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# The actualities of apple breeding in Latvia

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**Abstract.** For successful development of fruit production in Latvia it is necessary to obtain new cultivars suitable for commercial growing and able to compete with imported fruits. The aim of the breeding program at Institute of Horticulture is to combine the following: (1) high fruit quality, long storage, improved flesh firmness and biochemical content, especially Brix, polyphenols; (2) climate adapted tree with high and regular yields, easy for training, desirably with self-thinning fruits; (3) complex resistance or tolerance to main apple diseases – scab, mildew and others. The resistance has to be durable, so different resistance sources are combined in crosses, including genes Rvi6 and Rvi5. Sources of fire blight resistance are also used, as this disease now arrives in Latvia. Recently more attention is paid to late flowering with some resistance to spring frosts, as this trait is becoming increasingly important in Latvia with climate change. For improved quality, best cultivars grown worldwide are included, like 'Bohemia', 'Honeycrisp'. Late maturing is preferred, but with harvest not too late for Latvia. In 2024 six variety candidates were applied for registration: **'Inara'** ('Alesya' x 'Honeycrisp'), **'Raivo'** ('Bogatyr' x 'Fantazja'), **'Sarmīte'** (Co-op 7 x AMD-12-15-15) for commercial growing and **'Katrīnīte'** *Rvi6* (BM 41497 x 'Latkrimson') for home gardens; ornamental apples **'Antonija'** and **'Dūdars'** (both 'Top Millionaire' x D-1-94-2). Promising variety candidates for registration are **H-15-05-20 'Ilze'** ('Eksotika' x 'Bohemia'), **H-3-07-164 'Vizma'** ('Ligita' x 'Honeycrisp'), cider apple **P 53-1 'Pūres Sidra'** ('Redcroft' o.p.), ornamental crab **S1-8 'Austris'** ('Geneva crab' o.p.).
**Key words:** *Malus* × *domestica*, disease tolerance, climate adaptation, fruit quality.

## Introduction

For successful development of fruit production in Latvia it is necessary to obtain new cultivars suitable for commercial growing and able to compete with imported fruits. The existing assortment in commercial orchards (Kaufmane *et al.,* 2017) is dominated by Lithuanian cultivar 'Auksis', which is favoured for its reliable production and quality. However, the disease resistance is only medium, fruits tend to drop easily, and storage is only until March. Other popular cultivars include 'Antei', 'Belorusskoe Malinovoe' and 'Ligol' with longer storage, but susceptible to storage disorders (especially 'Antei') and scab.

By the latest statistic data (Agriculture of Latvia, 2024) the apple orchard area in Latvia in 2023 was 3,500 ha (all types of orchards), the total yield 7,700 t. This was 55% decrease compared to 13,900 t in 2020, and the main reason was unfavourable weather conditions. In several recent years, apple yields have suffered from spring frosts, storms, rain and hail. Latvian apple production and storage capacities do not supply local fruits all year round, which, in the present world situation, creates a risk to stable fruit supply.

Several newer cultivars of Latvian breeding released in 2006-2014 are scab resistant, but do not have long storage, with exception of 'Monta'. However, the productivity of 'Monta' is not always good (Rubauskis *et al.,* 2022). The most planted new cultivar is 'Dace' with very good quality, but susceptible to fruit rot.

The apple disease picture in Latvia is changing. Research of scab race genetic diversity in Latvia has started, using scab race diversifying genotypes, selected in the framework of Vinquest project (Sokolova *et al.,* 2022a). Study of 89 accessions in Latvian apple genetic resources collection showed that Rvi13 resistance was most frequent (Lacis *et al.,* 2024). This gene has been considered one of reliable resistance sources (Patocchi *et al.,* 2020), but in the orchard of our Institute sporulation was observed on

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'Durello di Forli' carrying *Rvi13* (Sokolova, 2024). The same research showed no infection for genotypes with *Rvi2, Rvi5, Rvi6, Rvi7, Rvi13, Rvi14* and *Rvi15*. Yet scab infection has been observed on *Rvi6* resistant cultivars in some locations in Latvia (Sokolova & Moročko-Bičevska, 2022a). In other location in Europe, different resistance genes were more frequent (Patocchi et al., 2020). These findings stress the importance of combining several resistance genes as well breeding for a specific location, as not all genes show the same effectivity in preventing scab infection (Höffer *et al*., 2021).

Although Latvia officially is a fire blight free zone, periodical outbreaks are observed (Morocko-Bicevska & Maldute, 2014), which in future should create the need of fire blight resistant cultivars. This is occurring on the background of climate change, especially changing onset and duration of spring (Briedis *et al.,* 2024).

