The Effect of Weather Conditions on Fruit Skin Colour Development and Pomological Characteristics of Four Apricot Cultivars Planted in Donja Zelina

Bernardica MILINOVIĆ [1] (✉), Tvrtko JELAČIĆ [1], Dunja HALAPIJA KAZIJA [1], Danijel ČIČEK [1], Predrag VUJEVIĆ [1], Zlatko ČMELIK [2]

Summary

Research was conducted on four apricot (*Prunus armeniaca* L.) cultivars of different ripening periods in Donja Zelina, during 2010 and 2011 growing seasons. Trees were planted in 2006, and grafted on a WaxWa rootstock. During 2010 growing season, ground- and over-colour of the fruit skin was measured from 97 to 114 days after full bloom (DAFB) for cultivars 'Hargrand', 'Harlayne' and 'Harogem' and from 81 to 99 DAFB for cultivar 'Pinkcot®' colorimetrically multiple times in intervals of three to four days using the change in ground-colour of fruit skin from green to green – yellow as a indicator for first measurement determined by colour chart for apricots. At harvest in 2010 and 2011, fruit weight, height, width and thickness, fruit flesh firmness and soluble solids content were determined as well.

The most intensive changes were recorded in value *a** of fruit skin ground- and over-colour in all four cultivars during the last 10 days before harvest in 2010, and ranged from 19.33 in cv. 'Hargrand' to 30.55 in cv. 'Harogem'. Cv. 'Pinkcot®' and cv. 'Harogem' have developed higher *b** values of fruit skin ground-colour then cultivars 'Hargrand' and 'Harlayne' in 2010, reaching values of 47.79 and 47.30, respectively. At harvest in 2011, values *a** and *b** were significantely lower then in 2010 for all four cultivars, however bigger differences were recorded in cv. 'Harogem' and cv. 'Pinkcot®'. For measured pomological characteristics at harvest, significant differences were observed between cultivars in both growing seasons for all measured characteristics, except for cv. 'Hargrand'. The biggest difference in fruit weight, height, width and thickness was observed in cv. 'Harlayne'.

Results suggest that high temperature fluctuations and below average precipitations influenced the fruit skin colour and quality parameters of apricots in the sense of smaller chromaticity values.

Key words

apricot, fruit skin colour, fruit weight, soluble solids

[1] Croatian Centre for Agriculture, Food and Rural Affairs, Institute of Pomology, Rim 98, 10000 Zagreb, Croatia
✉ e-mail: bernarda.milinovic@hcphs.hr
[2] University of Zagreb, Faculty of Agriculture, Department of Pomology, Svetošimunska 25, 10000 Zagreb, Croatia

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Introduction

Apricots (*Prunus armeniaca* L.) are the most popular temperate fruit trees (Faust *et al*., 1998) bearing delicious and multipurpose fruits. The fruits can be consumed fresh, dried, canned, juiced; made into jams, liqueurs, and also used in cosmetics industry as well as medicinally. The seed of some cultivars are edible, tasting like almonds (Faust *et al.,* 1998).

Mediterranean countries account for 95% of the total fresh apricot market, and the fruits are mainly imported and consumed by the European Community (Faust *et al*., 1998; Ham and Smith, 2006). Apricot is one of the few temperate fruit crops not affected by production surplus (Bassi, 1997). Although apricots are geographically widespread, they have not become economically viable except in areas with very specific climatic conditions. Optimal conditions for their cultivation are mountainous regions with a hot, dry summer and uniform, cold winters (Ham and Smith, 2001). Yield, fruit quality and harvest time of apricots, similar to other fruit crops are influenced by interaction between climate and soil conditions and by scion and rootstock compatibility. Production, fruit quality and time of harvest will be affected by these three factors (Ayanoglu and Kaska, 1995).

