

Some important growing characteristics of apple and apricot cultivars in two fruit growing regions in Romania

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Summary: The aim of this study was to determine some important growing characteristics of 5 resistant apple (Rajka, Rubinola, Topaz, Otawa and Goldstar) and 7 apricot (NJA 19, Goldrich, Harcot, Venus, Comando, Olimp, Cea mai buna de Ungaria) cultivars in two fruit growing regions in Romania from 2000 to 2003. Height of the apple trees (4-year-old tree) ranged between 1.96 m (cv. Topaz) and 2.39 m (cv. Rubinola). Diameter of the crown ranged from 0.96 m (cv. Goldstar) to 1.12 m (cv. Rajka). The trunk diameter ranged from 3.5 cm (cv. Goldstar) to 5.0 cm (cv. Rajka). The surface of the trunk section was the lowest for cv. Goldstar (9.7 cm²) and the largest for cv. Rajka (19.6 cm²). Height of the apricot trees (4 years old tree) ranged between 2.69 m (cv. Venus) and 3.38 m (cv. NJA – 19). Diameter of the crown ranged from 2.59 m (cv. Comandor) to 2.77 m (cv. Cea mai buna de Ungaria). The trunk diameter ranged from 9.54 cm (cv. Goldrich) to 13.30 cm (cv. NJA – 19). Length of annual branches was the lowest for cv. Goldrich (45.1 cm) and the highest for cv. NJA – 19 (83.8 cm). Bud swelling of apricot trees began on 8 March for cv. NJA – 19 and ended on 11 March for the control cultivar (Cea mai buna de Ungaria). The blooming started on 16 March for cv. NJA – 19 and 27 March for the control cultivar. Duration of fruit growth was 89 days for cv. NJA – 19 and 128 days for cv. Comandor. When the temperature decreased to 1.5 °C (in 2001), percentage of viable pollen grains ranged between 48.86 % (cv. Olimp) and 91.57 % (cv. Venus). The germinating grains ranged from 31 % (cv. Olimp) to 90 % (cv. Harcot). Free pollination was the lowest for cv. NJA – 19 (29 %) and the highest for cv. Harcot (41%), while self-pollination ranged between 6 (cv. Olimp) and 11 % (cvs. Comandor and Harcot). Apple yield ranged from 16.65 t/ha (cv. Otawa) to 24.35 t/ha (cv. Rajka) and the differences varied from 4.45 t/ha to – 3.25 t/ha compared to the control varieties. Apricot yield ranged from 11.47 kg/ tree or 9.53 t/ha (cv. Cea mai buna de Ungaria), to 38.83 kg/tree or 27.34 t/ha (cv. Olimp) and the differences varied from 3 t/ha to 17 t/ha compared to the control varieties. Apple fruit weight ranged from 162 g (cv. Otawa) to 222 g (cv. Goldstar) and apricot fruit weight from 42.52 g (cv. Goldrich) to 68.38 g (cv. Comandor). Color, taste and aroma were very specific to cultivars.

Key words: apple, apricot, taste, aroma, frost, tree growth, bloom, yield, fruit quality

Introduction

The annual decreases and fluctuations in the fruit production have inspired multiple concerns in the scientific research and practical activities. The concept of modern ecology includes that the assortment of cultivars has a determining role in the fruit production including apple and apricot production. Therefore, several cultivar characteristics of apple and apricot are improved continuously by plant breeding and the newly created cultivars are tested for suitability in commercial growing.

International studies have focused on the growing characteristics of disease resistant apple cultivars under various ecological conditions. In Romania, studies were also made to breed and test disease resistant apple cultivars (Cociu, 1989ab, 1990, 1993, Bălan, 1991). Growing characteristics of apple cultivars have been examined worldwide including productivity (e.g. Childers, 1973; Botez 1977; Teskey & Shoemaker, 1980; Tóth, 1998) flower and fruit setting characteristics (Nyéki et al., 2003) and disease resistance under conventional or environmentally-friendly production systems (e.g. Aldwinckle, 1974, Norton, 1981; Silbereisen, 1985; Crosby et al., 1992; van der Zwet, 1995;

