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Evaluation of Apricot Selections for the North Italian Environment

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Abstract

Within a breeding program started by CReSO, a Regional Research Consortium, in order to diversify the range of apricot cultivars suitable to be grown in the Piemonte Region, progenies were obtained in 1999 between Tonda di Costigliole (T) (male parent) and either Goldrich (G), or Laycot (L). Tonda di Costigliole was expected to confer good environmental adaptability, aroma and taste; Goldrich and Laycot were chosen for the large size of fruits, the good flesh firmness, and the intense skin colour. Following a preliminary evaluation, 5 selections were chosen and tested for tree and fruit traits in the environment of Piemonte. In 2006 and 2007, apricot samples were analysed for soluble solid content, titratable acidity, pH, fruit firmness, skin colour and sensory characteristics. This two-year study showed that 2 selections are very promising for their good qualitative traits: LxT P14 that maintained or improved several characteristics of Tonda di Costigliole and LxT P8 that was appreciated for overcolour and aroma.

INTRODUCTION

Italy produces about 7% of world total apricot amount (*Prunus armeniaca* L.) and it is the thirth producer country, after Turkey (17.2%) and Iran (9.1%) (FAO, 2007).

Campania, accounting for 33% of the national production and Emilia Romagna, for 26%, are the major producer Regions. Other important production areas are Basilicata (14%), Piemonte and Sicilia (5%) (ISTAT, 2007).

Apricot cultivation in Piemonte, is mainly spread in the area and surroundings of Costigliole di Saluzzo village (Cuneo province) and, to a lower extent, in the Asti province. In the last years the varietal choice has been addressed towards modern cultivars of recent introduction, but traditional varieties continue to be appreciated and cultivated. Tonda di Costigliole is the only autochthonous cultivar still grown in Piemonte and accounts about 40% of the whole regional production; its fruits are destined both to the fresh market and to processing as canned, dried and for jam production . This cultivar represents a case of perfect adaptation to local climatic conditions but has some limits, such as the small size and the poor colour of the apricot; nevertheless the fruit is appreciated for sweetness, aroma intensity and juiciness.

Within a breeding program, started by CReSO Research Consortium, progenies were obtained in 1999 using Tonda di Costigliole as male parent. The main objective was to expand the range of apricot varieties suitable to be grown in Piemonte Region by obtaining new selections with improved quality preserving the positive traits, such as good environmental adaptability, aroma and taste, of the local cultivar Tonda di Costigliole.

MATERIALS AND METHODS

In 1999, progenies were obtained from Tonda di Costigliole (male parent) and either Goldrich (GxT) or Laycot (LxT). Following a preliminary evaluation carried out at the experimental station of Astra Innovazione Mario Neri – Imola (CRPV – Emilia Romagna), 5 selections were chosen to be tested for agronomic performance and fruit quality in the environment of Piemonte Region. The trial was planted in 2004 at the CReSO experimental farm located at Manta (Cuneo Province), 395 m above sea level. This paper presents the results of 2 years of observations (2006 and 2007).

DNA analysis

The identity of the selections and their parentage were checked by SSR (*Simple Sequence Repeats*) analysis. DNA was extracted from young leaves, according to the protocol described by Thomas *et al.* (1993), with some modifications. Samples were analyzed at 10 SSR loci: 2 loci of *Prunus persica* L. (UDP96-003, UDP96-409 – Cipriani *et al.* 1999) and 8 loci of *Prunus armeniaca* L. (Pa CITA 7, Pa CITA 10, Pa CITA 23 – Lopes *et al*. 2002; UDAp-414, UDAp-420, UDAp-410, UDAp-415 – Messina *et al.* 2004; AMPA100 – Hagen *et al*. 2004). The SSR analysis was performed by a 3130 Genetic Analyzer capillary sequencer. Results were elaborated with the Genescan software and alleles were defined by their size, determined in base pairs by comparison with the size standard (Genescan-500 Liz).

Pomological and chemicals fruit traits

In 2006 and 2007, flowering and ripening times were recorded. In addition, fruits were sampled from the 5 selections and their parent cultivars. The following parameters were determined each year on three replicates of 10 fruits each: fruit weight, flesh firmness (using Durofel), total soluble solids (T.S.S.), pH and titratable acidity (T.A.).

Skin color was measured by a Minolta colorimeter. In this system of color representation, the values L*, a* and b* describe a uniform three-dimensional color space: the L* value corresponds to a dark-bright scale, a* is negative for green and positive for red, and b* is negative for blue and positive for yellow.

