

# Apple cultivars bred in Holovousy.

## Part 1 – Characteristics of the orchard

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### Abstract

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Twenty-one standard apple cultivars bred in Holovousy and registered in the Czech Republic during 1994–2011 were included in a comparative study. Their tree parameters and yields were evaluated from 2004 till 2011 in a comparison to cvs Golden Delicious and Jonagold within experimental orchards planted on M 9 rootstock using a tree spacing of  $4 \times 1$  m. The cultivars mutually differed in the mean term of flowering starting up to 6 days. The harvest time of 5 summer cultivars covered the harvest season from July 14 till the end of August. The remaining cultivars were storable, and on average, their harvest started between the September 8 (Nabella) and November 8 (Rubimeg). Cvs Resista, Selena and Vysočina were evaluated as totally resistant to scab and 5 other cultivars were distinguished by very low susceptibility to the disease. In the case of powdery mildew this desirable level of tolerance was observed on 7 cultivars. The most vigorous according to trunk cross-sectional area was cv. Mivine, whereas the weakest growing cv. Selena was 52% smaller in this parameter. Significant differences among cultivars were also found in the case of yield precocity. In total, the most productive in this study was cv. Clijo, with mean annual harvest equal to 44.3 t/ha. The lowest level of annual harvest (25.6 t/ha) gave cv. Selena, but its crop efficiency was one of the highest.

**Keywords:** time of flowering; time of harvest; scab; mildew; tree vigour; yields; yield efficiency

Our program of breeding aimed to obtain new apple cultivars started in early seventies of the last century upon collaboration with Dr. L. E. Hough from the Rutgers (The State University of New Jersey), New Brunswick, USA. He supplied us for several seasons with seeds from a great number of progenies obtained by crossing between selected donors of scab resistance of *Malus floribunda* 821 and standard grown cultivars. We conducted pre-selection of seedlings for this resistance and subsequent selection for fruit quality in their fruiting stage. From that time forward, about 10,000 flowers from around 50 different parental combinations have been cross-pollinated at Holovousy eve-

ry year. From seeds obtained in such way around 8,000 seedlings were yearly pre-selected for disease resistance or tolerance. After this pre-selection, up to 1,500 seedlings each year were budded on M 9 and planted into orchards for evaluation in the fruiting stage. The most promising seedlings were included into comparative trials with commercial cultivars and subsequently, upon results from the trials, were applied to the State variety trials as candidates for new cultivars.

The first standard apple cultivars released from our program were Nabella and Selena, registered in 1994 (BLAŽEK, PAPRŠTEIN, 1993; BLAŽEK et al 1995). The survey of all apple cultivars of standard

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Table 1. Survey of evaluated cultivars and their origin

Cultivar	Original HL number	Parentage		Year of CZ registration
		female	male	
Angold	362	HL A28/39 (Antonovka o.p.)	Golden Delicious	1995
Clijo	311B	Clivia	Jonalicious	2004
Dima	1259	Discovery	Mantet	2004
Fragrance	1645	Florina	Jarka	2012
Golden Delicious	(US origin)	Grimes golden	Golden Reinette	1959
Jarka	85	Golden Delicious	Lord Lambourne	1995
Jonagold	(US origin)	Golden Delicious	Jonathan	1991
Julia	461	Quinte	Discovery	1994
Klára	VIII-18/49	Hvězdnatá	Hájkova	1997
Kordona	393	McIntosh Wijcik	Florina	2006
Meteor	704A	Megumi	Melrose	2007
Miodar	649	Mio	Quinte	2004
Mivibe	676-5	Mio	Vista Bella	2006
Nabella	XIII-29-60	Mother	Starking Delicious	1994
Produkta	75-2-7	A28/39 (Antonovka o.p.)	Golden Spur	1997
Resista	835	Prima	NJ56	1997
Rubimeg	319	Megumi	Rubín	2003
Rubinstep	164	Clivia	Rubín	2003
Rucla	251	Clivia	Rubín	2006
Selena	HL75-26-7	Britemac	Prima	1994
Vysočina	1621	HL75-26-8 (Britemac × Prima)	McIntosh HL128A	2006
Zita	464	Mio	Jerseymac	2004
Zuzana	III-25-34	Glockenapfel	James Grieve	1997

HL – Holovousy

tree growth habit bred up to now at Holovousy and registered in the Czech Republic is given in Table 1. Within up to now published papers only 10 of them were mutually compared in some respects (BLAŽEK, KŘELINOVÁ 2006). Therefore a more complete comparison of all of them was the principal aim of the study. Cvs Golden Delicious and Jonagold were used as standard cultivars in this study. At present time cv. Golden Delicious is the most important commercial apple cultivar in the Czech Republic sharing 22.3% of the total apple orchard area in this country. Cv. Jonagold is on the third position there but its acreage has rapidly increased during recent years (BUCHTOVÁ 2011). Besides, cv. Jonagold has been the most widely planted apple variety in Europe in recent time (ANONYM 2012).