Fisher & Fisher, 1994,1996; Benaouf & Parisi, 1997; Fisher, 1999; Holb, 2000, 2003; Holb et al., 2001). Recently, some new data are available about fruit quality parameters of apple cultivars too. Gonda et al. (2001) studied fruit inner content and scab incidence of 6 apple cultivars in environmentally-friendly fruit production systems. Kuhn & Thybo (2001) studied the sensory quality (crispness, mealiness, skin toughness, apple flavour, sweetness, unripe flavour and overripe flavour) of scab-resistant apple cultivars such as Dayton, Primicia, Retina, Realka; Merlijn, Saturn, Initial, Rajka and Rubinola. Recently, more and more studies pay attention also to antioxidant activity and vitamin C content of foods, including apple fruits (e.g. Veres et al., 2003; Szabolcsi et al., 2004; Schmitz-Eiberger et al., 2003; Trierweiler et al., 2004). Schmitz-Eiberger et al. (2003) and Trierweiler et al. (2004) determined the antioxidant activity, ascorbic acid and phenolic compound content of six apple cultivars including the scab resistant cv. Topaz.

Studies have also emphasized the importance of growing characteristics of apricot cultivars under various ecological conditions and here only some examples were taken.

One research line is disease resistance to plum pox potyvirus. Polak et al. (1997) and Martinez-Gomez & Dicenta (2000) studied the plum pox potyvirus resistance of

apricot cultivars. They demonstrated the resistance of some cultivars including the newly introduced cvs. 'Goldrich' and 'Harcot' to some plum pox isolates, while most of the cultivars were susceptible to isolates of plum pox potyvirus.

Another important investigated subject is cold-hardiness and breeding potential of cultivars. *Layne & Gadsby* (1995) in Canada found that the ranking of breeding value from highest to lowest was as follows: Harlayne > Harcot > Harglow > J.L. Budd > Manchu > Veecot > Stella > Goldcot.

Much attention has been paid also to flower research. Several studies investigated blooming characteristics and pollination of apricot cultivars (*Erdős et al.*, 1999; *Szabó & Nyéki*, 1999; *Szalay & Szabó*, 1999; *Szalay et al.*, 2000; *Szabó et al.*, 2000; 2004). *Albuquerque et al.* (2002) studied the stage of ovule development at anthesis and its relationship with fruit set in several apricot cultivars growing under Mediterranean climatic conditions. Although generally the ovule was immature at anthesis, a great variability was found in the stage of development of the ovules on different cultivars. Moreover, the consequences of the developmental stage of apricot ovules at anthesis fertilization on were also shown on apricot cvs. Palstein and Goldrich (*Albuquerque et al.*, 2000).

The greatest attention is paid to tree growth characteristics and productivity. Recently, the effect of pruning and interspecific *Prunus* hybrid rootstocks on tree growth, yield and fruit size of apricot was determined (*Kappel*, 2003). *Perez-Pastor et al.* (2004) precisely determined the different phenological stages of mature apricot trees and the predominant dates of each stage were indicated in days and as the number of accumulated growing degree hours. When they studied the annual pattern of root, shoot and fruit growth, alternating root and shoot growth was observed, and also a relative separation between the main periods of shoot and fruit growth, which was found to be an advantageous characteristic when applying deficit irrigation. *Radi et al.* (2003) and *Bussi et al.* (2003) determined the effects of different levels of nitrogen, phosphorus and potassium (NPK) fertilizers on biochemical markers involved in the quality of apricots (sugars, organic acids and free acidity), technological qualities (phenolic compounds: substrates of the enzymatic browning reaction), vegetative growth, yield, and average fruit weight.

Most of the apricot studies emphasise that results may alter under different ecological or climate conditions.

The aim of this study was to determine some important growing characteristics of 5 resistant apple and 7 recently introduced apricot cultivars in two fruit growing regions of Romania.

Material and method

Climatic conditions of the fruit growing regions

Apple orchards were examined in the Crisul Repede fruit-growing region, Romania. In this region, the length of the vegetation period for apple is an average of 185 days. The

annual mean temperature oscillates around 10.1 °C and 16.8 °C during the vegetation period. Minimum temperature is -28 °C and it does not exceed the resistance limit specific to apple trees. Mean number of sunny hours during the vegetation period is 1635 hours and the annual precipitation is up to 622 mm with a favourable distribution.

