	Comments	
		% Stand	Market No. (000/ha)	Market Wt. (T/ha)	Avg Head Wt. (kg)	% Mktbl	% Stand	Market No. (000/ha)	Market Wt. (T/ha)	Avg Head Wt. (kg)	% Mktbl				
Annapolis	J	NA	NA	NA	NA	NA	40	24.0	3.9	0.2	67	3.0	1.8	Small heads. Bolting	
Breen	J	NA	NA	NA	NA	NA	70	51.6	8.6	0.2	97	4.5	3.0	Very nice looking but small heads reduce yields. Great flavor.	
Coastal Star	J	10	14.2	7.2	0.5	93	25	19.6	11.1	0.6	97	3.0	2.5	Excellent market % but poor stand	
Darlene	OSC	35	27.1	18.6	0.7	87	35	23.1	14.3	0.6	84	3.0	3.1	Poor stand limits yield. Good market %	
Early's Romaine	EFG	45	28.9	24.4	0.8	85	33	23.6	13.6	0.6	83	3.5	3.5	Excellent yields and high % marketable. Formed hearts	
Freckles***	HMO	55	8.9	3.2	0.4	26	61	45.8	13.5	0.3	89	4.0	2.9	Poor marketable yields due to bolting and tip burn. Good flavor	
Holon	J	10	13.3	6.5	0.5	100	23	18.7	7.6	0.4	86	4.5	2.7	Low yields due to poor stand. Excellent % marketable. Great flavor	
Iva Sol	Ren	40	13.3	5.5	0.4	34	35	42.7	8.9	0.2	74	3.0	2.2	Low % marketable due to bolting	
Jericho***	J	45	34.7	21.1	0.6	87	62	37.3	14.8	0.4	93	4.5	3.9	Excellent yield. Great flavor. Very bright green	
Little Caesar	Ren	60	26.2	13.8	0.5	65	25	21.8	5.9	0.3	52	3.5	2.6	Poor marketability due to tip burn.	
Paris White	Ren	55	38.7	18.3	0.5	80	54	33.8	15.9	0.5	78	4.0	3.6	Good marketability and flavor. Formed hearts	
Red Cash	J	NA	NA	NA	NA	NA	18	8.0	1.9	0.2	90	2.5	1.9	Poor stand. Small heads. Poor flavor	
Rose Heart	Ren	NA	NA	NA	NA	NA	55	25.8	19.1	0.7	94	3.0	3.6	Good yields	
Salvius	J	NA	NA	NA	NA	NA	40	21.3	17.0	0.8	97	3.5	3.5	Excellent market % and forms large heads	
Silvia	WSC	15	24.4	6.6	0.3	82	19	15.1	4.0	0.3	79	2.0	1.9	Small dark red heads. Prone to bolting. Poor flavor	
Sparx	J	NA	NA	NA	NA	NA	28	20.9	12.2	0.6	98	3.0	2.5	Poor yields due to low stand but excellent market %	
Vivian	Ren	10	0.9	0.5	0.6	16	NA	NA	NA	NA	NA	4.0	1.2	Very poor germination.	
Average		35	21.0	11.4	0.5	69	37	25.5	11.4	0.4	85	3.4	2.7		
Bold recommended in 2015							1st planting seeded - May 21		2nd planting seeded - June 22		Rating : 1-Poor				
Previously recommended ***							1st planting harvested - July 15		2nd planting harvested - August 13		5-Good				

Overall rating calculated based on the following weighting matrix; 25% stand %, 25% marketable yield, 25% marketable % , 25% flavor

Transplanted Romaine Lettuce

Cultivar	Supplier	1st Planting - Transplants				2nd Planting - Transplants				Flavor	Overall Rating	Comments
		Market No. (000/ha)	Market Wt (T/ha)	% Mktbl	Avg Head Wt. (kg)	Market No. (000/ha)	Market Wt. (T/ha)	% Mktbl	Avg Head Wt. (kg)			
Annapolis	J	NA	NA	NA	NA	17	8.6	98	0.5	3.0	3.1	
Breen	J	NA	NA	NA	NA	20	9.4	100	0.5	4.5	3.7	Excellent market %. Small heads. Very nice looking and excellent flavor
Coastal Star	J	1.3	2.2	7	1.7	20	15.6	99	0.8	3.0	2.5	Poor marketability in 1st planting due to severe tip burn.
Darlene	OSC	0.4	0.7	2	1.5	20	15.5	100	0.8	3.0	2.4	Poor market % in 1st planting due to severe tip burn.
Early's Romaine	EFG	16.4	24.2	100	1.5	20	26.1	100	1.3	3.5	4.5	Excellent market % and very large heads.
Freckles***	HMO	0.0	0	0	0	16	9.0	72	0.6	4.0	2.2	Poor market % due to tip burn and bolting. Good flavor
Holon	J	2.7	3.0	13	1.1	19	12.4	99	0.6	4.5	2.9	Poor market % in 1st planting due to severe tip burn. Excellent flavor
Iva Sol	Ren	12.4	4.3	80	0.3	11	4.6	51	0.4	3.0	2.4	Poor market % due to tip burn
Jericho***	J	0.0	0	0	0	20	20.6	100	1.1	4.5	3.0	Poor market % in 1st planting due to tip burn. Large heads with good flavor
Little Caesar	Ren	15.6	17.0	78	1.1	13	6.4	71	0.5	3.5	3.2	Good marketability. Formed hearts.
Paris White	Ren	0.0	0	0	0	20	14.4	100	0.7	4.0	2.6	Poor market % in 1st planting due to tip burn. Good flavor
Red Cash	J	NA	NA	NA	NA	20	6.3	81	0.3	2.5	2.6	Small heads. Poor flavor. Red leaf
Rose Heart	Ren	NA	NA	NA	NA	20	14.8	100	0.7	3.0	3.6	Excellent market %
Salvius	J	NA	NA	NA	NA	19	13.8	97	0.7	3.5	3.6	
Silvia	WSC	15.1	9.5	76	0.6	17	10.1	98	0.6	2.0	2.7	Dark red leaf. Poor flavor
Sparx	J	NA	NA	NA	NA	19	13.9	100	0.7	3.0	3.5	Excellent market %
Vivian	Ren	0.0	0	0	0	NA	NA	NA	NA	4.0	1.3	Very poor germination
Average		21	8.7	32	0.7	54	12.6	92	0.7	3.4	2.9	
Bold recommended in 2015		1st planting seeded - April 23				2nd planting seeded - May 26				Rating : 1-Poor		
Previously recommended ***		1st planting transplanted - May 21				2nd planting transplanted - June 23				5-Good		
		1st planting harvested- July 8				2nd planting harvested - July 23						

Overall rating calculated based on the following weighting matrix; 33% marketable yield, 33% marketable %, 33% flavor