2023 Vegetable Research Funding

	Title	Researcher	$ Amount Funded
1	Weed Control Evaluations in Lima Beans	D. E. Robinson	$19,000
2	Weed Control Evaluations in Snap Beans	D. E. Robinson	
3	Weed Control Evaluations in Carrots	D. E. Robinson	
4	Weed Control Evaluations in Peas	D. E. Robinson	
5	Effectiveness of pea inoculants on different soils and different planting dates – 2 years	J. Zandstra	$8,400
6	Investigations into the relationship between pea populations, soil type and cultivar, and yield response to increasing Tenderometer values – 2 years	J. Zandstra	$8,400
7	Using Genetic Tests to Confirm Herbicide Resistant Weeds in Ontario and Canadian Crops	K. Obeid	$5,000
8	Processing Pea Cultivar Evaluations	Nortera	$7,500
9	Autonomously Scanning Lima Beans for Specific Weeds	J. Sulik	$15,000
10	Sweet Corn Nitrate Survey	E. Roddy	$3,600
11	NYS Processing English Pea, Snap Bean and Sweet Corn Variety Trials	S. Reiners/ M. Rosato	$5,400 US
12	Pea Accelerator Challenge	Nortera	$6,150
13	Sweet Corn Planting Populations	Nortera	$2,000

Effectiveness of pea inoculant at different planting dates and nitrogen application.

University of Guelph, Ridgetown Campus
John Zandstra (PI) and Harpreet Hanzra (Vegetable Research Technician)

Methodology:

A trial was established on the Ridgetown Campus Research Farm to assess the effectiveness of pea inoculants and the impact of planting date as well as addition of nitrogen fertilizer. Plots were established on a sandy loam soil (65.7% sand, 5.6% silt, 28.7% clay) which had not grown green peas within the past 5 years. Each plot was 8 m x 3 m, and contained 12 rows, 18 cm apart. The peas were planted using Wintersteiger double cone plot seeder. There were four factors, cultivar (Tyne and Nitro), inoculant (inoculant and non-inoculant), planting dates (early and late), and nitrogen rate (0 and 50 lb of actual N per ac). All these factors were applied in combination to the experimental units. The cultivar seeding rates were 550,000 seeds/acre for Tyne and 720,000 seeds/acre for Nitro. Weeds were controlled by an application of Dual II Magnum (pre-plant), followed by post-emergent application of Assure and Basagram herbicides.

Assessment of pea nodulation was conducted at the R1(flower bud) stage based on a method described in "Assessing Field Pea Nodulation" by the Manitoba Pulse & Soybean Growers (Table 1). Ten pea plants were randomly selected from each plot and scored according to the categories in Table 1. The maturity of plots was assessed by comparing the tendrometer reading of a subsample to the target tenderometer value of 110. When mature, 2.0 m x 8 rows (2.88 m^2) were harvested per plot and shelled in a stationary pea sheller. At harvest, plant biomass and height from the harvested area were recorded. The final yield of the pea was reported as well as yield adjusted to 110 tendrometer reading based on conversion factors based on "Midwest Maturity Studies". At harvest, a 500 g pea sample from each plot was hand-sieved though a set of steel pea sieves and the percentage distribution of pea seed was recorded (Table 2). The trial was established as a randomized complete block design with 4 replications. Analysis of variance for a randomized complete block design was conducted using SAS software. Tukey-Kramer test was used to separate the treatments with significant differences.

Results and Discussion: Any trends related to inoculated vs no inoculant, and additional nitrogen fertilizer vs no additional nitrogen fertilizer were not apparent. Early planted peas tended to be taller with greater biomass (Table 3). There were significant effects of the treatment combinations on plant biomass, adjusted pea yield, and plant height. However, there were no significant differences among the treatments on pods per plant and nodule rating. The highest (6982.9 lb/ac) adjusted pea yield was recorded with a treatment combination of early planted Nitro cultivar with no inoculant and 50 lb /ac of actual N application, whereas the lowest (2961.7 lb/ac) was recorded from late planted Tyne cultivar with no inoculant and 50 lb /ac of actual N application (Table 3).

Table 1. Assessing field pea nodulation

Category	Description	Score
Plant Growth and Vigour	Plants green and vigorous	5
	Plants green and relatively small	3
	Plants slightly chlorotic (less green)	2
	Plants very chlorotic	1
Nodule Color and Number	Greater than five clusters of pink pigmented nodules	5
	Three to five clusters of predominantly pink nodules	3
	Less than three clusters of nodules, or whitish/greenish nodules	1
	No nodules, or white/green nodules	0
Nodule Position	Crown and lateral root nodulation	3
	Generally crown nodulation	2
	Generally lateral nodulation	1

11-13 = Effective Nodulation 7-10 = Less Effective Nodulation 1-6 = Unsatisfactory

Table 2. Green pea sieve sizes.

Sieve size	Diameter of circular opening in mm (inches)	
	Will not pass through	Will pass through
1	-	7.1 (18/64)
2	7.1 (18/64)	7.9 (20/64)
3	7.9 (20/64)	8.7 (22/64)
4	8.7 (22/64)	9.5 (24/64)
5	9.5 (24/64)	10.3 (26/64)
6	10.3 (26/64)	11.1 (28/64)

Table 3. Effect of pea inoculant, planting date and nitrogen application on plant biomass, height, number of pods per plant, and nodule rating crop parameters at Ridgetown, Ontario.

Treatments (Cultivars - inoculant-N rates)	Planting time	Days to Harvest (#)	Plant biomass (kg)	Plant height (cm)	Pods per plant (#)	Nodule rating	Yield (lb/ac)	Tendrometer reading	Yield Adjustment factor	Adjusted yield (lb/ac)
Tyne-IN-0	Early	67	10.2 abc	60.5 ab	5.3	12.4	8183.2	135.3	0.89	6517.1 a
Tyne-IN-50	Early	67	10.7 ab	66.3 a	4.4	12.2	5698.8	123.5	0.91	4740.3 ab
Tyne-NO-0	Early	67	10.1 abc	50.0 b	5.1	12.8	8096.4	136.5	0.88	6379.0 ab
Tyne-NO-50	Early	67	11.2 a	61.3 a	5.5	11.3	6269.1	126.3	0.90	5097.3 ab
Nitro-IN-0	Early	61	8.0 abcd	32.8 cd	5.6	12.1	7230.9	105.8	1.06	6841.6 a
Nitro-IN-50	Early	61	7.8 bcd	30.5 cde	7.1	12.1	6632.0	109.0	1.01	6056.8 ab
Nitro-NO-0	Early	61	7.9 abcd	30.0 cdef	4.9	12.2	6898.4	109.3	1.02	6303.4 ab
Nitro-NO-50	Early	61	8.5 abcd	29.5 cdef	6.7	11.5	7399.7	108.5	1.02	6982.9 a
Tyne-IN-0	Late	67	7.0 cd	34.0 c	5.4	12.0	5099.8	107.3	1.05	4789.2 ab
Tyne-IN-50	Late	67	7.1 cd	35.0 c	5.5	10.5	5070.3	107.0	1.03	4690.4 ab
Tyne-NO-0	Late	67	6.5 d	30.0 cdef	4.3	11.8	5189.2	111.8	0.99	4632.4 ab
Tyne-NO-50	Late	67	7.1 cd	28.0 cdef	5.0	10.1	5052.1	108.8	1.01	2961.7 b
Nitro-IN-0	Late	60	6.7 d	19.5 f	6.6	12.9	6051.3	117.0	0.99	5371.8 ab
Nitro-IN-50	Late	60	7.5 bcd	22.5 def	6.8	12.8	6008.7	120.3	1.01	5393.5 ab
Nitro-NO-0	Late	60	6.5 d	20.0 ef	5.8	12.7	5709.2	118.8	0.97	4965.8 ab
Nitro-NO-50	Late	60	6.8 cd	21.3 ef	6.3	10.9	5177.1	113.0	1.01	4690.5 ab
Effects										
Treatments			<0.0001	<0.0001	NS	NS	NS			0.0122
[z]SE			**0.6531**	**2.049**	**0.6446**	**0.6853**	**830.01**			**721.00**

[z]SE indicates standard error of means.

[a-f]In each column and for each effect, means followed by a different letter indicate statistically significant effect at $P<0.05$ per Tukey-Kramer adjustment.

The presented plant biomass in the table is from the randomly harvested area pf $2.88 m^2$.

Note: Early planting was done on May 6th and late planting of the pea trial was done on June 2nd, 2023.

Table 4. Percent size distribution of peas from different treatment combination at Ridgetown, Ontario.

Treatments		Sieve Size (size in mm which the pea will not pass through)						
(Cultivars - inoculant-N rates)		**>6**	**6 (10.31)**	**5 (9.52)**	**4 (8.72)**	**3 (7.93)**	**2 (7.14)**	**1 -**
Tyne-IN-0	Early	1.5	10.0	43.4	33.6	8.1	1.5	0.9
Tyne-IN-50	Early	3.2	11.5	38.1	31.8	9.7	2.8	1.9
Tyne-NO-0	Early	1.7	9.5	46.0	31.2	8.0	1.5	1.0
Tyne-NO-50	Early	1.9	11.2	41.5	31.6	9.3	2.2	1.0
Nitro-IN-0	Early	0.0	0.0	0.1	3.4	37.9	43.7	14.2
Nitro-IN-50	Early	0.0	0.0	0.2	5.2	39.9	39.5	14.2
Nitro-NO-0	Early	0.0	0.0	0.1	4.9	41.0	40.7	13.5
Nitro-NO-50	Early	0.0	0.0	0.0	4.0	36.2	43.7	15.3
Tyne-IN-0	Late	0.9	7.6	34.0	36.6	14.2	3.7	2.1
Tyne-IN-50	Late	1.1	9.0	34.2	35.5	13.7	3.6	1.9
Tyne-NO-0	Late	0.4	7.9	39.2	35.4	12.9	2.1	1.1
Tyne-NO-50	Late	1.5	9.0	36.2	34.3	12.6	3.5	1.8
Nitro-IN-0	Late	0.0	0.1	2.2	12.2	39.9	32.6	11.9
Nitro-IN-50	Late	0.0	0.1	2.0	12.7	38.6	32.7	12.4
Nitro-NO-0	Late	0.0	0.0	1.7	11.1	38.0	36.4	11.6
Nitro-NO-50	Late	0.0	0.1	1.9	12.1	41.0	32.2	11.4

Evaluation of the different cultivars and seeding rates on pea crop yield.

University of Guelph, Ridgetown Campus
John Zandstra (PI) and Harpreet Hanzra (Vegetable Research Technician)

Methodology:

A trial evaluating plant populations across pea cultivars was established on the Ridgetown Campus Research Farm on a sandy loam soil (65.7% sand, 5.6% silt, 28.7% clay). The trial was established as a randomized complete block design with 4 replications. The plot size was 8 m x 3 m, and contained 12 rows spaced 18 cm apart. The plots were established on May 8th, 2023, using a Wintersteiger double cone plot seeder. There were two factors, cultivar and seeding rates, these factors were applied in combination to the experimental units. The four cultivars were Sherwood, Nitro, Tyne, and Rihanna.

Table 1. Seeding rate treatments for each cultivar.

	Seeding rate per acre			
Cultivars	1	2	3	4
Sherwood	550000	650000	750000	850000
Tyne	475000	550000	625000	700000
Nitro	620000	720000	820000	920000
Rihanna	620000	720000	820000	920000

Weeds were controlled by an application of Dual II Magnum (pre-plant), followed by post-emergent application of Assure and Basagram herbicides. The maturity of plots was assessed by comparing the tendrometer reading of the subsample to the target tenderometer value of 110. At harvest, 2.0 m x 8 rows (2.88 m^2) were harvested per plot and shelled through a stationary pea sheller. In addition to this, plant biomass and height from the harvested area were recorded. The final reported yield of the pea was adjusted to 110 tendrometer reading based on conversion factors reported by "Midwest Maturity Studies". Using 500 g threshed peas sample from each plot, the percentage distribution of pea seed was recorded by hand-sieving through the set of steel pea sieves. Analysis of variance for a randomized complete block design was conducted by using SAS software. Tukey-Kramer test was used to separate the treatments with significant differences.

Results: As pea populations increased, the pods per plant tended to decrease in the cultivars Tyne, Nitro and Rihanna (Table 3). Peas per pod tended to decrease in response to increasing plant populations in Sherwood and Nitro. Yields (adjusted) peaked at 850 000 seeds per acre for Sherwood, 625 000 seed per acre for Tyne, 920 000 seeds per acre for Nitro and 720 000 seeds per acre for Rihanna; however there were no significant yield differences within any cultivar at different planting populations (Table 3).

Table 2: Green pea sieve sizes.

Sieve size	**Diameter of circular opening in mm (inches)**	
	Will not pass through	Will pass through
1	-	7.1 (18/64)
2	7.1 (18/64)	7.9 (20/64)
3	7.9 (20/64)	8.7 (22/64)
4	8.7 (22/64)	9.5 (24/64)
5	9.5 (24/64)	10.3 (26/64)
6	10.3 (26/64)	11.1 (28/64)

Table 3. Effect of cultivar and seeding rates on plant biomass, height, number of pods per plant, peas per pods, and adjusted yield at Ridgetown, Ontario.

Treatments (Cultivars and seeding rates)	Plant biomass (kg)	Plant height (cm)	Pods per plant (#)	Peas per pods (#)	Yield (lb/ac)	Tendrometer readings	Yield adjustment factor	Adjusted yield (lb/ac)
Sherwood @ 550000 seeds/ac	6.05 d	25.5 c	5.0 bc	5.5 bc	4010.2 ef	95	1.24	4932.0 b
Sherwood @ 650000 seeds/ac	6.13 d	23.4 c	4.3 c	5.8 bc	4054.7 ef	93	1.31	5361.3 ab
Sherwood @ 750000 seeds/ac	7.13 bcd	24.3 c	5.0 bc	5.3 c	4696.1 bcdef	94	1.29	6016.0 ab
Sherwood @ 850000 seeds/ac	6.76 cd	25.9 c	5.5 abc	5.3 bc	4396.9 cdef	89	1.38	6106.3 ab
Tyne @ 475000 seeds/ac	8.94 abc	53.7 a	6.7 abc	6.6 abc	6157.9 ab	117	0.96	5891.9 ab
Tyne @ 550000 seeds/ac	9.65 ab	61.5 a	7.0 abc	6.5 abc	5789.9 abcd	114	0.99	5703.5 ab
Tyne @ 625000 seeds/ac	10.23 a	54.1 a	6.3 abc	7.5 a	6536.0 a	122	0.93	6043.4 ab
Tyne @ 7000000 seeds/ac	10.85 a	59.5 a	6.3 abc	7.0 ab	6257.1 ab	115	0.97	5996.2 ab
Nitro @ 620000 seeds/ac	8.78 abc	28.9 bc	7.8 abc	6.8 abc	5641.4 abcde	92	1.32	7430.7 a
Nitro @720000 seeds/ac	8.90 abc	30.5 bc	6.3 abc	6.5 abc	5676.6 abcde	101	1.14	6432.3 ab
Nitro @ 820000 seeds/ac	9.53 abc	29.3 bc	6.5 abc	6.3 abc	5134.4 abcdef	92	1.32	6672.8 ab
Nitro @ 920000 seeds/ac	9.43 abc	27.6 c	6.5 abc	5.5 bc	6061.0 abc	93	1.29	7764.1 a
Rihanna @ 620000 seeds/ac	7.40 bcd	56.8 a	9.8 a	6.3 abc	3702.4 f	86	1.49	5379.3 ab
Rihanna @720000 seeds/ac	8.85 abc	54.9 a	9.5 ab	6.5 abc	5004.7 abcdef	88	1.43	7073.7 ab
Rihanna @ 820000 seeds/ac	8.48 abcd	52.3 a	8.3 abc	6.5 abc	4875.8 abcdef	95	1.27	6140.5 ab
Rihanna @ 920000 seeds/ac	9.23 abc	45.4 ab	8.0 abc	6.3 abc	4314.1 def	89	1.40	5901.7 ab
Effects								
Cultivar x seeding	<0.0001	<0.0001	0.0021	0.0009	<0.0001			0.0104
[z]SE	0.6318	3.4483	0.8690	0.3489	378.81			495.88

[z]SE indicates standard error of means.

