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Evaluation of pear (*Pyrus communis* L.) cultivars in Latvia

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Abstract

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Pears (*Pyrus communis* L.) are an important commercial crop in Latvia, ranked as a second most important fruit tree crop. The aim of this study was the choice of suitable new pear cultivars for growing in Latvia. The evaluation was carried out at the Latvia State Institute of Fruit-Growing. Eighteen cultivars were evaluated over six years. Flowering intensity, harvest date, average fruit weight, taste and chemical composition (total soluble solids, flesh firmness, titratable acidity (TA)) and resistance to diseases and pests were recorded. Flowering intensity showed significant differences among years: the highest was in 2009 and 2011, the lowest in 2007, but not among cultivars. The highest fruit weight (292 g) was detected for cv. Tavricheskaya, the high and stable fruit size for cv. Elektra. The best fruit qualities were produced by cvs Concorde, Condo and Conference. Stable and high content of soluble solids, high TA and fruit firmness were found in fruit of cv. Lyubimitsa Osennyaya. There were no cultivars resistant to European pear rust; the lowest susceptibility was detected for cv. Noyabrskaya (synonym Xenia), whereas cv. Talgarskaya Krasavitsa was resistant to sooty mould (caused by *Leptoxyphium fumago*) and cv. Smuglyanka – to pear leaf blister mite (*Eriophyes pyri*).

Keywords: phenology; flowering; fruit quality; disease resistance; pests; harvest

Pear (*Pyrus communis* L.) is the second most important tree fruit crop in Latvia – total pear growing area is about 200 ha (CSB 2011) and pears are among the most popular fruit consumed. Although pear orchard areas in Latvia continue to increase, domestic production cannot satisfy the demand. The majority of current commercial orchards were planted in the late 1990's, when the cultivar choice was mainly determined by winter hardiness and nursery availability. Most genotypes were local cultivars or older cultivars introduced from neighbouring countries, many of which were already outdated. Currently about 30 pear cultivars are grown in commercial orchards of Latvia (Skrīvele et al. 2008), many of which should be replaced by higher-quality cultivars, resistant to diseases and pests and suitable for dessert and/or processing, including production of fresh-cut salads.

Cultivar evaluation and selection should take into account both consumer and producer preferences, but provides a compromise between these two (Petzold 1989). Main characters important for customers are fruit shape, size, skin colour, taste and flesh texture, whereas growers are interested in winter-hardiness, resistance to diseases and pests, early yielding and productivity (Petzold 1989). Moreover, consumer demands in different countries may vary significantly. The stability of fruit traits over years is essential since fruit quality is highly dependent on weather conditions,

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which may differ between growing seasons (Petzold 1989). Latvian agro-climatic conditions limit the possibility of new pear cultivar introduction. A shorter growing period and low winter temperatures (down to –30°C) are the main limiting factors to introduce cultivars originated in western and southern Europe. Therefore considerable evaluation is necessary to find appropriate genotypes and ensure successful and profitable pear growing in Latvia. The aim of this study was the determination of new suitable pear cultivars for Latvia.

MATERIAL AND METHODS

Plant material. The study was performed in the pear collection of the Latvia State Institute of Fruit-Growing (LSIFG). All pear cultivars were grafted onto pear seedlings (*Pyrus communis*) (Table 1). Tree planting distances were 7 × 5 m. Understory management consisted of frequently mowed grass in the alleyways, while 1 m wide strips were treated with herbicides. The response of cultivars to diseases and pests was assessed in natural field conditions of infection, with the same fungicide treatment as in commercial orchards, uniformly applied to all the cultivars (4 treatments/growing season).

Cultivar evaluation. Flowering intensity was measured on a scale of 0 to 5 (0 – no flowers, 5 – flowers at all growing points). Date of flowering and harvesting was recorded for each cultivar to determine the number of days from flowering to harvest. Effective temperature sums (ETS) during vegetation period were estimated as follows: ETS = $\sum (D_i)$ of temperature above +5°C ($D_i = (T_i - 5)$, if $T_i > 5$).

Fruits were harvested at optimum maturity and stored at 3°C in the fruit storage. Storage conditions (temperature and air moisture) were ensured and monitored automatically by Rivacold Block-system (Rivacold Co., Ltd., Tewkesbury, UK). Before evaluation of visual traits (fruit shape, size and colour), biochemical characters and sensory properties fruits were transferred to 18–20°C ripening room. Eating ripeness was determined based on the optimal fruit texture of particular cultivar.

