

## **Evaluation of nine apple cultivars on rootstock B.396 in the young orchard**

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In 2002–2006 at the Lithuanian Institute of Horticulture blooming period, tree growth vigour, yield, resistance to scab (*Venturia inaequalis*), harvesting time, storage life and quality of fruits were studied in 9 new apple (*Malus × domestica* Borkh.) cultivars. Trees were grafted on rootstock B.396 with spacing 4 × 2 m.

The following apple cultivars were distinguished for particular characteristics: ‘Auksis’ – earliest blooming, ‘Scarlet Spur’, ‘Superchief’ and ‘Oregon Spur’ – latest blooming, ‘Oregon Spur’ – weakest growth, ‘Auksis’ and ‘Superchief’ – for yield in the young orchard; ‘Auksis’, ‘Early Red One’ and ‘Oregon Spur’ – for highest class of fruits; ‘Scarlet Spur’, ‘Auksis’ and ‘Fuji Nagafu’ – resistance to scab, ‘Red Idared × 10687’, ‘Superchief’ and ‘Oregon Spur’ – for storage life; ‘Early Red One’, ‘Scarlet Spur’ and ‘Auksis’ – for fruit weight and fruit quality.

**Key words:** apple, cultivars, phenology, growth, resistance to diseases, yield, quality of fruits.

**Introduction.** Selection efficiency is a key issue in a breeding programme. Breeding consists of identifying as quickly and as precisely as possible the most promising progeny plants. A challenge to efficiently is find the outstanding genotypes prone to become a successful commercial cultivar out of a large quantity of progeny plants (Kellerhals et al., 2009).

The assortment of apple cultivars suitable to the Lithuanian climate conditions differs significantly from the neighbouring countries. For this reason apple cultivar testing is one of the important bases for exchanging information about new introduced cultivars. To increase apple cultivars commercialization, knowledge on phenotypic, productivity and fruit quality are very important. The main task is to obtain new apple cultivars with superior fruit qualities, high productivity, resistance to diseases and pests, winter hardiness, storability and marketability (Kellerhals et al., 1999; Faedi et al., 2002; Sansavini et al., 2005).

Many introduced apple cultivars were investigated at the Lithuanian Institute of Horticulture (Uselis, 2001; Sasnauskas et al., 2005; Sasnauskas et al., 2007; Sasnauskas et al., 2008)

The aim of this study was to evaluate new introduced apple cultivars on B.396 rootstock.

**Object, methods and conditions.** Trial years and place. The trial, which involved 9 apple cultivars, was planted at the Lithuanian Institute of Horticulture in the autumn of 2002. Trees were grafted on B.396 rootstock. Evaluation and characterization of the cultivars was performed in 2005–2006.

**Meteorological conditions.** In 2002–2003 temperature in December (5 °C) and February (1.7 °C) was lower, while in 2003–2004 temperature in December (1.9 °C) and February (2.5 °C) was higher than multiannual value. During years of productivity the late spring frost at the beginning of bloom injured blossoms. At this time the minimal air temperature above the ground dropped from -0.3 °C to -4.9 °C, what injured fruit settings.

**Plant material.** The following introduced apple cultivars were compared with the standard cvs. ‘Auksis’ (Lithuania), ‘Early Red One’ (USA), ‘Fuji Nagafu’ (Japan), ‘Gala M23/3’ (New Zealand), ‘Jonagold 2361’ (USA), ‘Red Idared × 10687’ (USA), ‘Scarlet Spur’ (USA), ‘Superchief’ (USA) and ‘Oregon Spur’ (USA).

**Experimental design.** The trees were planted at the distance of 4 × 2 m. The trial was established in five replications. Each plot contained 1 fruit-tree. They were formed as spindle. Growing, fertilizing, pest, disease and weed control, soil cultivation, pruning, shaping and care of apple cultivars were maintained as recommended for commercial orchards (Intensyvios obelų ir kriaušių auginimo technologijos, 2005).