[a-f]In each column and for each effect, means followed by a different letter indicate statistically significant effect at $P<0.05$ per Tukey-Kramer adjustment.

The presented plant biomass in the table is from the randomly harvested area of $2.88m^2$.

The days to harvest for Sherwood, Nitro, Tyne, and Rihanna were 52, 60, 67, and 65 respectively.

Table 4. Percent size distribution of peas from cultivar and seeding rate experiment at Ridgetown, Ontario.

Treatments	Sieve Size (size in mm which the pea will not pass through)						
(Cultivars and seeding rates)	>6	**6 (10.31)**	**5 (9.52)**	**4 (8.72)**	**3 (7.93)**	**2 (7.14)**	**1 -**
Sherwood @ 550000 seeds/ac	0.1	3.7	26.1	39.2	19.5	6.8	2.8
Sherwood @ 650000 seeds/ac	0.3	5.3	28.4	38.3	18.8	5.7	2.0
Sherwood @ 750000 seeds/ac	0.3	4.3	25.3	42.0	19.6	5.2	2.0
Sherwood @ 850000 seeds/ac	0.5	4.8	26.2	41.7	18.8	5.2	1.6
Tyne @ 475000 seeds/ac	1.8	10.2	37.2	32.0	11.5	3.6	2.3
Tyne @ 550000 seeds/ac	2.5	11.8	35.4	31.9	11.5	3.9	2.1
Tyne @ 625000 seeds/ac	1.6	10.5	35.9	33.3	11.1	3.6	2.7
Tyne @ 7000000 seeds/ac	1.5	9.5	38.1	32.4	11.2	3.9	2.2
Nitro @ 620000 seeds/ac	0.0	0.0	0.3	4.0	33.6	42.2	18.9
Nitro @720000 seeds/ac	0.0	0.0	0.0	3.2	32.1	42.4	20.9
Nitro @ 820000 seeds/ac	0.0	0.0	0.1	3.5	26.9	47.1	21.3
Nitro @ 920000 seeds/ac	0.0	0.0	0.2	2.7	30.9	44.1	20.9
Rihanna @ 620000 seeds/ac	0.0	0.0	0.0	0.2	6.9	39.5	52.3
Rihanna @720000 seeds/ac	0.0	0.0	0.0	0.3	6.7	40.6	51.3
Rihanna @ 820000 seeds/ac	0.0	0.2	0.2	0.2	5.6	41.2	51.4
Rihanna @ 920000 seeds/ac	0.0	0.0	0.0	0.2	5.5	39.1	53.8

2023 Project Summary: Using Genetic Tests to Confirm Herbicide Resistant Weeds in Ontario Crops

Kristen Obeid, OMAFRA Weed Management Specialist - Horticulture

Since 2016, this project has developed 24 genetic quick tests (more in progress) to assist in identifying herbicide resistance in 14 weed species and confirmed 207 new cases of herbicide resistance in Ontario crops. These tests deliver a diagnostic and a recommendation to the grower within the same growing season. Traditional resistance testing in the greenhouse can take from three months to a year to get results back to growers. Now, leaf tissue instead of seed is collected. DNA is extracted from the leaf tissue to determine if there is a change in the sequencing resulting in a mutation making the plant resistant.

Tests have been developed to differentiate between Brassica and Amaranthus (pigweed) species. Tests differentiating pigweed species have been instrumental in confirming new cases of waterhemp in Ontario, Manitoba and Quebec. Once confirmed, the waterhemp is tested for Groups 2, 5, 9 and 14 resistances. Waterhemp has been found in 18 Ontario counties.

Table 1. Genetic Tests Currently Utilized by Harvest Genomics

Weed Species	Herbicide Group	Resistance & Tests
Large crabgrass	1	Metabolic: ACCase gene amplification
Common chickweed	2	Target-site (P197Q & unpublished)
Common ragweed	2	Target-site (W574L)
Eastern black nightshade	2	Target-site (A205V)
Giant foxtail	2	Target-site (unpublished)
Giant ragweed	2	Target-site (W574L)
Pigweed spp.	2	Target-site (S653N & W574L)
Common ragweed	5	Target-site (V219I)
Giant ragweed	5	Target-site (V219I)
Lamb's-quarters	5	Target-site (S264G)
Pigweed spp.	5	Target-site (A251V, S264G, V219I & F274L)
Brassica spp.	9	Presence of transgene
Canada fleabane	9	Target-site (P106S)
Common ragweed	9	Thr102Ile, Ala103Val, Pro106Ser sequencing assay
Italian ryegrass	9	Pro (CCA) to Ser (TCA) mutation at Codon 106 in EPSPS
Waterhemp	9	Metabolic: EPSPS gene amplification
Common ragweed	14	MAPAQ mutation R98L
Pigweed spp.	14	Target-site (ΔG210 in PPX2L)
Amaranthus spp.	-	Species identification
Brassica spp.	-	Species identification

Note: New test from MAPAQ highlighted in yellow
Note: Amaranthus spp. Includes green pigweed, redroot pigweed and waterhemp

In 2018, the protocols for these tests were shared with the Pest Diagnostic Lab of the Quebec Ministry of Agriculture, Fisheries and Food (MAPAQ) and the weeds lab of AAFC's Harrow

Research and Development Centre as a pilot project and made available to extension personal in Ontario and Quebec to submit samples, providing the diagnostic service to growers.
In 2019, all samples were sent from Ontario to the Pest Diagnostic Lab of the Quebec Ministry of Agriculture, Fisheries and Food (MAPAQ), whom provided the testing for free. In 2020, MAPAQ could no longer accept samples from out of province.

In 2020, Harvest Genomics www.harvestgenomics.ca signed an agreement with AAFC to obtain the protocols and started to provide the service to Ontario growers for a fee. In 2023, the partners in Harvest Genomics disbanded. TurnKey Genomics was then formed www.turnkeygenomics.ca and they obtained a licensing agreement from AAFC to provide the genetic testing service in Ontario for this project.

Results

Table 2. 2023 Results in Ontario to October 27

Crop	Weed	Herbicide Group	Total Fields	Positive Tests	%
		G5	15	9	60
Carrots	Pigweed spp.	G5/14		6	40
Corn	Common ragweed	G2/G5	2	2	100
Corn	Green foxtail	G2	1	0	0
Corn	Pigweed spp.	G2/G5/G14	1	0	0
Corn	Waterhemp	G2/G9	2	1	50
		G2/G9/G14		1	50
Grapes	Italian ryegrass	G9	1	0	0
IP Beans	Common ragweed	G2/G5	4	2	50
		G2/G5/G14		2	50
IP Beans	Pigweed spp.	G2	1	1	100
Popcorn	Lamb's-quarters	G5	1	0	0
Potatoes	Lamb's-quarters	G5	1	0	0
Potatoes	Pigweed spp.	G5	1	1	100
Soybeans	Canada fleabane	G9	1	1	100
Soybeans	Common ragweed	G2/G5	11	5	100
		G2/G5/G14		6	100
Soybeans	Pigweed spp.	G2	2	1	100
		G2/G5/G14		0	0
Soybeans	Waterhemp	G2/G14	12	3	25
		G2/G9/G14		5	42
		G9/14		3	25
		G5/G9/14		1*	8
Tomato	Pigweed spp.	G5	1	1	100
Unknown	Waterhemp	G2/G14	1	1	100
Wheat	Waterhemp	G2/14	2	1	50
		G2/G9/G14		1	50
White beans	Common ragweed	G2/G5/G14	1	1	100
White beans	Lamb's-quarters	G5	1	0	0
Totals			61	55	90

Note: Pigweed spp. includes green pigweed and redroot pigweed.
Note: The above data does not include 55 samples for waterhemp confirmations and resistance testing completed for Manitoba.
*Only one field has been found with G5 resistance at this time. There are 2 mechanisms of G5 resistance - target-site and metabolic. Seed will need to be collected and dose response experiments will need to be conducted on all fields to determine if G5 metabolic resistance and G27 resistance is present. There is no genetic test developed for G27 resistance yet. One is being worked on by Quebec researchers.

Significant Results:

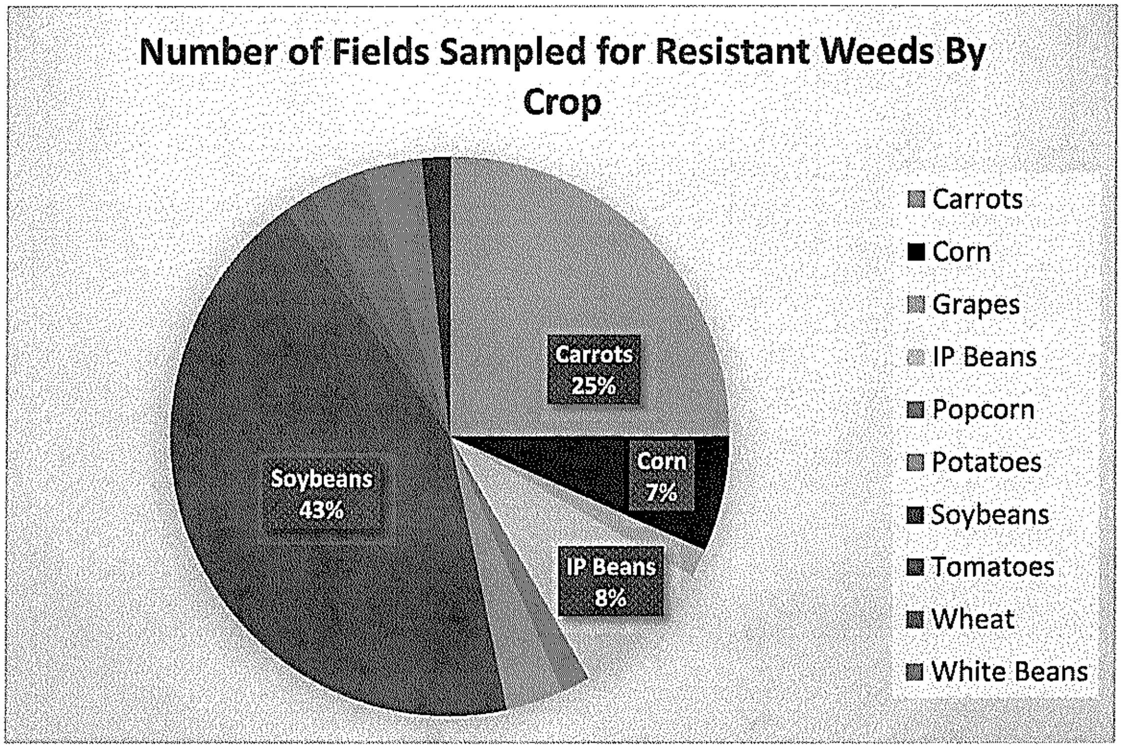
- Five-way resistant waterhemp to herbicide groups 2, 5, 9, 14 and 27 has been confirmed in 7 counties in Ontario - Chatham-Kent, Essex, Elgin, Lambton, Middlesex, Northumberland and Stormont, Dundas & Glengarry.
- Waterhemp has been confirmed in 18 counties in Ontario (Brant, Bruce, Chatham-Kent, Dufferin, Elgin, Essex, Haldimand, Huron, Lambton, Leeds and Grenville United Counties, Middlesex, Niagara, Norfolk, Northumberland, Ottawa, Stormont, Dundas and Glengarry, Wellington and Wentworth). No new counties were found this season.
- Over the course of this study, multiple resistant waterhemp has been confirmed in asparagus, corn, peppers, soybeans, sweet corn, wheat and white beans in Ontario. Wheat is new in 2023.
- In 2023, 100% of waterhemp confirmations were G14 resistant compared to 67% G9 resistant.
- Multiple resistant pigweed species (green pigweed and redroot pigweed) are commonly found in many horticulture crops for example: G2/G5 in pumpkins, potatoes, strawberries, sunflowers and tomatoes and G5/G14 in carrots.
- 33% of all pigweed spp. samples were multiple resistant to G5/G14 herbicides. All samples came from carrot fields.
- All common ragweed samples were multiple resistant. With 50% resistant to G2/G5 and 50% resistant to G2/G5/G14 herbicides. The common ragweed samples came from corn (2), IP beans (4), soybeans (11) and white beans (1).
- Three-way resistant common ragweed to herbicide groups 2, 5 and 14 has been confirmed in Bruce, Lambton and Prescott and Russell counties.
- Continued documentation of Canada fleabane resistant to G9 in apples, blueberries, carrots, grapes, onions, pumpkins and strawberries.
- Amaranthus species identification showed that waterhemp is often confused with green pigweed and tumble pigweed.

This testing has been instrumental in documenting new cases of herbicide resistant weeds. In 2023, 90% of the fields tested in Ontario were resistant to at least one herbicide group. Eighty percent of these fields were 2-way or 3-way resistant. Once confirmed producers were provided the resistance profile enabling a change in management to mitigate spread. Producers, agri-business and consultants that participated in the project were pleased with the timely results, welcomed the in-season management recommendations and highly value this service. For the most up to date herbicide resistant weeds information, visit our herbicide resistant weeds database on the Ontario Crop Protection Hub: Herbicide Resistant Weeds - Database and Maps (gov.on.ca)

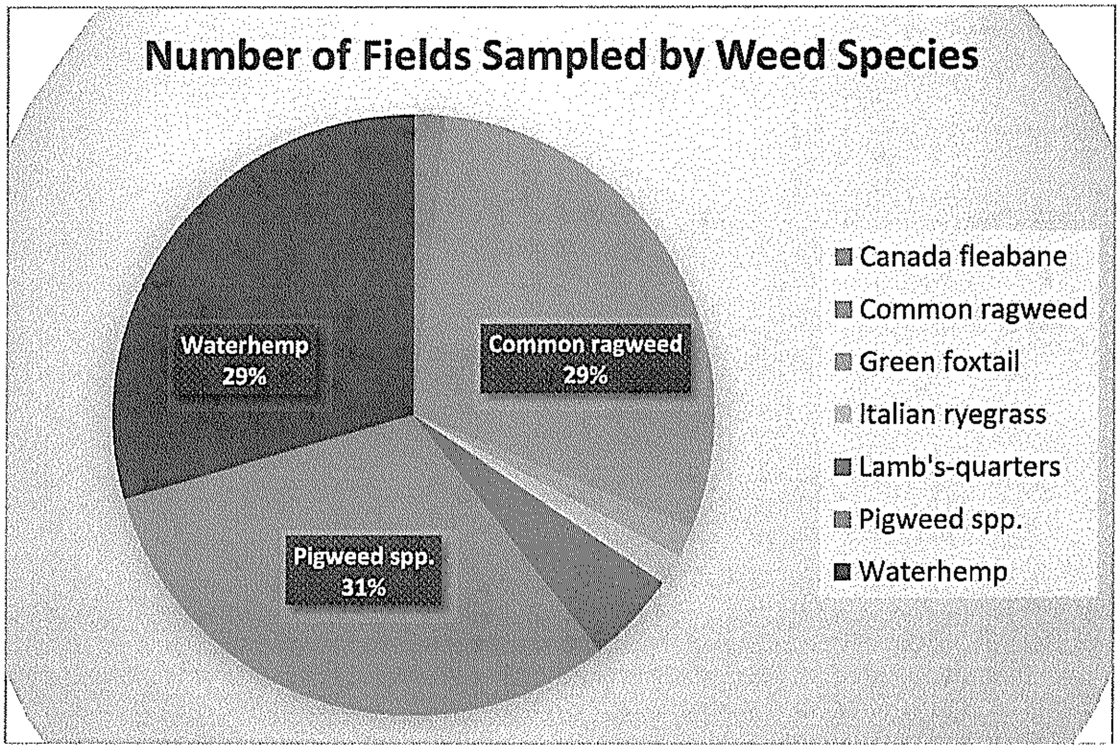
There are many more undocumented cases of herbicide resistant weeds in Canada. The resistance mechanism is unknown for most of them. The major concern is their distribution and economic impact for producers. Knowing where resistant biotypes are located will improve management and maintain the longevity of our crop protection tools.

