ECPGR Priority Descriptors for Peach [*Prunus persica* (L.) Batsch]

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Introduction

The First Priority Descriptors (FPDs) are those that should be prioritized in the characterization/evaluation work as they are considered as the most useful. They should therefore also be prioritized in the process of description of the accessions to be included in the European *Prunus* Database (EPDB) (Lateur et al. 2013).

The present document provides:

- the list of 23 FPDs selected by the *Prunus* Working Group for peach (*Prunus persica* (L.) Batsch), together with an additional set of 14 "second priority" descriptors deemed useful to supplement the FPD set with the aim of increasing completeness of the evaluation and/or characterization work;
- for those descriptors showing continuous variability, rankings on a 1-9 scale are generally provided; when the information is available, the peach and nectarine reference cultivars that can help assigning the accession to the correct ranking are indicated;
- guidelines and protocols to follow during the evaluation/characterization of the European accessions with a view of allowing an easier comparison of data from different collections.

Peach-specific guidelines

• Reference cultivars

In order to help scoring and classifying phenological and morphological features of peach genotypes, it is advisable to include in the evaluation work all or at least part of the following set of peach/nectarine reference cultivars:

1. **Redhaven**, worldwide known, medium flowering and ripening time; yellow, melting-fleshed peach of medium firmness;
2. **Big Top**, medium-early flowering and ripening time; yellow, very firm-fleshed and slow ripening, sub-acid nectarine;
3. **Stark Saturn**, medium ripening; white, medium-soft fleshed, sub-acid, flat peach;
4. **Springtime**, early flowering and ripening; white, soft-fleshed peach;
5. **Fairtime**, very late ripening; yellow fleshed peach of medium firmness;
6. **Andross**, late ripening; yellow, non melting, clingstone, firm-fleshed canning peach.

• Chilling requirement

In fruit trees, the chilling requirement (CR, descriptor #25) is the minimum amount of cold required by the flower buds to complete their morphological development during dormancy and bloom regularly. Each genotype has a specific CR which, if inadequately satisfied, can lead to serious disorders in the vegetative and flower bud break and development. Hence, assessment of CR is important to establish the potential adaptability of a genotype to a specific environment. It can be expressed in Chilling Hours (CH) or Chilling Units (CU), depending on the method used to calculate it. Several methods have been proposed so far, but the most commonly applied are:

- ✓ the method developed by Weinberger (1950), the simplest, which considers the temperatures below 7°C equally effective to rest completion: one hour below 7°C corresponds to one CH.
- ✓ the method proposed by Richardson et al. (1974), more complex but probably closer to measuring the real effects of temperature on buds, which considers the different effectiveness of temperatures in the range of 0°C to 16 °C, with an optimum of 7°C, and

the negative effect of temperatures above the 16°C threshold: one hour at 7°C corresponds to one CU, while higher or lower temperatures in the range 0°C-14°C result in a partial unit.

The CR of a genotype can be artificially measured by forcing bloom, in a warm environment, of fertile shoots collected periodically in the winter time after having accumulated a given quantity of hours below 7°C in the field, and recording the percentage of flower and vegetative buds that break in the following 10 to 14 days (Okie 1998). However, this method is cumbersome and time-consuming. A simple method to calculate indirectly the unknown CR of a genotype consists in comparing its bloom date with that of properly selected cultivar(s) whose CR has already been calculated (Scorza and Sherman 1996).

- **Flowering time**

Peach bears fruit mostly on 1-year-old wood, therefore the phenology of flowering in this species should be monitored on flower buds inserted on this type of fruiting wood. The flowering time (descriptor #1) is to be recorded when about 10% of the flower buds on medium vigour, 1-year-old shoots, have attained the open flower stage (BBCH code 61, according to Meier et al. 1994).

- **Harvest time**

The assessment of the precise date of harvest maturity of a peach/nectarine genotype is not a simple task, and generally requires expertise of the curator of the collection more than detailed protocols. Peach fruits on the same tree do not ripen at the same time (generally 3-5 pickings are required to complete the harvest, depending on the cultivars, the crop load, the weather conditions, etc.). The right picking time also depends on the final destination of the fruit. As a general rule, two indicators are crucial to assess the fruit ripening stage: skin ground colour (chlorophyll disappearance is a marker of ripening) and flesh firmness, measured with flesh texture analyser instruments. It is recommended to record the harvest time (descriptor #2) when some of the hanging fruits have first attained the eating maturity, which is considered reached when "the overall appearance, firmness and taste indicate that the fruit is ready for consumption" (CPVO 2012).