The amounts of the main sugars, polyalcohols and organic acids of the juice were determined using a DANI 86.10 capillary gaschromatograph after silanisation (Valentini and Botta, 1999).

Total polyphenolics, antioxidant activity and anthocyanin content were measured, in order to evaluate the antioxidant capacity of the selections. Anthocyanin content was quantified according to the pH differential method by Cheng and Breen (1991). Anthocyanins were estimated through absorbance measurement at 515 and 700 nm in buffers at pH 1.0 and pH 4.5. Results were expressed as mg of cyanidin-3-glucoside (C3G) per 100g of fresh fruit. Total polyphenolics were determined with the Folin-Ciocalteau reagent by the method of Slinkard and Singleton (1977) using gallic acid as standard. Results were expressed as mg gallic acid- equivalents (GAE) per 100g of fresh fruit. For the evaluation of the antioxidant activity the FRAP (Ferric Reducing Antioxidant Power) assay was used, following the method by Pellegrini *et al*. (2003), with some modifications. The method is based on the reduction of the Fe^{3+}-TPTZ complex to the ferrous form at low pH: this reduction is monitored by measuring the absorbance change at 593 nm. 120µl of diluted sample were mixed with 900µl of FRAP reagent prepared daily and the absorbance was recorded after 30' at 37°C. FRAP was calculated by a standard curve produced by the addition of freshly prepared solutions containing $FeSO_4$ x $7H_2O$ 100-1000 µM.

Sensory analysis

Sensory evaluation was carried out on samples of the 2007 harvest by a trained panel of 10 tasters of O.N.A.Frut. (National Organization of Fruit Tasters). Each sample was coded with a randomly selected three-digit number and consisted of more apricots cut into bite-size pieces. They were equilibrated to room temperature and presented together to each panellist in a randomised order. A total of 8 descriptors were used to evaluate organoleptic traits by quantitative descriptive analysis (QDA) method. The descriptors were: flesh colour, flesh odour intensity, flesh firmness, juiciness, sweetness, acidity and aroma. Samples were scored for each descriptor using a continuous scale ranging from 0 to 10, where 0 = absent and 10 = very high. In order to have preliminary information about overall quality of each sample, the panellists were also required to indicate their preference.

Chemical and sensory data were statistically analysed by ANOVA and means were compared by Tukey test.

RESULTS AND DISCUSSION

The genetic profiles obtained by SSR analysis (Table 1) confirmed the parentage of the selections and univocally identified them and the parent cultivars.

Fruits of the selections showed weight (Table 2) comparable or larger than Tonda di Costigliole, with significant differences in both years for LxT P15, and GxT P10. In addition, weight and size increased in 2007 in comparison with 2006, for all the selections. Fruit firmness improved in all selections but GxT P7 (Table 2); yet, only the selections LxT P15 and LxT P8 showed significant differences with Tonda di Costigliole in both years. The results of year 2007 were confirmed by sensory analysis.

Colour has a significant impact on consumer perception of apricot quality especially regarding fruit attractiveness and the percentage of overcolour varies depending on the genotype (Ruiz & Egea, 2008). By colorimetric analysis (Table 3), it was showed that the red component of the skin colour resulted improved in most selections. Overcolour (Table 3) was lower, on the average, in 2006 than in 2007 when all selections developed overcolour but GxT P10, that did not show this trait in both years; LxT P8 and LxT P14, in particular, were significantly more overcoloured than Tonda di Costigliole.

Results of chemical analysis (Table 4, 5 and 6) showed a quite large range of variation among the selections as concerns the amounts of acids and sugars. In both years, total soluble solids (Table 4) were higher than 13°Brix in all selections but GxT P10, and were over 16°Brix in LxT P14. The acidity is also another important descriptor to determine fruit taste: apricots of Tonda di Costigliole, Laycot and LxT P14 showed the lowest values of titratable acidity (Table 4). All of the other selections showed an increased value of acidity in 2007, except Tonda di Costigliole, LxT P15 and GxT P7.

Sucrose was always the prevalent sugar (Table 6), with percentages over total sugars ranging from 62% (LxT P8) to 72% (GXT P10) in 2006 (data not shown) and from 55% (LxT P14) to 79% (GxT P10) in 2007. The GXT P10 selection showed the highest percentage of sucrose in the 2 years. Glucose and fructose resulted respectively the second and the third sugar, accounting together approx. 30% total sugars. Some selections had relevant amounts of sorbitol (over 3%) as in

Tonda di Costigliole: the selections LxT P8, LxT P15 and LxT P14 maintained this trait in both years. Two selections showed relevant amounts of raffinose (over 1%): LxT P8 in 2006 (data not shown) and GxT P7 in 2007. In general, the total amount of minor sugars was remarkable (over 4%) for many selection (Table 6).