Project partners include: AAFC, AAFC-PMC, Bayer Crop Science Inc., BASF Canada, FMC Canada, FVGO, MAPAQ, OAG, OFVGA, OPVG and Syngenta Canada Inc.

APPENDICES



Total Number of Fields = 61



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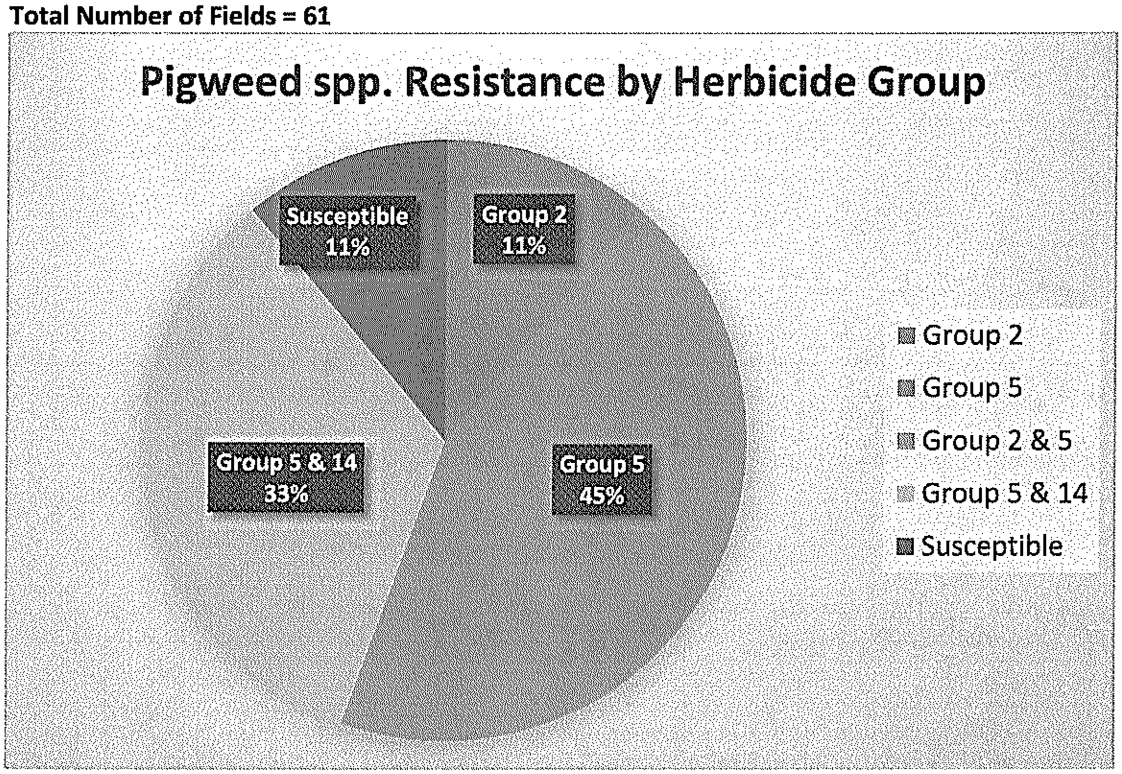
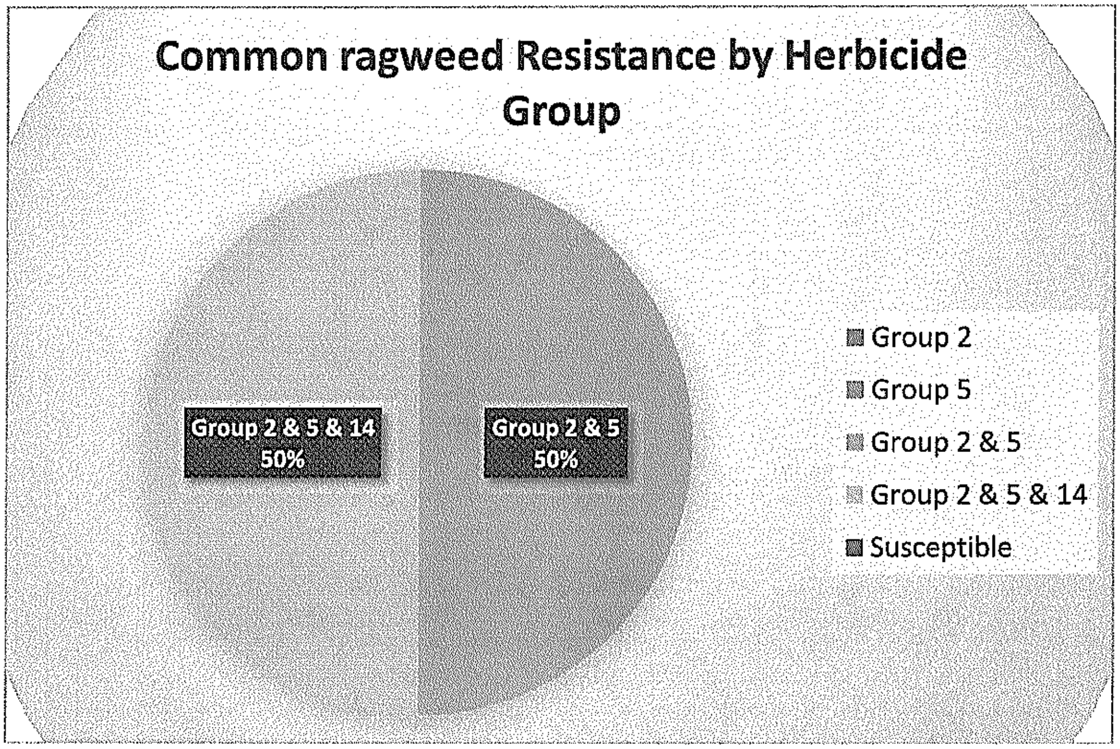


Total Number of Fields = 18



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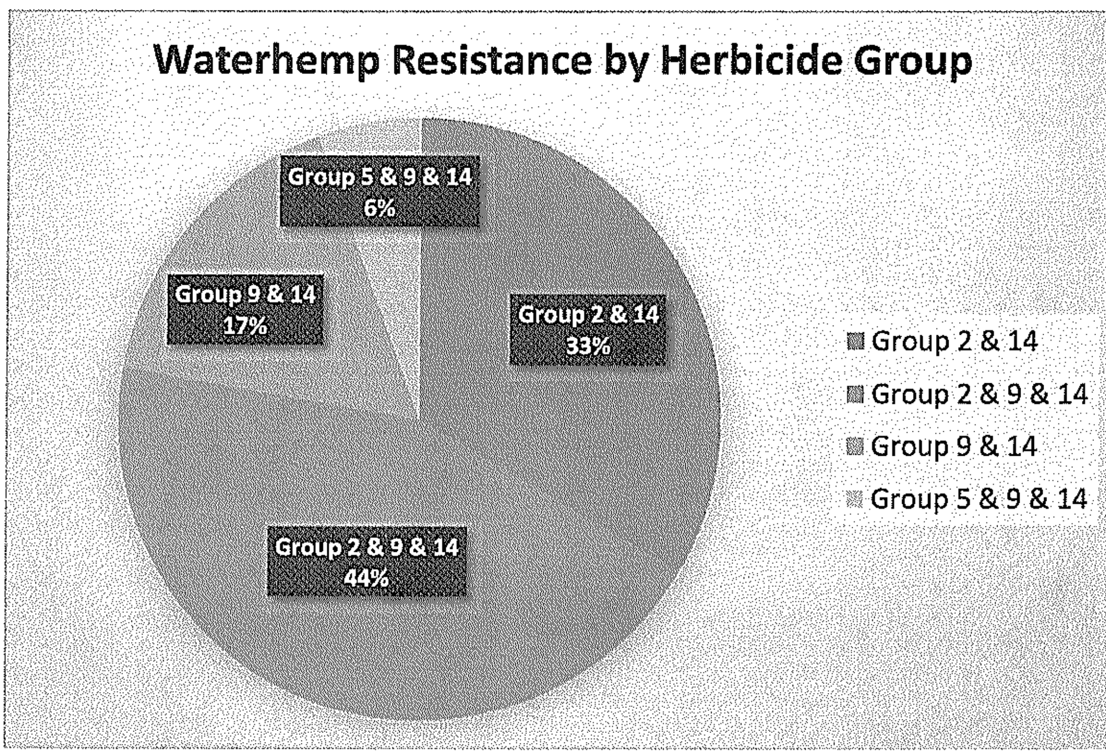
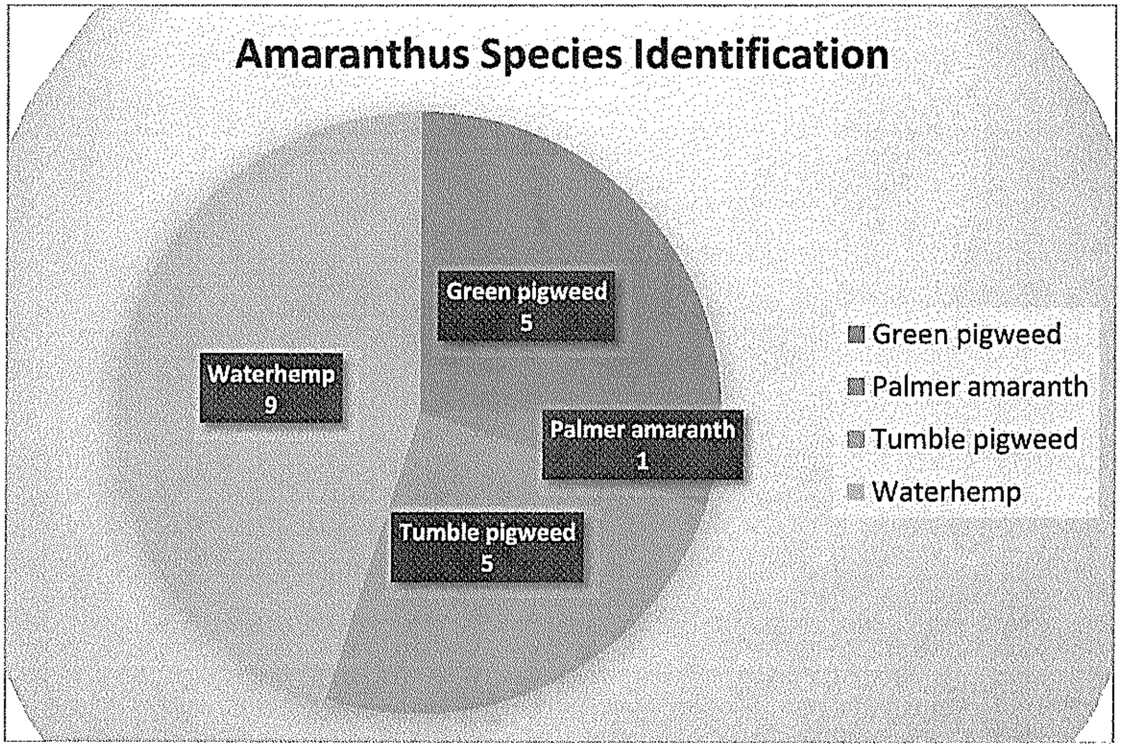


Total Number of Fields = 18



Total Number of Fields = 20

NORTERA

Background

New processing pea cultivars are being bred all the time. These new cultivars need to be tested in an Ontario growing environment in order to select those with optimum performance in an Ontario climate. Having data to support future cultivar purchases will ensure maximum productivity for Ontario pea growers.

Objective

1. Evaluate the suitability of available pea cultivars to the Ontario climate and their relative performance as compared to cultivars grown extensively in Ontario's pea program.
2. Identify cultivars that will fit into gaps in the Ontario pea program

EARLY PLANTING

SITE INFORMATION

Soil Type: Colwood Silt Loam

Tillage: Fall chisel, spring cultivate

Soil Fertility: pH 7.2, P(bicarb) 15, K(ppm) 143, Mg(ppm) 270, CEC 21.7

Herbicides: 0.6L Dual II Magnum, applied PPI

Planting Date: April 27, 2023

Each plot was planted in 7.5" row spacing to a length of 19 feet, and replicated 4 times. Each plot was split into three, five-foot long sections. At harvest, the middle 4 rows from each 5 foot section were used for harvest data collection. This allowed for a maximum of 3 separate harvest days for each entry.

Heat units to harvest are calculated at the end of the day of harvest.

LATE PLANTING

SITE INFORMATION

Soil Type: Tuscola Clay

Tillage: Fall chisel, spring cultivate

Herbicides: 0.6L Dual II Magnum + 130mL Pursuit applied PPI May 13, 2023

Planting Date: May 26, 2023

Each plot was planted in 7.5" row spacing to a length of 20 feet, and replicated 4 times. Each plot was split into three, five-foot long sections. At harvest, the middle 4 or 6 rows from each 5 foot section were used for harvest data collection. This allowed for a maximum of 3 separate harvest days for each entry.

Heat units to harvest are calculated at the end of the day of harvest.

Results
Early Planting - Tupperville, ON

Season Summary - Early Planting

The trial was planted into good conditions and adequate moisture. Following planting, the plot received a little over an inch of rain over a 4-5 days period, then remained dry until the second week of June. Temperatures remained relatively cool throughout the growing season, with nighttime temperature remaining relatively low.

Weed control was excellent, and any weed escapes were removed by hand throughout the season.

Due to the dry growing season, there was virtually no incidence of any of the root rot complexes, downy mildew, or powdery mildew throughout the season.

Harvest started on June 24th, fifty-eight (58) days after planting, and continued almost daily until July 1st, sixty-five (65) days after planting.