Apricot orchards were examined in the Oradea fruit-growing region, Romania which was not too far from the apple orchards studied. Conditions of the Crisul Repede fruit-growing region are slightly different from those of the Oradea fruit-growing region, however, there are some important characteristics which need to be demonstrated. The vegetation period of apricot is 196 days on average. The annual mean temperature oscillates around 10.0 °C and 16.7 °C during the vegetation period. Minimum temperature is -28 °C (as in the apple growing region) which reaches the frost sensitivity limit of fruit buds of apricot cultivars. Mean number of sunny hours during the vegetation period is 1630 hours and the annual precipitation is up to 635 mm with a favourable distribution. Frost damage of apricot blossom can happen 2–3 times out of 10 years.

Orchards and plant material

The studied apple orchard was established in a low inclination and in a southern position. The soil type is brown forest soil mixed with weaker soil elements with pH 6.0 and 6.5 and with a medium nutrient status. Five apple cultivars (Rajka, Rubinola, Topaz, Ottawa and Goldstar) and a control cultivar grafted on M9 rootstock were examined. Trees were planted in a high-density system (4 m × 1.3 m) including 2083 trees/ha. Observation was made in a three-year period when tree age was 2–4 years.

The studied apricot orchard was established on a hill with 12–15 % inclination and also in a southern position. The soil type and characteristics were the same as for the apple orchard. Six apricot cultivars (NJ 19, Goldrich, Harcot, Venus, Comando, Olimp) and a control cultivar (Cea mai buna de Ungaria) grafted on M9 rootstock were examined. Trees were planted in a high-density system (4 m × 1.3 m) including 2083 trees/ha. Observation was made in a three-year period when tree age was 2–4 years. Fruits of cvs. NJ 19 and Harcot are early ripening, cvs. Goldrich and Venus are middle ripening and cvs. Comandor and Olimp are late ripening.

Selected apple and apricot cultivars were compared in several measures with the control cultivar.

General tree measures

Five general tree measures were determined for both the apple and the apricot cultivars: tree height in meter, crown diameter in meter, trunk diameter in centimeter, surface of the transversal section in square centimeter and the general strength of the tree.

Measures for blooming and frost resistance

These measures were assessed only for apricot cultivars. Date of the bud swelling, date of the beginning of blooming, duration of fruit growth and general features of disease resistance and fertility were determined. Frost resistance was measured separately as percentage of viable and germinating pollen grains, percentage of fruit set with free pollination and self-pollination.

Measures for annual production

Annual yield production was measured in kg/tree or t/ha for both the apple and the apricot cultivars. Moreover, percentage of yield difference from the control cultivars was also calculated.

Fruit quality measures

Five fruit quality measures were determined for the apple cultivars: mass of fruit, basic and cover colour of a fruit, taste and aroma of a fruit measured with an organoleptic test. Four fruit quality measures were determined for the apricot cultivars: mass of fruit, proportion of stone seed, consistency of a fruit and the taste of the fruit measured with an organoleptic test.

Results

General tree measures

Apple

Height of the trees (4-year-old tree) ranged between 1.96 m (cv. Topaz) and 2.39 m (cv. Rubinola) (Table 1). Diameter of the crown ranged from 0.96 m (cv. Goldstar) to 1.12 m (Rajka). The trunk diameter ranged from 3.5 cm (cv. Goldstar) to 5.0 cm (cv. Rajka). The surface of the trunk section was the lowest for cv. Goldstar (9.7 cm²) and the largest for cv. Rajka (19.6 cm²). Generally, cv. Rajka presents a middle-high, cv. Rubinola a middle and cvs. Topaz, Ottawa and Goldstar a low growth (Table 1).

