Hop Variety Development Program for B.C.

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Introduction: What Are Hops?

The hop plant, *Humulus lupulus var.*, is a flowering plant that belongs to the *Cannabaceae* family, which also includes cannabis/hemp.

The plants produce long bines that readily climb up anything in reach, therefore commercial hops are grown using tall trellis systems.

Figure 1. Field trellis system for the hops.

As the plants mature, the female flowers begin producing resin and essential oil-rich cones which are harvested and dried for use in brewing beer. The resins and aromatic oils are made by numerous lupulin glands.

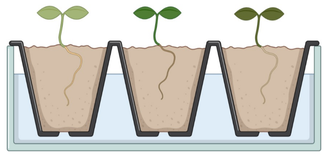
Figure 2. Bisected hop cone showing lupulin glands (left), and lupulin glands at 100x magnification (right).

Hops not only impart characteristic flavours and aromas to beer, but also function as natural preservatives. Historically, highly hopped beers such as India pale ales (IPAs) allowed for the transport of beers over longer distances (e.g. England to India).

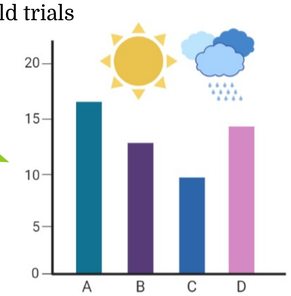
Project Overview

Goal: To produce new and unique hops varieties proprietary to BC

Multi-year project requiring multiple generations of hybrids and field trials

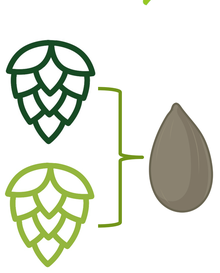


2. Plant hybrids in growth chambers & greenhouse

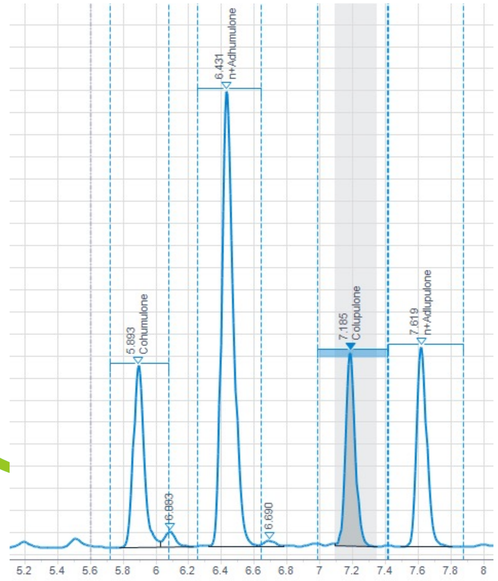


3. Monitor agronomics and desirable phenotypes in hop fields

4. Harvest cones from the top-performing hops varieties



1. Create hybrids and collect seeds



5. Chemical extraction and varietal analysis

Background: Why New Hops?

The craft beer market is rapidly growing in Canada with a ten-fold increase in number of breweries being established in Canada (particularly British Columbia and Ontario) in the past 6 years.

BC used to be one of the largest hop producers in the world, peaking in the 1940-50s.

Many commercial hop varieties are proprietary and are therefore not available to local hop growers, as well, are not adapted to the BC environment.

Figure 7. BC-grown hop cones, with a beer made from the same cones.

To help recharge the BC Hop industry, the KPU-AGC has partnered with GreenFlora Greenhouses to develop BC's own hop varieties, allowing for local growers to produce a truly BC-specific product adapted to the BC environment, as well as to be used also by local brewers in creating a unique beer.

Figure 6. Experimental hops varieties grown in field trial in Pemberton, BC.

Research Components and Methodologies

Evaluate chemical composition of hop products (e.g. cones and pellets) using in-lab HPLC, GC-MS & GC-O.

- High-Performance Liquid Chromatography (HPLC) Analysis to quantify bittering agents (alpha & beta acids)
- Gas Chromatography-Mass Spectrometry (GCMS) Analysis to quantify aromatic compounds (oils)
- GC-O Analysis for qualitative aroma detection

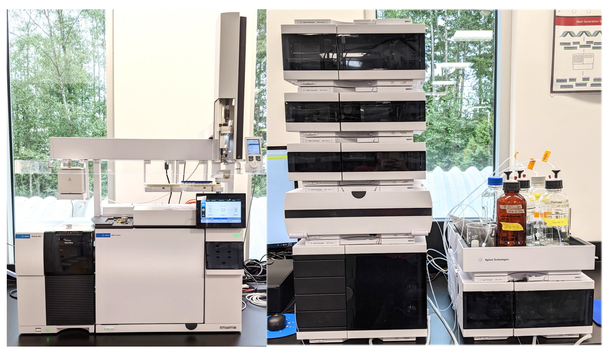


Figure 3. GC-MS (left) and HPLC (right) systems in the AGC lab for chemical analysis in hops cones and leaves.

Use predictive profiling to look for early indicators of cone characteristics

- Leaf chemical extractions for relative concentrations of aromatic metabolites
- Field phenotype monitoring
- Leaf trichome imaging for trichome abundance using machine learning and computer vision

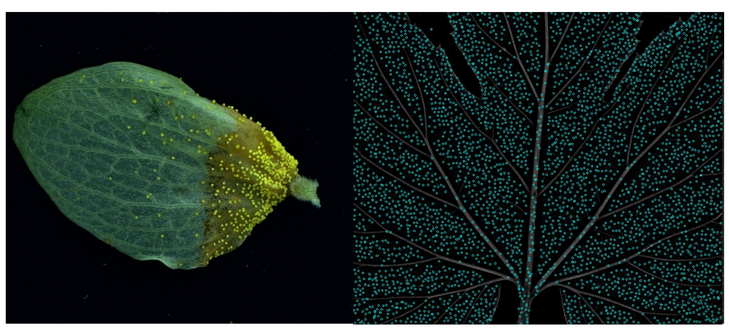


Figure 4. Images of lupulin glands on a hops cone bract (left) and leaf using a computer vision imaging station (right).

Genotyping hop accessions using microsatellite PCR and fragment length analysis (FLA) 'fingerprinting'

- Using microsatellites (SSRs) to determine the 'fingerprint' identity of commercial hops and compare to wild BC hops and new KPU-varieties

Figure 5. SeqStudio Genetic Analyzer in the AGC lab for genotyping hop accessions.

Calling all Brewers!

We are looking for brewers and beer enthusiasts to help evaluate our hop selections in the brewhouse.

Contact us at **agc@kpu.ca** for more information

The hop breeding project is working out of the KPU Applied Genomics Center (AGC) in partnership with Green Flora Greenhouses and BC Hop Grower's Association members.