2023 Pea Cultivar Evaluation Trial (Ontario) NORTERA

Weather

April	High	Low	Daily HU	Daily Percip
27	13.6	1.0	5	0
28	12.7	4.5	7	18.03
29	14.8	8.7	13	5.84
30	11.7	8.7	10	2.20

Total Air HU	1526
Total Percip	123.95

May	High	Low	Daily HU	Daily Percip
1	9.4	3.1	3	2.54
2	6.4	2.8	0	4.57
3	10.4	2.8	4	2.29
4	15.0	7.4	13	0
5	15.7	4.1	10	0
6	20.1	6.8	16	0
7	22.6	11.8	23	0.51
8	12.0	9.6	11	0
9	17.1	7.4	14	0.25
10	23.3	5.1	18	0
11	26.6	8.8	24	0
12	27.2	10.2	26	0
13	24.7	11.7	25	0
14	17.7	7.8	15	0
15	22.5	3.7	16	0
16	25.9	9.3	24	0
17	9.6	1.9	2	0
18	18.2	-0.8	8	0
19	24.0	5.8	19	0
20	14.7	10.7	15	3.81
21	23.1	9.7	22	0
22	21.8	8.6	19	0
23	25.9	9.2	24	0
24	17.6	6.5	14	0.25
25	14.9	4.8	10	0
26	21.4	3.3	14	0
27	28.3	5.4	21	0
28	26.5	9.1	24	0
29	29.2	9.9	27	0
30	30.3	12.2	30	0
31	30.4	15.8	30	0

June	High	Low	Daily HU	Daily Percip
1	32.1	14.6	30	0
2	30.8	15.3	30	0
3	24.3	16.2	28	0
4	25.7	9.9	24	0
5	25.8	10.9	25	0
6	20.4	10.8	20	0
7	20.9	8.9	19	0
8	21.2	9.9	20	0
9	25.3	9.3	23	0
10	27.5	12.9	28	0
11	21.3	13.8	24	11.94
12	17.6	12.1	19	2.29
13	16.7	10.4	16	3.81
14	28.1	9.1	25	0
15	22.1	12.4	23	4.06
16	18.0	13.7	21	13.21
17	25.4	11.2	25	0
18	28.3	10.5	25	0
19	28.2	11.8	28	0
20	28.9	15.7	30	0
21	28.3	15.5	30	0
22	25.1	16.1	29	0
23	20.6	17.7	26	11.08
24	28.2	17.4	30	3.81
25	28.5	17.8	30	8.13
26	22.5	17.5	28	6.1
27	19.9	17.1	25	0.25
28	24.4	13.2	26	0
29	26.2	13.7	28	0
30	28.2	18.4	30	0

July	High	Low	Daily HU	Daily Percip
1	28.2	19.8	30	0
2	26.4	21.4	30	1.52
3	26.4	19.7	30	11.94
4	29.6	17.6	30	0
5	30.8	19.1	30	0
6	28.7	20.1	30	4.83
7	28.3	16.3	30	0

Small Sieve Peas

Variety	Harvest Date	Growing Days	Acc Air HU	Harvested Weight (lbs)	Sieve 1	Sieve 2	Sieve 3	Sieve 4	Sieve 5	Avg Sieve	Expected Sieve	Unadjusted Yield (tons/acre)	Avg TD	Adjusted Yield (tons/acre)
CS-529F	27-Jun	61	1232	2.22	8.6%	8.1%	54.1%	20.3%	9.0%	3.1	2.2	0.97	100	1.09
Natalie	29-Jun	63	1285	3.45	20.9%	39.4%	33.0%	3.8%	2.9%	2.3	1.9	1.50	129	1.34
Nitro	3-Jul	67	1405	4.81	10.8%	35.6%	49.5%	3.1%	1.0%	2.5		2.10	118	1.97
ASR 40.4021	5-Jul	69	1465	5.73	8.9%	26.9%	60.7%	3.3%	0.2%	2.6	1.9	2.50	118	2.35
EXP798	5-Jul	69	1465	5.53	6.7%	22.6%	65.8%	4.7%	0.2%	2.7	2.2	2.41	132	2.12
Rhianna	7-Jul	71	1526	5.09	29.3%	40.7%	24.6%	2.9%	2.6%	2.1		2.22	117	2.11
Wav-202	7-Jul	71	1526	4.69	19.0%	38.6%	40.3%	1.9%	0.2%	2.3	2.1	2.04	112	2.00
												Trial Average		1.85

Varieties	Date		6/24	6/25	6/26	6/27	6/28	6/29	6/30	7/1	7/2	7/3	7/4	7/5	7/6	7/7
	Acc. HU		1148	1178	1206	1232	1257	1285	1315	1345	1375	1405	1435	1465	1495	1526
PETITE PEAS	Adj. Yield	Avg. Sieve	PETITE PEAS													
CS-529F	1.09	3.1	75		98	100										
Natalie	1.34	2.3	72			99		129								
Nitro	1.97	2.5								94		118				
ASR 40.4021	2.35	2.6												118		
EXP798	2.12	2.7												132		
Wav-202	2.00	2.3												85	91	112
Rhianna	2.11	2.1												94	103	117
AVERAGE	1.85															

2023 Pea Cultivar Evaluation Trial (Ontario) NORTERA

Large Sieve Peas

Variety	Harvest Date	Growing Days	Acc Air HU	Harvested Weight (lbs)	Sieve 1	Sieve 2	Sieve 3	Sieve 4	Sieve 5	Avg Sieve	Expected Sieve	Unadjusted Yield (tons/acre)	Avg TD	Adjusted Yield (tons/acre)
Sherwood	26-Jun	60	1206	3.63	2.2%	2.8%	28.7%	21.5%	44.9%	4.0		1.58	126	1.42
CS-503AF	26-Jun	60	1206	2.99	0.0%	1.0%	13.7%	39.8%	45.5%	4.3	3.4	1.30	118	1.22
PLS-534	27-Jun	61	1232	4.7	0.0%	1.3%	9.6%	16.4%	72.8%	4.6	3.8	2.05	122	1.88
BSC304	29-Jun	63	1285	4.01	6.7%	7.7%	39.7%	21.4%	24.4%	3.5	3.0	1.75	121	1.62
EXP461	29-Jun	63	1285	4.77	5.0%	3.4%	20.5%	26.2%	44.9%	4.0	3.4	2.08	125	1.89
PLS-613-89	1-Jul	65	1345	4.73	6.6%	18.4%	58.1%	14.6%	2.3%	2.9	3.0	2.06	120	1.92
Reliance	3-Jul	67	1405	4.55	2.9%	10.1%	34.9%	34.3%	17.8%	3.5		1.98	116	1.88
CS-492AF	3-Jul	67	1405	5.68	1.2%	3.2%	17.6%	40.7%	37.3%	4.1	3.4	2.47	129	2.20
Portage	3-Jul	67	1405	5.66	0.7%	1.6%	8.8%	22.4%	66.4%	4.5		2.47	147	2.07
PLS-566	5-Jul	69	1465	5.45	2.2%	1.5%	12.5%	33.0%	50.8%	4.3	3.7	2.37	128	2.11
389	5-Jul	69	1465	5.3	4.3%	8.7%	52.3%	30.9%	3.8%	3.2	2.6	2.31	158	1.92
ASR 40.3007	5-Jul	69	1465	5.12	6.6%	16.2%	59.0%	15.4%	2.7%	2.9	3.0	2.23	115	2.14
												Trial Average		**1.86**

Varieties	Date		6/24	6/25	6/26	6/27	6/28	6/29	6/30	7/1	7/2	7/3	7/4	7/5	7/6	7/7
	Acc. HU		1148	1178	1206	1232	1257	1285	1315	1345	1375	1405	1435	1465	1495	1526
LARGE PEAS	**Adj. Yield**	**Avg. Sieve**	**LARGE PEAS**													
Sherwood	1.42	4.0	88		126											
CS-503AF	1.22	4.3	78		118											
PLS-534	1.88	4.6				122										
BSC304	1.62	3.5				101		121								
EXP461	1.89	4.0				97		125								
PLS-613-89	1.92	2.9						97		120						
Portage	2.07	4.5										147				
Reliance	1.88	3.5										116				
CS-492AF	2.20	4.1								98		129				
389	1.92	3.2												158		
ASR 40.3007	2.14	2.9												115		
PLS-566	2.11	4.3												128		
AVERAGE	**1.86**															

Late Planting - Belmont, ON

Season Summary

The trial was planted into good conditions, however needed to be planted deeper than optimal to reach adequate soil moisture. Following planting, the trial remained dry until the second week of June, at which point frequent and heavy rains fell. Temperatures remained relatively cool throughout the growing season, with nighttime temperature remaining relatively low, providing for excellent growing conditions.

Weed control was excellent, and any weed escapes were removed by hand throughout the season.

Late in the season, incidence of the root rot complexes and foliar blights became evident due to excessive rainfall events and heavy dews nightly.

Harvest started on July 17th, fifty-two (52) days after planting, and continued almost daily until August 9th, seventy-five (75) days after planting.

Weather

May	High	Low	Daily HU	Daily Percip
26	23.5	2.5	0	0
27	26.7	4.6	20	0
28	28.9	7.1	24	0
29	29.7	9	27	0
30	30.1	15.6	30	0
31	31.2	12.4	30	0

June	High	Low	Daily HU	Daily Percip
1	32.2	13	30	0
2	33.5	14.6	30	0
3	23.4	16.7	28	0
4	24	10.9	23	0
5	24.6	10.4	24	0
6	24.9	12.2	25	0
7	21.6	6.8	17	0
8	22.8	11.1	23	0.51
9	24.5	9.6	23	0
10	29.5	7.5	25	0
11	25.1	14.6	28	3.3
12	15.1	12.2	17	12.19
13	19	9.3	17	17.02
14	21.3	9.3	20	1.52
15	23.2	8.1	20	1.02
16	20.9	13.6	23	0.25
17	25.3	11.2	25	0
18	31.5	7.2	27	0
19	28.6	10.8	27	0
20	28.4	17.7	30	0
21	29.4	16.6	30	0
22	25.3	14.2	28	0
23	22.6	16.2	27	7.62
24	28.4	18.1	30	0.76
25	29.8	15.9	30	1.02
26	23.7	16.8	28	18.62
27	23.2	15.8	27	0.51
28	25.1	10.7	24	0
29	27.4	8.2	24	0
30	20.3	18	26	0

July	High	Low	Daily HU	Daily Percip
1	30.7	19.8	30	1.78
2	22.1	20.3	30	36.58
3	28.5	18.6	30	5.84
4	33	16.6	30	0
5	31.9	17	30	0
6	29.8	19	30	12.95
7	24.9	13.1	26	0
8	20.9	11.7	21	0
9	24	13.7	26	
10	29.4	24	30	0
11	29.6	16.9	30	10.16
12	27.6	12.7	28	2.54
13	24.5	15.1	28	9.4
14	20.3	14.1	28	1.78
15	24.8	10.1	29	1.52
16	27.5	17.9	30	0.25
17	27.8	14.2	30	0
18	26.5	13.6	28	0
19	28.3	12.4	29	0
20	28.7	15.1	30	1.27
21	25.7	16.9	30	0
22	26.7	12.3	29	0
23	28.6	13.8	30	0
24	27.9	18.1	30	10.41
25	30.4	16.4	30	0
26	29.2	17.9	30	11.94
27	28.4	16.4	30	3.3
28	31.9	16.7	30	0
29	26.6	17.2	30	8.89
30	24.8	13	26	0
31	26.1	10.9	24	0

August	High	Low	Daily HU	Daily Percip
1	27.9	10.7	27	0
2	26	12.2	26	0
3	29.6	18	30	0
4	21.5	16.6	26	0
5	26.3	14.8	29	0
6	25.7	12.1	26	9.65
7	22.6	16.6	27	0
8	25.9	15.4	29	0
9	29.6	15.4	33	3.56

Total Air HU	2035
Total Percip	196.06

2023 Pea Cultivar Evaluation Trial (Ontario)

NORTERA

Small Sieve Peas

Variety	Harvest Date	Growing Days	Acc Air HU	Total Weight (lbs)	Sieve 1	Sieve 2	Sieve 3	Sieve 4	Sieve 5	Avg Sieve	Expected Sieve	Unadjusted Yield (tons/acre)	Avg TD	Adjusted Yield (tons/acre)
Natalie	Jul 18	53	1403	4.67	21.4%	37.0%	41.3%	0.2%	0.0%	2.2	1.9	1.36	114	1.30
Retrovert	Jul 18	53	1403	4.46	12.1%	19.5%	63.5%	4.9%	0.0%	2.6		1.30	112	1.27
Nitro	Jul 25	60	1611	3.88	10.1%	24.2%	61.3%	3.9%	0.5%	2.6		1.69	118	1.59
ASR 40.4021	Jul 26	61	1641	6.84	14.5%	22.5%	56.3%	6.0%	0.7%	2.6	1.9	1.99	109	2.01
SV3946QB	Jul 26	61	1641	4.9	10.0%	13.5%	55.9%	18.8%	1.8%	2.9	2.3	1.42	113	1.38
CS-533F	Jul 27	62	1671	2.45	17.1%	13.5%	57.1%	11.0%	1.2%	2.7	2.1	0.71	103	0.76
Rhianna	Jul 29	64	1731	4.95	40.4%	32.9%	24.4%	2.2%	0.0%	1.9		1.44	105	1.51
EXP800	Jul 31	66	1781	3.62	16.9%	27.6%	53.3%	2.2%	0.0%	2.4	2.0	1.05	121	0.98
PL-0122	Jul 31	66	1781	3.51	24.5%	31.9%	42.7%	0.9%	0.0%	2.2	2.1	1.02	122	0.94
Wav-202	Jul 31	66	1781	4.41	17.5%	37.2%	42.6%	2.7%	0.0%	2.3	2.1	1.28	119	1.20
												Trial Average		**1.29**

Varieties	Date		7/14	7/15	7/16	7/17	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31
	Acc. HU		1286	1315	1345	1375	1403	1431	1461	1492	1521	1551	1581	1611	1641	1671	1701	1731	1757	1781
PETITE PEAS	Adj. Yield	Avg. Sieve	PETITE PEAS																	
Retrovert	1.27	2.6	80			96	112													
Natelie	1.30	2.2	82			103	114													
Nitro	1.59	2.6								85		95		118						
ASR. 40 4021	2.01	2.6													109					
SV3946QB	1.38	2.9										80		100	113					
CS355F	0.76	2.7										74		87		103				
Rhianna	1.51	1.9													87	95		105		
WAV 202	1.20	2.3														82		96		119
EXP800	0.98	2.4																99		121
PL-0122	0.94	2.2																101		122
AVERAGE	**1.29**																			

Large Sieve Peas

Variety	Harvest Date	Growing Days	Acc Air HU	Total Weight (lbs)	Sieve 1	Sieve 2	Sieve 3	Sieve 4	Sieve 5	Avg Sieve	Expected Sieve	Unadjusted Yield (tons/acre)	Avg TD	Adjusted Yield (tons/acre)
CS-492AF	Jul 23	58	1551	6.54	5.4%	6.9%	28.9%	35.8%	23.1%	3.6	3.4	1.90	111	1.88
PLS-566	Jul 23	58	1551	6.73	4.5%	4.3%	19.8%	38.6%	32.8%	3.9	3.7	1.95	98	2.29
PLS-613-89	Jul 23	58	1551	5.17	21.9%	15.9%	44.3%	15.1%	2.9%	2.6	3.0	1.50	105	1.58
Reliance	Jul 25	60	1611	7.28	1.2%	2.1%	17.7%	35.3%	43.7%	4.2		3.17	128	2.82
Welland	Jul 26	61	1641	8.39	6.8%	12.2%	49.1%	26.0%	6.0%	3.1		2.44	108	2.49
CS-513F	Jul 27	62	1671	4.1	8.8%	6.8%	28.5%	23.2%	32.7%	3.6	3.8	1.19	114	1.14
PLS-576	Jul 27	62	1671	7.255	1.1%	2.2%	9.6%	17.6%	69.4%	4.5		2.11	121	1.96
BSC737 (EXP115)	Jul 29	64	1731	6.3	2.4%	3.3%	34.4%	41.1%	18.7%	3.7	3.6	1.83	121	1.70
CS-515AF	Jul 29	64	1731	6.53	2.9%	3.2%	20.4%	32.2%	41.3%	4.1	3.8	1.90	125	1.73
SV0823QG	Jul 29	64	1731	9.58	4.3%	7.1%	41.8%	34.2%	12.6%	3.4	3.3	2.78	122	2.56
SV1231QF	Jul 29	64	1731	7.71	3.4%	1.3%	16.0%	27.2%	52.1%	4.2	3.2	2.24	143	1.90
Tyne	Jul 29	64	1731	9.93	3.1%	3.6%	25.2%	40.0%	28.1%	3.9		2.88	124	2.62
SV6844QG	Jul 31	66	1781	8.79	1.0%	1.4%	17.9%	29.9%	49.8%	4.3	3.6	2.55	120	2.37
SV5685QG	Aug 9	75	2035	2.94	0.7%	3.4%	24.1%	28.2%	43.5%	4.1	3.4	0.85	102	0.93
												Trial Average		**2.00**