Sensory evaluations were conducted at the LSIFG. A tasting panel of at least 6 participants was used and 5 to 6 fruits typical for each cultivar were displayed on a white dish and evaluated for fruit appearance and taste. Sensory evaluation and following quality parameters were recorded at eating ripeness: flesh firmness, total soluble solids content (TSS) and titratable acidity (TA). Flesh firmness was measured on opposite sides of each fruit using Effegi FT 327 penetrometer (Effegi, Alfonsire, Italy). The content of total soluble solids was measured for freshly prepared juice using Atago Digital Hand-held Pocket refractometer (Atago Co., Ltd., Tokyo, Japan). Titratable acidity was determined using 20 g of sample weighted and blended with 100 ml of distilled water; 25 ml of filtrate was titrated with 0.1 N NaOH till pH 8.1. Acidity was determined by titration using a Jenway 3510 pH meter (Jenway, Stone, UK) with combined electrode. Results were recorded as the equivalent percentage of malic acid. Sensory evaluation was conducted using 5-point rating system where 5 mean the highest – excellent rating.

Severity of European pear rust (caused by *Gymnosporangium sabinae*) and sooty mould (caused by *Leptoxyphium fumago* (Woron.) R.C. Srivast.) as well as a degree of damage caused by pear leaf blister mite *Eriophyes pyri* were measured in scale 0–5, where 0 – tree has no infected or damaged leaves, 5 – 81 to 100% infected or damaged leaves.

Data analysis. The SPSS v. 15 data package (SPSS Inc., Chicago, USA) was used for the statistical calculations (ANOVA), with $P < 0.05$ considered as significant. The *t*-test (LSD, Duncan) was used for comparisons of the measurements.

RESULTS AND DISCUSSION

Flowering intensity and fruit development phenology

Average flowering intensity during the years of study varied for particular cultivars from 1.9 points (cv. Concorde) to 4.4 (cv. Talgarskaya Krasavitsa) (Table 1). Flowering intensity of the tested cultivars showed significant differences among years – the highest was in 2009 and 2011 (3.9 points), the lowest in 2007 (1.2 points). The lowest flowering intensity for all cultivars was in 2007 due to very low air temperature (–30°C) in the first ten days of February. A sharp temperature decrease caused freezing of flower buds, because the dormancy period was near to its end and frost resistance of trees and buds was reduced. Temperature fluctuations caused serious damages of flower buds in most of tested cultivars. Several cultivars (Hermann, Lyubimitsa Osennyaya, Orlas 3-8-17, Smuglyanka, and Vizh-

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Table 1. Evaluation of pear cultivar phenology, disease and pest susceptibility and fruit quality

Cultivar	Average flowering intensity (0–5 points)		Average ETS till harvest (°C)	Average number of days from flowering until harvest	EPR	SM injury	PBM injury	Flesh firmness (kg/0.5 cm^2)	TSS (°Brix)	TA (%)
	2006–2011	2007			(0–5 points)					
AMD 42-5-28	3.1	4	1,426	109	2.5	3.0	0.3	–	–	–
Concorde	1.9	1	1,708	149	3.5	2.5	0.4	–	–	–
Condo	2.8	1	1,694	148	4.1	3.0	1.0	–	–	–
Conference	2.3	1	1,675	142	3.1	2.3	0.8	5.0	14.0	–
Eckehard	3.0	1	1,714	144	4.0	2.0	1.0	9.6	12.5	0.12
Elektra	3.9	1	1,696	142	4.0	4.0	1.0	7.9	12.1	0.16
Hermann	2.8	0	1,248	94	3.5	2.0	0.3	9.0	12.2	0.10
Isolda	3.0	1	1,339	100	3.0	3.0	1.0	11.1	12.4	0.19
Lyubimitsa Osennyaya	3.3	0	1,757	152	4.0	2.0	1.0	8.1	14.2	–
Moldavskaya Rannaya	2.4	2	1,734	156	2.5	3.0	1.3	7.4	13.7	0.07
Noyabrskaya	3.1	1	1,749	151	2.0	3.0	2.0	8.1	14.5	0.08
Orlas 3-8-17	3.3	0	1,613	130	3.5	1.5	0.5	6.5	11.5	0.10
Shchedraya	3.0	1	1,651	135	4.0	2.0	1.0	8.3	14.0	0.08
Smuglyanka	3.4	0	1,717	146	3.0	1.5	0.0	8.4	11.7	0.08
Striiskaya	2.3	2	1,723	153	3.0	2.0	1.0	5.8	10.4	0.12
Talgarskaya Krasavitsa	4.4	4	1,735	150	3.0	0.0	0.5	6.1	12.5	0.11
Tavricheskaya	3.7	1	1,643	134	3.0	2.0	1.0	3.7	12.9	0.16
Vizhnitsa	2.5	0	1,707	154	4.0	2.0	1.0	5.0	12.7	0.14