Table 1. The growing characteristics of apple trees (Crisul Repede fruit-growing region, Romania 2000-2002)

Cultivar	Size of fruit trees				General strength
	Height (m)	Crown diameter (m)	Trunk diameter (cm)	Surface of the transversal section (cm ²)	
Rajka	2.23	1.12	5.0	19.6	Middle to high
Rubinola	2.39	1.08	4.4	15.2	Middle
X	2.21	0.89	4.1	13.4	-
Topaz	1.96	0.81	3.8	11.3	Middle to low
Ottawa	2.38	0.77	3.8	11.3	Middle to low
Goldstar	2.12	0.69	3.8	9.7	Middle to low

Apricot

Height of the fruit trees (4-years-old tree) ranged between 2.69 m (cv. Venus) and 3.38 m (cv. NJA - 19) (Table 2). Diameter of the crown ranged from 2.59 m (cv. Comandor) to 2.77 m (cv. Cea mai buna de Ungaria). The trunk diameter ranged from 9.54 cm (cv. Goldrich) to 13.30 cm (cv. NJA - 19). Length of annual branches was the lowest for cv. Goldrich (45.1 cm) and the highest for cv. NJA - 19 (83.8 cm). Generally, cv. Venus represents a weak-to-middle, cvs. Harcot, Olimp, Comandor and Goldrich a middle-strong and cvs. NJA 19 and Cea mai buna de Ungaria a strong growth (Table 2).

Table 2. The growing characteristics of the ten-year-old apricot trees (Oradea fruit-growing region, Romania 2001-2003)

Cultivar	Size of fruit trees				General strength
	Height (m)	Crown diameter (m)	Trunk diameter (cm)	Length of the annual branches (cm)	
NJA - 19	3.38	2.74	13.30	83.8	High
CMB de Ung.	3.10	2.77	9.70	75.0	High
Harcot	2.87	2.70	10.94	59.5	Middle to high
Olimp	2.85	2.69	10.42	56.6	Middle to high
Comandor	2.84	2.59	10.58	58.5	Middle to high
Goldrich	2.77	2.71	9.54	45.1	Middle to high
Venus	2.69	2.65	10.66	65.2	Middle to low
NJA - 19	3.38	2.74	13.30	83.8	High

Blooming and frost resistance of apricot cultivars

Bud swelling began on 8 March for cv. NJA - 19 and ended on 11 March for the control cultivar (Cea mai buna de Ungaria) (Table 3). The blooming started on 16 March for cv. NJA - 19 and 27 March for the control cultivar. Duration

Table 3. Some important phenological phases and general favourable characteristics of apricot cultivars (Oradea fruit-growing region, Romania, 2001-2003)

Cultivar	Phenological phases			Favourable characteristics
	Bud swelling	Beginning of bloom	Duration of fruit growth (day)	
NJA19	8 March	16 March	89	Relative resistance to cold and diseases
Olimp	9 March	17 March	127	Self-fertility and relative resistance to cold
Goldrich	9 March	24 March	114	Self-fertility and relative resistance to cold
Venus	10 March	24 March	103	Relative resistance to cold
Harcot	10 March	23 March	92	Relative resistance to cold
Comandor	10 March	26 March	128	Self-fertility and resistance to cold
CMB de Ung.	11 March	27 March	104	Self-fertility and resistance to cold

of fruit growth was 89 days for cv. NJA – 19 and 128 days for cv. Comandor. Most of the studied cultivars expressed a relative resistance to cold (Table 3).

When the temperature decreased to 1.5 °C, percentage of viable pollen grains ranged between 48.86 % (cv. Olimp) and 91.57 % (cv. Venus) (Table 4). The germinating grains ranged from 31 % (cv. Olimp) to 90 % (cv. Harcot). Free pollination was the lowest for cv. NJA – 19 (29%) and the highest for cv. Harcot (41%), while self-pollination ranged between 6 (cv. Olimp) and 11 % (cvs. Comondor and Harcot).

Table 4. Resistance of apricot flowers to the late spring frost (1.5 °C in 2001)

Cultivar	Viability of pollens		Degree of producing flowers	
	Viable grains %	Germinated grains %	Free pollination %	Self pollination %
Venus	91.57	88.0	33.0	11.0
Harcot	90.97	90.0	41.0	6.5
CMB de Ung.	88.90	80.0	32.0	6.6
Comandor	85.38	80.0	30.0	11.0
NJA 19	83.33	79.0	29.0	7.1
Goldrich	67.27	62.0	31.0	7.9
Olimp	48.86	31.0	37.0	6.0

Annual fruit production

Apple

The fruit production ranged from 16.65 t/ha (cv. Ottawa) to 24.35 t/ha (cv. Rajka) and the differences varied from 4.45 t/ha to – 3.25 t/ha compared to the control varieties (Table 5). Significant differences ($P > 0.05$) were found in the case of cv. Rajka compared to the control cultivar.