- **Fruit quality analysis and evaluation**

As the fruit quality of a peach/nectarine fruit is fully expressed at the eating maturity stage (BBCH code 89), it is recommended to perform both the instrumental analysis (descriptors #20 and #21) and the sensorial evaluation (descriptors #22 and #23) at this stage. At the eating maturity stage, the flesh firmness at cheeks of most peach/nectarine fruits has generally dropped to $\leq$2.0 kg (about 20 Newton, N). Fruit evaluation should be performed on a minimum of 5-10 fruits, ideally 20 fruits per accession, sampled following identical protocols across genotypes: fruits inserted on shoots of medium vigour, well exposed to sunlight, harvested around the canopy at man-height (avoid the inner or bottom parts of the canopy, where fruit quality is lower). Before performing the destructive analyses, let the fruit temperature equilibrate to the room temperature (22÷25°C). At least 5 fruits/accession should be individually measured for weight, flesh colour, fruit firmness and collectively measured for Soluble Solids Content (SSC) and Titratable Acidity (TA). To describe flesh colour (descriptor #16), it is recommended to control the terminology of the colours and its representation in standard Colour Charts, like the "Royal Horticultural Society Colour Chart". Measure flesh firmness on the two opposite cheeks of each fruit, after skin removal, with a penetrometer, automatic or hand-held, equipped with a 8-mm plunger and the penetration run until a 8-mm depth. To analyse both SSC and TA, remove a thin,

longitudinal flesh slice from each of the fruits sampled, then squeeze the slices together using a hand-presser, filtering the juice obtained by using wide-meshed cheese cloth or strainer to eliminate flesh residuals. Few drops of the juice are sufficient to measure SSC with a manual or analytical refractometer.

To measure TA, follow this procedure (adapted from Frett et al 2012):

- ✓ Put 10 ml of the filtered juice in a 50-ml beaker;
- ✓ Add 25 ml of distilled water, in order to allow complete dipping of the electrode sensor into the diluted juice (if an automatic titrator is used);
- ✓ Put a magnetic stirring bar into the beaker and place the beaker over a shaker to stir the juice throughout the titration (if an automatic titrator is used);
- ✓ Use 0.1 N NaOH to bring the juice to a final pH value of 8.2 (if using a manual titrator, add few drops of phenolphthalein indicator to the juice, and stop adding the 0.1 N NaOH when the colour of the juice turns purple).
- ✓ Record the amount (ml) of 0.1 N NaOH used.
- ✓ Calculate TA (expressed in meq/l) using the following formula:

TA (meq/l)= [mLs NaOH used] x [0.1 N NaOH] x [1000] / 10 ml juice.

- **Flesh phenotypes**

So far, three flesh phenotypes are known and well described in peach, which differ both for flesh texture and flesh softening process during ripening: Melting (M), Non-Melting (NM), Stony-hard (SH). A fourth flesh texture trait (SR), whose phenotype can be described as "very firm and slow ripening", can be found in the nectarine 'Big Top' (Bassi and Monet 2008) and in a few recently released Big Top-like cultivars. The M fruit shows a rapid and dramatic softening (called "melting") in the last phase of ripening. Most of the peaches and nectarines marketed worldwide belong to this phenotype, although the speed of softening greatly varies within this group. The NM fruit has a slower softening process, never melts and maintains a rather firm (gummy) texture when fully ripe. The lack of the melting phase is related to the lack of activity of the endopolygalacturonase enzyme, responsible for depolymerizing the cell wall pectins (Lester et al. 1996). The NM trait is also associated to the clingstone trait. All canning peaches belong to this genotype, although a number of NM cultivars for fresh market have been also developed. Both M and NM phenotypes produce high amounts of ethylene during ripening. The SH fruit does not produce ethylene (Haji et al. 2001). Flesh softening at full maturation in this phenotype is negligible, both on the tree and after harvest.

Finally, in the early ripening stage the SR phenotype resembles the SH flesh both for firmness and crispiness, though at full ripening it reveals its M nature, loosing consistency as much as the other melting types. Work is in progress to fully understand the physiological and genetic nature of the "slow ripening trait" (Bassi and Monet 2008).

- **Diseases**

Scoring the genotypes for their resistance/susceptibility to diseases is not an easy task: protocols for phenotyping such traits are often lacking, and the year course and the environmental characteristics of the evaluation site can influence the results. Resistance has often a multi-genic base, and it is not uncommon, indeed, to classify the same genotype into different classes of resistance when the evaluation is done in contrasting sites. The three descriptors #35, 36 and 37 rank the degree of susceptibility to three of the most dangerous pathogens for peach industry in Europe: *Taphrina deformans* (leaf curl), *Sphaeroteca pannosa* (powdery mildew) and *Monilinia* spp. (brown rot). The positioning of the reference cultivars in the various classes of susceptibility (and incidence, in %) was done in the light of multi-

year field evaluations in Forlì, Italy (lat. 44°13'N, long. 12°3'E; 730 mm of total rain, in rainy springs) and therefore should not be considered valid in absolute but indicative. Due to the many variability factors, phenotyping an accession for its resistance/susceptibility to a specific biotic agent requires at least 5-6 years of record on unsprayed trees.

The most appropriate time to monitor and score susceptibility to leaf curl and powdery mildew agents is early in the spring, while fruit susceptibility to brown rot is better monitored at ripening time.

Leaf curl

The first symptoms are reddish areas on developing leaves. These areas become thickened and puckered. This pathogen can infect young twigs and shoots, which become thickened and distorted. Symptoms on fruit, rather uncommon, make fruit skin corky and cracked. On average, nectarines are more susceptible than peaches.

Powdery mildew

The pathogen attacks young shoots and young leaves, which appear powdery, misshapen and puckered. Also young fruits can be infected, typically between shuck split and pit-hardening, and develop powdery white spots. As the fruit matures, infected areas may appear scabby and necrotic.