Varieties	Date		7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	8/5	8/6	8/7	8/8	8/9
	Acc. HU		1431	1461	1492	1521	1551	1581	1611	1641	1671	1701	1731	1757	1781	1808	1834	1864	1891	1920	1946	1973	2002	2035
LARGE PEAS	Adj. Yield	Avg. Sieve	LARGE PEAS																					
PLS-613-89	1.58	2.6	81		99		105																	
CS-492AF	1.88	3.6	82		97		111																	
PLS-566	2.29	3.9	81		92		98																	
Reliance	2.82	4.2			87		102		128															
389	1.71	2.9					91		111															
828	2.56	4.0			84		95		118															
Welland	2.49	3.1							99	108														
ASR.40.3007	1.75	3.1			75				100	112														
CS-513F	1.14	3.6									114													
PLS576	1.96	4.5									121													
SV1231QF	1.90	4.2											143											
BSC737 (EXP115)	1.70	3.7									99		121											
Tyne	2.62	3.9									102		124											
CS-515AF	1.73	4.1									105		125											
SV0823QG	2.56	3.4											122											
SV6844QG	2.37	4.3									79		91		120									
SV5685QG	0.93	4.1																77				85		102
AVERAGE	2.00																							

Acknowledgements

We wish to thank Cavanaleck Farms Ltd. for hosting this year's cultivar evaluations (late planting), the Ontario Processing Vegetable Growers and numerous seed companies for their financial contributions to this project.

Autonomous Weed Scouting Project Report – Year 1

Project Partners

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Other Researchers and Extension Personnel Collaborating on this Project:

- Kristen Obeid and Mike Cowbrough, Weed Specialists, OMAFRA
- Dr. Francois Tardif, University of Guelph – Professor, Plant Agriculture
- Shaun Sharpe, AAFC Weed Scientist, Saskatoon, Saskatchewan

Personnel additions since proposal:

- Dr Medhat Moussa, University of Guelph – Professor, Engineering

Facility additions since proposal:

- University of Guelph - Elora Research Farm
    - Used for lima bean control plots. These plots were imaged in addition to Nortera's commercial fields to have a more comprehensive training dataset.

Overall Research Summary

The multifaceted challenge to address weed escapes in lima bean production fields was defined by an inter-disciplinary team from academia (University of Guelph), government/regulatory (OMAFRA), growers (Nortera Foods) and industry (Haggerty AgRobotics) stakeholders. This group worked together to plan the technologies, processes and expertise required to address this challenge.

The following methodology was/will be followed:

1. Collect in-field images of pigweed species, Eastern black nightshade, and horsenettle at different times throughout the season. All three weed species cause significant harvestability and processing issues.
2. Use images to develop a model to detect weed zones in the field – weed density map.
3. Use weed density maps to inform herbicide application and harvest decisions.

4. Compare historical losses associated with pigweed species, Eastern black nightshade and horsenettle to the new method utilizing the weed density map.
5. Compare herbicide costs of conventionally managed versus autonomously scouted lima bean crop.

The first step in addressing this challenge was to create a database of overhead images of lima beans in the various environments they are produced in Ontario. This was done by utilizing a designated (controlled) research plot at the Elora Research Station, in addition to several commercial fields across SW Ontario. The research plot and a commercial lima bean field was imaged each week. The research plot allowed for the database to include the complete progression of lima bean growth, with various treatments applied to the crop. The commercial sites provided images to the database that would include the variability found in real-life, commercial applications. For both sets of imaging sites, the crop management schedule was made in accordance with industry standards set by OMAFRA and followed by Nortera Foods.

Imaging took place after first planting in May, until the first week of October – just before lima bean harvest.

For the imaging apparatus, teams from the University of Guelph and Haggerty AgRobotics collaborated to build the prototype imaging implement, create the data collection protocol, and build the software needed to control the imaging system. Images were collected from two different cameras simultaneously as the imaging implement was driven across the fields. The two types of cameras were a standard RGB camera, and a higher-end near-infrared capable camera. All the images were to be geolocated with RTK.

The implement was attached to an all-terrain vehicle to image the larger commercial sites, which had varying weed varieties and densities. The implement was interfaced with an autonomous platform to collect lima bean images in the control site at Elora, where the plot had two of the weed species.

In addition to building the database for training the pattern recognition model, the team also used the data-collection process to collect information towards optimizing the next iteration of the imaging implement. Speed of image collection and height of the cameras were investigated. The commercial fields were imaged at three different speeds, and a camera height of 6' to assess the widest possible camera field-of-view and fastest speeds possible while giving accurate enough images for scouting. Ideally, each camera has a very wide field of view so that less cameras can be used, and less passes across the field can be made. Also, the faster the platform can run, without sacrificing the image quality, the faster fields can be scouted.

Dr. John Sulik's team imaged the same fields using Phantom4 and Mavik3 drones to compare the efficacy of drone images to the ground-based system being focused on for this project.

These images will be used to build the pattern recognition model that will be used to prescribe herbicide application maps for early-stage lima-bean crop protection, and harvest stage contaminant avoidance mapping.

During the first year of the project, we received additional funding support from Nortera, Haggerty AgRobotics and the OMAFRA Supply Chain Stability and Adaptability Program administered by the Agriculture Adaptation Council. The University of Guelph has also been able to leverage funding support from the Ontario Innovation Center to develop the imaging software needed to build the mapping capacity for this project.

This work will be presented during grower organization annual general meetings and industry conferences (Ontario Processing Vegetable Industry Conference, Ontario Fruit and Vegetable Convention, Ontario Pest Management Conference, etcetera). Demonstrations of this project have occurred during the Ontario Weed Tour and Canada's Outdoor Farm Show.

Next Steps

The team at the University of Guelph will be designing and training the model used for detecting weeds in a way that makes the output actionable by growers. This process will include trialing different weed identification architectures and parameters to optimize it for this application. A critical component of this will be speed of processing, for this application, the images must be converted to a weed density map within 1-2 days in order for the map to be practically actionable by a sprayer and combine. Part of the processing and program to be developed will be to stitch the identified weed images into a geolocated map. This map is known as the weed density (heat) map. This map will be converted into a .shp file, which modern sprayers and combines use to automate herbicide application at each nozzle and lift the combine headers when they are over a dense area of weeds.

While the team at the University of Guelph are labeling and assessing the image dataset, they will determine the optimal camera height and the fastest speed the cameras can pass over the field, while maintaining adequate image quality. The team at Haggerty AgRobotics will use this information to configure the autonomous platform to run at this speed and create the commercial scale imaging implement.

The pattern recognition model, necessary peripheral programming and imaging boom will be created this winter and used in the 2024 growing season for herbicide application maps and harvest avoidance maps. The weed identification model and output programming will continue to be optimized throughout the 2024 growing season.

Project Title: Sweet Corn Soil Nitrate Survey

Lead Investigator: Elaine Roddy, Vegetable Crops Specialist, OMAFRA

Collaborators: Dan Oliver, Nortera; Danny Jefferies; OMAFRA, Colin Elgie, OMAFRA

Introduction

High fertilizer input costs have many growers re-evaluating their fertility rates, especially nitrogen. OMAFRA conducted on-farm sweet corn nitrogen response trials at 27 sites from 2003-2010. These studies found that the existing OMAFRA nitrogen fertilizer rate of 80 lb/acre was adequate for most mid-to-late season processing sweet corn crops. Early-planted crops grown on coarser textured soils may respond to higher levels of nitrogen fertilizer.

With nitrogen currently priced at $1.47/lb (urea ammonium nitrate) the most economical rate of nitrogen drops to 50 lbs/acre, based on the 2003-2010 study data. Most sweet corn growers would be concerned that these rates are too low to support a high yielding crop.

The use of the pre-side dress nitrate test (PSNT) can be a valuable tool to help growers select the most economical rate of nitrogen while reducing the risk of under-applying and falling short of their yield goal. From an environmental perspective, it also reduces the likelihood of over-applying nitrogen fertilizers and risking losses through leaching or denitrification (production of greenhouse gasses).

Table 1. PSNT Rates based on the 2002-2010 Sweet Corn Nitrogen Study

Pre Side Dress Nitrate Test levels	Side Dress Nitrogen Rate
0-10 ppm	120 lbs/ac
11-20 ppm	80 lbs/ac
21-30 ppm	40 lbs/ac
> 30 ppm	no additional nitrogen required

Historically, sweet corn growers have been hesitant to use the PSNT to develop their fertility program. The test itself is labour intensive and many growers lack the experience and confidence to apply it across all their acreage. The 2023 survey provided the Ontario processing sweet corn industry with real-time information regarding soil nitrate levels across the growing region from mid-June through July. This will give growers an opportunity to fine-tune their application rates as well as an opportunity to gain more exposure and confidence in this technology.

Methodology

Soil nitrate sampling was conducted at 28 grower sites in consultation with the field staff at Nortera. Sites were selected based on crop stage, geography and the growers intention to side-dress their nitrogen fertilizer. Pre-plant nitrogen rates at survey sites ranged from 0-118 lbs/acre. A preference was given to sites receiving less than 50 lbs/acre nitrogen in pre-plant plus planter applications, however due to a limited availability of potential sites, the survey was extended to include a wider range of rates.

Samples were taken at the 4-8 leaf stage of corn development over the course of 4-weeks. Sample breakdowns were as follows:

June 20, 2023 – 5 sites (Glanworth-Lambeth)

June 28, 2023 – 5 sites (Lambeth, Wheatly, Belmont)

July 10, 2023 – 8 sites (Strathroy, Dresden)

July 18, 2023 – 10 sites (St. Thomas, Glanworth, Chatham, Lambeth)

Samples were analyzed at Honeyland Ag Services in Ailsa Craig and the weekly results were communicated to the growers directly by Nortera and in the OMAFRA blog, ONvegetables.com

Post-harvest sampling was conducted at each survey site post-harvest to determine the amounts of residual nitrate left at the end of the season. Two sets of samples were taken at the 0-12" and 12-24" depths.

PSNT Results

Late June PSNT levels were lower than expected. Likely due to the dry soil conditions throughout June. Almost all of the fields were at or below the 10 ppm baseline, indicating a strong response to side-dress nitrogen applications at that time. Based on the 2003-2010 study results, a side-dress nitrogen rate of 120 lbs/acre would have been recommended at 7/10 sites sampled in June. This is considerably higher than the standard OMAFRA rate of 80 lbs/acre.

For the July sampling dates, soil nitrate levels had increased and were generally in the 10-30 ppm range, indicating a moderate-to-low response to side-dress nitrogen at that time. See Table 1. *PSNT Rates based on the 2002-2010 Sweet Corn Nitrogen Study*, below. Over the course of the survey, there were no sites that exceeded the 30 ppm threshold at which there would be no expected response from additional fertilizer nitrogen.

See Figure 1, *Pre-Side Dress Nitrate Levels by Sampling Date*, below.

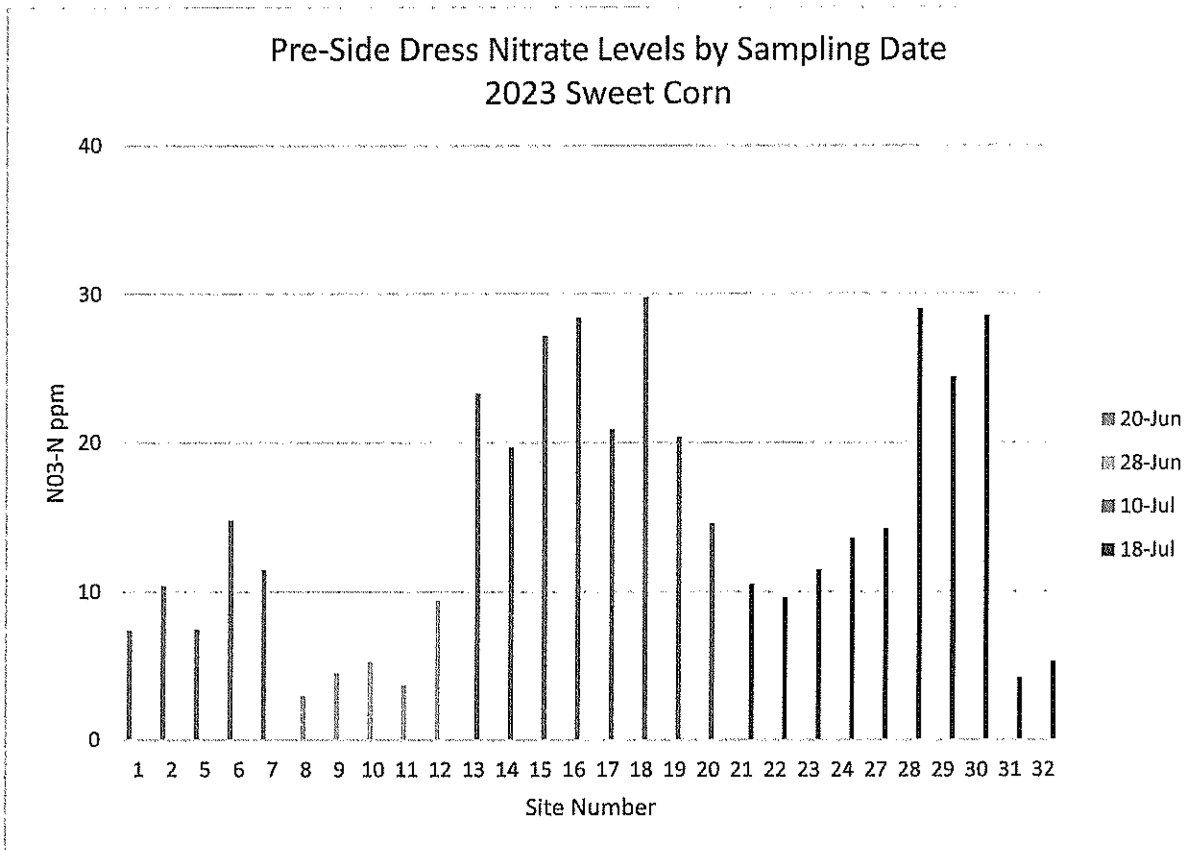
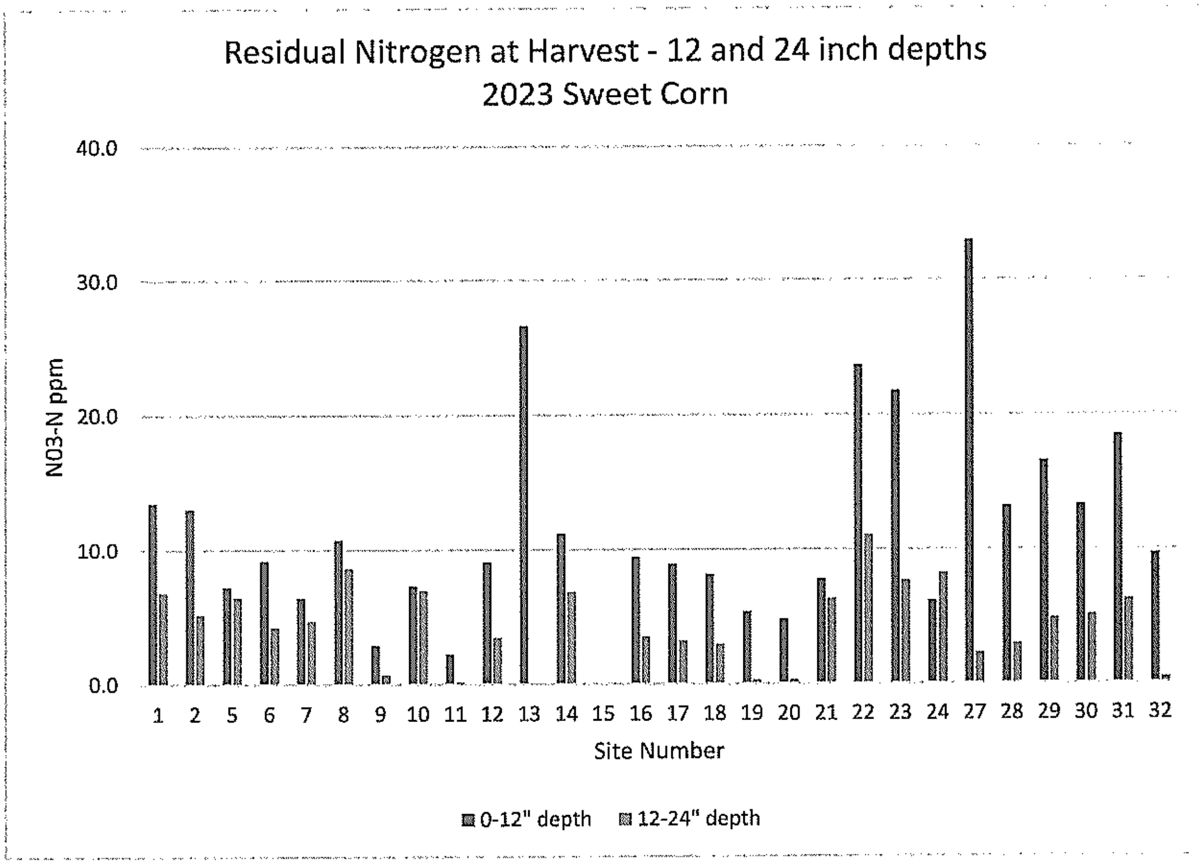