Although industry is relying on traditional cultivars that ensure standard level of quality, certain changes in the market can be noticed in regard to introduction of new genotypes that would be more suitable for transport and attractive to consumers with high quality expectations. Tricon *et al.* (2009) have described a different evolution observed over time in the newly released apricot cultivars, characterized by an improvement of the main fruit quality attributes, mainly due to the variability of the germplasm base used in breeding programs. Authors also cite that this new cultivar variability is a developing trend in the future as opposite to other fruit crops where the main aim is fruit standardization.

In apricot production producers are faced with two main problems: rapid ripening and extremely high susceptibility to fruit damage during harvest, transport and storage due to very high fruit water content (Liu *et al.,* 2009). In order to minimize the fruit damage, harvesting is often done prematurely while characteristic aromas have not fully developed that results with fruits not attractive to consumers. Consequently, understanding the process of fruit ripening, namely interaction and influence of climate conditions on the length of the fruit ripening of certain apricot cultivars is crucial in determining the optimal harvest window (Grotte *et al.,* 2006).

During apricot fruit ripening a complex biochemical reactions are initiated that lead to formation of phenol compounds, carotenoids and volatiles. Among these natural compounds, carotenoids are dominant group of pigments responsible for most of yellow and red colour in fruits. Among stone fruit most of the data on fruit skin colour development found in literature concern peaches (Ferrer *et al*., 2005), but there are almost none on apricots. The final stages of ripeness in peaches are characterized by changes in colour, firmness, acidity and soluble solids content (Rood, 1957; Kader *et al*., 1982; Delwiche and Baumgardner, 1985; Heyes and Sealey, 1996). Different ripeness indicators, most of which included colour were used in monitoring the process of fruit development. Contradictory results concerning correlation between colour measurements, pigment composition, physiological maturity and visual value of the fruit can be found in literature as well. Colour changes in most fruits include the loss of the chlorophyll and synthesis of new pigments such as carotenoids and /or anthocyanin's, and unmasking of other pigments that were formed in earlier fruit development stages (Kader, 1992). Chemical analysis of pigment concentrations are long-lasting and destructive, therefore advantage is given to rapid, non-destructive measurements (Tijskens *et al*., 2008). Research on formation of carotenoid pigments during the maturation period is somewhat difficult due to their large number and composition that varies qualitatively and quantitatively and are susceptible to isomerisation and oxidation (Khachik *et al.,* 1992; van der Berg *et al.,* 2000).

The aim of this research is to determine the differences in fruit skin colour development and some quality parameters of four apricot cultivars under different weather conditions.

Materials and methods

Research was conducted on apricot cultivars 'Hargrand', 'Harogem', 'Harlayne' and 'Pinkcot®' grafted on WaxWa rootstock. Trees were planted in 2006 in experimental orchard of the Institute of Pomology of the Croatian Centre for Agriculture,

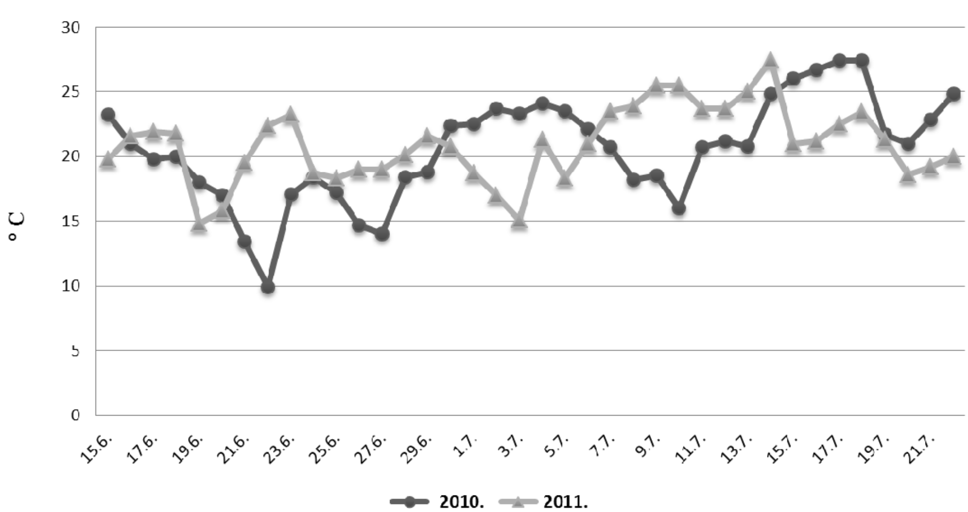

Figure 1.
Average daily temperatures in June and July of 2010 and 2011(°C), Donja Zelina