Brown rot

During the pre-harvest period, peach fruit susceptibility to brown rot increases dramatically. Symptoms of infections on fruits may first appear as small circular spots, which develop and enlarge rapidly. Diseased fruits typically shrivel and turn dark, either dropping to the ground or remaining hanging on the tree (mummies). Mummies are the major source of overwintering fungal inoculum. Fruits injured by hail, oriental fruit moths or other insects are very susceptible to brown rot infections. Harvested fruit is also commonly contaminated with spores of the brown rot fungus, and this can result in infection during storage.

First Priority Descriptors (FPD) for Peach

Note: IBPGR, CPVO and UPOV descriptor numbers are, where relevant, indicated.

1. Flowering time (IBPGR # 4.2.1; CPVO & UPOV # 67)

(time of beginning of flowering)

	Flowering time	days ± Redhaven	Peach reference cvs.	Nectarine reference cvs.
1	Extremely early	*earlier than -8*	*earlier than Tejon*	*earlier than Sunlight*
2	Very early	*-6÷-8*	*Tejon*	*Sunlight*
3	Early	*-4÷-6*	*Springtime*	*Armking*
4	Early/intermediate	*-2÷-4*	*Flavorcrest*	*Fantasia*
5	Intermediate	*0±2*	*Redhaven*	*Maria Aurelia*
6	Intermediate/late	*+2÷+4*	*Cresthaven*	*Nectared 4*
7	Late	*+4÷+6*	*Veteran*	*Philip*
8	Very late	*+6÷+8*	*Summerqueen*	*Golden State*
9	Extremely late	*later than +8*	*later than Summerqueen*	*later than Golden State*

Note: The stage of beginning of flowering is generally easy to assess with a reasonable accuracy in both showy and non-showy flowers. However, especially in genotypes with small-sized, non-showy flowers, the stigmas, the anthers or both the stigma and anthers might emerge from the corolla before the petals open (see Fig. 1). In this case, the beginning of flowering stage is considered reached when 10% of stigmas, anthers or both have emerged from the flowers in the tree.

Figure 1. Small sized, campanulaceous (non-showy) flowers in which the stigmas (in the magnified flower in the left also the anthers) have emerged from the still closed corolla.

2. Harvest time (IBPGR # 4.2.2; CPVO & UPOV # 68)

(time of beginning harvesting of fully mature fruit)

	Harvest time	days ± Redhaven	Peach reference cvs.	Nectarine reference cvs.
1	Extremely early	*earlier than -35*		
2	Very early	*-26÷-35*	*Rich May*	
3	Early	*-16÷-25*	*Springcrest*	
4	Early/intermediate	*-6÷-15*	*Royal Glory*	*Big Top*
5	Intermediate	*-5÷+5*	*Rich Lady*	
6	Intermediate/late	*+6÷+15*	*Glohaven*	
7	Late	*+16÷+25*	*Suncrest*	
8	Very late	*+26÷+35*	*Fayette*	*Western Red*
9	Extremely late	*later than +35*	*Tardibelle*	*California*

3. Tree size (CPVO & UPOV # 1)

	Tree size	Peach reference cvs.	Nectarine reference cvs
1	Dwarf	*Bonanza*	*Didone*
2	Small	*Richaven*	
3	Medium	*Elegant Lady*	*Big Top*
4	Large	*Redhaven*	
5	Very large	*Champion*	

Note: Class 1 groups the dwarf genotypes (Fig.2, left). The dwarf size in peach is controlled by a single recessive gene (*dw/dw*) which affects the internode length (7-8 mm vs. 20-25 mm in the standard trees) producing very short branches and consequently small-sized trees (Hansche 1988). Dwarf trees remain small – 1.0 to 2.0 m high – even when adult.

Classes 2 to 5 group standard (*Dw/-)* trees with different degrees of size, based on height and spread measurements of adult trees relative to reference cultivars grafted onto the same rootstock.

Figure 2. Young, coetaneous dwarf (left) and standard (right) peach trees. Each coloured section of the graded rod is 20 cm long.

1. Dwarf 3. Medium

4. Tree habit (IBPGR # 6.1.1; CPVO & UPOV # 3)

The variability observed for this trait depends on the average width of the crotch angle between one-year-old shoots and the supporting, higher ranking wood (Bassi et al. 2003). With respect to the zenith, the columnar is the type with the narrowest angle, while the weeping is that with the widest (Fig.3).

	Tree habit	Peach reference cvs.	Nectarine reference cvs.
1	Columnar	*Pillar*	*Alice-col*
2	Upright		
3	Semi-upright	*Redhaven*	*Fantasia*
4	Standard	*Elegant Lady*	
5	Open	*Gage Elberta*	
6	Compact	*Compact Redhaven*	
7	Weeping	*Biancopendulo*	*White Glory*

Figure 3. Tree habit (source: Bassi et al. 2003).