Fruit antioxidant capacity (FRAP value) was significantly higher than in Tonda di Costigliole (Table 7) in the selections GxT P10 and LxT P8; total phenolic content was significantly higher than Tonda di Costigliole only in the selection GxT P10. Anthocyanin content was very low in apricot (data not shown): in 3 selections the method did not detect any quantity, in other 2, the value were lower than in the parents.

The main descriptors used in sensory evaluation for characterizing the different selections were skin colour, intensity of apricot odour, firmness, sweet and bitter taste and apricot aroma intensity (Fig. 1). Regarding flesh firmness and colour traits, the breeding sorted good results; in fact panellists described all selections as firmer and more coloured than Tonda di Costigliole. Taste and aroma were positive features of Tonda di Costigliole to be maintained in the progeny: sweetness was rated higher in LxT P14. Acidity varied among samples but data of selections were not significantly different from the value of Tonda di Costigliole. LxT P15 selection was described as having slightly more bitter fruits than the others. One selection (LxT P8) resulted improved for aroma. In general, almost all selections were appreciated by panellists that expressed an overall quality judgment (Goldrich 5.56c; Laycot 6.67abc; Tonda di Costigliole 6.63abc; LxT P8 8.19a; LxT P14 7.88ab; LxT P15 6.06bc; GxT P7 7.11abc; GxT P10 6.22abc) and rated LxT P8 the highest, followed by LxT P14.

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CONCLUSIONS

Apricot is a plant far less cultivated than other *Prunus* species, particularly peaches, and its cultivation is mainly limited to the Mediterranean areas. The breeding goals, therefore, are frequently restricted to climatic requirements and they do not consider many other objectives (Egea, 2006). In order to match a larger number of objectives, yet, it is fundamental to maintain biodiversity and, in particular, to preserve the good traits of the local and typical varieties. This will favour the breeding of cultivars joining adaptability to each particular environment with good physical and chemical characteristics, that are required to ensure consumers’ acceptability (Abbot, 1999).

The results of the two years of observations showed that 2 selections are very promising for their good qualitative traits. LxT P14, in particular, mantained or improved several characteristics of Tonda di Costigliole, the local reference cultivar. LxT P 8 was appreciated for the good overcolour and aroma.

Since year-by-year variation for physical, chemical and sensorial attributes in apricot can be significant (Audergon *et al.*, 1991; Ruiz and Egea, 2008) a third year of observations and the evaluation of yield will be necessary to complete the study and define the value of the selected material.

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Tables

Table 1. Genetic profiles at 10 SSR loci of the apricot selections and of their parent cultivars.

Cultivar / Selection	*loci (allele size expressed in base pairs)*									
	UDP96-003		UDP96-409		PaCITA7		PaCITA10		PaCITA23	
L X T P8	94	112	133	163	188	194	164	174	141	141
L X T P14	112	112	155	163	211	211	164	174	147	152
L X T P15	112	112	155	163	211	211	172	174	141	147
G X T P7	98	112	133	137	194	211	174	174	141	147
G X T P10	112	112	137	155	211	211	174	174	141	147
Laycot	94	112	141	163	188	211	164	172	141	147
Goldrich	98	112	133	137	206	211	174	176	143	147
Tonda di Costigliole	112	112	133	155	194	211	174	174	141	152
Cultivar / Selection	**UDAp-410**		**UDAp-414**		**UDAp-415**		**UDAp-420**		**AMPA100**	
L X T P8	139	152	173	173	147	158	158	166	213	217
L X T P14	139	152	152	173	147	158	158	170	213	217
L X T P15	139	152	173	173	147	158	166	180	207	207
G X T P7	123	125	152	169	163	163	166	180	195	207
G X T P10	123	152	169	173	163	163	170	172	195	207
Laycot	139	139	165	173	147	163	158	180	207	213
Goldrich	123	123	165	169	163	173	172	180	195	207
Tonda di Costigliole	125	152	152	173	158	163	166	170	207	217

Table 2. Physical data of the apricot selections and of their parent cultivars in 2006 and 2007. Means with the same letter do not significantly differ for p≤ 0.05.