**Observations and statistical analysis.** In the trial the following characters of apple cultivars was established: blooming periods, days; tree growth vigour, m and cm; resistance to scab (*Venturia inaequalis*), scores (1-no disease symptoms detected on leaves, 9-injured more than 75 % of leaf area); yield, t ha<sup>-1</sup>; distribution of fruits to classes according to diameter, %; dates of harvesting time and storage life (at 1–3 °C temperature); fruit weight, g; quality of fruits, scores. All data were subjected to analysis of variance. The significance of differences between the cultivars was estimated at 0.05 levels (Fisher’s Protected LSD and Duncan’s Multiple Range Test) (Tarakanovas, Raudonius, 2003).

**Results.** Blooming was earliest in ‘Auksis’ (May 18) and latest in ‘Jonagold 2361’ (May 24) (Table 1). Full blooming began most early in ‘Auksis’ (May 23) and latest in ‘Oregon Spur’ (May 27). Full blooming ended most early in ‘Velte’ (May 23) and latest in ‘Teremok’ (May 29). The end of full blooming was earliest in ‘Auksis’, ‘Early Red One’, ‘Jonagold 2361’, ‘Red Idared × 10687’ and ‘Superchief’ (May 27) and latest in ‘Oregon Spur’ (May 29). The end of blooming was earliest in ‘Auksis’, ‘Fuji Nagafu’, ‘Gala M23/3’ and ‘Jonagold 2361’ (May 29), while latest in ‘Scarlet Spur’, ‘Superchief’ and ‘Oregon Spur’ (May 31). According to investigation data, the blooming period continued for 6–13 days.

**Table 1.** Dates of blooming periods of apple cultivars  
**1 lentelė.** Obelų veislių žydėjimo tarpsniai

Babtai, 2005–2006

Cultivars Veislės	Beginning of blooming, month, day Žydėjimo pradžia, mėn., diena	Beginning of full blooming, month, day Masinio žydėjimo pradžia, mėn., diena	End of full bloo- ming, month, day Masinio žydėjimo pabaiga, mėn., diena	End of bloo- ming, month, day Žydėjimo pabai- ga, mėn., diena
‘Auksis’	05-18 a*	05-23 a	05-27 a	05-29 a
‘Early Red One’	05-22 cde	05-25 bcd	05-27 a	05-30 ab
‘Fuji Nagafu’	05-21 bc	05-24 ab	05-28 abc	05-29 a
‘Gala M23/3’	05-22 cde	05-26 cd	05-28 abc	05-29 a
‘Jonagold 2361’	05-24 e	05-26 cd	05-27 a	05-29 a
‘Red Idared × 10687’	05-20 b	05-25 bcd	05-27 a	05-30 ab
‘Scarlet Spur’	05-22 cde	05-26 cd	05-29 bc	05-31 bc
‘Superchief’	05-19 ab	05-25 bcd	05-27 a	05-31 bc
‘Oregon Spur’	05-23 cde	05-27 d	05-29 c	05-31 c
Mean	05-21	05-25	05-27	05-30

\* Duncan’s multiple range t-test. / Duomenys apskaičiuoti pagal Dunkano kriterijų.

Means followed by the same letter are not significantly different at  $P = 0.05$ . / Tarp vidurkių, pažymėtų tomis pačiomis raidėmis, nėra esminių skirtumų, kai  $P = 0,05$ .

**T r e e g r o w t h.** In the fifth growth year apple trees of the investigated cultivars grew from 2.26 m (‘Fuji Nagafu’) to 2.76 m (‘Jonagold 2361’) (Table 2). Crown diameter ranged between 1.70 m (‘Scarlet Spur’) to 2.50 m (‘Superchief’). According to the trunk size the most vigorous was ‘Superchief’ (13.5 cm). The weakest growth was found of ‘Oregon Spur’ (11.03 cm).