1. Columnar

2. Upright

4. Standard

5. Open

6. Compact

7. Weeping

5. Presence of nectaries (CPVO & UPOV # 30)

(presence/absence of glands at the leaf petiole)

	Nectaries	Peach reference cvs.	Nectarine reference cvs.
1	Absent	*Crimson Glo*	*Galoping*
2	Present	*Redhaven*	*Big Top*

Figure 4. Presence of nectaries

1. Absent 2. Present

6. Shape of leaf nectaries (IBPGR # 6.1.5; CPVO & UPOV # 31)

	Shape of nectaries	Peach reference cvs.	Nectarine reference cvs.
1	Reniform	*Redhaven*	*May Grand*
2	Globose (round)	*Springcrest*	*Freedom*

Figure 5. Shape of leaf nectaries.

1. Reniform 2. Globose

7. Flower type (IBPGR # 4.2.3; CPVO & UPOV # 9)

	Flower type	Peach reference cvs.	Nectarine reference cvs.
1	Rosaceous / Showy	*Flavorcrest*	*Flavortop*
2	Campanulate / Non-showy	*Springtime*	*Armking*

Figure 6. Flower type.

1. Rosaceous/showy

2. Campanulate/non-showy

8. Fruit skin pubescence (IBPGR # 6.2.4; CPVO & UPOV # 44)

(presence/absence of skin pubescence)

	Fruit skin pubescence	
1	Absent	Peach
2	Present	Nectarine

9. Fruit size (IBPGR # 6.2.4; CPVO & UPOV # 32)

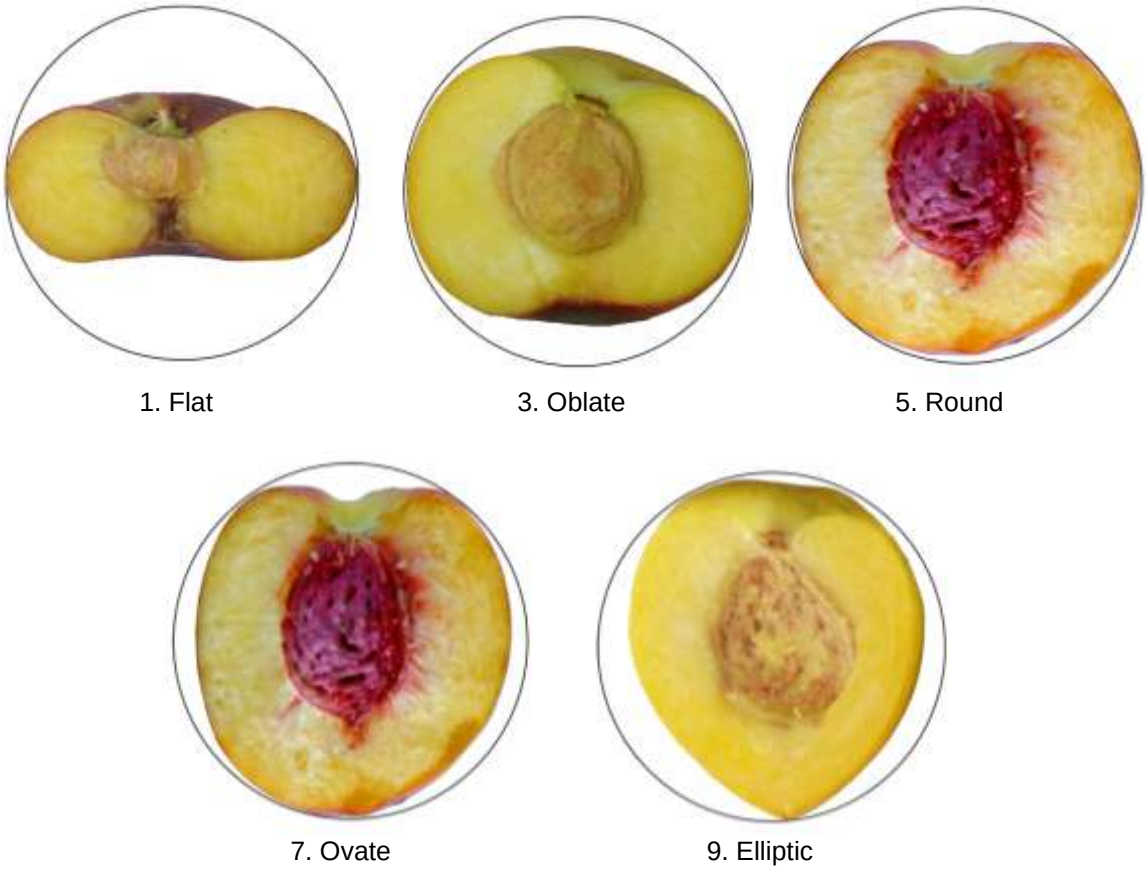
	Fruit size	Weight (g) (for peaches)	Peach reference cvs.	Weight (g) (for nectarines)	Nectarine reference cvs.
1	Very small	<100	*Oro A*	<80	*Nectadiana*
2	X	100-120		80-100	
3	Small	120-140	*Springtime*	100-120	*Supercrimson*
4	X	140-160		120-140	
5	Medium	160-180	*Redhaven*	140-160	*Silver Late*
6	X	180-200		160-180	
7	Large	200-220	*Fairtime*	180-200	*Orion*
8	X	220-240		200-220	
9	Very large	>240	*Cesarini*	>220	*Alitop, Zephir*

Note: Different weight ranges were provided to grade peaches and nectarines because, harvest date and growth condition being equal, the latter are smaller than the former.