Figure 1, Pre-Side Dress Nitrate Levels by Sampling Date.

Residual Soil Nitrate Levels

Nitrate-nitrogen levels at harvest can be used as an indicator of the amount of nitrogen "left over" in the soil after crop removal. Low levels of nitrates in the fall are desirable to minimize losses due to leeching. Management practices such as cover crops may also help to reduce the potential for nitrate losses.

The residual soil nitrate data collected in this survey will be further evaluated as grower agronomic information on fertilizer rates and field yields becomes available.



Benefits/Outcome

It is hoped that this survey and its results will help to increase the awareness of the PSNT as a tool for sweet corn nitrogen management across the processing sweet corn grower base allowing growers to become more comfortable with adjusting their soil nitrogen fertility program based on in-season trends and soil test information.

The 2023 Soil Nitrate Survey was being conducted by OMAFRA staff Elaine Roddy, Danny Jeffries and Colin Elgie with the support of Dan Oliver (Nortera). This project was funded by the Ontario Processing Vegetable Growers.

Pea Accelerator Challenge (2023) - Ontario

Background
Outside of Integrated Pest Management, little supporting research is available locally to support pea growers in achieving higher crop yields. There is a gap in knowledge on the topic of soil management, crop nutrition, and the impacts of extreme weather on crop yields.

Objective
The Pea Accelerator Challenge set out to systematically survey and collect key field, soil, weather, crop, and crop production data in order to identify trends that may exist in high and/or low yielding peas.

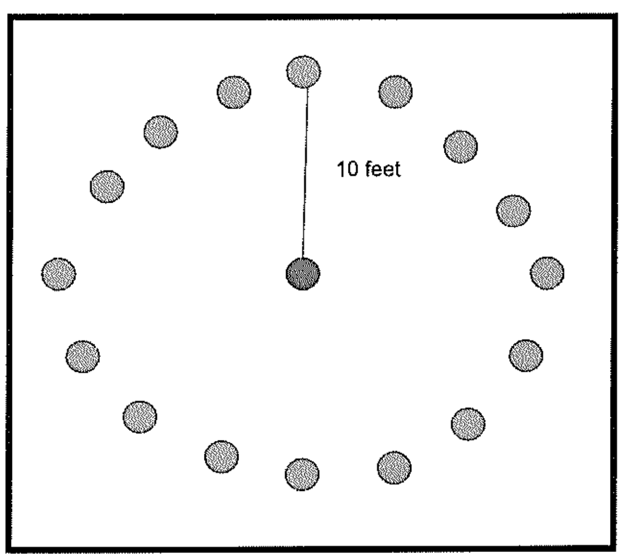
Materials & Methods
15 fields, evenly distributed across the pea growing regions, were selected for inclusion in the project. Five (5) sub-sites were chosen from each field and used as sample locations, based on known historical yield variability, soil type differences, or other factors deemed appropriate, in consultation with the growers.

The following information was collected:

- Soil chemistry (i.e. CEC, pH, macro and micro nutrients)
- Soil properties (soil type, water holding capacity, bulk density, total organic carbon)
- All cropping practices employed (i.e. tillage, variety info, fertilizer applications, crop history)
- 3 X plant tissue analysis throughout the season @ 4-node, 10% bloom, and at harvest

Soil Samples Collection
Each sub-site at each location was soil sampled prior to fertilizer application and crop planting.

1. Each sub-site location was GPS located and stored for future reference
2. 10-12 soil cores were taken within a 10' radius of the centre of the subsite at a 6" depth. All cores are mixed in a plastic pail and submissions bags are filled



Tissue Samples Collection
Each sub-site at each location was tissue sampled at 3 key crop stages: 4-node, 10% bloom, immediately prior to harvest

4-node = when 4 nodes have fully expanded leaves
10% bloom = when 10% of plants have at least 1 open flower
Prior to harvest = immediately prior to harvest sample collection

Harvest
Each sub-site at each location was manually harvested in order to collect yield information. 12 rows X 6' (feet) in length was harvested and processed using the standard pea pregrading processes in order to capture yield and tenderometer information.

Results
Of the 15 fields selected, data was fully generated from 12. Of the three sites not completed, one had fertilizer applied prior to soil sampling taking place, and 2 were lost due to commercial harvest occurring prior to manual harvesting of the sample locations.

All data collected was analyzed by Leah Ritcey-Thorpe, Surveillance Coordinator and Data Analyst, OMAFRA. There was large variability in yield within each site as well as large variability in soil variables. The large variability captured was an intentional aspect of the experimental design; however, the extreme variability has led to difficulties extracting trends and relationships between yield and the variables measured.

To account for variability across one site, we recommend that the future experimental design include a larger number of subsites on each farm. The subsites within one site should also be randomly chosen to capture a realistic picture of the variability. e.g.: ~ 20 subsites within one site, fewer sites overall.

MEANS AND VARIANCE IN YIELD

Table 1. The average yield, standard deviation, and coefficient of variation (CV) for each grower. The highest variability of yield occurred in site 9 and the lowest variability occurred in site 5.

Grower ID	**Number of subsites**	**Average Yield (tons/acres)**	**Standard Deviation**	**Coefficient of Variation (CV) (%)** Calculated as the standard deviation / mean x 100. The coefficient of variation shows the degree of variability in yield between the 5 subsites for each grower.
1	5	3.204	0.747	23.3%
2	5	3.196	0.579	18.1%
3	5	2.546	0.302	11.9%
4	5	2.530	0.866	34.2%
5	5	2.224	0.231	10.4%
6	5	2.212	0.725	32.8%
7	5	2.202	0.542	24.6%
8	5	2.170	0.512	23.6%
9	5	2.126	0.833	39.2%
10	5	2.058	0.426	20.7%
11	5	1.964	0.348	17.7%
12	4	1.860	0.627	33.7%

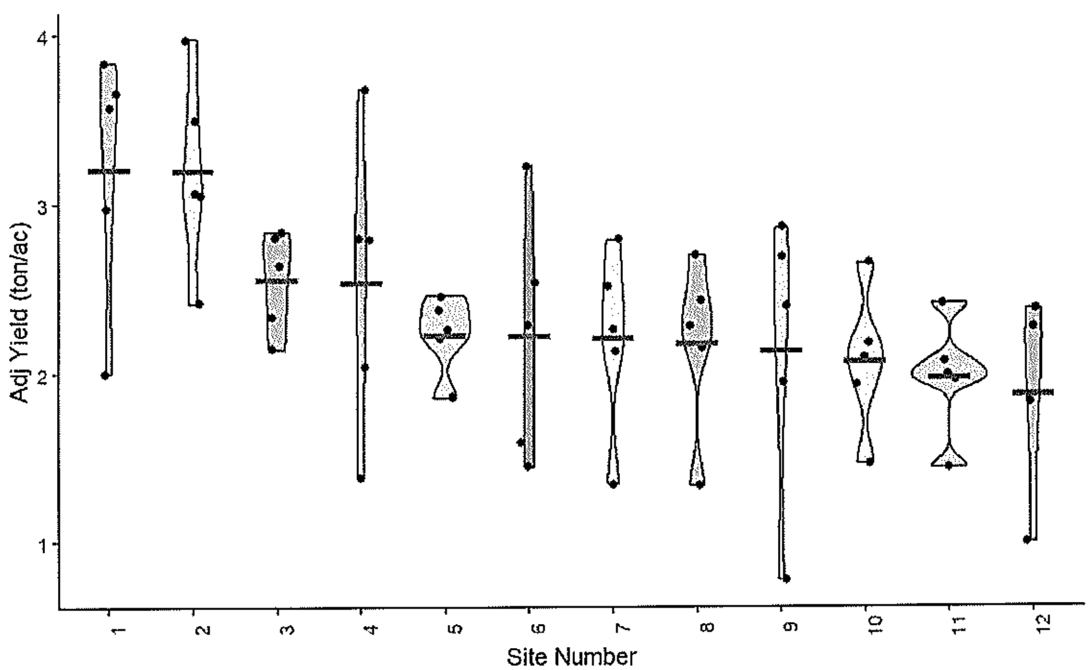


Figure 1. "Violin plot" depicting the distribution of yield on each site. Points represent the yield taken from each site and the red cross bar represents the average yield for

that site. Interpretation: long, thin = more variability in yield; short, wide = less variability in yield.

BOXPLOTS – SOIL AND TISSUE VARIABLES

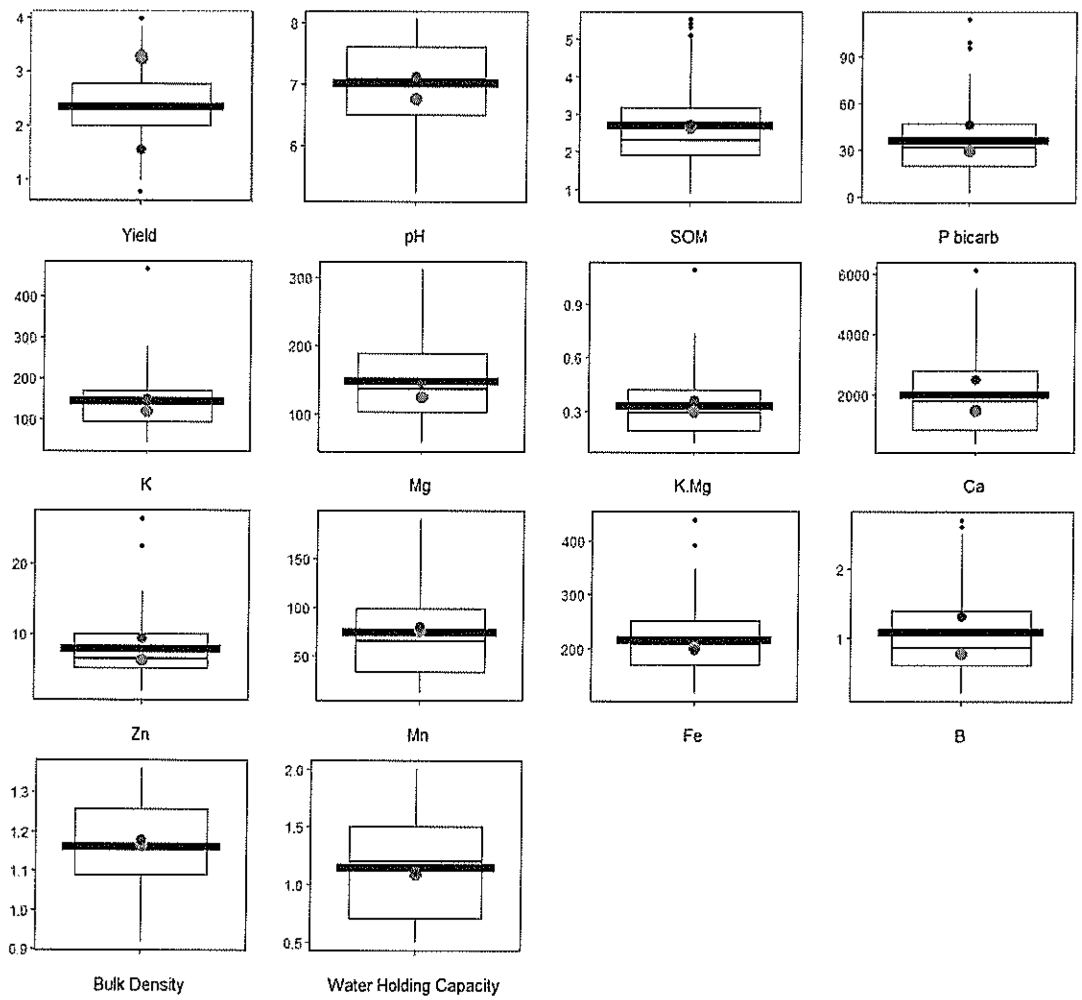


Figure 2. Boxplots depicting soil variables across all sites, where the total number of data points = 59. No significant differences depicted between the top 25% highest yielding sites and the rest of the data for any of the soil variables listed above.

-The inside of box represents 50% of the data
-Red cross bar = average of all data points for that soil variable
-Black dots = outliers
-Green dot = average of the top 25% highest yielding sites
-Red dot = average of the bottom 25% lowest yielding sites
-Green outline = The difference between the top 25% highest yielding sites and the **rest** of the data for that variable was statistically different with $p < 0.05$ as determined by either a Wilcoxon rank sum or Welch two-sample t-test.