ETS – effective temperature sum; EPR – European pear rust; SM – sooty mould; PBM – pear leaf blister mite; TSS – total soluble solids content; TA – titratable acidity

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nitsa) did not flower in 2007 at all. Only cv. Talgarskaya Krasavitsa did not suffer from frost damages of flower buds. Weak flowering in 2007 (1.5 points in average) was observed for cvs Concorde, Condo, Conference, Elektra, Eckehard, and Noyabrskaya. In 2008 flowering intensity for all cultivars was satisfactory, except for the cv. Lyubimitsa Osennyaya that could be explained by poor ability of this cultivar to recover after extreme climate conditions. Cvs Tavricheskaya, Elektra and Talgarskaya Krasavitsa showed the most stable and highest flowering intensity during all years of evaluation.

The start of flowering fluctuated among years within a two-week time span, from May 4 in 2008 to May 18 in 2011. Early and late cultivars started flowering simultaneously. Differences among cultivars appeared in the ripening dates of fruits, tested cultivars had variable average number of days from flowering until harvest – from 94 (cv. Hermann) to 156 (cv. Moldavskaya Rannaya) (Table 1). The number of days from flowering until harvest for early-ripening pear cultivars varied from 94 to 109 and for late-ripening cultivars from 130 to 152 days. It was dependent on the ETS (effective temperature sum, above +5°C) – the higher temperature ensured shorter fruit development and ripening period. The highest ETS (1,700°C) was in 2006 and 2011, which correlated with fast fruit development and earlier ripening. The lowest ETS value was in 2008 (1,561°C). The ETS during the growing season until the harvest for late-ripening pear cultivars was 1,613 to 1,757°C, for early-ripening pear cultivars it was 1,248 to 1,426°C (Table 1). Although there were no significant statistical differences among years proved, the number of days from flowering until harvest differed among the years, being lowest in 2011 (126 days) and highest in 2008 (149 days).

Average fruit weight

There were no significant differences in fruit weight between years; however, there were significant differences between cultivars within the different years (Fig. 1). Fruits of most of the tested cultivars were in the optimal range of average fruit weight (AFW), which is between 150 and 250 g (Kappel et al. 1995). Exceptions were cvs Hermann (136 g) and Talgarskaya Krasavitsa (140 g), which had the smallest fruits, and cv. Tavricheskaya with the largest fruits (292 g). Cv. Hermann, when grown in Latvia, had smaller fruits than described by Fischer (2005), possibly due to unfavourable growing conditions. The widely grown cv. Conference in Latvian agroclimate conditions showed variation of fruit weight (max. AFW in 2009: 225 g, minimal in 2011: 140 g), which is in accordance with other studies – from 139 g (Ruess 2007) to 188 g (Paprštein et al. 2009). Large fruits (AFW over 200 g) had cvs AMD 42-5-28, Condo, Concorde, Eckehard, Moldavskaya Rannaya and Orlas 3-8-17 (Fig. 1).

The most stable AFW during all years of testing had cvs Eckehard (242 g) and Elektra (199 g). Cultivar evaluation performed in the Czech Republic by