Food and Rural Affairs in Donja Zelina, near Zagreb. Trees are planted at 4 x 3 m distance. Standard management practices are implemented yearly (pruning, fertilization, pest control). The orchard is drip-irrigated. Experimental orchard in Donja Zelina is located on 180 m above mean sea level (AMSL) and with open southwest exposition. The soil in orchard is described as albic stagnosol.

The area is characterized by average annual temperature of 10.7°C, and 855.1 mm of total rainfall. In both research years average monthly temperatures during the vegetation period did not vary significantly from the average for Zagreb area. However, at the time of ripening (95 – 114 days after full bloom (DAFB)) of apricot cultivars in trial, i.e. in June and July of 2011, average daily temperature differed significantly from average values in 2010 (Fig. 1). The biggest difference between the seasons was noticed in period from 20th to 24th June when the difference in average daily temperature was 8.5°C. The following highest marked difference in average daily temperature was recorded in period from 1st to 3rd July, when the temperature difference was 6.2°C (23.2°C in 2010 and 17.0°C in 2011). Difference of 5.5°C was recorded between 7th to 13th July, when the temperature difference was 5.5°C (19.0°C in 2010 and 24.5°C in 2011).

Average rainfall in 2010 was usual for Zagreb area. Average precipitations in 2011 however, were significantly lower (454.3 mm) with extremely low amounts between January and March (37 mm in 2011 in comparison to average of 142 mm). In both years, July was characterized with 25% less precipitation from Zagreb area average.

During 2010 growing season ground- and over-colour of fruits were measured repeatedly in intervals of three to four days starting with the change of ground-colour from green to green – yellow (for cv. 'Hargrand' and cv. 'Harogem': 97, 100, 104, 107, 111 and 114; for cv. 'Harlayne': 97, 100, 104, 107 and 111 DAFB; for cv. 'Pinkcot®': 81, 84, 88, 92, 95 and 99 DAFB). Colour change was determined by CTIFL colour chart, when the ground colour of fruit skin was similar to colour no 2 (CTIFL, 2007). The experiment consisted of five trees of individual cultivar. On each tree, five fruits were marked randomly. Fruit colour measurements were carried out at approximately the same location on exposed and shaded side of each fruit with portable Konica Minolta Spectrophotometer CM-700d by using CIE $L^*a^*b^*$ system, where value L^* represents lightness i.e. illumination from 0 (total dark or black) to 100 (total transparency or white). Value a^* measures redness/greenness ($+a^*$ represents the red, while $-a^*$ represents green). Value b^* measures yellowness/blueness ($+b^*$ represents yellow, while $-b^*$ represents blue) (Hutchings, 1994). Hue angle (°), Hue = arctg (b*/a*), represents the hue of the colour (Voss, 1992) which values are defined as follows: red - pink: 0°, yellow: 90°, bluish - green: 180° and blue: 270° (McGuire, 1992). Chroma was calculated using the following formula: $C = (a^{*2} + b^{*2})1/2$, and it is a measure for chromaticity (C*), and represents the purity or colour saturation (Voss, 1992).

At maturity (determined organoleptically), along with the colour, fruit weight, length, width and thickness, fruit flesh firmness and soluble solids content were measured.

During 2010 and 2011, ground- and over-colour of fruits were measured, as well as pomological parameters at maturity. Fruit weight was determined by digital scale (Ohaus® Scout™ *Pro*; USA) to 0.01 g precision; fruit length, width and thickness were measured by digital calliper to 0.01 mm precision. Soluble solids were measured by digital refractometer (Atago PAL-1; Japan), and fruit firmness by penetrometer (Magnes Taylor handheld penetrometer model Effegy FT 327, Italy). Meteorological data (temperature and humidity) were collected daily from the meteorological station, installed in the orchard.