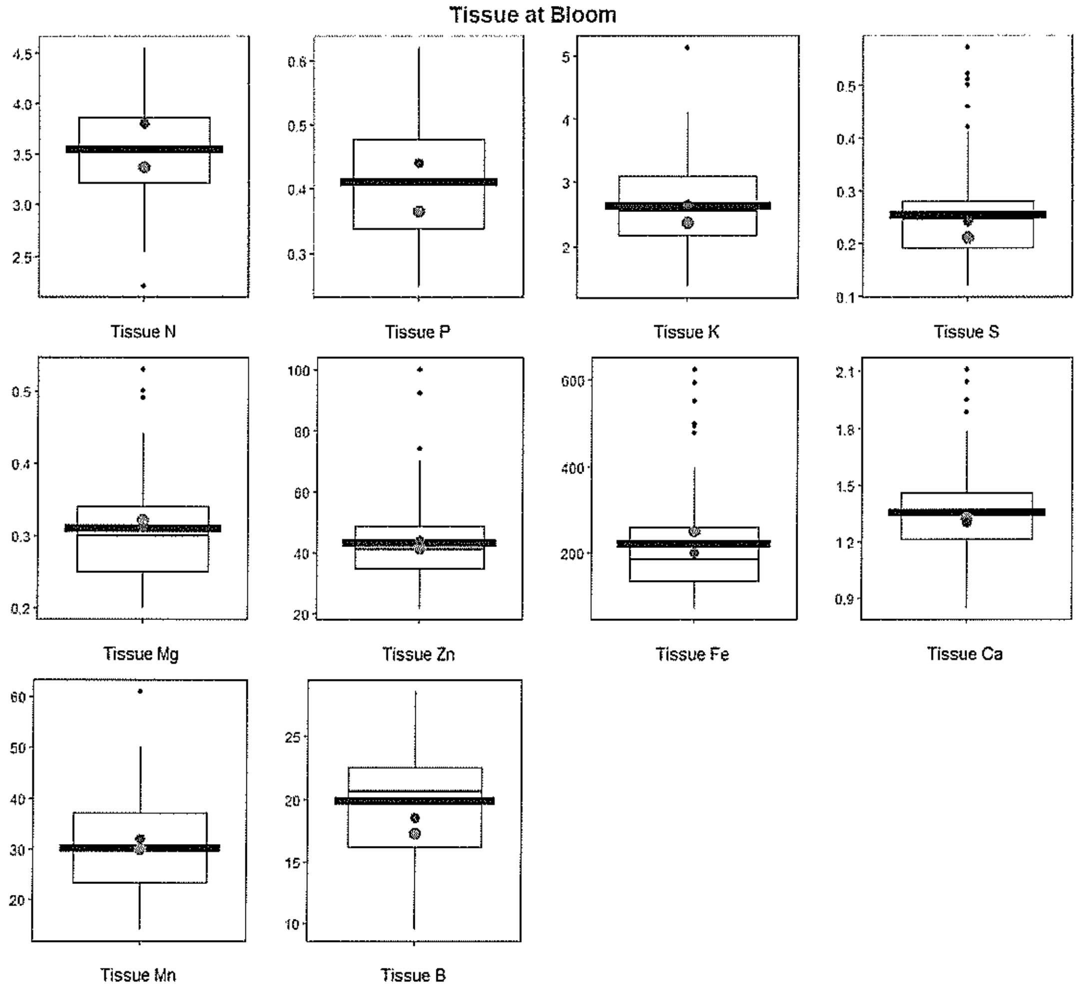


Figure 3. Boxplots depicting tissue variables at bloom across all sites, where the total number of data points = 59. Significant differences depicted between the top 25% highest yielding sites and the rest of the data for tissue S, tissue N, and tissue P.

-The inside of box represents 50% of the data
-Red cross bar = average of all data points for that soil variable
-Black dots = outliers
-Green dot = average of the top 25% highest yielding sites
-Red dot = average of the bottom 25% lowest yielding sites
-Green outline = The difference between the top 25% highest yielding sites and the **rest** of the data for that variable was statistically different with $p < 0.05$ as determined by either a Wilcoxon rank sum or Welch two-sample t-test.

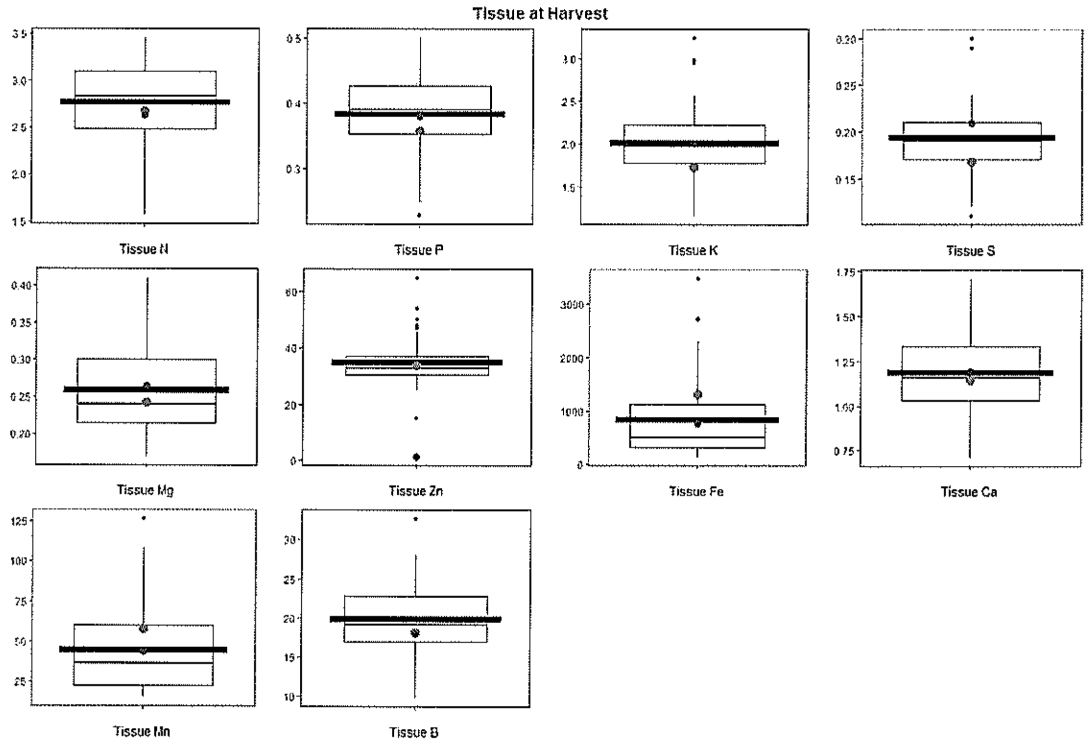


Figure 4. Boxplots depicting tissue variables at harvest across all sites, where the total number of data points = 43. *Site 1, 4, and 8 excluded from the analysis due to inconsistency in harvest methods. Significant differences depicted between the top 25% highest yielding sites and the rest of the data for tissue S, tissue Fe, and tissue Mn.

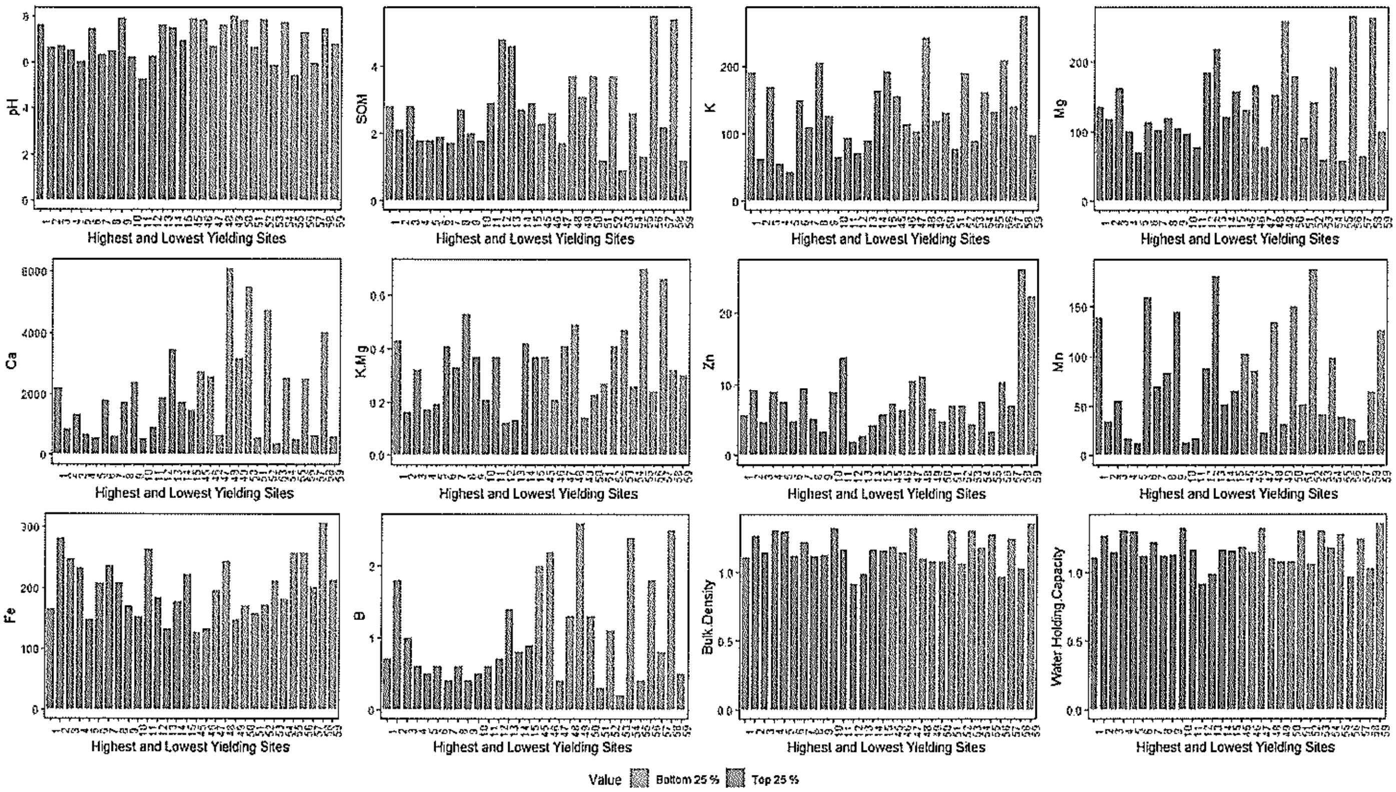
-The inside of box represents 50% of the data
-Red cross bar = average of all data points for that soil variable
-Black dots = outliers
-Green dot = average of the top 25% highest yielding sites
-Red dot = average of the bottom 25% lowest yielding sites
-Green outline = The difference between the top 25% highest yielding sites and the **rest** of the data for that variable was statistically different with $p < 0.05$ as determined by either a Wilcoxon rank sum or Welch two-sample t-test.

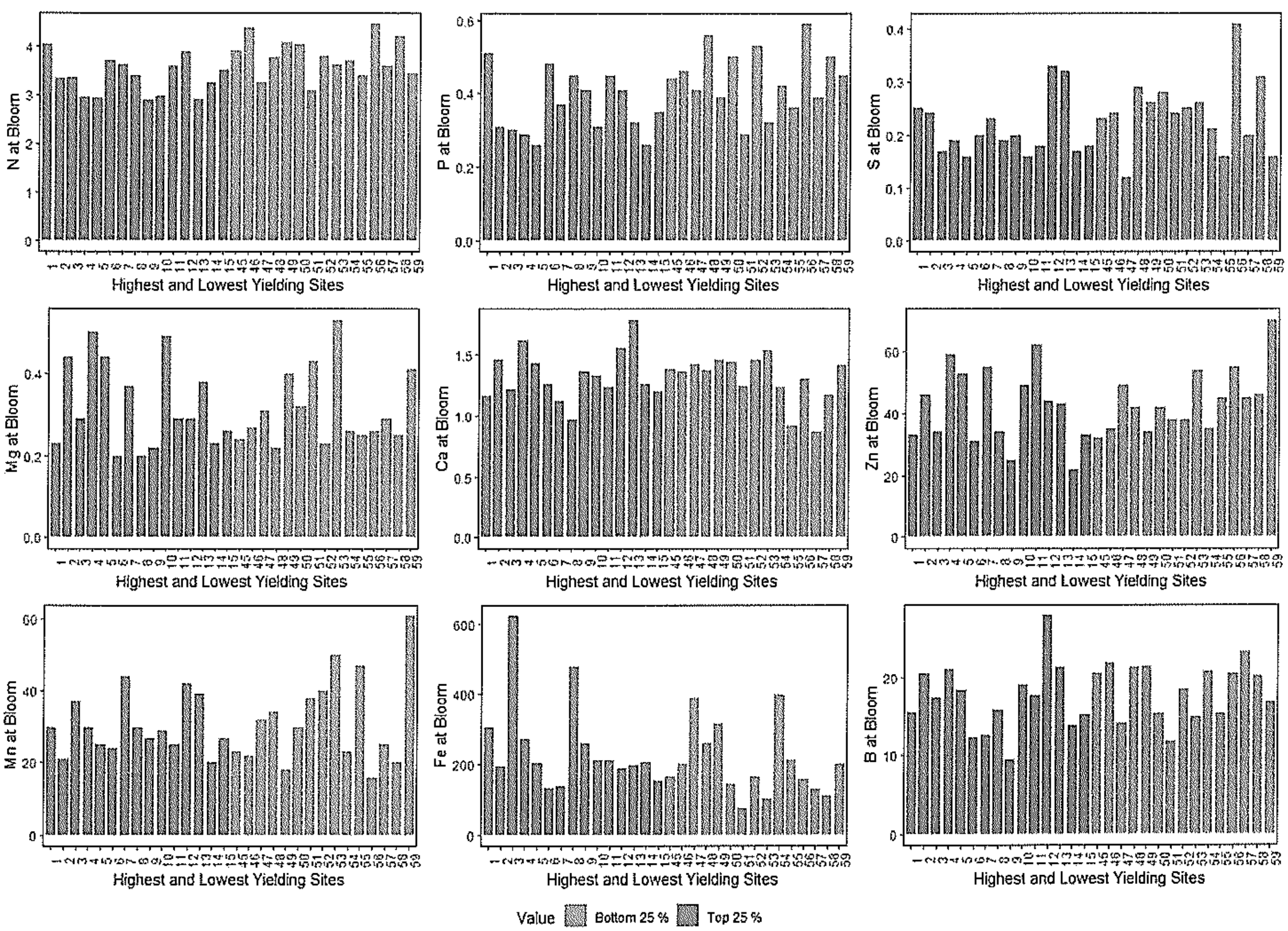
BAR PLOTS

The following bar plots represent the 25% highest yielding and 25% lowest yielding subsites for each measured variable. The purpose of the bar graphs are to visually showcase which variables have high variability within the highest and lowest yielding subsites in terms.