## MATERIAL AND METHODS

All cultivars were evaluated in experimental orchards established at Holovousy using M 9 rootstock and tree spacing of 4 × 1 m. The location is characterised by an average yearly temperature of 8.1°C, average rainfall of about 650 mm and altitude about 300 m a.s.l. The majority of items including the standard ones were studied in the orchard established in the spring 2003 using 3 trees planted without replication as a minimum. Most frequently, however, a greater number of trees were planted in replications. The rest of cultivars were evaluated during earlier years in the orchards established either at 1992 or 1989. All orchards were maintained with clean herbicide strips under the tree canopies

and with mulched grass along the alleyways. Trees were trained in the slender spindle form and canopies were kept in reasonable densities and size using pruning both in winter and summer time. In some more vigorous cultivars somewhat greater canopy volume was allowed to develop during the last years if necessary. Fertilising and spraying (based on integrated apple orchard protection guidelines) consisted of normal commercial practices with exception of the first three years after orchard establishment when fungicide treatments were not applied due to evaluation of cultivars regarding their susceptibility to common diseases rated in August using a 1–9 scale (9 = no symptoms). In the years of full cropping hand fruit thinning was applied after June fruitlets drop if necessary.

Every year phenological data concerning time of flowering and optimum harvest ripening (based on standard indicators) were gathered for each cultivar. The start of flowering was defined by the date when 10% of flowers were open and the end of the phenological characteristic was defined by the date when a majority of petals had fallen. The start of the harvest ripening was estimated according to typical fruit coloration and their ease of separation from spurs. On the contrary the end of the phenological stage was estimated by advance fruit coloration and by subsequent storage behaviour of several fruit samples harvested in progressive time schedule. During the harvest ripening season all fruits were

harvested and weights of the harvested fruit from each tree noted. The final estimation of harvest maturity period for each cultivar was done upon commonly used principles (JARADAT, EL ASSI 2007).

The yield per tree and weight of 10 fruit samples were recorded. At the end of the growing season canopy dimensions and trunk diameter of each tree were measured and used for calculation of the canopy volume and trunk-cross-sectional area (TCSA).

These data were tested by analysis of variance. Cultivar means were separated by the Tukey's Least Significance Difference test at  $P < 0.05$ .

## RESULTS AND DISCUSSION

### Time of flowering

The start date of flowering during evaluated years 2004–2011 fluctuated within 16 days. The earliest flowering season started on April 18, 2008 and latest one on the May 4, 2006. In the total mean the flowering started on April 29 (Fig. 1). The most early in the time of flowering were cvs Mivibe and Rubinstep whereas in the case of cvs Clio, Meteor and Resista this phenological season was the latest. The mean difference between both groups was equal to 4 days. The cultivars within both extremes should not be used as mutual pollinators because the overlapping of their time of flowering is not sufficient.

