

The morphology of stigmata in stone fruit species

Szabó Z.¹, Nyéki J.¹ and Felhősné Vácz E.²

¹Debrecen University, Centre of Agricultural Sciences,
H-4032 Debrecen, Böszörményi út 138.

²Szent István University, Faculty of Horticulture, Dept. of Botany 1118
Budapest, Ménesi út 44.

INTERNATIONAL
JOURNAL OF
HORTICULTURAL
SCIENCE

AGROINFORM
Publishing House, Hungary



Key words: stigma, morphology, sweet cherry, sour cherry, plum, apricot, peach

Summary: The morphology of the stigma has been studied in 50 varieties belonging to 6 stone fruit species. The majority of samples had elliptical stigmata with some exceptions with circular form (*Duarte*, *Tuleu gras*). The surface of the stigma is papillary, flattened in side view (sweet cherry) or bulging (apricot, peach). The suture of the stigma is clearly visible as a depression and the varieties may differ in this respect.

The size of the stigma depends highly from the season, although the varietal differences are maintained. The dimension of stigmatic surface is characteristic for the species expressed in square millimetres: sweet cherry 0.92 to 2.91; sour cherry 1.64 to 2.48; plum 0.83 to 1.80; oriental plum 0.53 to 1.15; apricot 0.57 to 1.69 mm².

The size and morphology of the stigma changes according to varieties too, and it may be used in description and identification of varieties.

No correlation has been found between the size of stigma and the fertility relations (self-fertility or self-incompatibility) of the respective varieties.

Introduction

The stigma is the distal part of the pistil. Its function is the capturing of pollen grains. The quality and size of the surface is, according to the generally accepted claim, adapted to that role, i.e. the way of pollination, and subject to phylogenetic patterns of the taxon.

For the growth of pollen tubes and fertilisation, the stigma, the style, especially its length and structure are decisive (Gulyás 1975). Filarszky (1911) described the types of stigmata and grouped them according to their form as globular, dish, shield, feathery and branching as a brush.

Cresti and associates (1985) described the morphology of stigmata of fruit trees including some stone fruit species. They stated that the stigmatic surface of European plum and sweet cherry is warty. The skin of warts is not striated in plum, whereas the warts are irregular in sweet cherry. On the stigma of plums, a radial depression is extending from the middle to the margin. In sweet cherry there is a hole in the middle of the stigma. The stigma of both, apricot and peach, is lobate, partially, and a split represents the suture. The warts on the surface are variable in size and shape.

Preininger (1989) following Cresti et al. (1985) dealt with the stigma of European and oriental plum and confirms their statements referring to the papillary surface and the depressed fold of the suture. The shape of the stigma has

been called elliptical with the exception of the oriental plums, *Duarte* and *Bluefre*, with circular stigmata. The form of the stigma is considered as typical to the variety.

Conditions of pollination depend also on the ratio of diameter of stigma per pollen size as suggested by Surányi (1980). The chance of a pollen to be cached by the stigma depends on mathematical probabilities expressed by that ratio. High values of the quotient are proper to self-fertile varieties. They have also larger stigmata, according to his observations, hence their high fertility.

The diameter of the stigma being one of the most important morphogenetic features of the flower and characteristic to the variety, depends also on the season and is also decisive to fertility (Nyéki 1974, Surányi 1985).

Preininger (1989) observed substantial differences in the diameter of stigma between European and oriental plum. Stigmata of European plums are generally larger, longer and more extended.

The epidermis of the stigma has differentiated to a glandular epidermis, the papillae are bulging on the surface and are covered by a cuticle. The glandular epidermis is secreting a sugary liquid which stimulates the growth of pollen tubes. According to Haraszti (1976) the stigma may be considered to be a nectary from both point of view, structurally as well as functionally.

Material and methods

During the period between 1985 and 1990, the morphology of stigmata has been studied in 5 sweet cherry, 4 sour cherry, 7 oriental plum, 26 European plum, 4 apricot and 4 peach varieties.

Open flowers have collected at random from the selected trees (2–3 per variety) being in full bloom. The samples were closed in plastic boxes put in a refrigerator until processing.

Observations were made under stereo-microscope on fresh stigmata. The main features, i.e. shape, surface, margin, edge, suture, have been noted. The shape was either elliptical, slightly elliptical or circular, the surface either flattened, bulging or irregular, the margin either smooth or undulate, the edge straight or more or less recurved, the suture either slightly depressed or depressed as well as deeply depressed.