Worldwide, the main aims of breeding for productivity and fruit quality remain the same as decades ago, but new cultivars are increasingly created for the international market, for example, New Zealand cultivars planted in Europe (White & Bus, 1996). More attention is paid to apple flesh quality and consumer acceptance. Significant progress has been made in apple quality breeding, helped by genetic research and better understanding of quality traits (Laurens *et al.,* 2018). in commercial apples. Now a similar problem seems to develop, as many breeding programs include crosses of cultivar 'Honeycrisp' which has an outstanding flesh texture, but its descendants may have inherited serious physiological disorders of tree and fruits (Howard *et al*., 2018).

## Materials and Methods

The general aim stated in the breeding program at Institute of Horticulture is to combine fruit quality, climate adaptation and productivity, and complex resistance. Methods of classical breeding are used, combining with gene marker research.

**Breeding for resistance.** This means resistance or tolerance to main apple diseases – apple scab *Venturia inaequalis* (Cooke) Wint., apple mildew *Podosphaera leucotricha* (Ellis & Everh.) E.S. Salmon, canker *Neonectria ditissima* (Tul. & C. Tul.) Samuels & Rossman, and others. The resistance has to be durable, so different resistance sources are combined in crosses, including scab resistance genes *Rvi6* and *Rvi5*. Sources of fire blight *Erwinina amylovora* (Burrill) Winslow *et al.* resistance are also used in hybridization, as this disease now arrives in Latvia. Resistance crosses have included mostly *Rvi6* gene sources - 'Enterprise', 'Rewena'(both also tolerant to fire blight), 'Scarlett O'Hara', Topaz', Belarussian cultivar 'Diyament'. Hybridization includes also number of Latvian cultivars and elite hybrids with *Rvi6* or *Rvi5* scab resistance, for example, the elite hybrid D-1-92-32 *Rvi5*, cultivars'Felicita' *Rvi6* (canker tolerant), 'Paulis' *Rvi6* (mildew and canker tolerant). From earlier obtained crosses combining *Rv6* and *Rvi5* genes and crosses to obtain homozygous *Rvi6* gene carriers; selected hybrids were used in further hybridization.

Breeding for mildew resistance is more difficult, as there are very few locally grown cultivars with mildew resistance or relative tolerance, and donors must be relied on cultivars from Western Europe and the USA.

**Breeding for climate adaptation**. This includes climate adapted tree with high and regular yields, goof winter-hardiness. Commercially successful cultivars grown in Latvia are included in crosses for this aim – 'Alesya', Antei', 'Belorusskoe Malinovoe', 'Lobo' and others. They are hybridized with disease resistance and quality donors.

Recently more attention is paid to late flowering with some resistance to spring frosts, as this trait is becoming increasingly important in Latvia with climate change. Late flowering cultivars in crosses include 'Spartan', Latvian cultivars 'Andris', Eksotika', 'Pure Ametist'.

**Breeding for tree habit and productivity**. Only hybrids with easily branching tree and wide branching angles are selected as promising, as most easy in tree training. Regular yields and partial fruit self-thinning are preferred, while crop overload is considered a negative trait, demanding extra job for thinning.

**Breeding for quality.** This includes high fruit market and eating quality, long storage, improved flesh firmness and biochemical content, especially Brix, polyphenols, firmness. Late maturing is preferred, but with harvest not too late for Latvia. For improved quality, best cultivars grown worldwide are included, like 'Bohemia', 'Honeycrisp'. 'Ligol'. Crosses were made also with 'Braeburn', 'Fuji' and 'Kanzi' (Nicoter), and recently with Swiss cultivars ''Ariwa', 'Galiwa'; 'Ladina', 'Mariella' and 'Milwa' (Junami).

**Hybrid evaluation.** Annually about 10 cross combinations were performed, and after artificial scab infection and evaluation of mildew infection severity in greenhouse, approximately 1000 hybrid seedlings planted in field. In the field, tree health and productivity are evaluated in points (9-point scale), tree growth habit and fruit quality described, time of flowering and harvest registered. After obtaining several fruit yields, the best hybrids are propagated on dwarfing rootstock B.396 and planted in 3 replications by 2 trees each. In this 2nd stage trial, yield amount

(kg), fruit mass (g) and % of marketable fruits are evaluated. Fruits are analysed for Brix, acid, flesh firmness and total polyphehols content, on a sample of 10 fruits. Fruit storage length (weeks at 2±1 °C, common storage) is determined for samples of 30-60 fruits. Observations of disease damage and phenology continue, and evaluation of tree fruiting and growth habit on the dwarfing rootstock is done. In critical years, frost and hail damage are evaluated (9-point scale). Selected elite hybrids (variety candidates) are planted at farms and in growing technology trials.