10. Fruit shape (IBPGR # 6.2.5; CPVO & UPOV # 33)
(fruit longitudinal section)

	Fruit shape	Peach reference cvs.	Nectarine reference cvs.
1	Flat	*Stark Saturn*	*Mesembrine*
2	X		
3	Oblate	*Robin*	*Red Diamond*
4	X		
5	Round	*Redwing*	*Springred*
6	X		
7	Ovate	*Fairhaven, Slappey*	*Armking*
8	X		
9	Elliptic	*Elberta*	*Alitop*

Figure 7. Fruit shape.



Note: The most updated CPVO and UPOV guidelines do not include the Ovate (7) shape, presumably because it is considered commercially unacceptable, therefore absent in newly released cultivars; however, dealing with genetic resources, it is important to provide a more detailed list of categories. For images and pictures describing fruit shape in peach see also Morettini et al. (1962), Okie (1998) and Bellini et al. (2007).

11. Fruit ground colour (IBPGR # 6.2.7; CPVO & UPOV # 40)

(colour of the skin of fully mature fruit)

	Fruit ground colour	Peach reference cvs.	Nectarine reference cvs.
1	Green	*Rubberina*	*Tom Grand*
2	Greenish-white	*Springtime, Veteran*	*Morton*
3	Cream-green	*Carman*	
4	Cream-white	*Maria Bianca*	*Snowqueen*
5	Cream	*Amsden*	
6	Pink white	*Hale precoce*	
7	Greenish yellow		
8	Light yellow	*Spring gold*	*Armking*
9	Yellow	*J.H. Hale, Suncrest*	*Honey Gold*
10	Orange yellow	*Redtop*	*Maria Aurelia*
11	Not visible	*Vista Rich*	

Figure 8. Fruit ground colour.

2. Greenish-white

4. Cream-white

5. Cream

6. Pink white

7. Greenish yellow

9. Yellow

10. Orange yellow

11. Not visible

12. Fruit over colour (adapted from IBPGR # 6.2.8; CPVO & UPOV # 43)

(over colour of the skin of fully mature fruit)

	Fruit over colour	Peach reference cultivars	Nectarine reference cvs.
1	Absent	*Ghiaccio 1*	
2	Orange red	*Velvet*	
3	Pink	*Genard*	
4	Pink red		*Fuzalode*
5	Light red	*Redtop*	
6	Medium red		*Red Diamond*
7	Dark red	*Redwing*	
8	Blackish red	*Vista Rich*	

Figure 9. Fruit over colour.

1. Absent 2. Orange red 4. Pink red

6. Medium red 7. Dark red 8. Blackish red

13. Extent of fruit over colour (CPVO & UPOV # 43)

(blush: anthocyanin coloration of skin)

	Fruit over colour	Over colour extent (%)	Peach reference cvs.	Nectarine reference cvs.
1	None	0	*Ghiaccio 1, Oro A*	
2	Very slight	10÷15		
3	Slight	15÷30	*Amsden*	*Armking*
4	Slight to medium	30÷45		
5	Medium	45÷60	*Redhaven, J.H. Hale*	*May Grand*
6	Medium to widespread	60÷75		
7	Widespread	75÷90	*Suncrest, Springcrest*	*Red Gold*
8	Very widespread	90÷100		*Big Top*
9	Hiding ground colour		*Vista Rich*	

Figure 10. Extent of over colour.

1. None

2. Very slight

4. Slight to medium

6. Medium to widespread

8. Very widespread

9. Hiding ground colour

14. Flesh type

	Flesh type	Peach reference cvs.	Nectarine reference cvs.
1	Melting	*Redhaven*	*Spring Red*
2	Non-melting	*Andross*	*Maria Dorata*
3	Stony hard	*Yumyeong*	
4	Slow softening		*Big Top*

The distinctive characteristics of the four flesh genotypes are detailed in the "Flesh phenotypes" paragraph (p. 3).

15. Flesh firmness (IBPGR # 6.2.10; CPVO & UPOV # 50)

(evaluated on fully mature fruits)

	Flesh firmness	Peach reference cvs.	Nectarine reference cvs.
1	Very soft	*Tejon*	*Morton*
2	X		
3	Soft	*Amsden*	*Mayred*
4	X		
5	Medium	*Redhaven*	*Firebrite*
6	X		*Fantasia*
7	Firm	*Rich Lady*	
8	X		*Big Top*
9	Very firm	*Yumyeong*	

16. Flesh colour (IBPGR #4.2.5; CPVO & UPOV # 51)

(excluding anthocyanin coloration)

	Flesh colour	Peach reference cvs.	Nectarine reference cvs.
1	Greenish white	*Amsden*	*Morton*
2	White (snow white)	*Springtime*	*Caldesi 2000*
3	Cream white	*Maria Bianca*	*Snow Queen*
4	Greenish yellow	*Vesuvio*	*Armking*
5	Light yellow	*Redhaven*	*Springred*
6	Yellow		*Big Top*
7	Orange yellow	*Babygold 6*	*Maria Aurelia*
8	Orange		*Sungold*

Figure 11. Flesh colour.

