

Overwintering hoophouse crops in northern Ontario



IN A NUTSHELL

Ryan and Isabelle tested different varieties and planting dates across two winter seasons to assess overwintering success of kale, cilantro and swiss chard in their unheated hoophouses in Cache Bay, northern Ontario.

- Kale and cilantro successfully overwintered in both years and were affected by their locations between the two hoophouses.
- Swiss chard did not survive in 2022 and was not included in the 2022/2023 trial.
- Planting date did not affect the yield of kale or cilantro.
- Winterbor F1 was the best kale of the three varieties tested and Caribe was the best cilantro of three varieties tested, with respect to its saleability and survivability.

FARMER-RESEARCHER

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Ferme j'me champ beine

FUNDING

Federal Economic Development
Agency for Northern Ontario

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Foundation

MOTIVATION

Ryan and Isabelle are looking to find varieties that can be transplanted into their unheated hoophouses late in the fall, survive the winter and go on to produce high-quality plants early in the spring. Located in northern Ontario, they are always looking for ways to extend their growing season.

Ideally, after this screening is completed, they would like to continue exploring this question by trying different fall planting dates of the best varieties in order to test the ideal transplant size going into the winter.

The objective for this trial was to find which varieties of kale, chard and cilantro yield the most in the spring after a fall planting in an unheated hoophouse in northern Ontario.

METHODS

2021/2022

Ryan and Isabelle planted three varieties each of kale, cilantro and swiss chard into hoophouses 1 and 2. In a 90-ft row of each hoophouse, they planted 5-ft sections of each variety across four blocks.

- **Cilantro:** They sowed one tray of each variety in 128-cell trays with three seeds per cell on August 25, 2021.
- **Swiss chard:** They sowed one tray of each variety in 50-cell trays with three seeds per cell on September 3, 2021.
- **Kale:** They sowed two trays of each variety in 50-cell trays with three seeds per cell on September 3, 2021.

They transplanted all crops on October 6, 2021, including six kale plants, 20 swiss chard plants and 21 cilantro plants into each section. See **Figure 1** for a map of the design.



A photo of an unheated house house at Field Good Farms, with row cover to help moderate the cold temperatures.

2022/2023

For the 2022/2023 winter season, Ryan and Isabelle refined their question and tested one variety each of kale (Winterbor) and cilantro (Caribe) across three planting dates to assess the best time to sow these crops for overwintering. Although Red Russian had higher yield and disease resistance, Winterbor was a better seller at the market and also survived the winter.

Similar to 2022/2023, they laid out four blocks across one row each in Hoophouse 2 and 3. They randomized the order of crop type (kale, cilantro) but did not randomize the order of the planting dates. See **Figure 1** for a visualization of the design.

DATE OF PLANTINGS

Planting 1: September 23, 2023

Planting 2: October 3, 2023

Planting 3: October 14, 2023

2021/2022 TRIAL			2022/2023 TRIAL		
Hoophouse 1			Hoophouse 2		
	Main Plot	Sub plot		Main Plot	Sub plot
Block 1	Kale	Winterbor	Block 3	Cilantro	Caribe
		Red Russian			Leisure
		Scarlet			Santo
	Chard	Red Rhubarb		Kale	Scarlet
		Silverado			Red Russian
		Bali			Winterbor
Cilantro	Caribe	Chard	Scarlet		
	Santo		Red Russian		
	Leisure		Winterbor		
Block 2	Chard	Bali	Block 4	Cilantro	Leisure
		Red Rhubarb			Santo
		Silverado			Caribe
	Cilantro	Santo		Chard	Bali
		Caribe			Silverado
		Leisure			Red Rhubarb
Kale	Winterbor	Kale	Winterbor		
	Scarlet		Red Russian		
	Red Russian		Scarlet		
			Hoophouse 2		
	Main Plot	Subplot		Main Plot	Subplot
Block 1	Kale	Planting 1	Block 3	Cilantro	Planting 1
		Planting 2			Planting 2
		Planting 3			Planting 3
	Cilantro	Planting 1		Kale	Planting 1
		Planting 2			Planting 2
		Planting 3			Planting 3
Block 2	Kale	Planting 1	Block 4	Cilantro	Planting 1
		Planting 2			Planting 2
		Planting 3			Planting 3
	Cilantro	Planting 1		Kale	Planting 1
		Planting 2			Planting 2
		Planting 3			Planting 3

Figure 1. Hoophouse layout for the trials in 2021/2022 and 2022/2023. In each hoophouse, Ryan and Isabelle randomized the order of the crop type (i.e. order of kale, chard, cilantro) and the order of the three varieties of each crop. Each subplot is a 5 foot long section of a bed.

DATA ANALYSIS

To evaluate the different varieties of each crop type for the 2021/2022 and 2022/2023 seasons, we used a statistical model called analysis of variance (ANOVA) with a 95% confidence level to calculate the least significant difference (LSD) needed to call the treatments “statistically different”.