Cultivar / Selection	Weight (g)		Selection improved for weight	Firmness (durofel)		Selection improved for firmness
	2006	2007		2006	2007	
Goldrich	65.37 a	94.20 a	/	41.83 d	59.77 c	/
Laycot	65.17 a	70.40 b	/	36.69 d	64.37 bc	/
Tonda di Costigliole	**34.23 c**	**41.23 e**	**/**	**54.72 c**	**58.30 cd**	**/**
LxT P8	39.80 b	42.23 e	+	64.17 b	68.47 ab	++
LxT P14	30.60 c	49.77 d	+	67.08 b	63.93 bc	+
LxT P15	42.60 b	55.10 cd	++	80.68 a	71.83 a	++
GxT P7	32.43 c	51.47 d	+	43.80 d	52.23 d	/
GxT P10	39.07 b	59.73 c	++	70.52 b	61.10 c	+

+ = better than Tonda di Costigliole in one year; ++ = better than Tonda di Costigliole in 2 years.

Table 3. Skin colour of apricot selections and parent cultivars. Means with the same letter do not significantly differ for p≤ 0.05.

Cultivar / Selection	Ground colour L*		Ground colour a*		Ground colour b*		Overcolour %	
	2006	2007	2006	2007	2006	2007	2006	2007
Goldrich	56.2f	63.5c	21.2a	18.5a	47.1abc	48.9a	/	1.3d
Laycot	59.0e	64.5bc	18. 9b	17.5a	45.1cd	45.7cde	11.3c	18.0bc
Tonda di Costigliole	**68.7a**	**71.5a**	**8.8c**	**7.7d**	**48.5a**	**44.1ef**	**0.7d**	**6.0d**
LxT P8	63.3c	65.9b	17.8b	12.9b	46.1abcd	46.8 bcd	22.5b	28.8a
LxT P14	66.3b	70.3a	9.6c	10.7bc	45.7bcd	47.94ab	31.0a	29.3a
LxT P15	61.5d	64.0c	18.5b	18.7a	42.3e	42.62 f	0.17d	10.8cd
GxT P7	66.0b	70.3a	9.5c	8.4cd	43.6de	45.19de	0.77d	6.4d
GxT P10	61.2d	63.4c	19.3ab	17.4a	47.6ab	47 bc	/	/

Table 4. Soluble solids and titratable acidity of ripen apricot selections and parent cultivars. Means with the same letter do not significantly differ for p≤ 0.05.

Cultivar / Selection	2006	2007	2006	2007
	RSR (°Brix)	RSR (°Brix)	Acidity (meq/100ml)	Acidity (meq/100ml)
Goldrich	14.8 c	12.1 c	30.8 b	36.0 a
Laycot	16.1 a	14.1 b	18.3 h	23.9 d
Tonda di Costigliole	**16.4 a**	**14.7 b**	**21.5 f**	**17.5 f**
LxT P8	15.4 b	13.8 b	27.1 d	30.1 b
LxT P14	16.4 a	16.1 a	20.3 g	21.6 e
LxT P15	16.4 a	14.6 b	28.5 c	27.8 c
GxT P7	14.2 d	14.2 b	26.3 e	22.5 de
GxT P10	12.6 e	11.4 c	31.5 a	31.1 b

Table 5. Amounts of main organic acids of ripen apricot (mg/100g fresh fruit) in 2007. Means with the same letter do not significantly differ for p≤ 0.05.

Cultivar / Selection	Succinic acid	D-malic acid	Citric acid	Quinic acid	Total
Goldrich	42 abc	814 ab	1994 a	61 ab	2911
Laycot	53 ab	699 abc	1513 ab	82 a	2347
Tonda di Costigliole	**22 c**	**582 cd**	**1241 b**	**25 cd**	**1870**
LxT P8	27 bc	612 bcd	1693 ab	12 d	2344
LxT P14	35 abc	839 a	1292 b	27 cd	2193
LxT P15	29 abc	754 abc	1541 ab	48 bc	2372
GxT P7	59 a	593 cd	1805 ab	44 bc	2501
GxT P10	36 abc	413 d	1970 a	83 a	2502

Table 6. Amounts of main sugars and sugar-alcohols in ripen apricot (mg/100g fresh fruit) in 2007. Means with the same letter do not significantly differ for p≤ 0.05.