1. Greenish white

2. White

4. Greenish yellow

5. Light yellow

6. Yellow

7. Orange yellow

17. Anthocyanin coloration of the flesh (CPVO & UPOV # 52, 53, 54)

	Red colour in the flesh	Peach reference cvs.	Nectarine reference cvs.
1	Absent	*Ghiaccio 1*	
2	Weak	*Rich Lady*	
3	Only under the skin		*Nectavigne*
4	Under the skin and around the stone		
5	Only around the stone	*Summer Lady*	
6	In the whole flesh, faint	*Royal Majestic*	
7	In the whole flesh, intense	*Sanguine Vineuse*	

Figure 12. Anthocyanin coloration of the flesh.

1. Absent 2. Weak 3. Only under the skin

5. Only around the stone 6. In the whole flesh, faint 7. In the whole flesh, intense

Note: the onset of the red colour in the flesh, if any, usually occurs at the fruit maturity stage. The red pigments can be located under the skin and/or around the stone (the two positions are independent), and their amount and distribution in the flesh depend on the genotype but are also influenced by the environment (quantitative trait).

In the case of the "blood flesh" fruit, two different genes responsible for the intense and widespread red coloration of the flesh have been found so far:

1. Bf/- The red pigment appears since the early developmental stage of the fruit and is under the control of a single dominant Mendelian trait (Werner et al. 1998); it is invariably associated with the red midrib leaf phenotype and reduced tree vigour.

2. DBf/- This gene is also single and dominant, but the red pigment appears only in the later stages of the fruit development, and is neither associated to the red midrib or the reduced vigour (T. Pascal, personal communication).

18. Flesh-to-stone adherence (IBPGR # 6.3.3; CPVO & UPOV # 64-65)

	Flesh-to-stone adherence	Peach reference cvs.	Nectarine reference cvs.
1	Freestone	*Elberta*	*Maria Aurelia*
2	Semi-freestone	*Cardinal*	*Maria Emilia*
3	Clingstone	*Andross*	*Fairlane*

Figure 13. Flesh-to-stone adherence.

1. Freestone 3. Clingstone

19. Stone shape (IBPGR # 6.3.2; CPVO & UPOV # 59

(lateral view)

	Stone shape	Peach reference cvs.	Nectarine reference cvs.
1	Oblate	*Stark Saturn*	*Mesembrine*
2	Round	*Cresthaven, Andross*	
3	Elliptic		*Orion*
4	Obovate	*Rubidoux*	

Figure 14. Stone shape.

1. Oblate 2. Round 3. Elliptic 4. Obovate

20. Fruit Soluble Solids Content (SSC)

(instrumental measure)

	Soluble solids content	% Brix	Peach reference cvs.	Nectarine reference cvs.
1	Extremely low content	<8		
2	X	8-9	*Francoise*	*Weinberger*
3	Low content	9-10	*Alexandra*	*Armking*
4	X	10-11		
5	Medium content	11-12	*Redhaven*	*Orion*
6	X	12-13		
7	High content	13-14	*Royal Time*	*Big Top*
8	Very high content	14-15	*Stark Saturn*	
9	Extremely high content	>15	*Sweet cap*	*Romagna Top*

21. Fruit Titratable Acidity (TA)

(instrumental measure)

	Acid content	TA (meq/l)	Peach reference cvs.	Nectarine reference cvs.
1	Extremely low content	<30		
2	X	30-50	*Stark Saturn*	*Zephir*
3	Low content	50-70	*Sweet Fire*	*Big top*
4	X	70-90	*Andross*	
5	Intermediate content	90-110	*Redhaven*	*Rita Star, Rose Diamond*
6	X	110-130		
7	High content	130-150	*Rubirich*	*Nectaross*
8	Very high	150-170	*Regina d'Ottobre*	*Armking, Sweet Lady*
9	Extremely high content	>170		*August Red*

22. Sensorial analysis of sugar/acid ratio

	Balance acidity/sweetness of flesh	Peach reference cvs.	Nectarine reference cvs.
1	Extremely acid taste		
2	X	*Rich May*	*Big Ball, Armking*
3	Acid taste	*Rich Lady*	*Nectaross*
4	X		
5	Balanced taste	*O'Henry*	
6	X		
7	Sweet taste	*Sweet Cap*	*Big Top, Zephir*
8	X	*Royal Glory*	
9	Extremely sweet taste		

When tasting a fruit, the general impression of the taste can be defined relatively easily by the relative balance between acidity and sweetness perception. In a scale 1 to 9, the lowest class is that where the perception of sour taste almost completely masks the perception of sweetness of the fruit and vice versa for the highest class.

23. Sensorial analysis of Global Taste Quality

	Global taste quality
1	Extremely poor
2	Very poor
3	Poor
4	Poor to good
5	Good
6	Good to very good
7	Very good
8	X
9	Extremely good

The evaluator is asked to assess the fruit taste quality on a 1 to 9 scale, as the result of the overall evaluation of the several sensory attributes which are known to affect taste (e.g. sweetness, acidity, sweetness/acidity balance, flesh texture and firmness, juiciness, etc.).