**Table 2.** General tree growth vigour of apple cultivars  
**2 lentelė.** Obelų veislių vaismedžių augumas

Babtai, 2006

Cultivars Veislės	Tree height Vaismedžių aukštis (m)	Crown diameter Vainiko skers- muo (m)	Crown projection area Vainiko projekcijos plotas (m <sup>2</sup> )	Trunk diameter Kamieno skers- muo (cm)
1	2	3	4	5
‘Auksis’	2.53 bcd*	1.95 abc	3.01 abc	12.7 bcd
‘Early Red One’	2.70 bcd	2.21 bcde	3.89 bcde	12.8 bcd
‘Fuji Nagafu’	2.26 a	2.18 bcde	3.74 abcde	12.8 bcd
‘Gala M23/3’	2.63 bcd	2.08 abcde	3.40 abcde	13.1 bcd
‘Jonagold 2361’	2.76 d	2.00 abcde	3.31 abcde	13. bcd
‘Red Idared × 10687’	2.56 bcd	2.31 cde	4.32 cde	12.9 bcd

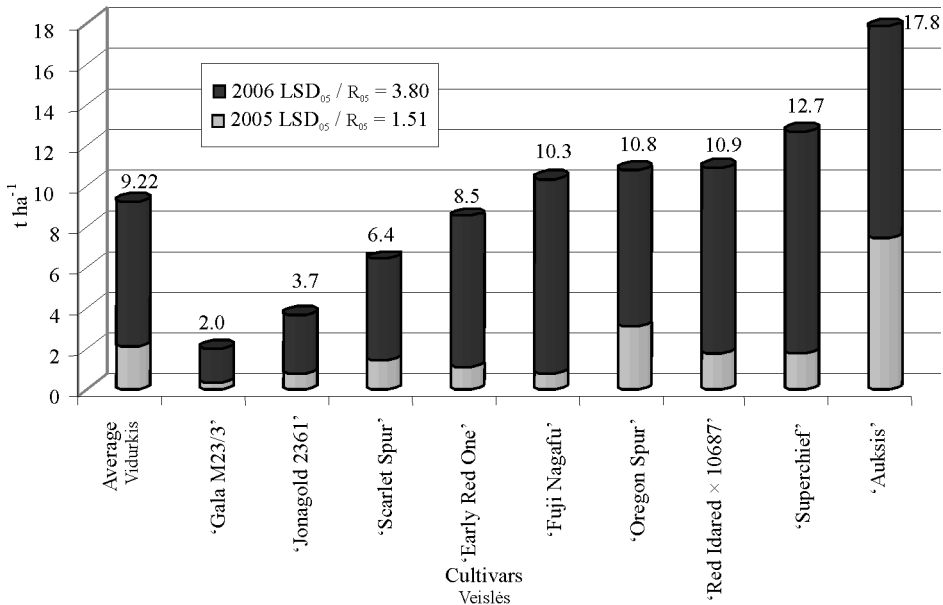
**Table 2** continued  
**2 lentelės tęsinys**

<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
'Scarlet Spur'	2.56 bcd	1.70 a	2.28 a	12.5 bcd
'Superchief'	2.55 bcd	2.50 e	4.92 e	13.5 d
'Oregon Spur'	2.43 ab	1.75 ab	2.38 ab	11.03 a
Mean	2.55	2.08	3.47	12.8
Veislių vidurkis				

\* Duncan's multiple range t-test / Duomenys apskaičiuoti pagal Dunkano kriterijų.

Means followed by the same letter are not significantly different at  $P = 0.05$  / Tarp vidurkių, pažymėtų tomis pačiomis raidėmis, nėra esminių skirtumų, kai  $P = 0,05$ .

