Ministry of Agriculture Project "Evaluation of apple and raspberry breeding material for the introduction of integrated growing technologies of agricultural crops" (2012-2020)

Results in 2019

Apple breeding

The aim if the apple breeding program at Institute of Horticulture is to obtain and select apple cultivars adapted to the conditions of Latvia and the Baltic sea region, with high fruit quality and winter-hardy, regularly producing trees easy in training, with complex resistance to apple diseases most important in the region, with different consumption time.

In 2019, significant damages to the fruit crop were caused by spring frosts, hail and fruit rot. Part of apples suffered also from wind drop and high summer temperatures, reducing fruit quality and storage. On the other side, this allowed to select hybrids tolerant to a complex of unfavourable conditions.

In the hybrid field (Stage 1) evaluation was completed for hybrid families obtained in 2003-2006, and continued for hybrid families from 2007-2011. For next stage trials 19 apple hybrids were propagated on rootstock B396, and 16 columnar and crabapple hybrids – on MM106. In trials on clonal rootstocks (Stage 2) 5 super-elite hybrids were selected which will be propagated for a tree training experiment in 2020, to evaluate their suitability for production and cultivar registration. Evaluation was continued in trials established in 2012- 2017. Parameters of productivity and fruit quality were evaluated, along with the frost and hail damages. Taste panel results were summarized for the fruits of 2018/2019 storage season. A tree training trial (Stage 3) was established in 2019 for promising apple cultivars and hybrids, including 9 elite hybrids from the breeding program.

Cooperation continued with vineries "Ledusvīni" and "Mr.Plūme**",** testing the suitability of the hybrids of our institute for winemaking. In 2019 as the most promising was selected apple Nr.19-97-154. In Estonia, 2 scab resistant apple cultivars have been registered from crosses obtained in our Institute - 'Virve' un 'Kalju' (breeder's rights – Polli Horticulture Research Centre).

By the complex of traits, the best hybrids were selected as variety candidates: H-4-03-1 ('Lora'), H-3-97-18 ('Čakstes Auči'), ornamental apples H-17-05-27 ('Auce'), H-17-05-16 ('Dudars'). As potential variety candidates 7 more hybrids were selected: Nr.16-97-29 Vf/Rvi6 (Priscilla o.p.), Nr.17-97-64 Vr/Rvi17 (Releta o.p.), Nr.28-97-26 (Redchief o.p.), H-6-03-45 (Dayton x Zarya Alatau), H-7-03-42 Vf/Rvi6, H-7-03-47 (Co-op 7 x Andris), . These hybrids need additional observations for 1-2 more years.

New apple cultivars: DUS testing was started in spring of 2019 cultivars 'Felicita', 'Inta' and ornamental apple 'Karlens'. Variety candidates H-4-03-1 (preliminary name'Lora') and ornamental apple H-17-05-27 ('Auce') were handed in for registration in February 2020. Celebrating the 160th birthday of the first President of Latvia, Jānis Čakste, summer apple hybrid H-3-97-18 was named 'Čakstes Auči'. It was propagated for planting at the native farm of J.Čakste, but will not be protected by breeder's rights.

The results of apple breeding in 2019 were presented in 2 scientific papers (subjected), 2 popular science articles, 2 lectures and 1 seminar, 5 fruit exhibitions.

Raspberry Breeding

The winter of 2018/2019 was favourable for raspberry over-wintering. The spring of 2019 was dry (0.9 mm in 3rd decade of April), from January to April the precipitation was not sufficient to compensate the after-effect of the 2018 drought. June also was relatively dry. Drought had negative effect on raspberry shoot development and berry quality. High air temperatures in 3rd decade of July (over 30°C) resulted in earlier flowering and maturing of primocane raspberries. In combination with insufficient rainfall in August their berry mass was lower. Due to high air temperatures in August and September practically all yield of primocane raspberries could be harvested. The total rainfall from May to October (298 mm) was almost twice higher than in 2018, but the moisture supply in periods critical for plant development was crucial.