Two-factor analysis of variance (ANOVA) for cultivar x year using the statistical software Statistica 10.0 (StatSoft , Inc., USA) provided estimates of varietal and annual differences. Standard error was determined using Fisher LSD test with a 0.05 level of significance.

Results and Discussion

Comparing the results of colour measurements and pomological parameters, significant differences in cultivar response to weather conditions in both growing seasons can be noticed.

Development of fruit skin colour of apricot cultivars in trial

Fruit skin colour is one of the most important parameter in determining the maturity level of fruit cultivars (Francis & Clydesdale, 1975). Each cultivar is attributed by specific fruit colour development and a ground- and over-colour hue. In general, monitoring of development of fruit ground-colour facilitates the determination of optimum harvest window.

Multiple measurements in 2010 of fruit ground- and over-colour indicated significant differences in colour development between all four cultivars. In cv. 'Harlayne' value L^* did not change significantly between 97 DAFB until the harvest. In cv. 'Hargrand' and cv. 'Harogem' value L^* slowly increased between 97 DAFB until harvest. Value L^* in cv. 'Pinkcot®' similarly to other cultivars slowly increased between 81 and 92 DAFB. However, in period between 92 and 99 DAFB it increased significantly.

Value b^* of fruit ground-colour of all four cultivars slowly increased between 97 and 81 DAFB respectively, until the harvest. However, a discrete grouping of cultivars can be noticed. Cv. 'Hargrand' and cv. 'Harlayne' had the similar development of value b^* between 97 and 111 DAFB. Cv. 'Harogem'and cv. 'Pinkcot®' reached the similar value of b^* axis at harvest, however, cv. 'Pinkcot®' showed the biggest change between 81 DAFB and harvest.

Value a^* (Fig. 2) varied significantly from 97 and 81 DAFB respectively, until the harvest for all four cultivars. Precisely, it ranged from -0.01 to 28.48 in cv. 'Pinkcot®' from 1.14 to 30.55 in cv. 'Harogem', from 6.64 to 28.39 in cv. 'Hargrand' and from 6.64 to 23.69 in cv. 'Harlayne'. The biggest increase in value a^* was recorded between 97 and 104 DAFB for cv. 'Harogem' and cv. 'Hargrand', after which it increased slowly until the harvest.

The biggest increase in value a^* in cv. 'Pinkcot®' was recorded between 81 and 92 DAFB. Value a^* in cv. 'Harlayne' increased slowly between 97 and 100 DAFB, and then significantly in period between 100 and 107 DAFB, after which it stayed stable until the harvest. This pattern of fruit skin development could be connected with the favourable temperatures during 2010, namely in period from 15th to 19th of June (for cv. 'Pinkcot®'), from 3rd to 7th of July (for all four cultivars) and in period from 13th and 17th of July

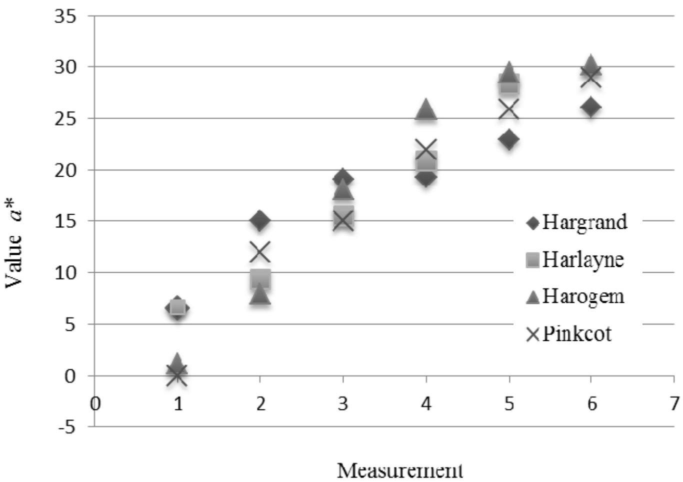

Figure 2. Development of value a* of fruit ground-colour of cultivars in year 2010