**Yield.** In general yield of the investigated apple cultivars was relatively low, because during years of productivity spring frost injured blossoms. Apple trees of cv. 'Aukšis' ( $7.4 \text{ t ha}^{-1}$ ) and 'Oregon Spur' ( $3.1 \text{ t ha}^{-1}$ ) produced a higher yield in the fourth year in orchard, while trees of cv. 'Gala M23/3' ( $0.4 \text{ t ha}^{-1}$ ) – the smallest one (Fig. 1). During five-year period in orchard apple trees of cv. 'Aukšis' ( $10.4 \text{ t ha}^{-1}$ ) and 'Superchief' ( $10.9 \text{ t ha}^{-1}$ ) produced a higher yield, while 'Gala M23/3' ( $1.6 \text{ t ha}^{-1}$ ) produced a smaller one. The cumulative yield of apple cultivars ranged between  $2\text{--}17.8 \text{ t ha}^{-1}$ . Cvs. 'Aukšis' ( $17.8 \text{ t ha}^{-1}$ ), 'Superchief' ( $12.7 \text{ t ha}^{-1}$ ), 'Red Idared  $\times$  10687' ( $10.9 \text{ t ha}^{-1}$ ), 'Oregon Spur' ( $10.8 \text{ t ha}^{-1}$ ) and 'Fuji Nagafu' ( $10.3 \text{ t ha}^{-1}$ ) produced the highest yield than the average of apple cultivars. On the other hand, cvs. 'Gala M23/3' ( $2 \text{ t ha}^{-1}$ ) and 'Jonagold 2361' ( $3.7 \text{ t ha}^{-1}$ ) produced the lowest yield.

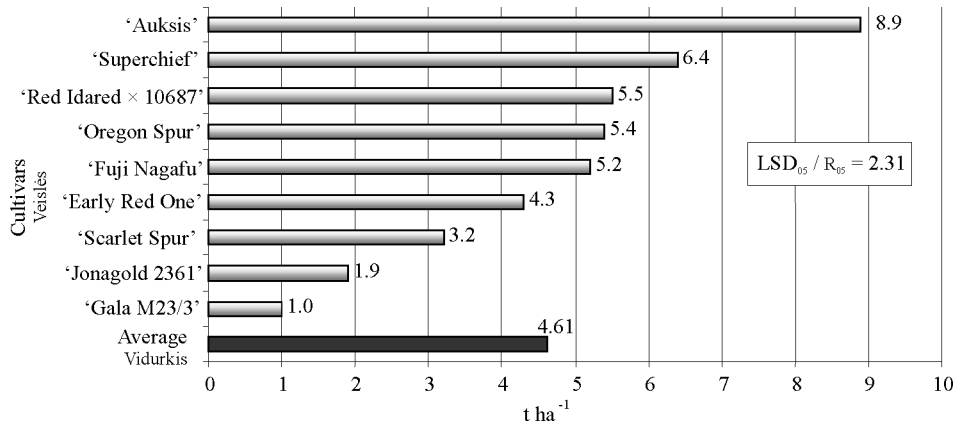


**Fig. 1.** Cumulative yield of apple cultivars ( $\text{t ha}^{-1}$ )

**1 pav.** Obelių veislių suminis vaisių derlius,  $\text{t ha}^{-1}$

Babtai, 2005–2006

Average yield of apple cultivars ranged between 1–8.9 t ha<sup>-1</sup> in 2005–2006 (Fig. 2). Cvs. ‘Gala M23/3’ (1 t ha<sup>-1</sup>), ‘Jonagold 2361’ (1.9 t ha<sup>-1</sup>) and ‘Scarlet Spur’ (3.2 t ha<sup>-1</sup>) produced a smaller, while ‘Auksis’ (8.9 t ha<sup>-1</sup>) and ‘Superchief’ (6.4 t ha<sup>-1</sup>) produced the highest yield.



