

**THE INFLUENCE OF METEOROLOGICAL PARAMETERS ON FRUIT  
DOUBLING IN STONE FRUIT SPECIES**

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**Abstract**

Exposure of stone fruit species to high temperatures during flower-bud differentiation leads to the occurrence of double pistils, which results in the development of double fruits. In order to analyze this phenomenon in our ecological conditions, tests were carried out during the three-year period (2011-2013) in the collection orchards of the Experimental farm “Radmilovac” of the Faculty of Agriculture in Belgrade. The influence of air temperature and rainfall on fruit doubling was studied in 16 cultivars of peaches and nectarines, 15 cultivars of apricot and 10 cultivars of plum.

The average percentage of double fruits in a three-year period was the highest in peach (20.0%), followed by plum (10.9%) and apricot (4.1%). In peach and nectarine cultivars the average percentage of double fruits was the highest in 2013 (38.8%), and it was more than three times higher comparing with other two years. In plum cultivars the average percentage of double fruits was also the highest in 2013 (13.7%). In apricot cultivars the percentage of double fruits was the lowest in 2013 due to very low fruit set because of unfavorable weather conditions for pollination.

**Key words:** peach, plum, apricot, double fruits, temperature, rainfall.

**Introduction**

Double fruits or ‘twins’ occur in some stone fruits species (peach, plum, cherry, apricot) in many production regions with arid climates (Kudela and Krejzar, 2005). Fruit doubling occur when the flower buds are under stress at the initial phase of their differentiation. The lack of water and high temperatures affect the fruit doubling (Patten et al., 1981; Johnson et al., 1992; Naor et al., 2005). Double-fruits have no market value and should be removed by thinning.

Handley and Johnson (2000) found that the fruit doubling in peach can be significantly reduced by irrigation shortly before or during carpel differentiation (late August in California). Setting up nets above the orchard that shading the trees can also contribute to reducing the incidence of double fruits (Beppu and Kataoka, 2000).

Cultivar is the most important factor in production of fruits (Ogašanovic et al., 2005). Cultivars of stone fruits differ in the extent of fruit doubling. Engin and Ünal (2004) reported that the occurrence of double fruits is especially pronounced in peach cultivars ‘Cardinal’ and ‘Dixired’.

The aim of this study was to investigate the occurrence of double fruits in ecological conditions of the region of Belgrade in a number of cultivars of peach, nectarine, plum and apricot.

### Material and methods

The tests were performed in collection orchards of the Experimental farm “Radmilovac” of the Faculty of Agriculture in Belgrade. Studies were conducted on 16 cultivars of peach and nectarine, 15 cultivars of apricot and 10 plum cultivars. Most of the tested cultivars are significantly represented in fruit production in Serbia. The tests were performed in young plantations, whose age was 3-7 years, and which are grown without irrigation. Peach orchard is maintained as high density system, with spacing 3.6 x 1.3 m, and trees are trained as Sloping Leader (Zec et al., 2013). Plum orchard has spacing of 4 x 3 m and training system is Central Leader. Apricot orchard was established with space 4,5 x 3 m and training system is Central Leader.

Percentage of double fruits was measured on tagged shoots containing approximately 500 flowers. Number of fruits was counted 1 month after bloom. The study was conducted during the three-year period (2011-2013). The most important meteorological parameters were monitored using automatic weather station “Metos” during the initial period of differentiation of flower buds (July to September) and they are presented in Table 1.

Table 1. The average monthly temperatures and total rainfall in the period July-September at the Experimental farm „Radmilovac“ (2010-2012)

Month	2010		2011		2012	
	Temperature (°C)	Rainfall (mm)	Temperature (°C)	Rainfall (mm)	Temperature (°C)	Rainfall (mm)
July	22.8	44	22.4	70	25.1	22
August	22.0	27	22.7	6	24.1	4
September	16.9	56	20.7	42	20.0	18
Average / Sum	20.6	127	21.9	118	23.1	44

Data were statistically analyzed using analysis of variance for two-factorial experiment. The significance of differences between mean values was determined using LSD test for the probability of 0.05.

### Results and discussion

Fruit doubling is occurring every year in peaches and nectarines in varying degree. During the period of study, the highest average percentage of double fruits in all cultivars was obtained in 2013 and it was 38.8% (Table 2). The lowest percentage of double fruits was found in 2011 (10.2%). Mean values of double fruits percentage in peaches and nectarines were significantly higher in 2013 compared with two other years.

The average air temperature in the period July - September of 2012 was 1.2°C and 2.5°C higher than in the same period in 2011 and 2010, respectively. In the same period in 2012 fell nearly 3 times less rainfall compared with two other years (2010 and 2011). In the period July - September of 2012, fruit trees were exposed to severe stress due to high temperatures and drought, resulting in the appearance of a high percentage of double fruits in the next year (2013) in all cultivars of peach and nectarine. Naor (2006) also noted that high temperature and drought stress in July and August initiate the appearance of double pistils in peach.