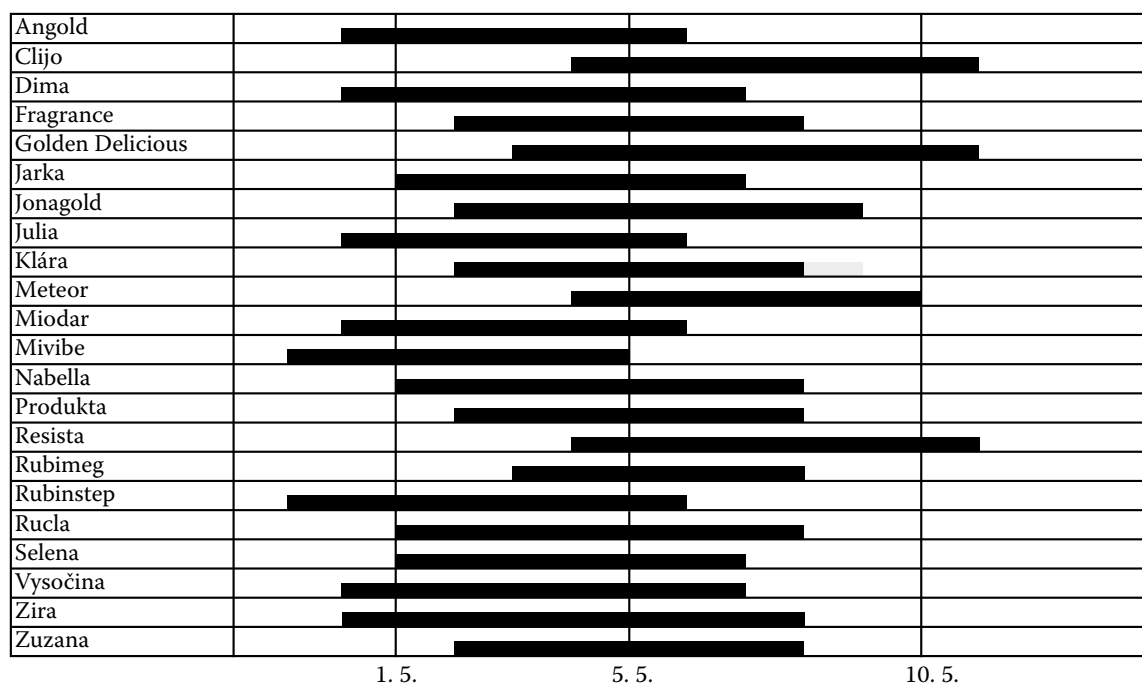
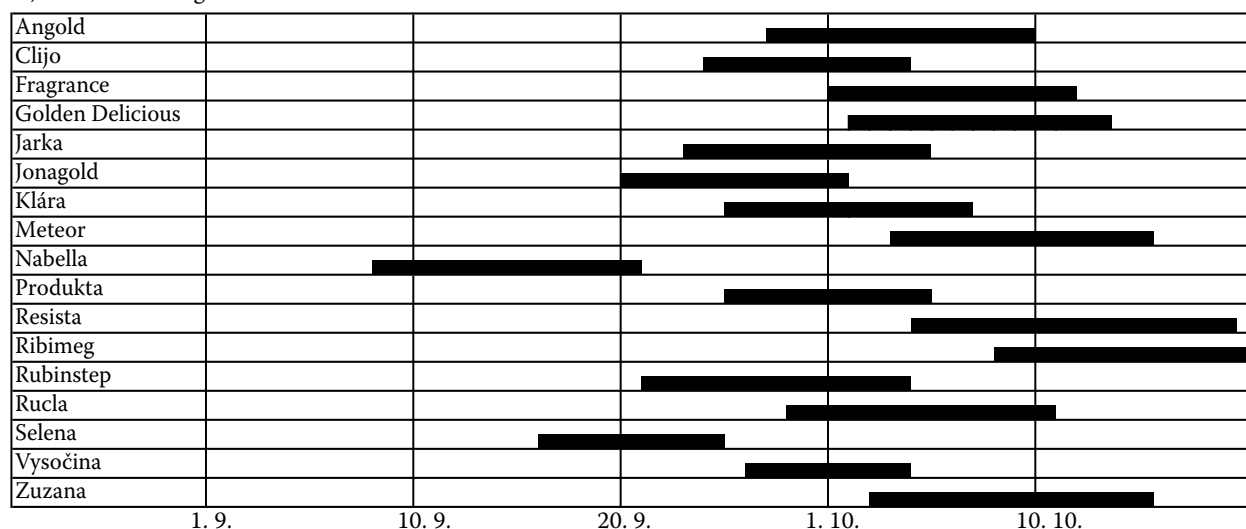


Fig. 1. Mean time of flowering in 2004–2011

## a) Standard storage cultivars



## b) Summer cultivars



Fig. 2. Mean time of harvest maturity in 2004–2011

**Time of harvest ripening**

The mean data on the harvest maturity of evaluated cultivars are summarized in Fig. 2. The start of the phenological stage fluctuated in the years under observation roughly within a one week range partly connected to time of flowering and level of fruit set. Cv. Zita was the earliest being ready for harvest on July 14, on average. In the next sequence, summer cvs Julia, Dima, Miodar and Mivibe followed, covering the harvest season approximately until the end of August.