**Fig. 2.** Average yield of apple cultivars (t ha<sup>-1</sup>)  
**2 pav.** Vidutinis dvejų tyrimo metų obelių veislių vaisių derlius, t ha<sup>-1</sup>  
 Babtai, 2005–2006

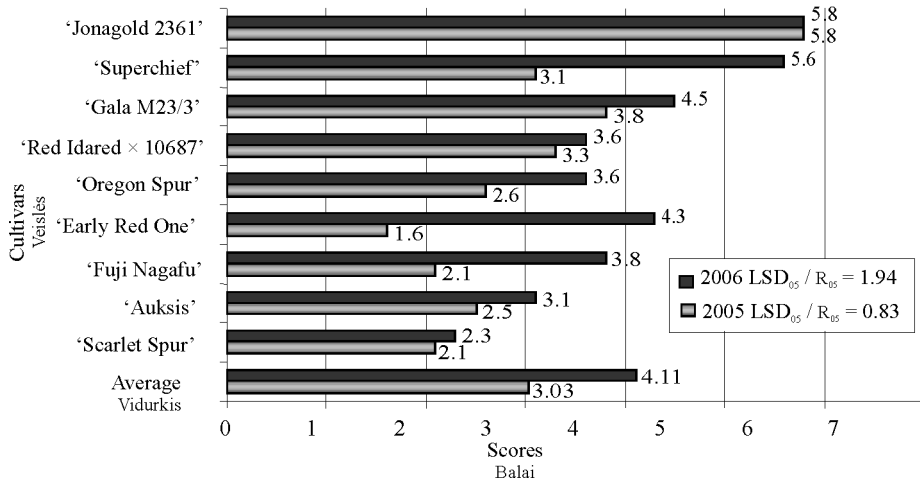
Distribution of fruits to classes according to diameter established that cvs. ‘Auksis’, ‘Early Red One’ and ‘Oregon Spur’ produced of fruits the highest class (Table 3). 4–26 % of apples was of 1 and 2 class. Cvs. ‘Fuji Nagafu’, ‘Gala M23/3’, ‘Jonagold 2361’ and ‘Red Idared × 10687’ produced not specific fruits.

**Table 3.** Distribution of fruits to classes according to diameter (%)  
**3 lentelė.** Vaisių suskirstymas į klases pagal skersmenį, %

Babtai, 2006

Cultivars Veislės	The highest class Aukščiausia klasė					1 and 2 classes 1 ir 2 klasės	Not specific Nerūšiniai
	> 75 mm	75 mm	70 mm	65 mm	sum total iš viso	60–64 mm	up to 60 mm iki 60 mm
'Auksis'	41		29	30	100		
'Early Red One'	30	44	22	4	100		
'Fuji Nagafu'		4	28	26	58	24	18
'Gala M23/3'			4	38	42	24	34
'Jonagold 2361'		6	26	40	72	26	2
'Red Idared × 10687'	16	20	38	10	84	8	8
'Scarlet Spur'	60	10	14	8	92	8	
'Superchief'	14	32	34	16	96	4	
'Oregon Spur'	42	46	10	2	100		

**Resistance to scab.** In all trees were found symptoms of scab (Fig. 3). High susceptibility to scab was observed on trees of ‘Jonagold 2361’, ‘Superchief’ and ‘Gala M23/3’. On the other hand, trees of ‘Scarlet Spur’, ‘Auksis’ and ‘Fuji Nagafu’ were more resistant to this disease.



**Fig. 3.** Apple cultivar resistance to scab  
**3 pav.** Obelių veislių atsparumas rauplėms  
 Babtai, 2005–2006

**Storage life.** The earliest picking of fruits had cv. ‘Auksis’ (09 15) and ‘Gala M23/3’ (09 17), latest – cv. ‘Red Idared x 10687’ (09 30) (Table 4).

Data of cold storage durability show that fruits of cvs. ‘Red Idared × 10687’ (05 13), ‘Oregon Spur’ (05 16) and ‘Superchief’ (05 20) keep longer. Cv. ‘Gala M23/3’ was distinguished for the short time of storage life (01 19).

**Quality parameters.** All cultivars demonstrated intermediate (5–6.9 scores) and good (7–7.5 scores) fruit appearance. Cvs. ‘Scarlet Spur’ (7.5 score), ‘Early Red One’ (7.4 score) and ‘Auksis’ (7.4 score) produced better appearance than other cultivars (Table 4).