Second Priority Descriptors for Peach

24. Tree vigour (IBPGR # 6.1.2; CPVO & UPOV # 2)

	Tree vigour	Peach reference cvs.	Nectarine reference cvs.
1	Extremely weak		
2	Very weak		
3	Weak	*J.H. Hale*	*Mayred*
4	X		
5	Medium	*Redhaven*	*Nectarose*
6	X		
7	Strong	*Springtime*	*Flavortop*
8	Very strong		
9	Extremely strong		

25. Chilling requirement (IBPGR # 6.1.3)

(CH = number of hours below 7°C required to overcome endodormancy)

	Chilling requirement	Amount of CH	Peach reference cvs.	Nectarine reference cvs.
1	Extremely low	*<100*	*FlordaGrande*	
2	Very low	*100-200*	*Flordaprince*	*Mayglo*
3	Low	*200-300*	*Oro A*	
4	Medium-low	*300-500*	*Flordaking*	
5	Medium	*500-700*	*Spring Crest*	*Armking*
6	Medium-high	*700-900*	*Elegant Lady, Fayette*	*Indipendence*
7	High	*900-1100*	*Redhaven*	*Spring Red*
8	Very high	*1100-1300*		
9	Extremely high	*>1300*		

The peach and reference varieties categorized by their CH requirement were taken from Okie (1998). Their chilling requirement was directly calculated (Weinberger 1950) or inferred by comparison with the bloom date of cultivars of known chilling requirement.

26. Density of flower buds (CPVO & UPOV # 8)

(to be assessed on one-year-old shoots)

	Density of flower buds	Peach reference cvs.	Nectarine reference cvs.
1	Extremely sparse		
2	X		
3	Very sparse		*Big Top*
4	X		
5	Medium	*Rich Lady*	
6	X		
7	Very dense		
8	X		*Armking*
9	Extremely dense		

Figure 15. Density of flower buds.

2. Very sparse

8. Very dense

27. Position of the stigma compared to the anthers (CPVO & UPOV # 16)

	Position of the stigma
1	Below anthers
2	Same level as anthers
3	Above anthers

Figure 16. Position of the stigma compared to the anthers.

1. Below the anthers

2. Same level as the anthers

3. Above the anthers

28. Pattern of skin over colour (IBPGR # 6.2.8; CPVO & UPOV # 43)

	Pattern type	Peach reference cvs	Nectarine reference cvs.
1	Solid	*Diamond Princess*	
2	Striped	*Vista Rich*	
3	Mottled		
4	Marbled	*Zee Lady*	
5	Striped and marbled		
6	Other		

Figure 17. Pattern of skin over colour.

1. Solid 2. Striped 3. Mottled 4. Marbled

29. Fruit: prominence of suture (CPVO & UPOV # 37)

	Prominence degree	Peach reference cvs	Nectarine reference cvs.
1	Extremely week		
2	Very weak		
3	Weak		
4	Weak to medium		
5	Medium		
6	Medium to strong		
7	Strong		
8	Very strong		
9	Extremely strong		

Figure 18. Prominence of suture. Not yet available

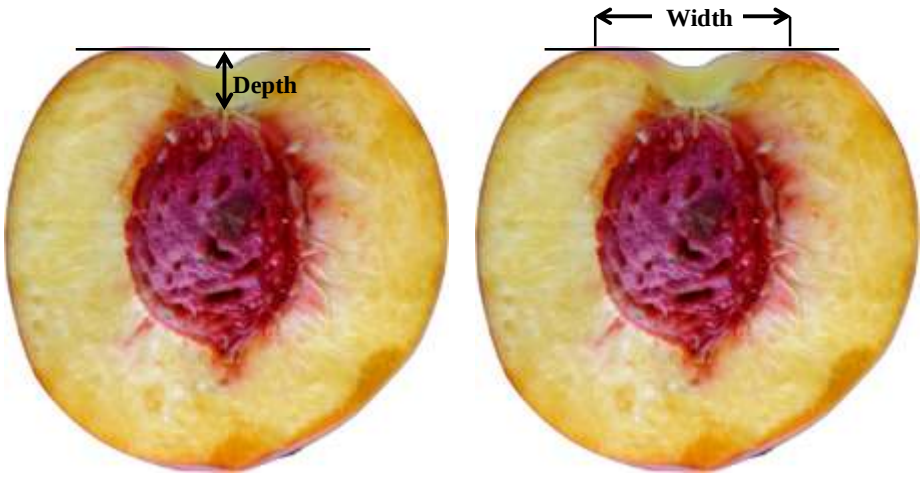
30. Fruit: depth of stalk cavity (CPVO & UPOV # 38)

	Depth of stalk cavity	Peach reference cvs.	Nectarine reference cvs
1	Extremely shallow		
2	X	*Stark Saturn, Ufo3*	*Mesembrine*
3	Shallow		
4	X		
5	Medium	*Crimson Lady*	*Elegant Lady*
6	X		
7	Deep	*Rich Lady*	
8	Very deep		
9	Extremely deep		

31. Fruit: width of stalk cavity (CPVO & UPOV # 39)

	Width of stalk cavity	Peach reference cvs.	Nectarine reference cvs
1	Extremely narrow		
2	Very narrow		
3	Narrow		*Summer Beauty*
4	X		
5	Medium	*Fayette*	*Elegant Lady*
6	X		
7	Broad	*Fairtime*	
8	Very broad		
9	Extremely broad		

Figure 19. Fruit: depth and width of stalk cavity.