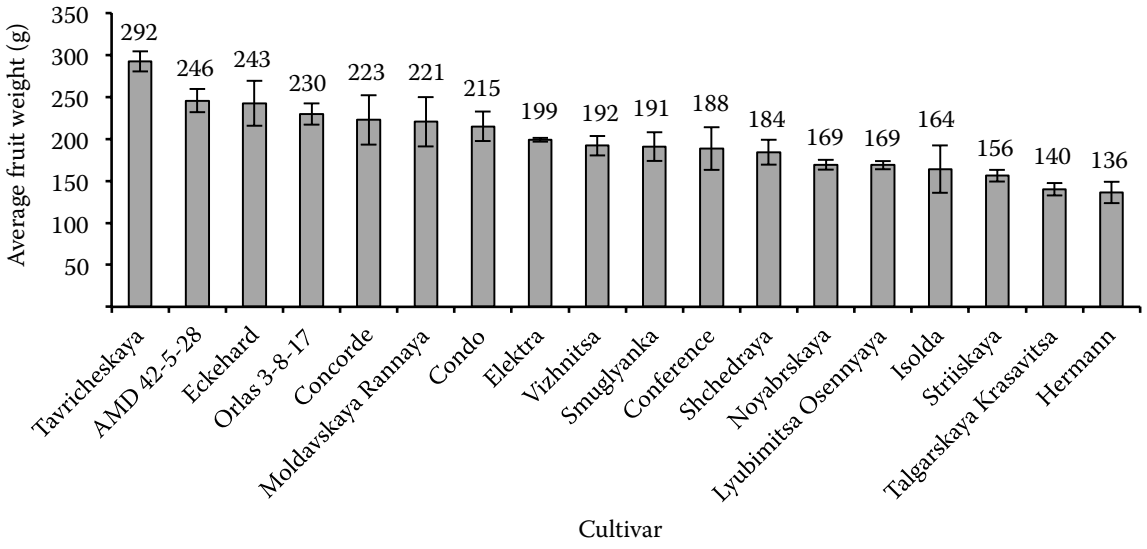

Fig. 1. Evaluation of pear cultivar average fruit weight (2006–2011)

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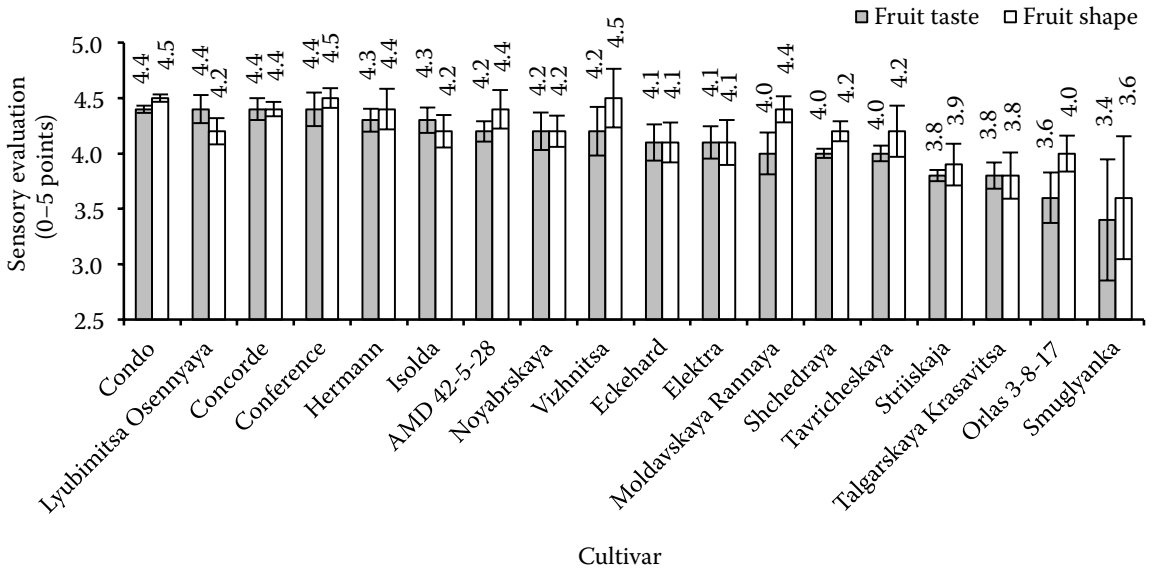

Fig. 2. Sensory evaluation of pear cultivar fruit quality (taste, appearance)

Paprstein et al. (2013) showed similar fruit weight results for cv. Elektra – 200 g. Fischer (2005) describes cv. Eckehard as having large to very large fruits (250 g). High stability in AFW was also found for cv. Noyabrskaya (169 g), but it was lower than found by Höhne (2010) and Heijerman-Peppelman et al. (2009), who ranked it in the group of cultivars with large fruits (AFW 200 to 300 g). High variability of AFW among years was found for cv. Isolda; from 85 to 250 g. High variation of fruit size (160 to 200 g depending on yield) for this cultivar was already stated in other studies (Fischer 2005).

Sensory evaluation

Marketable pear fruits throughout the world have similar requirements. They should be good looking and tasty, but there can be differences among countries. Therefore, sensory evaluation was used to discover the customer preferences for pear fruit quality in Latvia. External appearance was evaluated by fruit shape, colour and fruit weight. Most consumers liked the classic pear shape (for example, cvs Conference, Concorde and Lyubimitsa Osennyaya) (Fig. 2). The highest scores were for large fruits – at least 200 g (cvs Concorde, Condo, Elektra); while the highest rating for fruit colour encompassed the pale greens or yellows with blush (cvs Elektra, Hermann, Orlas 3-8-17, Shchedraya). Sensory evaluation indicated that fruits with russeting and/or dark green fruit skin colour had the lowest acceptance (cvs Striiskaya and Smuglyanka). According to sensory evaluation, consumers liked neutral sweet fruit taste, without any specific flavour, only very weak muscat flavour or acidity was acceptable.