Fruits of cvs. ‘Auksis’ (7.4 score), ‘Gala M23/3’ (7.4 score) and ‘Scarlet Spur’ (7.4 score) had good taste. Cv. ‘Oregon Spur’ (5.8 score) had intermediate fruit taste. Fruit taste of other cultivars ranged between 7–7.3 scores.

Results of organoleptic evaluation shows that fruits of cvs. ‘Auksis’ (7.4 score), ‘Early Red One’ (7.4 score) and ‘Scarlet Spur’ (7.4 score) had good quality (general estimate – involves taste and appearance). Other cultivars and hybrids had good quality (7.0–7.2 scores), except cv. ‘Oregon Spur’ (5.8 score) and ‘Fuji Nagafu’ (5.9 score).

The biggest fruits produced cv. ‘Early Red One’ (170 g), ‘Auksis’ (150 g) and ‘Scarlet Spur’ (147 g), while the smallest ones – apple trees of cv. ‘Fuji Nagafu’ (112 g).

**Table 4.** Harvest date, end of storage and fruit quality parameters of apple cultivars

**4 lentelė.** Obelių vaisių skynimo laikas, laikymosi pabaiga ir kokybės rodikliai

Babtai, 2005–2006

Cultivars Veislės	Harvest date (month, day) Skynimo laikas, mėn., d.	End of storage (month, day) Laikymosi pa- baiga, mėn., d.	Fruit weight Vaisių masė (g)	Appearance (scores) Patrauklu- mas, balais	Taste (scores) Skonis, balais	Quality evalu- ation (scores) Vaisių kokybė, balais
‘Auksis’	09-15 a*	03-15 cde	150 cde	7.4 cde	7.4 de	7.4 cd
‘Early Red One’	09-24 b	02-17 bcd	170 e	7.4 cde	7.3 cde	7.4 cd
‘Fuji Nagafu’	09-29 bcd	03-18 cde	112 a	5.8 a	7.1 bcd	5.9 a
‘Gala M23/3’	09-17 a	01-19 ab	115 ab	7.0 b	7.4 de	7.2 b
‘Jonagold 2361’	09-25 bcd	04-10 de	120 ab	7.2 b	7.0 bcd	7.1 b
‘Red Idared × 10687’	09-30 d	05-13 ef	122 ab	7.2 b	7.1 bcd	7.1 b
‘Scarlet Spur’	09-26 bcd	03-06 cde	147 cde	7.5 e	7.4 e	7.4 d
‘Superchief’	09-29 bcd	05-20 f	119 ab	7.3 bc	7.2 cde	7.2 b
‘Oregon Spur’	09-29 bcd	05-16 ef	137 bc	5.9 a	5.8 a	5.8 a
Mean	09-25	04-16	132	6.96	7.07	7.16

Veislių vidurkis

\* Duncan’s multiple range t-test / Duomenys apskaičiuoti pagal Dunkano kriterijų.

Means followed by the same letter are not significantly different at  $P = 0.05$  / Tarp vidurkių, pažymėtų tomis pačiomis raidėmis, nėra esminių skirtumų, kai  $P = 0,05$ .

**Discussion.** One of the requirements for successful avoiding of spring frost is late flowering. Phenological data show that late flowering was observed of ‘Scarlet Spur’, ‘Superchief’ and ‘Oregon Spur’ trees.

Fruit growers prefer the trees of weakest growth, because they demand little labour, produce good yield and are of high fruit quality every year since the second year after their planting in the orchard (Bielicki et al., 2002). Different cultivars present a different vigour, different tendency to branching and to fruit bud initiation. Results of the trial show that the weakest growth was found of ‘Oregon Spur’ and the most vigorous were trees of ‘Superchief’ and ‘Fuji Nagafu’. Tabakov and Yordanov (2007) reported that the trees of ‘Fuji Nagafu’ were significantly higher than the other investigated trees.