32. Fruit: flesh fibre (CPVO & UPOV # 55)

	Fruit flesh fibre	Peach reference cvs.	Nectarine reference cvs.
1	Absent or weak	*Redhaven*	
2	Moderate		*Big Top*
3	Strong	*Sunhigh, Oro A*	

Figure 20. Flesh fibre.

3. Strong

33. Stone: size compared to fruit (IBPGR # 6.3.1; CPVO & UPOV # 58)

	Stone relative size to fruit	Peach reference cvs.	Nectarine reference cvs
1	Extremely small		
2	X		
3	Small	*Alex, Robin*	
4	X		
5	Medium	*Redhaven*	
6	X		
7	Large	*Somervee*	
8	X		
9	Extremely large		

Figure 21. Stone relative size to fruit. Photo for 5 to be changed

3. Small 5. Medium 7. Large

34. Stone: relief of surface (CPVO & UPOV # 62)

	Type of relief
1	Only pits
2	Predominantly pits
3	Pits and grooves
4	Predominantly grooves
5	Only grooves

Figure 22. Stone: relief of surface.

2. Predominantly pits

4. Predominantly grooves

35. Diseases: leaf and fruit susceptibility to leaf curl (IBPGR # 8.2.8)

(agent: *Taphrina deformans*)

	Degree of susceptibility to leaf curl	Incidence (%)	Cultivars	Remarks, observation in the field
1	None	0	*Cesarini**	No visible symptom at all
2	Very low	0÷1	*Bella di Roma, Aliblanca*	Only one or few leaves affected, only detectable on close scrutiny of the tree
3	Low	1÷5	*Big Top, Redhaven*	Infected leaves readily apparent but without important consequences for the tree
4	X	X	*Fayette*	
5	Medium	~ 25	*Summer Rich*	Widespread symptoms on a substantial part of leaves and young shoots. Possible symptoms on a few fruits
6	X	X		
7	High	~ 50	*Fairlane, Tropic Sweet*	Heavy infection on the whole canopy. Symptoms also on fruits
8	X	~ 75		
9	Extremely high	> 90		Tree survival seriously compromised

***** The resistance of Cesarini to the leaf curl disease agent is, indeed, due to the rapid host cell death due to a hypersensitive response at the infection site; dying cells prevent further pathogen development.

Figure 23. Young shoot (left) and nectarine fruit (top centre) badly injured by the leaf curl agent. On the right, canopy of the peach cv. 'Ruby Pearl' (untreated), in a year particularly favourable to the disease. Susceptibility score attributed to the tree = 7 (High).

36. Diseases: leaf and fruit susceptibility to powdery mildew (IBPGR # 8.2.2)

(agent: *Sphaeroteca pannosa*)

	Degree of susceptibility to powdery mildew	Incidence (%)	Cultivars	Remarks, observation in the field
1	None	0	*Oro A*	No visible symptom at all
2	Very low	0÷1		One or very few organs affected, only detectable on close scrutiny of the tree
3	Low	1÷5	*Redhaven*	Infected organs readily apparent but without important consequences for the tree
4	X	X	*Fayette, Independence*	
5	Medium	~ 25	*Caldesi 2010*	Widespread symptoms over the tree on a substantial part of the fruits and the leaves
6	X	X		
7	High	~ 50	*Nectaross, Silver King*	Heavy infection (approximately half of the fruits/leaves are infected)
8	X	~ 75		
9	Extremely high	> 90		Tree survival seriously compromised

Figure 24. Typical spots in nectarine (above, left) and peach (above, right) fruits. In the picture below, very severe symptoms of powdery mildew infection on shoots/leaves (susceptibility ranking attributed to the tree = 9) as compared to a sound leaf from a resistant genotype (rank=0).

37. Diseases: fruit susceptibility to brown rot (IBPGR # 8.2.1)

(agent: *Monilinia* spp.)

	Degree of susceptibility to brown rot	Incidence (%)	Cultivars	Remarks, observation in the field
1	None	0		No visible symptom at all
2	Very low	0÷1	*Bolinha*	One or very few fruits affected, only detectable on close scrutiny of the tree
3	Low	1÷5	*Contender*	Infected fruits readily apparent but without important consequences on yield
4	X	X	*Redhaven*	
5	Medium	~ 25		Widespread symptoms over the tree on a substantial part of the fruit
6	X	X		
7	High	~ 50	*Elegant Lady*	Heavy infection (approximately half of the fruits are infected)
8	X	~ 75		
9	Extremely high	> 90		Tree survival seriously compromised

Figure 25. Typical disease symptoms induced by *Monilinia* spp. on peach fruits (top left). Fruit infected profusely sporulate, shrivel, and eventually become tough mummies (top right). Rots also occur in the postharvest, during storage and shipment (bottom).

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