From the main group of storage cultivars the earliest was cv. Nabella, that was ready for harvest on the September 8, on average. It was followed by cv. Selena which could be harvested 8 days later. The harvest time of all other cultivars was within the last week of September or in the first week of October. The latest in this stage were cvs Rubimeg, Resista and Meteor.

**Susceptibility to scab and mildew**

Regarding scab, the most susceptible was the standard cv. Golden Delicious. According to the data

in Table 2, its mean rate of infection was equal to 5.3 and maximum incidence of the disease to the point 3 within 1–9 rating scale. Not much better in respect to scab incidence were classified cvs Jarka, Jonagold, Fragrance and Dima. To the subsequent group of medium susceptibility to the disease, the following ones should be included: Clijo, Meteor, Miodar, Mivibe, Rubimeg, Rucla and Zuzana. On the contrary, cvs Resista, Selena and Vysočina were classified as totally resistant to the disease. They are carriers of *Vf* resistance gene coming from *Malus floribunda* 821, as it was previously stated in some publications. Also summer apple Julia is distinguished by its high level of scab resistance, that is, however, laid on a different basis – polygenic one. All remaining cultivars were classified as low susceptible to scab.

In the case of powdery mildew, according to data presented in Table 2, the most susceptible was cv. Resista. Cvs Angold, Zita, Jonagold and Golden Delicious could be considered similarly susceptible. On the contrary, very low susceptibility to the disease was reported at cvs Meteor, Dima, Nabella, Rubinstep, Jarka, Rubimeg and Rucla.

The present rating of standard cvs Golden Delicious and Jonagold are more or less in agreement

Table 2. Selected tree characteristics

Cultivar	Scab incidence (scale 1–9)		Powdery mildew incidence (scale 1–9)		TCSA (cm <sup>2</sup> )	Canopy volume (m <sup>2</sup> )	Cropping efficiency index (kg/cm <sup>2</sup> )
	mean	max.	mean	max.			
Angold	8.1	7	6.2	4	18.1	1.53	9.1
Clijo	7.7	6	7.3	6	31.6	1.72	10.3
Dima	6.9	5	8.3	7	24.2	1.47	7.0
Fragrance	6.7	5	7.6	6	29.3	1.94	8.8
Golden Delicious	5.3	3	6.7	5	22.9	1.46	9.3
Jarka	5.9	4	8.1	7	17.3	1.09	11.8
Jonagold	6.1	4	6.5	5	30.5	1.88	8.1
Julia	8.5	8	7.8	7	21.7	1.24	10.5
Klára	7.9	7	7.9	7	24.9	1.33	7.7
Meteor	7.6	6	8.4	7	24.2	1.64	7.6
Miodar	7.7	6	7.9	7	30.1	1.83	7.5
Mivibe	7.4	6	7.9	7	34.4	1.97	6.5
Nabella	7.9	7	8.3	7	20.2	1.65	7.0
Produkta	8.3	7	7.2	6	29.5	1.20	12.2
Resista	9.0	9	5.1	3	24.7	1.57	9.7
Rubimeg	7.5	6	8.0	7	17.5	1.07	13.2
Rubinstep	8.2	7	8.2	7	21.4	1.79	9.5
Rucla	7.9	6	8.0	7	28.0	1.93	8.5
Selena	9.0	9	7.5	6	15.4	0.96	10.6
Vysočina	9.0	9	7.1	6	21.1	1.26	11.7
Zita	8.1	7	6.3	4	25.6	1.62	7.6
Zuzana	7.4	6	7.1	6	33.1	2.02	6.4
Mean	7.7		7.5		25.0	1.55	9.3
LSD $P \geq 0.05$	0.34		0.22		3.2	0.11	0.27

to our previous evaluation (BLAŽEK et al. 2006). The level of susceptibility of both the cultivars is in agreement to an earlier study in America. On the contrary, in our study cv. Golden Delicious is very susceptible to scab whereas in America it was considered only as a less susceptible cultivar (NORTON 1981).

### Tree vigour

The data concerning this feature are also presented in Table 2. The most vigorous according to TCSA were cvs Mivibe, Zuzana and Clijo. On the contrary the least vigorous ones were cvs Selena,

Jarka and Rubimeg. The TCSA of cv. Selena was about 55% weaker than that of cv. Mivibe. Overall sequence of cultivars according to increase values of TCSA is illustrated by Fig. 3.