Table 2. Average values of double fruits occurrence in peach and nectarine cultivars (%)

Cultivar	Year			Average
	2011	2012	2013	
Autumn Glo	17.67	20.33	68.67	35.6 g
Big Top	2.67	2.00	30.33	11.7 b
Bolero	3.67	3.00	29.33	12.0 b
Caldesi 2000	14.00	12.00	34.00	20.0 c
Maria Lucia	9.33	12.00	32.00	17.8 c
Max 7	11.00	15.00	42.00	22.7 d
Morsiani 51	16.33	13.67	56.67	28.9 e
Orion	15.00	12.00	44.33	23.8 d
Redhaven	8.33	9.00	24.00	13.8 b
Rita Star	5.67	4.67	15.00	8.4 a
Royal Glory	10.00	12.33	33.33	18.6 c
Sirio	10.00	14.33	60.67	28.3 e
Sun Prince	7.67	8.67	23.33	13.2 b
Venus	10.00	8.00	22.67	13.6 b
Vin anka	14.33	21.00	63.00	32.8 f
White Glo	7.00	8.33	41.67	19.0 c
Average	10.17 a	11.02 a	38.81 b	20.00
LSD 0.05	Cultivar			2.30
	Year			0.90

The highest percentage of double fruits in the period of study (2011-2013) was recorded in 'Autumn Glo' peach (35.6%), and the lowest percentage was found in nectarine 'Rita Star' (8.4%). Differences between cultivars were statistically significant. Perez-Gonzalez and Merlin (2001) state that later blooming cultivars are more prone to fruit doubling, and that this trait is influenced by genotype.

The highest percentage of double fruits (13.7%) in plum cultivars was found in 2013 (Table 3). The lowest percentage of double fruits was recorded in 2011 (8.4%). Mean values of fruit doubling percentages in plum significantly differed between years of study.

Table 3. Average values of double fruits occurrence in plum cultivars (%)

Cultivar	Year			Average
	2011	2012	2013	
a anska leptica	9.33	12.67	8.00	10.0 d
a anska najbolja	9.00	11.33	12.33	10.9 d
a anska rana	14.33	18.00	16.67	16.3 f
a anska rodna	5.00	3.67	5.33	4.7 b
Delikatnaja	3.33	2.67	17.33	7.8 c
Elena	10.00	20.33	33.00	21.1 g
Grossa di Felicio	0.00	0.00	0.00	0.0 a
Jojo	7.67	7.00	14.67	9.8 d
Stanley	13.33	15.00	16.00	14.8 e
Toper	11.67	16.00	13.67	13.8 e
Average	8.37 a	10.67 b	13.70 c	10.91
LSD 0.05	Cultivar			1.11
	Year			0.61

Extreme weather conditions (high temperatures and drought) in the summer of 2012, contributed to increased occurrence of double fruits of plum cultivars in the 2013, such as in peaches. Kudela and Krejzar (2005) also reported increased occurrence of double fruits in plum as a result of exposure to high temperatures and drought during the previous summer.

The highest percentage of double fruits in the three-year period was obtained in cultivar ‘Elena’ (21.1%), and the lowest percentage was found in cultivar ‘Grossa di Felicio’ (0%). The obtained differences are genetically determined.

The studied apricot cultivars had a lower percentage of double fruits in comparison with peaches, nectarines and plums. For 2011 and 2012 years it was averaged 6.1% (Table 4). In 2013 double fruits were not found in apricot cultivars. In this year the weather conditions during the flowering of apricots (late March and early April) were very unfavorable. Low daily temperatures (below 10°C) and the absence of bees resulted in very poor fruit set and low yield.

Table 3. Average values of double fruits occurrence in apricot cultivars (%)

Cultivar	Year			Average
	2011	2012	2013	
Cegledi Arany	8.00	6.67	0.00	4.9 d
Goldrich	11.00	1.67	0.00	4.2 bcd
Hungarian Best	7.67	14.67	0.00	7.4 e
Laycot	1.67	2.33	0.00	1.3 a
Lenova	4.67	1.67	0.00	2.1 a
Leskora	8.00	3.00	0.00	3.7 bc
Litoral	8.00	2.67	0.00	3.6 bc
Neptun	7.33	18.67	0.00	8.7 g
Ninfa	2.67	1.67	0.00	1.4 a
Novosadska rodna	10.33	2.00	0.00	4.1 bcd
Pisana	2.33	4.33	0.00	2.2 a
Re Umberto	2.33	12.67	0.00	5.0 d
Silred	7.33	2.67	0.00	3.3 b
Silvercot	10.33	2.67	0.00	4.3 bcd
Sundrop	11.00	2.33	0.00	4.4 cd
Average	6.84 a	5.31 b	0.00 c	4.05
LSD 0.05	Cultivar			0.90
	Year			0.40

Obtained results for 2011 and 2012 years also indicated that tested apricot cultivars significantly differed in percentage of double fruits. Cultivars ‘Neptun’ and ‘Hungarian Best’ were the most susceptible to fruit doubling. The results obtained in this study are consistent with the findings of Milatovic and Stojanovic (2005). They report that the occurrence of double pistils in apricot is relatively small and that only in some cultivars and in some years it exceeds 10%.

### Conclusion

High air temperatures and low amount of rainfall affect the significant increase of fruit doubling in cultivars of peach, nectarine and plum.

It was noted that some cultivars of peach, nectarine and plum have a genetic predisposition for a higher percentage of double fruits.

Cultivars that are more prone to the formation of double fruits should be grown under irrigation. It could reduce the effects of adverse weather conditions on the intensity of this phenomenon.

Occurrence of double fruits in tested cultivars of apricot was expressed to a lesser extent compared with peaches, nectarines and plums. To define apricot cultivars precisely in terms of this trait it is necessary to continue the research.

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