The length and width of the style has been measured in light microscope. Each variety was represented by 20 flowers which hardly opened. Stigmata have been excised by a razor blade and mounted on a slide in 50% glycerol.

Measurements are made using an ocular micrometer. The scale of the ocular has been calibrated by an objective-micrometer. The size of the stigma was expressed in μm . The size of the surface was calculated according to the formula: $T = a \times b \times \pi$, where a and b are the two, longer and shorter radii of the ellipsis. The values of μm^2 were transformed to mm^2 values.

Results

Morphological traits of the stigma are presented in *Table 1*. Stigmata of sweet cherries are elliptical or reniform. The surface of was in all varieties flattened, the margin undulate in *Germersdorfi óriás*, the edge not recurved in *Van*, but slightly recurved in the rest of varieties. The suture is distinct on the surface of the stigma, there is a depression.

In sour cherries, the stigmata are equally elliptical. The suture on the surface, as a depression is shallow (*Újfehértói fürtös*), intermediate (*Érdi bötermő*), or deep (*Pándy 7*, *Cigánymeggy 7*). The edge is recurved in all varieties, the surface is bulging except in *Érdi bötermő* where slightly flattened or in *Pándy meggy 7* where irregular.

In European plum, stigmata are circular (*Tuleu gras*) or slightly elliptical. The surface is bulging in *Althann ringlő*, and slightly flattened in the rest. The edge is recurved in *Althann ringlő*, but only slightly in the other three varieties. The suture is generally distinct, rather deep in *Althann ringlő*, less so in others, hardly visible in *Tuleu gras*.

Stigmata of oriental plums are similar to the European plums. In *Duarte* the stigma is circular, in the rest of varieties slightly elliptical. The surface is slightly bulging (*Elephant Heart*) or bulging, the edge is recurved or slightly recurved like in European plums. The suture appears variably, slightly depressed (*Methley*, *Elephant Heart*), or markedly depressed (*Duarte*, *Friar*), like in European plums.

The stigmata of apricots are slightly elliptical, bulging in *Ceglédi óriás*, slightly flattened in *Borsi-féle kései rózsza*,

slightly bulging in the rest of apricots studied. The edge of stigma is slightly recurved, whereas markedly recurved in *Ceglédi óriás*. The suture is distinctly depressed in *Borsi-féle kései rózsza* and *Ceglédi óriás*, slightly depressed in *Gönci magyar kajszai* and *Bergeron*.

In peaches the morphology of stigmata was difficult to associate with varieties, the surface is bulging, uniformly, the edge slightly recurved except in *Redhaven* being markedly recurved. The suture of the stigma is visible as a depression.

The quantitative data, length, width and surface, are shown in *Table 2* and *3*.

In sweet cherries, substantial differences were found over two years between the data of measurements of varieties. The surface area of the stigmata varied in 1989 between 0.92 and 1.62 mm^2 , in 1990 between 1.43 and 2.91 mm^2 . Outstanding high value was proper to *Jaboulay* (2.91 mm^2), also in length and width (2106 μm , 1762 μm , respectively). Lowest values of area were in *Bigarreau Burlat*, 1989 (0.92 mm^2) also in length and width. The effect of the season was strong regarding data of the two subsequent years.

The stigma of sour cherry is larger (longer and wider) than of sweet cherry. The area varied between 1.64 and 2.48 mm^2 . The effect of seasons was observed in *Cigánymeggy 7* and *Újfehértói fürtös*, whereas *Pándy 7* and *Érdi bötermő* did not change during the two years. The largest area is found in 1989 at *Pándy 7*, but in 1990 at *Újfehértói fürtös*. The latter changed the width as well as the length of the stigma, whereas the former the length, only (1936 and 1634 μm , on the other hand 1894 μm , respectively). Lowest values of both years were found in *Cigánymeggy 7* (1.64, and 1.72 mm^2). Related to the rest of varieties, those values are outstanding.

Among Europea plums, *Althann ringlő* produced the highest values in both seasons as for the length and width of the stigma, consequently, for the area of stigmatic surface (1.80 and 1.64 mm^2). *Stanley* was the sole variety in being invariable over the years. The smallest stigmatic area is found in 1989 at *President*, however, in 1990 at *Stanley*. Length varied between 1075 and 1515, width between 985 and 1380 μm , whereas the area between 0.83 and 1.80 mm^2 .