According to the canopy volume the most vigorous were cvs Zuzana, Mivibe and Fragrance. Opposite to them, the smallest canopy had again the most distinguishing cvs Selena, Rubimeg and Jarka. Difference between the extremes was equal to 52%. Tree vigour of standard cultivars was roughly in the range given in previous publications (AUTIO et al. 2001; BLAŽEK, VARGA 2001; CRASSWELLER et al. 2001; KENIS, KEULEMANS 2007; CLINE et al. 2010). The information on greater demands of cv. Jonagold for using a dwarfing rootstock regarding its

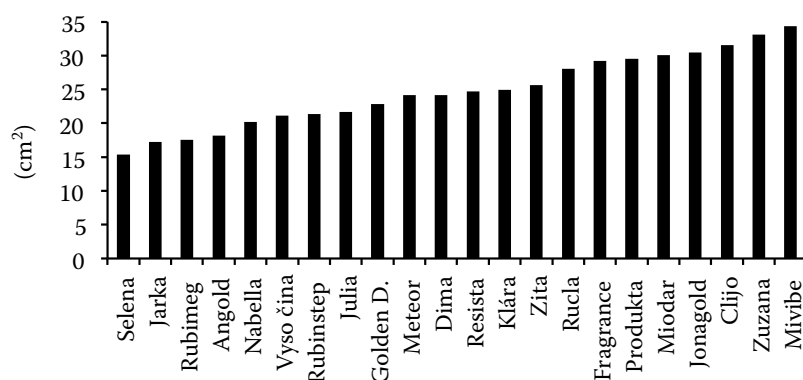


Fig. 3. Cultivars ranged in an increasing order according to their tree vigour expressed by trunk cross section area

vigour control was recently reported by VERCAMMEN and GOMAND (2011).

### Yields and productivity

The most precocious according to the yields in the first two years of cropping were cvs Klára, Dima, Fragrance and Rubinstep (Table 3). On the contrary

relatively the latest start of cropping was recorded in the case of cvs Angold, Zita, Mivibe and Miodar.

The highest value of total fruit harvest per tree for the whole evaluated period equal to 92.8 kg was recorded on the cv. Clijo. In a declining order it was followed by cvs Fragrance, Rubinstep and Rucla. During the years of full cropping the mean value of fruit harvest per tree in the case of cv. Clijo was equal to 17.7 kg. This yield level corresponds to the

Table 3. Yields of trees (in kg/tree) in the first seven years after planting and in 2011

Cultivar	Year after planting							$\Sigma$	2011
	2	3	4	5	6	7	8		
Angold	0.9	0.8	10.0	8.8	14.0	12.8	24.1	71.2	3.5
Clijo	0.7	3.5	16.8	10.1	25.7	3.9	32.0	92.8	0
Dima	0.3	5.8	9.0	15.1	5.8	18.3	3.2	57.3	
Fragrance	0.6	4.8	10.4	11.6	18.5	17.0	27.4	90.4	4.7
Golden Delicious	0.8	2.3	14.1	4.5	19.4	6.6	23.0	70.8	3.1
Jarka	0.5	3.8	11.4	5.0	19.1	11.7	17.3	68.7	
Jonagold	0.2	2.8	12.2	10.0	19.5	10.5	23.9	79.0	1.5
Julia	0.3	3.9	9.8	11.6	15.4	8.8	19.5	69.4	1.6
Klára	0.1	9.3	1.5	22.6	4.6	21.1	1.5	60.7	
Meteor	0.2	3.4	9.6	10.7	14.3	6.5	21.1	65.8	1.3
Miodar	0.3	1.7	5.4	4.5	15.4	24.1	19.0	70.6	
Mivibe	0.6	1.3	6.5	13.6	15.4	18.6	9.5	65.6	0
Nabella	0.7	2.5	6.2	7.3	12.7	12.8	18.6	60.8	2.2
Produkta	0.8	3.6	12.4	6.9	28.4	6.1	19.2	77.5	3.6
Resista	0.0	3.2	9.5	5.9	24.0	14.9	21.6	79.2	0.7
Rubimeg	0.4	1.9	6.0	10.1	17.5	18.4	18.6	72.9	0
Rubinstep	1.3	3.9	8.1	10.9	21.6	15.8	28.4	89.9	1.7
Rucla	1.0	3.0	10.6	11.5	21.9	16.1	21.5	85.7	3.0
Selena	0.8	1.9	7.3	8.0	13.0	6.8	16.1	53.9	2.6
Vysočina	0.0	3.5	9.8	13.8	15.3	14.8	20.4	77.6	1.5
Zita	0.2	1.4	3.7	7.7	19.1	13.1	18.0	63.3	
Zuzana	0.0	3.2	7.2	10.0	14.3	14.7	18.3	67.7	3.4
Mean	0.6	3.3	8.9	10.0	17.0	13.4	19.1	73.9	2.0
LSD $P \geq 0.05$	0.5	1.7	3.1	3.9	5.3	4.5	6.6	4.3	