Table 5. The annual production of apple trees (Crisul Repede fruit-growing region, Romania 2000–2002)

Cultivar	Production (t/ha)	Relative production (%)	Difference (t/ha)
Rajka	24.35	122	+4.45
Goldstar	21.03	105.67	+1.13
Rubinola	20.14	101.2	+0.24
X	19.9	100	–
Topaz	17.41	87.48	-2.49
Ottawa	16.65	83.66	-3.25

Apricot

The fruit production ranged from 11.47 kg/ tree or 9.53 t/ha (cv. Cea mai buna de Ungaria), to 38.83 kg/ tree or 27.34 t/ha (cv. Olimp) and the differences varied from 3 t/ha to 17 t/ha compared to the control varieties (Table 6). Fruit production of all cultivars was significantly different ($P > 0.05$) compared to the control cultivar.

Fruit quality measures

Apple

Fruit weight ranged from 162 g (cv. Ottawa) to 222 g (cv. Goldstar) (Table 7). Colour, taste and aroma were very specific to cultivars.

Table 6. The annual production for ten- to twelve-year-old apricot trees (Oradea fruit-growing region, Romania, 2001–2003)

Cultivar	Fruit production			Difference (t/ha)
	Absolute		Relative production (%)	
	kg/tree	t/ha		
Olimp	32.83	27.34	287	+17
Goldrich	32.31	26.91	282	+17
NJA 19	22.36	18.62	195	+9
Venus	20.59	17.15	180	+7
Harcot	15.05	12.53	131	+3
Comandor	19.07	15.88	167	+6
CMB de Ung.	11.47	9.53	100	–

Table 7. Fruit quality parameters of apple cultivars (Crisul Repede fruit-growing region, Romania 2000–2002)

Cultivar	Fruit weight (g)	Colour		Organoleptic features	
		Fond	Cover color	Taste	Aroma
Rajka	219	Orange-yellow	Red	Acidulous sweet	Fine specific
Rubinola	187	Green-yellow	Light-red	Acidulous sweet	Fine specific
Topaz	163	Orange-yellow	Orange-red	Acidulous sweet	Fine specific
Ottawa	162	Light-green	Yellowish-green	Acidulated sweet	Less pronounces
Goldstar	222	Yellowish-green	Pink to red	Pleasant sweet	Specific

Apricot

Fruit weight ranged from 42.52 g (cv. Goldrich) to 68.38 g (cv. Comandor) (Table 7). Colour, taste and aroma were very specific to cultivars.

Table 8. Fruit quality parameters of apricot cultivars (Oradea fruit-growing region, Romania, 2001–2003)

Cultivar	Fruit characteristics		Organoleptic features	
	Fruit g	Stone proportion %	Consistency	Taste
Comandor	68.38	7.03	Firm	Balanced – fine
NJA 19	50.25	6.47	Middle	Pleasant – wean
Venus	48.58	4.28	Middle	Sweetish – fine
Olimp	48.29	8.71	Middle	Bitter-sweet-fine
Harcot	49.20	7.29	Firm	Balanced – sweet
CMB de Ung.	47.81	7.26	Middle	Bitter-sweet-tasty
Goldrich	42.52	7.01	Middle	Easy-acidulated-tasty

Conclusions

All resistant apple cultivars showed sufficient growing characteristics and yield production which indicate that these cultivars can be recommended for commercial apple growing. Moreover, these resistant cultivars may have an

advantage compared to most well known scab susceptible cultivars (such as cvs. Jonagoly, Mutsu, Gala) as they can be planted with low disease risk in organic apple orchards.

All tested apricot cultivars were as good as or better than in cv. Cea mai buna de Ungaria most growing characteristics and yield production. In the Oradea fruit-growing basin, the blooming phenological phase for apricot tree starts early when the danger of frost and late hard frosts is still present. The presence of the low temperatures during the blooming phenological phase can determine the decrease of the productive potential of fruit trees which is different according to the variety. Therefore, we recommend the multiplication and introduction of cvs. Olimp, Goldrich, NJA 19, Venus and Comandor in the new plantations and the decreasing of the production of cv. Cea mai buna de Ungaria.

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