Cultivar / Selection	D-sorbitol	myo-inositol	Sucrose	D-(+)-raffinose	Fructose	Glucose	D-(+)-xylose	Total
Goldrich	108 de	64 cd	5469	47	624 b	2652 bc	54	9018
Laycot	610 ab	78 bc	6767	126	562 bc	1994 cd	64	10201
Tonda di Costigliole	**433 bc**	**76 bcd**	**6959**	**53**	**695 ab**	**3214 ab**	**28**	**11458**
LxT P8	735 a	61 d	5422	83	614 b	2118 cd	26	9059
LxT P14	415 bc	97 a	6625	50	868 a	3949 a	46	12050
LxT P15	704 a	64 cd	5739	87	664 b	2168 cd	42	9468
GxT P7	274 cd	77 bcd	12754	455	382 cd	2627 bc	62	16631
GxT P10	20 e	85 ab	7252	31	261 d	1509 d	58	9216

Table 7. Antioxidant activity and amounts of total phenolics of ripen apricot (2007). Means with the same letter do not significantly differ for p≤ 0.05.

Cultivar/Selection	FRAP (mmol Fe^{2+}/kg)	Total polyphenolics (mg gallic ac./100 g)	Cultivar/Selection	FRAP (mmol Fe^{2+}/kg)	Total polyphenolics (mg gallic ac./100 g)
Goldrich	11.55 ab	119.03 ab	LxT P14	6.83 c	51.31 d
Laycot	11.06 ab	64.33 cd	LxT P15	12.40 ab	114.35 ab
Tonda di Costigliole	**10.65 b**	**97.78 bc**	GxT P7	12.37 ab	98.68 bc
LxT P8	13.28 a	101.17 bc	GxT P10	13.33 a	143.40 a

Figures

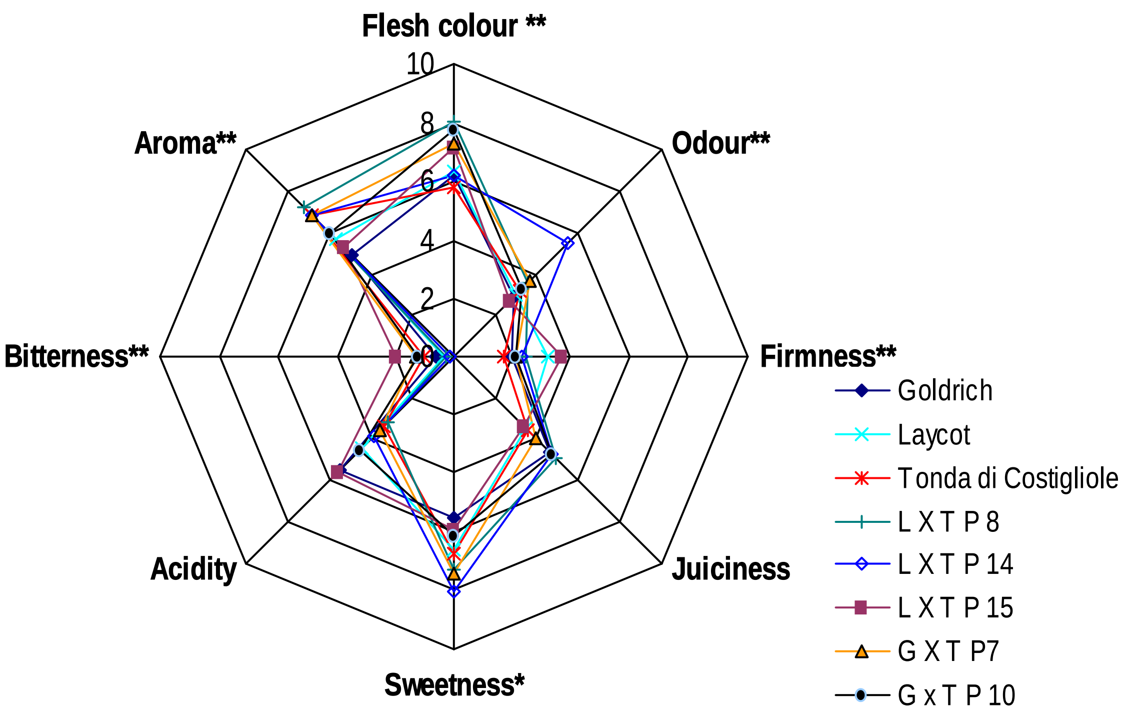

Fig. 1. Sensory profiles of apricot cultivars and selections (2007); * p≤0.05; ** p≤0.01.