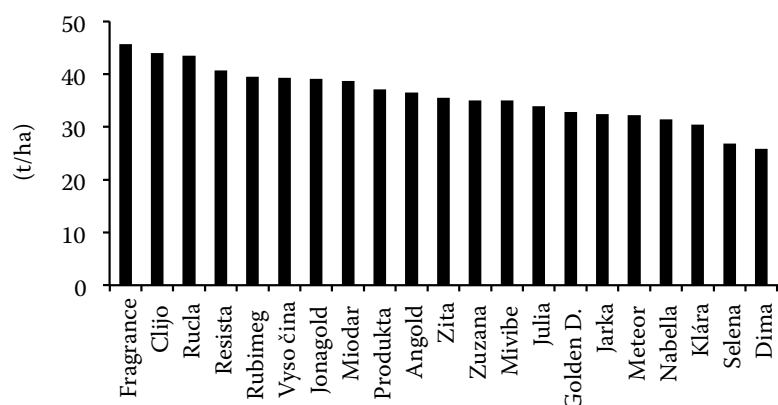


Fig. 4. Cultivars ranged in a downward order according to mean yields during full cropping stage transferred to the area of 1 ha

mean harvest of 44.3 t/ha. The absolutely highest fruit harvest, 32 kg/tree, was recorded in the case of cv. Clijo in 2010. After area transmission this yield corresponds nearly to 80 t/ha.

The lowest mean yield per tree was recorded in cvs Selena, Dima, Klára and Nabella. In cv. Selena, mean yield per tree was 10.2 kg, corresponding to a harvest of 25.6 t/ha. Overall sequence of cultivars in decreasing order according to mean yields during full cropping stage transferred to the area of 1 ha is illustrated in Fig. 4. In the last column of Table 3 yields evaluated in the most critical year 2011 are given. The highest amount of fruit was harvested on cvs Fragrance, Produkta, Angold and Zuzana, whereas no fruits were on cvs Clijo, Mivibe and Rubimeg.

The yield level of standard cvs Golden Delicious and Jonagold is in agreement to our previous findings (BLAŽEK 2006; BLAŽEK, KŘELINOVÁ 2006). A significant difference was only in the case of cv. Zuzana that was relatively more productive in this study. General level of standard cultivar yields recorded in this study is similar to the values reported from similar dense plantings.

### Cropping efficiency

Mean values of cultivars according to their cropping efficiency are given in the last column of Table 2. By the highest value of this characteristic were distinguished cv. Rubimeg followed by cvs Produkta, Jarka, Vysočina and Selena. On the other hand, in cvs Zuzana, Mivibe, Dima and Nabella this parameter was the lowest. Especially in the case of cv. Selena, the value of the parameter indicates that its fruit harvest per area would have been much higher if its trees had been planted in similar tree spacing (SZCZYGIEL et al. 2000; WIDMER, KREBS 2000).

### CONCLUSIONS

- The mean time of flowering of evaluated cultivars varied within 4 days.
- The ripening time of summer cultivars covered harvest season since the mid July until the end of August.
- The harvest time of other cultivars varied since the September 8 till the first week of October.
- Three cultivars (Resista, Selena and Vysočina) were classified as resistant to the scab and summer apple cv. Julia was highly tolerant to the disease.
- With respect to other diseases 7 cultivars (Meteor, Dima, Nabella, Rubinstep, Jarka, Rubimeg and Rucla) were classified as tolerant to powdery mildew.
- With respect to tree performance the least vigorous cultivars were Selena, Jarka and Rubimeg, whereas Zuzana, Mivibe and Fragrance were the most vigorous ones.
- The most productive cultivar was Clijo that was followed in the characteristic by Fragrance, Rubinstep and Rucla. On the contrary the least productive were cvs Zuzana, Mivibe, Dima and Nabella.

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