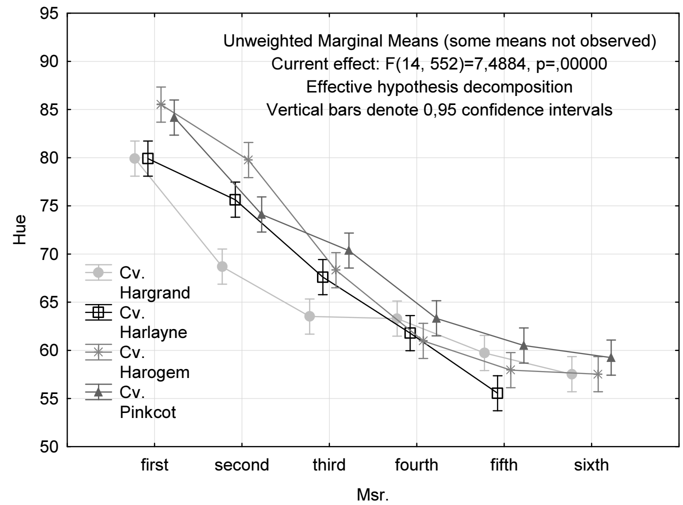

Figure 3. Mean calculated values for Hue of fruit ground-colour of apricot cultivars in trial – multiple measurements in 2010 (±SD)

(for cvs. 'Hargrand', 'Harlayne' and 'Harogem'). Therefore, the role of value *a** is more important in determining the optimum harvest window than values *L**and *b**. Our results suggest that optimum harvest window for cv. 'Harlayne' and cv. 'Hargrand' is between 107 and 111 DAFB, for cv. 'Harogem' between 111 and 114 DAFB, and for cv. 'Pinkcot®' between 95 and 99 DAFB.

In time of commercial maturity, apricot cultivars in trial differed in fruit ground- and over-colour. The ground-colour of cv. 'Hargrand' is light orange that sometimes can span to darker orange. This cultivar does not have expressed over-colour; however, sun exposed fruits can develop an over-colour in a form of a thick dark red dots. Cv. 'Harlayne', similar to cv. 'Hargrand' does not have expressed over-colour but can also develop sparse red dotted colouration on a sun exposed side of fruits. The ground-colour of this cultivar is dark orange (Lichou, 1998). Cv. 'Harogem' and cv. 'Pinkcot®' are characterised by expressed red over-colour that can extend to almost purple-red in cv. 'Pinkcot®', while cv. 'Harogem' can develop intensive dark red over-colour. Ground-colour in cv. 'Harogem' is intensive orange, while cv. 'Pinkcot®' has somewhat lighter orange colour. In general, the coverage of over-colour is higher in cv. 'Pinkcot®'.

Calculated values for Chroma of fruit ground-colour apricot cultivars in the trial (Fig. 4) clearly demonstrated that characteristic intensive orange ground –colour was developed the fastest in cv. 'Harogem', followed by cv. 'Pinkcot®'. Similarly, the Hue (Fig. 3) value clearly indicated specific lighter nuance of the cv. 'Pinkcot®' ground-colour. Cv. 'Harlayne' had the darkest nuance of the ground-colour, while its Chroma was more intensive then the one of cv. 'Hargrand'. At the beginning of the fruit maturation, Chroma value of cv. 'Hargrand' ground-colour developed with the similar intensity as in cv. 'Harogem' and cv. 'Pinkcot®'. However, its value was the lowest of all cultivars in the trial in time of the maturity. Calculated values for Chroma and Hue of fruit ground-colour are consistent with characteristics of cultivars in the trial.