Fruit flavour showed significant differences among the tested varieties. The lowest score in all years of study was found for cv. Striiskaya (3.6 to 3.8 points), whereas the highest was for cvs Concorde, Condo, and Conference (4.4 points in average). These cultivars also showed stability of fruit quality among the years of testing. Fruit flavour of cvs Eckehard, Elektra, Moldavskaya Rannaya, Orlas 3-8-17, Striiskaya and Talgarskaya Krasavitsa was very variable and had unstable scores over the years of testing. During warmer summers they got enough fruit sweetness, but in cooler ones; fruit were flavourless. Since the weather conditions over the years are variable, the flavourless fruits may be used for processing to decrease the losses of growers of these cultivars. Large and firm pear fruits can be used in processing of fresh-cut salads in combination with other fruits (Krasnova et al. 2010).

The values of biochemical characteristics for pear fruits were very variable. The fruit firmness for tested cultivars varied from 3.7 kg 0.5/cm^2 (cv. Tavricheskaya) to 11.1 kg 0.5/cm^2 (cv. Isolda), content of soluble solids ranged from 10.4°Brix (cv. Striiskaya) to 14.5°Brix (cv. Noyabrskaya), and titratable acids

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from 0.07% (cv. Moldavskaya Rannaya) to 0.19% (cv. Isolda) (Table 1). Stable and high content of soluble solids (14.2°Brix) as well as high fruit firmness (8.1 kg/0.5 cm^2) was found in fruit of cv. Lyubimitsa Osennyaya. There were some differences in fruit biochemical composition of fruits grown in Latvia as compared with elsewhere in Europe. For example, cv. Noyabrskaya had higher TSS (14.5%) and lower TA than previously found in Poland (Wawrzynczak et al. 2006). Flesh firmness of cv. Conference grown in Latvia was 5 kg/0.5 cm^2 and TSS – 14.0%, but in Germany, firmness was 6.5 kg/0.5 cm^2 and TSS – 12.0% (Fischer, Weber 2005).

Diseases and pest susceptibility

European pear rust in Latvia is spreading not only in home and organic orchards, but also in commercial plantations, which use the fungicides for disease control (Prokopova 2011). Average severity of European pear rust for tested cultivars was 3.3 points. The highest severity was found for cv. Condo (4.1 points), the lowest cv. Noyabrskaya (2 points) (Table 1). Like in other studies (Kellerhals et al. 2012) completely resistant cultivars were not found among the tested ones. It was observed also that severity of disease was dependent on the location of tree. More infected trees were located at the edges of the trial block, but in the middle of planting the infection was lower regardless of cultivar.

Average severity of sooty mould was 2.2 points. The highest severity was stated for cv. Elektra (4 points), while the lowest – 1.5 points for cvs Orlas 3-8-17 and cv. Smuglyanka. Infection by sooty mould was not found on cv. Talgarskaya Krasavitsa (Table 1).

The pear leaf blister mite *Eriophyes pyri* may cause severe damage on pear leaves and fruits. In this trial pear leaf blister mite caused little damage (0.8 points in average). The highest degree of invasion was found in the cv. Noyabrskaya (2 points), the lowest – on AMD 42-5-28 and Hermann (0.3 points). Damages caused by pear leaf blister mite were not detected on cv. Smuglyanka (Table 1).

CONCLUSION

The highest and the most stable flowering intensity among years of testing was found in cvs Elektra, Talgarskaya Krasavitsa, and Tavricheskaya.

The number of days from flowering until harvest for late-ripening cultivars was 130 to 152, and for early-ripening pear cultivars it was 94 to 109. The effective temperature sums above +5°C (ETS) during the growing season until the harvest for late-ripening pear cultivars was: 1,613 to 1,757°C, for early-ripening pear cultivars it was 1,248 to 1,426°C.

The ideal pear fruit for the Latvian consumer should have classic pear shape (cvs Conference, Concorde, and Lyubimitsa Osennyaya); large fruits, at least 200 g (cvs Concorde, Condo, Elektra); pale greens or yellows skin colour with blush and neutral sweet fruit taste.

Stable and high content of soluble solids (14.2°Brix) as well as high firmness (8.1 kg/0.5 cm^2) was found in fruits from the cv. Lyubimitsa Osennyaya.

Cv. Elektra had the highest susceptibility to diseases and pest damages among the tested cultivars. Cv. Talgarskaya Krasavitsa was found to be resistant to sooty mould and cv. Smuglyanka to pear leaf blister mite.

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