Using a 95% confidence level means that if we measure a difference between any two treatments that is greater than the calculated LSD, we expect this difference would occur 95 times out of 100 under the same conditions.

In this case, we consider the difference reliable and refer to the results as statistically significant. On the other hand, if we measure a difference between any two treatments that is less than the calculated LSD, we consider these treatments unreliably different or statistically similar. We could make these statistical calculations because Ryan and Isabelle’s experimental design involved replication of the treatments.



Kale and cilantro growing in an unheated hoophouse in spring 2023.

FINDINGS

RESULTS FOR THE 2021/2022 SEASON

GERMINATION 2021/2022

- For kale, the top performing variety for germination was Winterbor (69%) followed by Red Russian and Scarlet at 68% and 57%, respectively.
- The best germinating variety for swiss chard was Silverado (70%) followed by Red Rhubarb (53%) and Bali (33%).
- For cilantro the best germination rate was for the variety Caribe (71%) followed by Leisure (61%) and Santo (33%).

For all varieties, we can’t assign confidence to these differences because the trial did not have replicate measurements for germination.

Germination Rates

CROP	VARIETY	GERMINATION RATE *
Kale	Winterbor	69%
	Red Russian	68%
	Scarlet	57%
Chard	Red Rhubarb	53%
	Silverado	70%
	Bali	33%
Cilantro	Santo	33%
	Caribe	71%
	Leisure	61%

* No statistics analysis were performed due to no replication

SURVIVAL RATE 2021/2022

- For kale, the top performing variety for overwintering survival was Winterbor followed by Scarlet and Red Russian, all with a mixture of top growth and root growth. However, due to variability among the subplots, we found no significant difference in survival rate among varieties (P=0.153).
- For cilantro the best overwintering survival rate was for the variety Santo followed by Leisure and Caribe. However, due to variability among the subplots, we found no significant difference in survival rate among varieties (P=0.713).
- The three chard varieties did not survive overwintering in the hoophouse.

Mean Survival Rate

CROP	VARIETY	AVERAGE SURVIVAL RATE
Kale	Winterbor	67%
	Red Russian	17%
	Scarlet	42%
	LSD	NS
Chard	Red Rhubarb	0%
	Silverado	0%
	Bali	0%
	LSD	NA
Cilantro	Santo	24%
	Caribe	14%
	Leisure	20%
	LSD	NS

DISEASE RESISTANCE, PEST RESISTANCE, VISUAL APPEAL 2021/2022

- For kale, disease resistance, pest resistance and visual appeal was highest for Red Russian in all three categories followed by Scarlet and lastly Winterbor. The performance of Red Russian was statistically significant with respect to disease rating (0.005) and visual appeal (0.034).
- For cilantro, Ryan and Isabelle rated all three varieties 5 or very high resistance against pests (0.25) and disease (P=0.25); and they also found no significant difference in the visual appeal rating (0.496).

MARKETABLE YIELD BY BUNCH 2021/2022

- There were no significant difference in mean number of marketable bunches among the varieties of kale (P=0.552) or cilantro (P=0.616).

TEMPERATURE AND NOTES 2021/2022

Ryan and Isabelle noted that the plants got far too large in the fall. They also noted that the fall was very warm and the winter very cold, with 17 nights below -25°C between January 7 - February 28, 2022.

Mean Overall Disease Resistance, Pest Resistance and Visual Appeal

CROP	VARIETY	DISEASE RATING	PEST RESISTANCE RATING	VISUAL APPEAL RATING
Kale	Winterbor	3.5	3.8	2.2
	Red Russian	5	5	4
	Scarlet	3	1.5	0.9
	LSD	0.9	NS	1.7
Cilantro	Santo	5	5	2.3
	Caribe	5	5	2.8
	Leisure	5	5	1.6
	LSD	NS	NS	NS

Marketable Yield by Bunch

CROP	VARIETY (CROP)	HARVEST 1	HARVEST 2	MEAN # BUNCHES
Kale	Winterbor Kale	1	2.75	0.62
	Red Russian Kale	4	2.5	1.1
	ScarletKale	3	1.5	0.9
		LSD		NS
Cilantro	Santo	4	0	0.7
	Caribe	4.5	1	1.4
	Leisure	4.5	0	0.6
		LSD		NS

We found no significant difference in mean harvest among the varieties of kale (P=0.552) or cilantro (P=0.616).

RESULTS FOR THE 2022/2023 SEASON

Ryan and Isabelle harvested kale and cilantro from April 1 to April 25. For the cilantro in hoophouse 2, it looked like there would have been another good harvest (likely the best). However, they had to remove the trial to make room for main season plantings.

CILANTRO

- No effect of planting date on yield in terms of weight (p=0.71) or number of bunches (p=0.56).
- There was a significant effect of hoophouse on both weight (p=0.008) and number of bunches (p=0.008).
- There was higher yield in hoophouse 2 compared to hoophouse 3, which Ryan and Isabelle speculate could be due to conditions being too wet for cilantro in hoophouse 3.