Results of similar research could not be found in literature, especially for same cultivars. However, Petrisor *et al.* (2010) have measured the fruit skin colour of apricot cultivars 'Dacia' and 'Nicusor' in Romania harvested in four maturation stages (green mature, half-ripe, ripe and over-ripe). Development of values *L**, Chroma and Hue angle in their research follow our evolution pattern as well. Their results suggest the importance of Hue value in determination of apricot maturity stage. Similar conclusion was reached by Hegedüs *et al.* (2011), who measured the ground colour of apricot cultivars 'Gonci magyarkajszi' and 'Preventa' in Hungary harvested in three ripening stages (unripe, half-ripe and fully ripe).

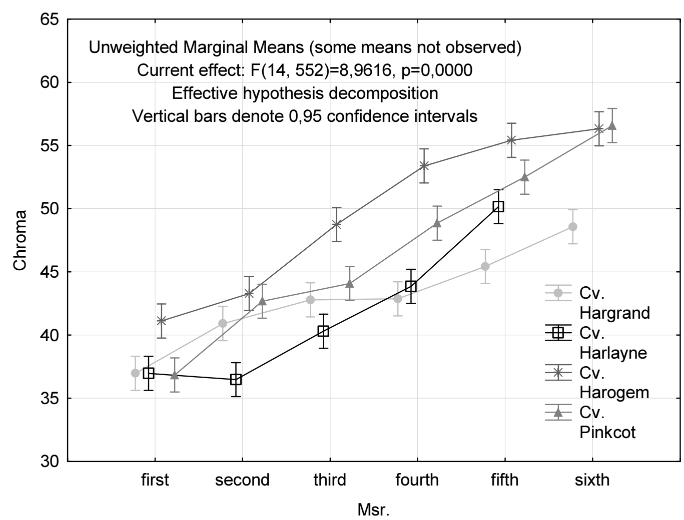

Figure 4. Mean calculated values for Chroma of fruit ground-colour of apricot cultivars in trial – multiple measurements in 2010 (± SD)

Fruit colour at harvest

Results of measurement of fruit ground- and over-colour indicated significant differences in *L*a*b** values of apricot cultivars in the trial for both growing years (Table 1). Mean of value

Table 1. Mean $L^*a^*b^*$ (±SD) values of fruit ground- and over-colour of apricot cultivars during 2010 and 2011 growing seasons at harvest

Cultivar	Year	L^* ground-colour	a^* ground-colour	b^* ground-colour	L^* over-colour	a^* over-colour	b^* over-colour
Hargrand	2010	59.53±1.99ab	23.69 ±3.58e	39.49 ± 2.87d	57.36 ± 3.19a	26.94 ± 3.06b	37.38 ± 3.83c
	2011	60.76 ± 1.92bc	14.91± 1.80a	24.73 ± 1.55a	54.63 ± 3.77a	16.46 ± 2.18a	17.26 ± 3.71a
Harlayne	2010	58.85 ± 1.19a	28.39 ± 1.23b	41.15 ± 2.00d	56.22 ± 3.61a	30.43 ±1.29c	38.36 ± 4.93c
	2011	62.82 ± 1.30d	15.12 ± 1.25a	25.44 ± 1.09ab	56.43 ± 3.12a	16.30 ±1.65a	17.98 ± 3.48a
Harogem	2010	60.56 ± 3.01abc	30.55 ± 1.45f	47.30 ± 2.65e	45.64 ± 5.92d	37.53 ± 3.75e	28.57 ± 8.09d
	2011	61.99 ± 1.50cd	17.83 ± 2.38c	27.22 ±1.52bc	49.41 ± 1.94c	17.40 ± 2.05a	9.052 ± 2.08b
Pinkcot	2010	60.53 ± 2.39abc	28.48 ± 2.10b	47.79 ± 2.14e	38.42 ± 4.6d	33.89 ± 3.81d	19.67 ± 6.67a
	2011	62.84 ± 1.96d	19.77 ± 1.29d	28.04 ± 1.93c	48.68 ± 2.46bc	17.84 ± 3.6a	9.06 ± 3.39b
Cultivar		0.0960	< 0.0001	< 0.0001	ns	< 0.0001	< 0.0001
Year		< 0.0001	ns	ns	0.0010	ns	ns
Interaction Cultivar x Year		0.1250	0.0002	< 0.0001	< 0.0001	< 0.0001	0.0050