Stigmata of oriental plums are shorter, narrower and have a smaller area than European plums. The effect of the two seasons is observed also on the differences between varieties. The smallest area was in *Duarte* (0.53 and 0.61 mm^2), largest in *Elephant Heart* (0.84 and 1.15 mm^2). Length changed between 870 and 1250, width between 750 and 1183 μm , area between 0.53 and 1.15 mm^2 . In 1989 and 1990 measurements of stigmata are performed at Siófok (*Table 3*). Stigmata are smaller in oriental plums than in European plums. Varieties as well as seasons produced large variation.

In apricot too, the effects of varieties as well as of both seasons proved to be decisive. Smallest stigmatic area was in 1989 at *Ceglédi óriás* (0.73 mm^2), in 1990 at *Bergeron* (1.21 mm^2). Length varied between 1044 and 1519, width between 888 and 1090 μm , area between 0.73 and 1.45 mm^2 .

Table 2 Measures of stigmata in stone fruit species (Kecskemét)

Variety	Length (µm)		Width (µm)		Area (mm ²)		Mean of area
	1989	1990	1989	1990	1989	1990	
Sweet cherry							
Bigarreau B.	1.167	1.762	1.004	1.497	0.92	2.07	1.49
Germersdorfi	1.240	1.579	1.050	1.162	1.02	1.44	1.23
Jaboulay	–	2.106	–	1.762	–	2.91	2.91
Szomolyai f.	–	1.852	–	1.566	–	2.28	2.28
Van	1.634	1.534	1.270	1.188	1.43	1.52	
Mean	1.347	1.766	1.108	1.435	1.18	2.03	1.61
Sour cherry							
Cigánymeggy	1.575	1.162	1.325	1.325	1.320	1.64	1.68
Érdi bötermő	1.850	1.840	1.615	1.606	2.34	2.32	2.33
Pándy 7	1.894	1.914	1.596	1.598	2.37	2.40	2.38
Újfehértói fűrtös	1.805	0.936	1.510	1.634	2.14	2.48	2.31
Mean	1.781	1.838	1.511	1.539	2.12	2.23	2.17
European plum							
Althann ringlő	1.611	1.515	1.430	1.380	1.80	1.64	1.72
President	1.075	1.200	0.985	1.095	0.83	1.03	0.93
Stanley	1.187	1.137	1.064	1.057	0.99	0.94	0.96
Tuleu gras	1.195	1.420	1.090	1.330	1.02	1.48	1.25
Mean	1.267	1.318	1.142	1.215	1.16	1.27	1.21
Japanese plum							
Duarte	0.870	0.962	0.795	0.807	0.53	0.61	0.57
Elephant Heart	1.082	1.250	0.990	1.183	0.84	1.15	0.99
Friar	0.905	–	0.750	–	0.54	–	0.54
Methly	0.964	1.082	0.852	0.993	0.64	0.83	0.73
Mean	0.995	1.098	0.847	0.994	0.63	0.86	0.74
Apricot							
Bergeron	1.045	1.420	0.909	1.090	0.74	1.21	0.97
Borsi-féle k.r.	1.104	1.400	0.902	1.266	0.78	1.35	1.06
Ceglédi óriás	1.044	1.472	0.888	1.120	0.73	1.44	1.08
Gönci m.k.	1.083	1.519	0.956	1.223	0.82	1.45	1.13
Mean	1.069	1.452	0.914	1.175	0.76	1.36	1.06
Peach							
Babygold 5	0.944	1.440	0.784	1.185	0.58	1.34	0.96
Independence	0.921	1.403	0.795	1.214	0.57	1.33	0.95
Redhaven	1.100	1.605	0.890	1.345	0.77	1.69	1.23
Springtime	1.047	1.300	0.827	0.856	0.68	1.03	0.86
Mean	1.003	1.437	0.827	1.150	0.65	1.35	1.00