## Results

**Disease resistance.** Results of scab resistance breeding have been successful in Latvia, recently resulting in several promising cultivars – 'Valentino' with *Rvi5* scab resistance, polygenic resistant 'Lora', 'Sarmite'. Several hybrids combining *Rvi6* and *Rvi5* are pending for registration. However, many *Rvi6* resistant hybrids have shown leaf and fruit blotch symptoms in unsprayed orchard, possibly caused by *Alternaria mali* Roberts or *Diplocarpon coronariae* (Ellis & Davis) Wöhner & Rossman.

So far, the best mildew tolerance donors in crosses have been 'Spartan' and 'Ladina' (less than 10-% susceptible seedlings), while for 'Enterprise' the result depended on the other cross parent. Most other ross combinations, however, have shown high mildew infestation in nursery. It refers both to hybrids of commercial cultivars and landraces grown in Latvia, as well as elite hybrids of Latvian breeding.

**Regularity of production.** Recent years have shown increasing damages of fruit yield due to spring frost and lack of pollination. Fruit yields have varied strongly in the territory of Latvia, as shown by reports from farmers. For example, in 2024 frosts -5°C were observed in May 8 to 9 in Vidzeme and Latgale regions. Poor fruit set occurred also when air temperatures during apple flowering did not fall below 0°C, but the weather was unfavourable for bee pollination., like it happened in 2025.

Data from Institute orchard at Dobele were collected for the relation of flowering abundance to fruit set in unfavourable years (only trees with medium good to abundant flowering were evaluated). Yield losses of 50 to 100% for 1 to 3 years were observed for a number of hybrids, especially early ripening ones, and new Latvian cultivar 'Edite' *Rvi6*. Hybrids with irregular fruit set are discarded.

Vert few productive hybrids were selected from crosses of the hardiest local cultivars with 'Fuji' and 'Braeburn', which suggests unsuitability of these late harvest parents for breeding n Northern Europe.

**Tree habit and productivity.** In recently established trials of elite hybrids on B.396, observation of productivity and tree habit continue. Preliminary results show very good results in the cross combination 'Scarlett O'Hara' x D-1-92-32, combining genes *Rvi6* and *Rvi5*.

**Fruit quality and storage.** Consumer polls at fruit exhibitions in Latvia have showed high consumer acceptance of two hybrids of 'Honeycrisp' - H-3-07-164 ('Vizma') and H-1-07-36 ('Inara'), as well as a hybrid of 'Bohemia'- H-15-05-20 ('Ilze'). These hybrids show also good biochemical content – Brix (soluble solids), good firmness, total polyphenols, better or similar to standard cultivar 'Auksis' which on average had 13.1°Brix, firmness 5.6 kg $cm^{-2}$, polyphenols 101.5 mg 100 $g^{-1}$. Fruits of these hybrids store 5-6 months in common storage. Even longer storage had candidate cultivar 'Sarmite', 6-7 months.

**New apple cultivars.** In 2024 six cultivar candidates were applied for registration - three for commercial growing, one for home gardens and two ornamental apples.

**'Inara'** - cross **'**Alesya' x 'Honeycrisp' Very attractive bright red apple, firm, crisp and juicy, taste subacid, very good, good storage; not subject to 'Honeycrisp' type storage problems. Tree medium vigour, easy in training, early and annual yields. Scab and mildew tolerance good, medium tolerant to fruit rots in unsprayed orchard. Fruits contain 14-15°Brix, 0.4% acids, 129-158 mg 100 $g^{-1}$ polyphenols. Flesh firmness at harvest 10 kg $cm^{-2}$, later 5 kg $cm^{-2}$. Promising for commercial growing.

**'Raivo'** - cross 'Bogatyr' x 'Fantazja'. Large apples with purple over-colour, subacid with dominance of sweetness, very tasty, good storage. Tree vigorous, spreading, productive, fruits partly self-thinning. Scab and mildew tolerance good to medium, tolerant to fruit rots. Fruits contain 13.5°Brix, 0.5% acids, 120 mg 100 $g^{-1}$ polyphenols. Flesh firmness is medium, 4.8 kg $cm^{-2}$. Promising for commercial growing.

**'Sarmīte'** - cross Co-op 7 x AMD-12-15-15 (Andris). Late ripening, pink striped apple, firm, good subacid taste. Has very good storage and resistance to diseases. Tree medium vigour, easy in training, good regular yields, fruits self-thinning. Fruits contain 14°Brix, 0.7% acids, 104 mg 100 $g^{-1}$ polyphenols. Flesh firmness a t harvest 9.3 kg $cm^{-2}$. Promising for commercial, organic and home gardens.