In the hybrid field (Stage 1) early bud bust was observed for hybrids 1r.51-1, 1r.51-44 and 2r.41-4. The best plant health had 1r.51-1, 1r.51-4 and 1r.51(2)-7. For most hybrids, fruit maturing started in 1st decade of July. In spite of the drought, the yield of the best hybrids was very good (6-7 points), but berry size was 5-7 points. Berry taste of the best hybrids was 6-7 points. The most productive was hybrid 1r.43-30 (Nr.16-4-4 o.p.) it also has large berries (6g). good productivity had also 1r.-51-9, 1r.-51-30(2) and 1r.-43-43 (300g, 233 g and 211 g from cane, respectively). The most widespread disease was *Didymella applanata*. Most hybrids had weak or medium infection.

Primocane raspberries started to mature on August 10. The most productive hybrid 6-5-5 reached the yield maximum on August 30 and continued production to October 10. The largest fruit mass for all hybrids was in first pickings. The tallest productive canes had hybrid 5-43-10. The highest amount of fruiting twigs (20) had hybrid 3-41-11. The biggest number of berries per shoot had hybrid 3-41-20 (162 berries).

In Stage 2 trial of summer raspberries the highest yield had S2-12-17 (1936.7 g per plant or 11.6 t ha^{-1}), S11-25a-4 (1900.7 g or 11.4 t ha^{-1}) and S1-12-73 (2523.2 g or 15.1 t ha^{-1}). The average berry mas, because of drought, was relatively low, the largest berries had S1-12-1 (3.7g). The disease occurrence in the dry conditions was significantly lower, but damages of aphid mites were observed. The highest total phenolic content had S1-12-13 (252.55 mg $100g^{-1}$), along with high anthocyanin content (45.78 mg $100g^{-1}$). The highest anthocyanin content had S13-17-11 (63.06 mg $100g^{-1}$). **Hybrids S11-25a-4 and S1-12-13 were selected as variety candidates. For wider trials were selected also hybrids S2-12-17 and S1-12-73.**

In Stage 2 trial of primocane raspberries the most productive were cultivar ‘Polana’(2.65 kg per plant) and hybrid B 6R 9 (2.55 kg), the last also had the highest yield per shoot (99.8 g). The biggest average berry mass had ‘Himbo Top’ – 3.1g. three hybrids had average berry mass of 2.9 g: P 6R 3, HT 6R 10, P 6R 32, and hybrid HT 6R 18 had 2.8 g. **Three hybrids were selected which may have perspective for growing under cover: by yield amount - B 6R 9, by berry quality and good flavour - P 6R 3 and P 6R 33.**

Genome research

The evaluation of plant material developed in the LatHort apple breeding program was continued for its potential resistance to apple scab (*Venturia inaequalis*). In 2019, genotyping of scab resistance genes on three hybrid combinations (populations): 'Kandil Orlovsky' × 'Florina' (no. 4), 'Kurnakovskoye' × 'Rewena' (no. 5) and 'Scarlett O'Hara' × D -1-92-32 (No. 6) was performed including in total 333 samples. Genotyping was performed using adapted, gene-specific molecular markers (Cheng et al., 1998; Vejl et al., 2003). Resistance gene identification data from all 6 hybrid populations and resistance field observation data (3-year assessment) from previous years were also included in the common analysis.

Genotyping of all 11 parents involved in the development of hybrid populations was performed using 22 previously tested microsatellite or SSR markers (Liebhard et al 2002; Silfverberg-Dilworth et al 2006; Celton et al. 2009; Patocchi et al., 2009). In general, all used markers were informative in study on apple breeding material. The genetic linkage of the apple breeding material was determined by cluster analysis. PCoA was performed to determine the genetic linkage using specific fragments that identify scab resistance genes. In general, the genes identified were similar in parental genotypes.

General conclusions:

- The phenotypic expression of apple scab resistance is influenced by heredity and genetic factors, whereas the environment has only modifying effect.
- Apart from the resistance genes present in the plant genotype, the apple scab's resistance is influenced by a combination of factors, including the geographical origin of the apple, the health of the tree, and resistance to other diseases.
- Molecular studies, which include field resistance assessment, provide a more realistic model of the resistance selection process.