

Project Title: Pickling cucumber breeding for Ontario: First steps

Research Agency and Location: University of Guelph Ridgetown Campus; 120 Main St. E., Ridgetown, ON N0P 2C0

Lead and Key Investigators: Steve Loewen

Objectives:

1. To engage in discussions with stakeholders in the Ontario pickling cucumber industry to (a) learn about the industry and (b) determine breeding objectives for a pickling cucumber breeding program.
2. To begin assembling cucumber germplasm as the basis for starting a breeding program.
3. To gain experience establishing and growing pickling cucumber field plots.
4. To gain experience growing field cucumbers in the greenhouse in preparation for controlled crosses.
5. To begin developing procedures for measuring fruit quality.

Materials and Methodology:

1. In June, July and August I arranged meetings by phone, Zoom, and in-person to speak with cucumber industry stakeholders to learn about the industry.

Stakeholder group	Number of Individuals contacted
Government (OMAFRA)	2
University Researchers	5
Grower representatives	3
Shippers and Packers	3
Seed Companies	3
Total	16
Meetings actually held	14

In addition, I also attended the Tacos at Twilight meeting July 11 and the Brinestock Evaluation meeting October 24.

Results and Conclusions:

1. Where possible, face-to-face meetings were arranged with many stakeholders. In other cases phone calls or Zoom meetings were held. There were 2 individuals where an initial response was received to my introductory email, but meeting arrangements did not work out.
 - (a) Stakeholders were very helpful and open to responding to my questions as I tried to learn about the structure and workings of the pickling cucumber industry in Ontario. In a number of cases individuals were willing to share privileged or proprietary information to help me understand the industry at a deeper level. There are additional stakeholders that I would like to meet with in future years to continue my learning and to broaden my understanding.
 - (b) Based on discussions to date for breeding objectives, I understand the Ontario pickling cucumber industry to need high yielding, parthenocarpic, gynoecious, hybrid cultivars for hand harvest, with resistance to downy mildew. Ontario production is distinguished by an

ability to reliably supply grade sizes 1 and 2, and the ability to harvest through August and into September. Any cultivars developed need to support these distinguishing features. The cucumbers of suitable cultivars need to have uniform green colour, tender skins and interiors that are firm and free of any hollowness after brining. Shape and size should be uniform with L:D ratio ranging from 2.8 to 3.2 and no taper. These breeding objectives will be refined over time.

2. Twenty different cultivars were already obtained at the start of the season. Plant Gene Resources of Canada holds a small collection of mostly old cucumber cultivars.
 - (a) One of the most important findings this season was that Yiqun Weng (U. Wisconsin) does not have any germplasm to release. His work is focused on cucumber genetics but not on breeding. The lack of access to modern pickling cucumber germplasm will be one of the biggest limitations to advancing a breeding program at Ridgetown. There are still some options that need to be explored with seed companies and with researchers at MSU, NCSU and Cornell. In any case, future work at Ridgetown will need to focus on developing modern cucumber germplasm. While not preferred, it is possible that we may need to start with commercial hybrids not covered by plant breeders' rights, as a source of germplasm.
 - (b) It was Y. Weng's opinion that *Cucumis hystrix* does not contain any useful genes for cultivated cucumber.
3. We were successful at establishing pickling cucumber field plots from transplants using the AMA Horticulture Ellepot trays. We gained experience controlling weeds and keeping the plot free of disease. We gained experience setting up a drip irrigation system.
 - (a) A very valuable conversation was had with T. Wehner (recently retired cucumber breeder at NCSU) on pickling cucumber breeding field plots. Briefly, for breeding plots used to develop inbred lines, he recommended plots ranging from 4 to 5 feet long, in rows 5 feet apart, and separated by 4 to 5 foot alleys. At this plot size he recommended that sowing the row by hand was faster than sowing by machine, and that plants be thinned to a final number of 16 plants per plot. Several breeding strategies were discussed.
 - (b) Another very important finding this season was that when managing both a processing tomato breeding program and a pickling cucumber breeding program at the same time there are not the synergies between the two programs that were expected. Operations such as spraying fungicides are frequent for both crops and the time required to accomplish this negatively affects weed control operations. In tomatoes, making controlled crosses by hand is not difficult but it is time consuming. In cucumbers, making controlled crosses is much more complicated because of the range of sex expression on plants and the need to manipulate that with ethylene and silver thiosulfate.
4. We were very successful in growing cucumber plants in the greenhouse. Growth was rapid and flowering was profuse.
 - (a) We purchased reagents to make silver thiosulfate to manipulate sex expression in the flowers. As of this date of writing we do not yet have experience using it.
 - (b) We should be able to achieve at least 3, and very likely 4 generations annually in the greenhouse. Because of the relative ease of making controlled crosses in the greenhouse, and the need identified for developing germplasm, the greenhouse component of this project will become very important.

- (c) An important finding from this season is that we will need to set up the capability to propagate cucumbers vegetatively. Cuttings are not difficult to root but we may need to develop capacity for *in vitro* tissue culture. There are eight different variations of sex expression in cucumber plants (Haiyan, et al., 2023). Flower sex at 20 nodes must be observed to confirm sex expression in cucumber plants (Dhall, et al., 2022). During development of gynoecious and parthenocarpic cucumber inbred lines, plants at this stage of development are extremely difficult to induce production of male flowers as a pollen source for selfing. In addition to preventing the loss of individuals with desirable trait combinations by maintenance through tissue culture, regenerating plants from culture can result in young plants that are responsive to induction of male flowers as pollen sources for selfing.
5. The meeting with T. Wehner was helpful for starting to develop methods of measuring and assessing fruit quality parameters. Tasting a small piece of cotyledon can be used as an early-stage, rapid screening method to detect bitterness. A shear test has been used by some breeders as a quick way to test for firmness. Skin tenderness can be estimated rapidly using a thumbnail test and comparing to check varieties with known skin toughness. We will be developing further, rapid methods to screen breeding lines for important traits.