**'Katrīnīte'** *Rvi6* - cross BM 41497 x 'Latkrimson' Attractive and tasty bicolor apple which needs several pickings. Fruits drop easily when ripe, harvest time medium, but fruits store very well. Disease resistant and a regular yielder, tree easy in training. For home gardens.

**'Antonija'** - cross 'Top Millionaire' x D-1-94-2, red-leaf crab, a perfect unbranched column, disease tolerant. Ornamental apple.

**'Dūdars'** - cross Top Millionaire' x D-1-94-2, red-leaf crab, tolerant to diseases and spring frosts. Ornamental apple, suitable also for processing.

More cultivar candidates are planned for registration in 2025:

**H-15-05-20** (proposed name **'Ilze'**) - cross 'Eksotika' x 'Bohemia'. Combines very good fruit quality, good storage, tolerance to diseases, productivity and easy tree training. Fruits uniform, striped red, subacid, very good eating quality, storage 5 months. Fruits contain 12.3-14.3°Brix, 0.6% acids, medium polyphenols: 83-85 mg 100 $g^{-1}$. Flesh firmness 5.8-6.3 kg $cm^{-2}$. Promising for commercial growing and home gardens.

**H-3-07-164** (proposed name **'Vizma'**) cross 'Ligita' x 'Honeycrisp'. Bright yellow fruits with excellent eating quality and good storage, easy tree training. Very good biochemical content - 14.5-16°Brix, 0.7-0.8% acids, 150-175 mg 100 $g^{-1}$ polyphenols. Flesh firm, 7.5-8 kg $cm^{-2}$, but skin rather susceptible to bruises. However, some commercial growers are interested in testing it.

Cider apple **P 53-1 (**proposed name **'Pūres Sidra'**) - obtained as seedling of 'Redcroft'. Medium early ripening, sweet cider apple with slight tannins. Tre medium vigour, productive, tends to become biennial. Tolerant to scab and fruit rots, but medium susceptible to mildew. Contains 14-18°Brix, acids 0.2%, polyphenols 83 mg $100g^{-1}$, flesh firmness 9.4 kg $cm^{-2}$; juice outcome 54.6%.

Ornamental crab **S1-8 (**proposed name **'Austris'**) – cross 'Geneva crab' x 'Duftzauber' Dark red-leaf crab with high ornamental value, tolerant to diseases.

In 2026, one more promising hybrid is planned for cultivar application:

**H-7-97-38** (proposed name **'Inalina'**) - cross 'Merrigold' x 'Stars' A very sweet (15-16°Brix), red-on-yellow striped, conical apple with good storage. Upright vigorous tree; medium tolerance to scab, tolerant to other diseases. Has potential as a specialty (niche) apple.

## Discussion

In respect to tree architecture, productivity, fruit quality and storage, the newest Latvian cultivars show goof potential for commercial growing, and their fruits have good market potential. However, their resistance to unfavourable environment factors must be evaluated more widely in farm trials.

As *Rvi6* scab resistance is no more reliable, more attention must be paid to including in breeding other resistance genes. Combining *Rvi6* with *Rvi5* has shown good results in our breeding program, but it is essential that other genes are included in future hybridization to obtain a wider resistance base. For this aim, screening of the genetic resources collection must be extended, as insufficient genetic data on the local cultivars hinder their effective use in breeding.

To obtain cultivars suitable for organic growing, future breeding must include also resistance to apple blotch (*Alternarua mali, Diplocodon coronariae*). Breeding for canker resistance needs more observation of new cultivars in different regions and artificial infection, as canker occurrence in Institute trials is low. On the contrary, mildew infection here is much higher than observed in farms of Northern Latvia, which creates good background for mildew resistance selection, but involvement of resistant cultivars from other breeding programs in hybridization must be extended.

The recent years have shown the necessity to obtain spring frost tolerant cultivars, involving more late flowering donors. However, recent observations of cultivars in our collection show that late flowering is not essential for spring frost resistance; our new cultivars all have medium flowering time, but show low frost damages.

## Conclusions

Cultivars meeting the needs of Latvian apple growers and with good market potential can be obtained in Latvia, as shown by recent breeding results.

In breeding, attention should be paid to the challenges resulting from changing climate – regularity of yields, new or less investigated pathogens.

The genetic base of apple breeding must be extended, using the results of genetic screening in the apple collection.