Table 3 Stigmatic area of plum varieties

Variety	Stigmatic area	
	1984	1985
Japanese plum		
Burbank	0.4816	0.5882
Duarte	0.5960	0.3274
Elephant Heart	0.8409	0.5916
Methley	0.5041	0.3408
Santa Rosa	0.5036	0.4860
Shiro	0.4200	0.3804
European plum		
Ageni	0.5921	0.6312
Besztercei Bt.2	1.0075	0.7057
Besztercei Nm.122	0.5613	0.6949
Bluefre	0.6670	0.6513
Czar (Tsar)	0.9691	0.7950
Cacanska najbolja	1.0542	0.7047
Cambridge Gage	0.6229	0.6694
Debreceni muskotály	0.8840	0.7650
Early Laxton	0.5217	0.5608
Early Italian	0.4958	0.8360
Grovers Late Victoria	0.7890	0.7723
Ontaria	0.9536	0.9405
Olasz kék (Italian plum)	0.6381	0.9438
President	1.0931	0.7057
Pozegaca	0.6313	0.7145
Regina Claudia di Bavay	0.8213	1.1251
Ruth Gerstetter	0.8200	0.7821
Richards Early Italian		0.6988
Stanley	0.4772	0.2880
Tuleu Timpuriu	0.9830	0.7777
Victoria	0.8174	0.9585

The smallest stigmata of peaches appeared in 1989 at *Independence*, in 1990 at *Springtime* (0.57, 1.03 mm², respectively). In both years, *Redhaven* showed the largest stigmata, with lengths 1.100 and 1.605, widths 0.890 and 1.345 µm, areas 0.77 and 1.69 mm². The data of the area varied between 0.57 and 1.69 mm². Seasons and varieties produced remarkable differences.

The six fruit species could be characterised, numerically, according to their averages (Table 4), as differences are significant. The area of the stigmata was smallest in oriental plums (0.74 mm²), largest in sour cherries (2.17 mm²). Measures of anthers and of stigmata is related to the size of the flowers. In oriental plums, flowers as well as flower parts are equally small.

Table 4 Characterisation of the stigmatic area of fruit species

Species	Stigmatic surface	
	Number of varieties studied	mm ²
Sweet cherry	5	1.61
Sour cherry	4	2.17
European plum	4	1.21
Oriental plum	4	0.74
Apricot	4	1.06
Peach	4	1.00

The variability caused by seasons was too high, therefore, differences between self-incompatible and self-fertile varieties cannot be proved.

Earlier studies seemed to prove the close genetic kinship of the varieties, *Pándy meggy* and *Újfehértói fürtös*. Arguments have been based on similarity in size of stigmata, but measures of the anthers did not fit to the scheme.

The supposedly close genetic relation between the apricot varieties of the "óriás" group (*Ceglédi óriás*, *Ligeti óriás*, *Nagykőrösi óriás* and *Szegedi mammut*) has been corroborated with the number stamina as well as the size of anthers.

References

- Cresti, M., Ciampolini, F. & Sansavini, S. (1985):** Caratteristiche morfologiche dello stigma di alcune piante da frutto. *Rivista della Ortoflorofrutticoltura*. 49–62.
- Filarszky N. (1911):** *Növénymorphológia*. Franklin-Társulat, Magyar Irod. Intézet és Könyvnyomda, Budapest.
- Gulyás S. (1975):** A méhlegelő (The pasture for honeybees). In: Halmágyi L., Keresztesi B. *A méhlegelő*. 50–93. Akadémia Kiadó, Budapest.
- Haraszi Á. (1976):** *Növény szerkezettan és növényélettan (Plant organography and physiology)*. Tankönyvkiadó, Budapest.
- Nyéki J. (1974):** *Meggy fajták virágzása és termékenyülése. (Bloom and fertilisation of sour cherry varieties) Kandidátusi Értekezés (Thesis)*, Kertészeti Egyetem, Budapest (Kézirat).
- Preininger É. (1989):** *Szilvafajták virágszerkezete és pollenmorfológiája. (Flower structure and pollen morphology of plum varieties) Diplomamunka, Kertészeti és Élelmiszeripari Egyetem, Budapest (Kézirat)*.
- Surányi D. (1980):** Comparative morphological and phenological study on plum varieties. *Acta Agron. Hung.* 29: 78–79.
- Surányi D. (1985):** Gyűjteményes és termesztett szilvafajták virágszerkezete, alaktani bélyegek és az öntermékenyülés kapcsolata.
- Terpó A. (1968):** Az ivaros szaporodás és szervei. In: Kárpáti Z., Görgényi L.-né and Terpó A.: *Kertészeti Növénytan I. növény-szerkezettan*. 228–318. Mezőgazd. Kiadó, Budapest.