NORTERA

Pea Accelerator Challenge (2023) - Ontario





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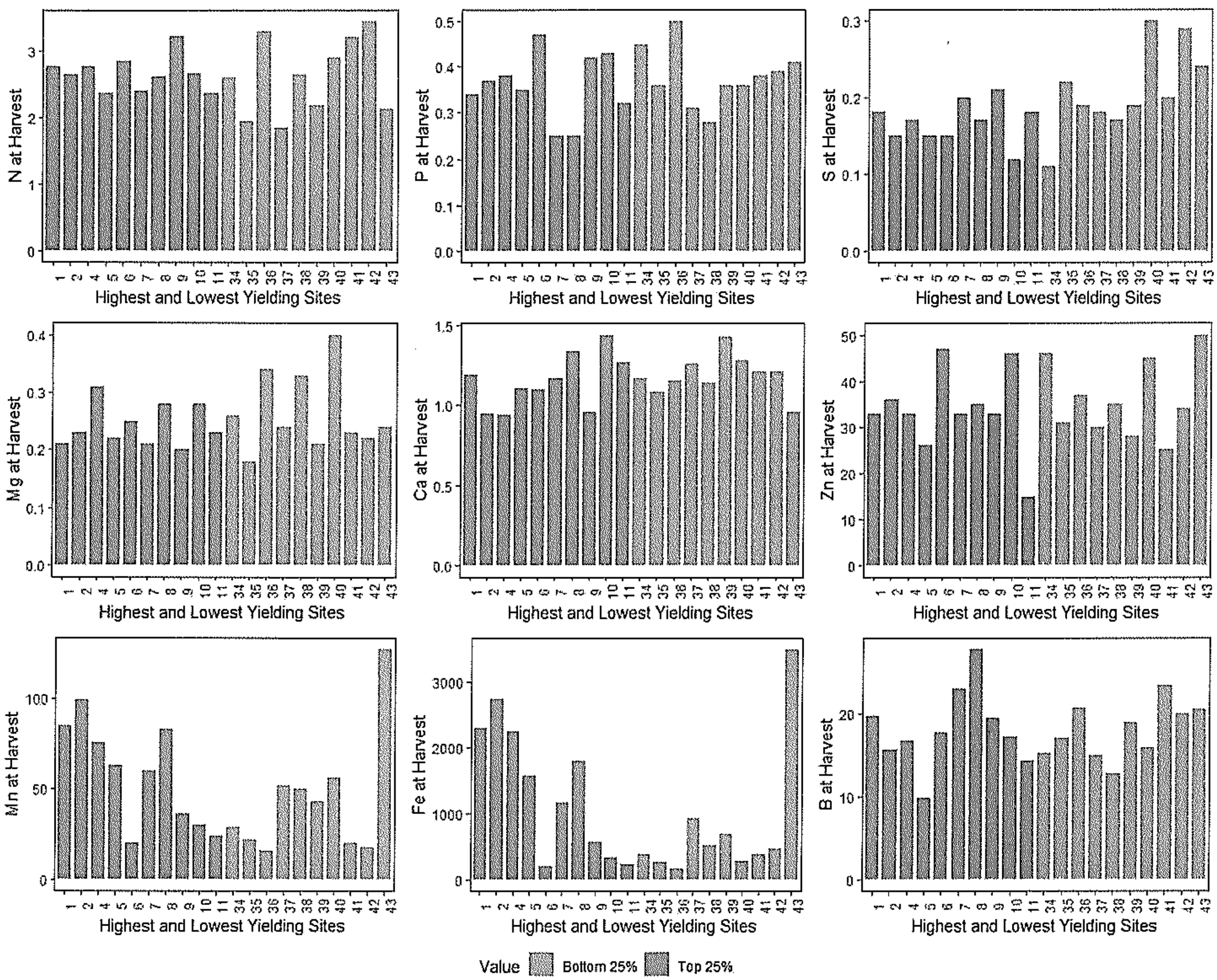
Pea Accelerator Challenge (2023) - Ontario



NORTERA

PROJECT TITLE
Sweet Corn Planting Populations (2023)

BACKGROUND

Optimum final plant density is required to ensure maximum factory recovery and field yield. Work was done over 10 years ago to determine the optimum planting population for sweet corn. Since then, very few hybrids tested at that time are still being planted today and the planting population recommendation may no longer be viable. Similarly, only one optimum planting population was established at the time. As genetics improve, some hybrids may express greater stress tolerance, particularly to crowding stress.

OBJECTIVE

Evaluate 5 commercial sweet corn hybrids on their response to varying planting density in regards to yield and theoretical recovery.

MATERIALS & METHODS

The trial was conducted as a randomized complete block design, replicated 4 times in plots seeded 4 rows wide, 20' long. All hybrids were evaluated at the following planting populations: 15,000, 20,000, 25,000, 30,000

All crop nutrition and weed control was managed as per industry standard.

Plots were evaluated to confirm the desired final plant stands were met at the 3-leaf stage by counting the number of plants emerged in the middle 2 rows of each plot.

At harvest, all cobs were harvested from the middle two rows of each plot, sorted by cob diameter (>2" and <2") and each size category was weighed. It is assumed that ears less than 2" in diameter would not be harvested mechanically.

RESULTS

Across all hybrids tested, increasing plant density resulted in fewer ears per plant. As expected, each hybrid tested reacted differently to changes in plant density. Overall, increasing plant density reduced average harvestable ear weight as well, however different hybrids responded more dramatically than others in this way. It is important to note that certain processing parameters are impacted by the hybrid reacting to changes in plant density, however are not discussed in this report.

This project will conclude after the 2025 growing season, compiling three years of project data.

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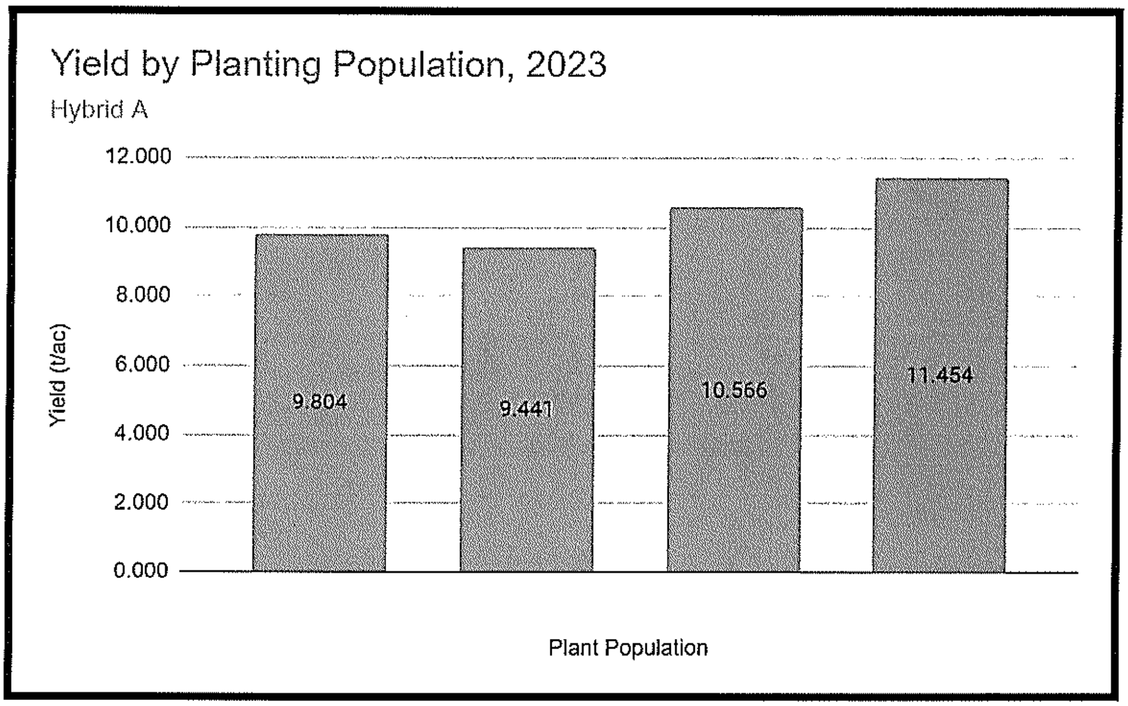
PROJECT TITLE
Sweet Corn Planting Populations (2023)

Variety	Population	Cobs Harvested	Cobs/ Plant	Weight of Harvested Cobs (lbs)	% Harvestable (Count)	% Harvestable (Weight)	Average Harvestable Cob Weight	Estimated Yield (t/ac)	Standard Deviation	Comments
Hybrid A	15,000	24.75	1.65	21.17	85.36%	92.77%	0.935	9.804	0.437	
Hybrid A	20,000	28.50	1.43	21.13	75.05%	88.76%	0.893	9.441	1.660	
Hybrid A	25,000	26.50	1.06	21.66	94.35%	97.49%	0.847	10.566	0.641	
Hybrid A	30,000	30.75	1.03	23.16	98.39%	98.90%	0.758	11.454	0.287	
Hybrid B	15,000	13.75	0.92	21.76	81.81%	91.04%	0.881	9.905	0.000	Average of 2 reps
Hybrid B	20,000	26.25	1.31	21.65	79.90%	91.87%	0.952	9.958	1.107	
Hybrid B	25,000	26.25	1.05	22.22	97.21%	98.49%	0.858	10.943	0.512	
Hybrid B	30,000	28.75	0.96	23.75	90.33%	94.29%	0.866	11.194	0.546	
Hybrid C	15,000	20.00	1.33	19.78	95.30%	97.16%	1.011	9.601	0.575	Average of 3 reps
Hybrid C	20,000	25.25	1.26	22.93	85.46%	89.76%	0.962	10.295	1.424	
Hybrid C	25,000	25.75	1.03	22.88	83.95%	87.31%	0.922	10.191	3.111	
Hybrid C	30,000	29.00	0.97	24.95	86.15%	90.99%	0.928	11.343	1.241	Average of 3 reps
Hybrid D	15,000	31.50	2.10	24.66	73.27%	91.41%	1.014	11.263	0.333	
Hybrid D	20,000	26.25	1.31	23.35	87.37%	94.66%	0.986	11.029	0.576	
Hybrid D	25,000	36.50	1.46	27.37	69.70%	90.04%	0.972	12.273	0.782	
Hybrid D	30,000	31.75	1.06	25.30	90.72%	96.39%	0.855	12.215	1.202	
Hybrid E	15,000	19.75	1.32	17.05	80.03%	90.85%	0.984	7.730	0.260	
Hybrid E	20,000	23.00	1.15	19.51	82.73%	86.10%	0.885	8.411	0.812	
Hybrid E	25,000	24.67	0.99	20.61	70.25%	77.58%	0.921	7.997	1.209	Average of 3 reps
Hybrid E	30,000	26.50	0.88	20.82	71.78%	74.77%	0.822	7.789	0.451	



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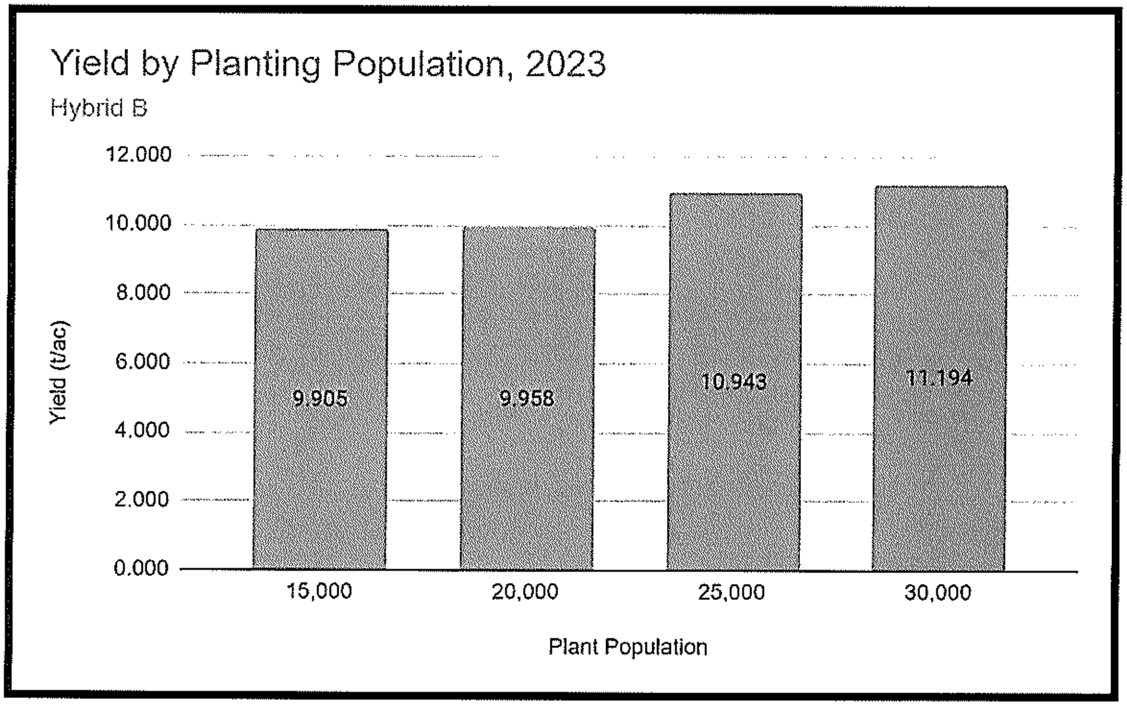
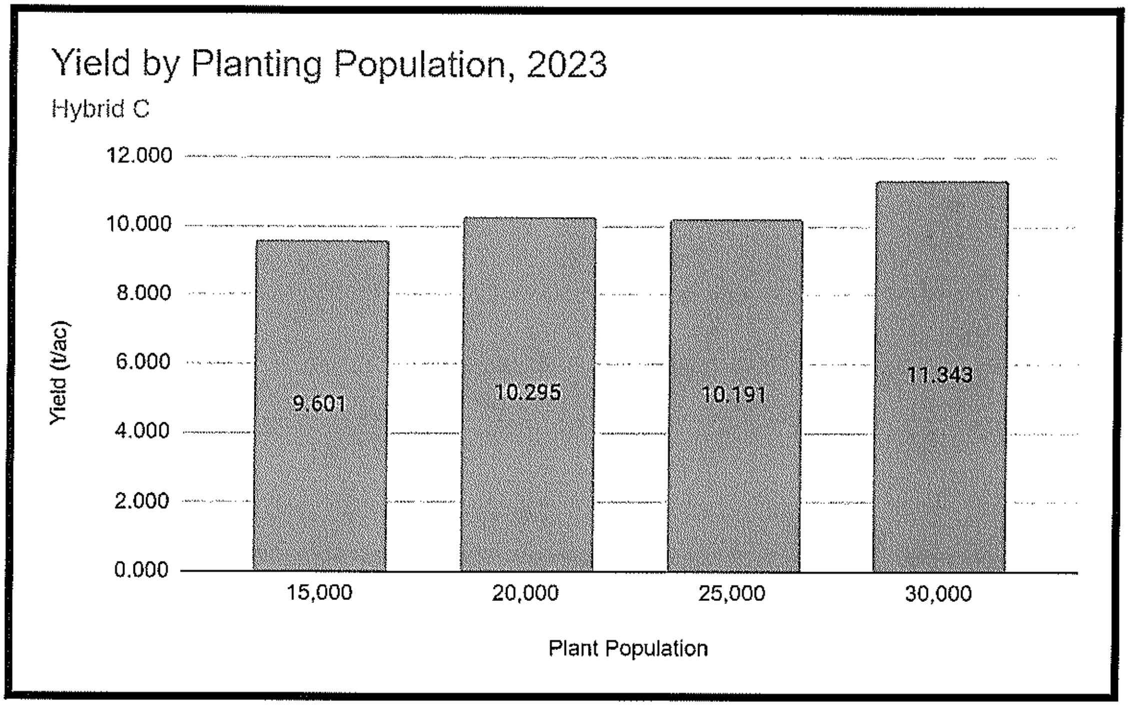
PROJECT TITLE
Sweet Corn Planting Populations (2023)





NORTERA

PROJECT TITLE
Sweet Corn Planting Populations (2023)