Means followed by the same letter within columns and season are not significantly different by Fisher LSD test, $p < 0.05$; ns = not significant

Table 2. Mean values (± SD) of measured pomological parameters of cultivars during year 2010 and 2011 at harvest

Cultivar	Year	Fruit weight (g)	Fruit height (mm)	Fruit width (mm)	Fruit thickness (mm)	Fruit firmness (kg/cm^2)	SSC (°Brix)
Hargrand	2010	68.29±11.39d	49.29±2.13a	49.80±2.77ad	48.01±3.33c	1.56±0.49a	17.65±2.26a
	2011	73.97±8.84d	49.22±2.0a	51.24±2.07a	49.00±2.43c	2.32±0.58c	19.74±0.93cd
Harlayne	2010	90.88±16.40e	54.75±3.43e	55.38±3.59e	51.98±3.49e	1.55±0.38a	16.25±1.48b
	2011	49.17±2.35a	41.64±0.64d	44.51±0.88b	42.60±1.02ab	1.88±0.48ab	21.90±1.19e
Harogem	2010	58.18±8.6bc	47.98±2.18ac	50.18±2.36a	43.62±2.7ab	1.54±0.13a	16.07±1.06b
	2011	46.49±3.59a	44.17±0.85b	47.68±1.37c	39.43±1.65d	2.06±0.76bc	18.66±0.93ac
Pinkcot	2010	59.88±10.35c	46.60±3.68c	47.98±2.98cd	44.44±2.24b	1.59±0.22a	20.09±1.58d
	2011	50.24±4.42ab	44.18±2.11b	45.01±1.11b	41.82±1.52a	1.55±0.26a	17.56±0.93a
Cultivar		< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0922	ns
Year		< 0.0001	< 0.0001	< 0.0001	< 0.0001	ns	< 0.0001
Interaction Cultivar x Year		< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0430	< 0.0001

Means followed by the same letter within columns and factors are not significantly different by Fisher LSD test, $p < 0.05$, ns 0 not significant

L^* of fruit ground-colour at the time of harvest in both growing seasons did not vary significantly and was lower in 2010 for all four cultivars, which indicated that fruit skin nuance was lighter and clearer then in year 2011. Chromatic a^* and b^* values of fruit ground-colour varied significantly per cultivar and growing season, and generally were significantly higher in 2010 due to smaller night and day temperature difference in 2011. Thus, the highest difference in values was noticed in cv. 'Harogem', which value a^* reached 30.55 in 2010 and 17.83 in 2011 respectively, and value b^* reached 47.30 in 2010, but in 2011 reached only 27.22. Therefore, this cultivar was influenced the most by high temperatures during final stages of fruit development when it comes to insufficient formation of characteristic orange ground-colour of fruit. Given the value b^* of the fruit ground-colour in 2010, a grouping of cultivars was noticed, with values that ranged from 39.49 to 41.15 for cv. 'Hargrand' and cv. 'Harlayne'. Cvs. 'Harogem' and 'Pinkcot®' had significantly higher values that ranged between 47.30 and 47.79. Cultivars also differed in value a^* of fruit ground-colour in both growing seasons, except for cv. 'Hargrand' and cv. 'Harlayne' in 2011 and, unexpectedly, for cv. 'Harlayne' and cv. 'Pinkcot®' in 2010. Our results are in agreement with the research conducted by Campbell *et al.* (2011) on cvs. 'Harlayne', 'Hargrand' and 'Harogem' in New York State, USA, however they did not specify what side of the fruit skin was measured.

Influence of growing season to fruit skin over-colour development was observed, as well as expected grouping of cultivars when it comes to over-colour intensity. Statistically significant differences were not observed in value L^* in both growing seasons for cv. 'Hargrand' and cv. 'Harlayne', which ranged from 54.63 (cv. 'Hargrand' in 2011) to 57.36 (cv. 'Hargrand' in 2010). Value L^* for cv. 'Harogem' and cv. 'Pinkcot®' ranged from 38.42 (cv. 'Pinkcot®' in 2010) to 49.41 (cv. 'Harogem' 2011).