Data show that different genotypes might have different productivity. During five years in orchard apple trees of cvs. ‘Auksis’ and ‘Superchief’ produced the highest yield.

Apple scab is a serious disease of apple trees. The infection of apples makes them unsuitable for fresh market. On the other hand, scab resistant apple cultivars fit very well to the concept of the low input and sustainable fruit production (Rutkowski et al., 2005). Results of trial show that trees of ‘Scarlet Spur’, ‘Auksis’ and ‘Fuji Nagafu’ were more resistance to scab.

Quality criteria, which are of importance to the consumer and therefore determine apple acceptance, comprise properties related to sensory, nutritional and technological

quality (Höhn, 1990). Cvc. 'Auksis' and 'Gala M23/3' produced the earliest yield, cv. 'Red Idared x 10687' – the latest one. A long storage life is the most important factor in deciding what cultivars are to be grown in a commercial orchard. The investigation shows that fruit of cvs. 'Red Idared x 10687', 'Superchief' and 'Oregon Spur' keep longer.

As fruit growing becomes a more competitive business, breeding for fruit quality becomes increasingly important (Labuschagne et al., 2004). This demonstrates that it is essential to evaluate such parameter like fruit weight and eating quality. In a Swiss survey ideal apple should be "juicy, crisp and flavorful" (Höhn, 1990). Results of organoleptic evaluation show that fruits of cv. 'Early Red One', 'Scarlet Spur' and 'Auksis' had better fruit quality and weight.

**Conclusions.** The following apple cultivars were distinguished for particular characteristics: 'Auksis' – earliest blooming, 'Scarlet Spur', 'Superchief' and 'Oregon Spur' – latest blooming, 'Oregon Spur' – weakest growth, 'Auksis' and 'Superchief' – for yield in the young orchard; 'Auksis', 'Early Red One' and 'Oregon Spur' – for highest class of fruits; 'Red Idared x 10687', 'Superchief' and 'Oregon Spur' – for storage life; 'Scarlet Spur', 'Auksis' and 'Fuji Nagafu' – resistance to scab, 'Early Red One', 'Scarlet Spur' and 'Auksis' – for fruit weight and fruit quality.

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## **Devynių obelių veislių su B.396 poskiepiu tyrimas jauname sode**

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### *Santrauka*

2002–2006 m. Lietuvos sodininkystės ir daržininkystės institute tirta devynių introdukuotų obelių (*Malus × domestica* Borkh.) veislių žydėjimo tarpsniai, vaismedžių augumas, derlius, atsparumas rauplėms (*Venturia inaequalis*), skynimo laikas, laikymosi pabaiga ir vaisių kokybė. Dvimečiai obelių sodinukai su B.396 poskiepiu pasodinti 2002 m. rudenį. Sodinimo schema – 4 × 2 m. Sodinta po vieną vaismedį laukelyje penkiais pakartojimais.

Įvertinus požymių visumą, išsiskyrė šios obelių veislės: ‘Auksis’ – ankstyvu žydėjimu, ‘Scarlet Spur’, ‘Superchief’ ir ‘Oregon Spur’ – vėlyvu žydėjimu, ‘Oregon Spur’ – silpniausiu augumu, ‘Auksis’ ir ‘Superchief’ – jauno sodo derliumi; ‘Auksis’, ‘Early Red One’ ir ‘Oregon Spur’ – aukščiausios klasės vaisiais; ‘Scarlet Spur’, ‘Auksis’ ir ‘Fuji Nagafu’ – sąlyginiu atsparumu rauplėms, ‘Red Idared x 10687’, ‘Superchief’ ir ‘Oregon Spur’ – išsilaikymo trukme; ‘Early Red One’, ‘Scarlet Spur’ ir ‘Auksis’ – vaisių mase ir kokybe.

**Reikšminiai žodžiai:** obelys, veislės, fenologija, augumas, atsparumas ligoms, derlius, vaisių kokybė.