## References

Agriculture of Latvia, 2024. Central Statistical Bureau of Latvia (2024). Collection of Statistics, pp.48-49. /Nr_16_Latvijas_Lauksaimnieciba_2024_(24_00)_LV_EN_0.pdf

Briedis, M., Hahn, S. & Bauer, S. (2024). Duration and variability of spring green- up mediate population consequences of climate change. *Ecology Letters,* 27, e14380. Available from: https://doi.org/10.1111/ele.14380

Höfer, M.; Flachowsky, H.; Schröpfer, S.; Peil, A. (2021). Evaluation of Scab and Mildew Resistance in the Gene Bank Collection of Apples in Dresden-Pillnitz. *Plants,* 2021, 10, 1227. https://doi.org/10.3390/plants10061227

Howard, N.P., van de Weg, E., Tillman, J. *et al* (2018). Two QTL characterized for soft scald and soggy breakdown in apple (*Malus × domestica*) through pedigree-based analysis of a large population of interconnected families. *Tree Genetics &*

*Genomes* **14**, 2 (2018). https://doi.org/10.1007/s11295-017-1216-y

Kaufmane, E., Skrīvele ,M., Ikase, L. (2017). Fruit growing in Latvia – industry and science. *Proc. of the Latvian Academy of Sciences,* Section B, Vol. 71, No. 3 (708), 237-247.

Lācis, G., Kārkliņa, K. and Ikase, L. (2024). Marker-based identification of potential scab resistance donors in Latvian apple collection. *Acta Hortic.* 1412. ISHS 2024. DOI 10.17660/ActaHortic.2024.1412.6

Laurens, F., M.J. Aranzana, P. Arus, D. Bassi, M. Bink, J. Bonany, A. Caprera, L. Corelli-Grappadelli, E. Costes, C.-E. Durel, J.-B. Mauroux, H. Muranty, N. Nazzicari, T. Pascal, A. Patocchi, A. Peil, B. Quilot-Turion, L. Rossini, A. Stella, M. Troggio, R. Velasco, E. van de Weg, (2018). An integrated approach for increasing breeding efficiency in apple and peach in Europe. Horticulture Research, Volume 5, 2018, 11. https://doi.org/10.1038/s41438-018-0016-3

Morocko-Bicevska, I. and Maldute, S. (2014). Fire blight in Latvia: occurrence, management and problems. *Acta Hortic.* 1056, 133-136. DOI: 10.17660/ActaHortic.2014.1056.19

Patocchi, A., Wehrli, A., Dubuis, P.H., Auwerkerken, A., Leida, C., Cipriani, G., Passey, T., MStaples, M., Didelot, F., Philion, V., Peil, A., Laszakovits, H., Rühmer, T., Boeck, K., Baniulis, D., Strasser, K., Vavra, R., Guerra, W., Masny, S., Ruess, F., Le Berre, F., Nybom, H., Tartarini, S., Spornberger, A., Pikunova, A., and Bus, V.G.M. (2020). Ten Years of VINQUEST: First Insight for Breeding New Apple Cultivars with Durable Apple Scab Resistance**.** *Plant Disease,* 104, 2074-2081. https://doi.org/10.1094/PDIS-11-19-2473-SR

Rubauskis, E., Bundzena, G. and Borisova, I. (2022). Performance of apple orchard systems in the Nordic climate. *Acta Hortic.* 1346, 365-374. DOI: 10.17660/ActaHortic.2022.1346.46

Sansavini, S., Donati, F., Costa, F. and Tartarini, S. (2004). Advances in apple breeding for enhanced fruit quality and resistance to biotic stresses: new varieties for the European market. *Journal of Fruit and Ornamental Plant Research,* vol. 12, 2004 Special ed., p.13-52.

Sokolova, O., and Moročko-Bičevska, I. (2022). Evaluation of Apple Scab and Occurrence of Venturia Inaequalis Races on Differential Malus Genotypes in Latvia. *Proc. of the Latvian Academy of Sciences,* Section B, Vol. l. 76, No. 4 (739), p,488–494.

Sokolova O., Moročķo-Bičevksa I., Lacis G. (2022a). Genetic Diversity of *Venturia inaequalis* in Latvia Revealed by Microsatellite Markers. *Pathogens,* 2022 Oct 9;11(10):1165. doi: 10.3390/pathogens11101165.

Sokolova O. (2024). Characterization of population diversity of Venturia inaequalis and Vernturia pyrina in Latvia. *Summary of the Doctoral thesis.* Jelgava, 2024, 55 p.

White, A.G. and Bus, V.G. (1996). Breeding commercial apple cultivars in New Zealand with resistances to pests and diseases. In *Eucarpia Symposium on Fruit Breeding and Genetics 484*, pp. 157-162.