In value a^* readings of fruit over-colour, cv. 'Harogem' and cv. 'Pinkcot®' managed to develop their characteristic dark red colouration during 2010. Value b^* of fruit over-colour was significantly higher in cv. 'Hargrand' and cv. 'Harlayne' in both vegetation years, which highlighted higher quantity of yellow colour, while lower values of cv. 'Harogem' and cv. 'Pinkcot®' indicated higher amount of violet colour. Results obtained by Hegedüs *et al.* (2011) on apricot cultivars 'Gonci magyarkajszi' and 'Preventa' in Hungary are in line with our results when it comes to value L^* of fruit skin ground-colour of fully ripped fruits in both growing seasons. Their value b^* is similar to our values obtained during 2010. Our value a^* in both vegetation years, however, reached higher values than value a^* of Hungarian apricots.

Pomological measurements

The results of pomological measurements indicated high variability among cultivars and years for all cultivars, except cv. 'Hargrand' (Table 2). Fruits of other cultivars were in average of smaller weight, height, width and thickness during 2011. The highest difference in fruit weight was observed in cv. 'Harlayne', which average fruit weight was 90.88 g in 2010 and 49.17 in 2011. Similarly, fruit height ranged from 41.64 mm in 2011 to 54.75 in 2010, fruit width from 44.51 mm to 55.38 mm in cv. 'Harlayne' as well. Fruit thickness ranged from 39.43 mm in 2011 in cv. 'Harogem' to 51.98 mm in 2011 in cv. 'Harlayne'. Our results regarding fruit weight of apricot cvs. 'Harogem', 'Harlayne' and 'Harogem' are in line with results obtained by Cambell *et al.* (2011), however, the values of SSC obtained in our research are significantly higher in both growing seasons.

Fruit firmness is an important criterion for monitoring product ripeness throughout the marketing channels (Lichou, 1998). Optimum fruit firmness at harvest for cultivars in trial ranges between 1.55 to 2.50 kg/cm^2 (Lichou *et al.,* 2003). Fruit firmness at harvest did not vary significantly for cultivars in trial in both growing seasons, except for cv. 'Hargrand', where, in year 2011 fruit reached average firmness of 2.32 kg cm^{-2} and in year 2010 1.56 kg cm^{-2}. Higher average daily temperatures during intensive ripening period in 2011 influenced favourably the soluble solids content (SSC) for cvs. 'Hargrand', 'Harlayne' and 'Harogem'; their values increased for 3.44°Brix in average, except for cv. 'Pinkcot®' which soluble solids content (SSC) decreased for 2.53°Brix.

Conclusion

From the results presented in this study it can be concluded that high drop in average minimum daily temperature (from average minimum of 15°C to average minimum of 9°C) in period between 17th – 20th of June 2011 significantly reduced development of fruit ground- colour of cv. 'Pinkcot®'. Similar influence on poor colour development was noticed in cv. 'Hargrand', cv. 'Harlayne' and cv. 'Harogem' as a result of difference in average day and night temperatures in period from 24th to 28th of June 2011 (average night temperature of 15°C, and average daily temperature of 20°C). Fruit firmness, however, as very important fruit ripeness indicator did not vary significantly in both growing seasons.

Chromatic *a** value of apricot fruit ground- colour can be indicator for the beginning of harvesting of cultivars in the trial, combined with fruit firmness and soluble solids content (SSC). Our results suggest that at time of harvesting value *a** of fruit skin ground colour should range from 20.00 to 22.00 for cv. 'Hargrand' and cv. 'Harlayne', and from 26.00 to 29.00 for cv. 'Harogem' and cv. 'Pinkcot®', under normal weather conditions. In order to reach affirm conclusions, recording of *on tree* development of fruit skin colour of apricots should be conducted over several years.

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