KALE

Even with the earliest of the three planting dates, Ryan and Isabelle tried to trick the kale by planting really late so as to prevent it from going to seed the following season. However, the kale went to seed so this data is for kale raab (the bolting tops of kale), which worked well. The raab was delicious, marketable and early enough to harvest prior to main season hoophouse crops.

- Across the three dates there was no statistically significant difference in yield in terms of weight ($p=0.91$) or number of bunches ($p=0.96$).
- There was a significant effect of hoophouse on yield weight ($p=0.027$) but not number of bunches ($p=0.53$).
- In contrast to the results by location for cilantro, they observed greater yield weight of kale in hoophouse 3 compared to hoophouse 2. This was due to vole damage in hoophouse 2, which led to lower yields; and possibly was too dry for the crop.

DIFFERENCES ACROSS THE HOOPHOUSES

HOOPHOUSE 2

- Hoophouse 2 was harvested intensely since 2018.
- It tended to be drier where the trials were planted and was not set up to water very early in the spring, which may inform the later harvest start dates.
- The trial plants were in a bed against the south side of the tunnel.

HOOPHOUSE 3

- Hoophouse 3 was harvested intensely but only since spring 2022.
- It was built in an area that used to have cattle on it and tends to yield higher in general.
- The profile of this tunnel is larger than hoophouse 2 (30'x100' vs 24'x96') and, therefore, may moderate temperatures differently.
- The trial plants were closer to the middle of the tunnel.
- This tunnel got really wet in early the spring.

NEXT STEPS

If they were to do another trial, Ryan and Isabelle would plant the kale — or even broccoli—raab plants much closer so as to boost the raab yield per bed foot.

TAKE HOME MESSAGE

Kale and cilantro overwinter in unheated hoophouses at Field Good Farm in northern Ontario, but not swiss chard. The top performing kale was Red Russian, with Winterbor also surviving and being a better seller at the market.

The top performing cilantro was Caribe. There was no difference between planting date, suggesting it is not a determinant factor in yield.

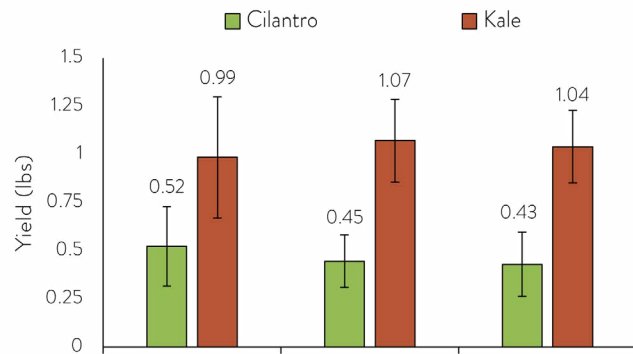


Figure 2. Average yield across the four replicates for each planting for kale and cilantro in 2023.

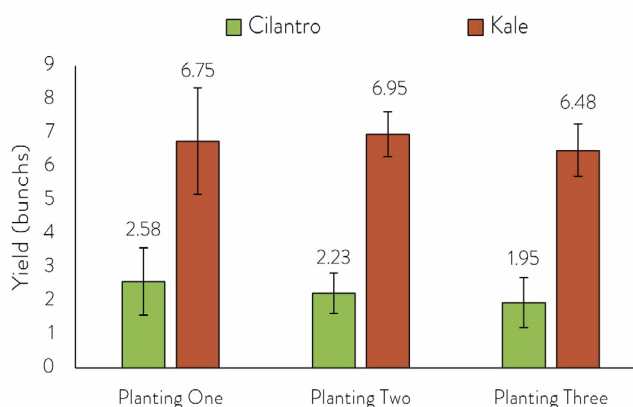


Figure 3. Average number of bunches in the four replicates for each planting for kale and cilantro in 2023.

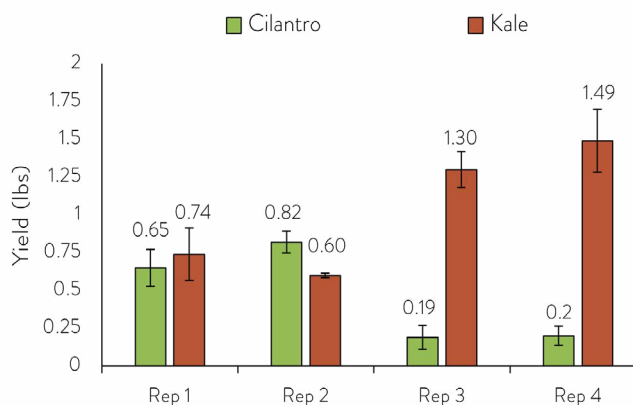


Figure 4. Average yield by weight of kale and cilantro in the four replicate blocks. Replicates 1 and 2 were in hoop house 2 and reps 3 and 4 were in hoophouse 3.