Influence of Fruit Thinning and Summer Pruning on the Yield and Fruit Quality of Peach Cultivar 'Royal Gem'

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Summary

Peach is one of the most important fruit species for human consumption. In the peach cultivation many pomotechnical treatments are conducted and some of the most interesting are summer pruning and fruit thinning. By implementation of mentioned pomotechnical treatments higher fruit quality can be achieved which is nowadays very important for the market fruit value. In this research the influence of summer pruning and fruit thinning in different combinations on the pomological characteristics and physico-chemical properties of peach fruit cultivar 'Royal Gem' was studied. Implemented pomotechnical treatments differently affected the studied properties. The highest yield was determined in control (7.23 kg tree^{-1}) while the lowest (4.38 kg tree^{-1}) in treatment 2 (fruit thinning without summer pruning). Fruit thinning and summer pruning significantly influenced on the increase of average fruit weight, fruit firmness and fruit diameter. The lowest fruit weight (75.74 g) was determined in control while the highest fruit weight (92.93 g) was determined in treatment 3 (summer pruning without fruit thinning). The highest fruit diameter (57.69 mm) was also determined in treatment 3 while the lowest in control (52.59 mm). The highest fruit firmness (4.14 kg/cm^2) was in treatment 1. For chemical quality properties no significant differences have been determined due to the implemented pomotechnical treatments. The pomotechnical treatments conducted in this research showed to be effective for improving the fruit quality while the best results were achieved by treatment of fruit thinning.

Key words

fruit thinning, peach, pomological characteristics, summer pruning, yield

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Introduction

Nowadays, market requires high-quality fruits in which production numerous pomotechnical and agricultural techniques are combined, with the main aim of improving the fruit quality. Regular pruning is necessary for the peach because it bear fruits on the one-year long shoots (Jemrić, 2007). Pruning is a pomotechnical treatment and a common practice for regulating the vegetative growth and yield, forming the tree shape, and it facilitates other cultural practices in peach cultivation (Ashraf and Ashraf, 2014). Summer pruning complements the winter pruning, attempting to balance the vigour and productivity of fruit tree, reduces the vegetative growth, redirects the growth of the young shoots, removes the unnecessary young shoots inside the crown which competing with fruits for water and nutrients and shading the interior of the crown (Hossain et al., 2006). The main reason why the summer pruning should be conducted is the growth of less vigorous shoots on which more flower buds develop (Sosna, 2010). As well, better fruit coloring, higher content of soluble solids, a smaller proportion of total acids and better differentiation of flower buds are benefits (Ikinci, 2014, Hossain et al., 2006). Often, peach has an unstable reaction on the summer pruning, which may increase or decrease the growth and prolong the vegetation (Ikinci et al., 2013). The reduction of vegetative growth may be the results of the removal of a large part of the leaf surface which reduces the amount of carbohydrates needed for further growth (Ikinci, 2014). The effect of summer pruning is significantly influenced by genotype and the positive effect of mentioned treatment occurs in years of alternative production (Blažkova and Drahošova, 2012). Another important pomotechnical practice in peach cultivation is fruit thinning. The primary objective of fruit thinning is an increase of fruit quality by getting larger and more uniform fruits (Reighard and Byers, 2009). It is important to emphasize that by conducting only one pomotechnical practice i.e. thinning is not possible positively influence on all fruit quality factors because among them there are positive and negative correlation relations (Link, 2000). Depending on the implementation period, the flowers (just prior to or during flowering) or fruits can be thinned. The thinning time is a very important factor and many authors cite that the first phase of fruit growth (45-60 days after flowering) is the best time for thinning because intensive growth of fruits is achieved by mentioned treatment (Byers and Marini, 1994; Jimenez and Royo Diaz, 2002; Njoroge and Reighard, 2008). In that phase thinning stimulates cell division and cell elongation leading to the increased fruit size (Byers and Marini, 1994).

The aim of this research was to determine the influence of summer pruning and manual fruit thinning on yield, pomological, physical and chemical properties of peach cultivar 'Royal Gem' grown in the northwestern Croatia.

Materials and methods

Plant material

The research was conducted in a peach orchard in Dugo Selo (Hrebinec) on the peach cultivar 'Royal Gem'. The rootstock was the vineyard peach (*Prunus persica* var. *vulgaris* L.) seedling and tree shape was slender spindle. In the orchard were regularly conducted common cultural practices in peach cultivation. Cultivar 'Royal Gem' ripens in mid-July, the stone easily separates from fruit pulp, has dark red colored peel and yellow pulp. The experiment was set up on the 20 randomly selected peach trees (arranged in different locations) in 4 treatment combinations: treatment 1 – fruit thinning without summer pruning; treatment 2 – fruit thinning and summer pruning; treatment 3 – summer pruning without fruit thinning; control – without fruit thinning and summer pruning. Each treatment combination was set up on 5 trees. The experiment was conducted during 2013 year. Fruit thinning was conducted 45-60 days after full flowering (in mid-May). The thinning was carried out as follows: on the long shoot one fruit per each 15 cm was left, and other fruits were removed, while on the short shoot only one fruit was left. Summer pruning was carried out in mid-June with the aim of removing the excess shoots for better illumination of the central part of the crown and better fruit coloration.

Methods

The fruits from every tree were harvested in optimal harvest time (mid-July), placed in special box and transported in the laboratory of the Department of Pomology Faculty of Agriculture University of Zagreb. On the sample of 20 peach fruits following physical and chemical properties were determined: fruit and stone weight (g), fruit height and width (mm), fruit firmness (kg/cm^2), total soluble solids content (°Brix), total acid content (%) and pH value.

The fruit and stone weight was measured on the analytical scale (Mettler Toledo P 1210, USA). The yield (kg/tree) was mathematically expressed based on the data of fruit weight and number of harvested fruits. The height and width of fruits were determined by digital caliper (Somet, Czech Republic). Fruit shape index was mathematically expressed as the ratio of fruit height and width. Fruit firmness was determined by manual penetrometer (FT 327, Italy) with probe diameter of 8 mm. Total soluble solid content was determined by digital refractometer (ATAGO PAL-1, Japan) from fruit juice. Total acid content was determined by potentiometric titration (AOAC, 1995) and the results were expressed as malic acid. pH value of juice was determined by digital pH-meter (Mettler–Toledo SevenMulti, Switzerland). Statistical analyses of the obtained results were performed using the SAS® version 9.2 (SAS, 2010). The experiments were performed in triplicate. Data were subjected to the one-way analysis of variance (ANOVA) and mean values were compared by the t-test (LSD) at $P \leq 0.05$.

Results and discussion

The results of the determined physical and chemical properties are shown on Figures 1, 2 and 3 and Tables 1 and 2.

The highest yield per tree (Fig. 1) as well as the fruit number (Fig. 2) were determined in control, while significantly lower results of listed properties were found in treatment 2 (combined thinning and summer pruning). Obtained results suggest that thinning affected on the reduction of the total yield and fruit number which is in agreement with the results obtained by Njoroge and Reighard (2008) and El-Boray et al. (2012). Jimenez and Royo Diaz (2002) determined the correlation between yield and number of fruits on the shoot which also depends on thinning. According to the results of listed authors the yield increases as the number of fruits on the shoot increases. Ikinci (2014) researched the influence of summer pruning on the reduction of

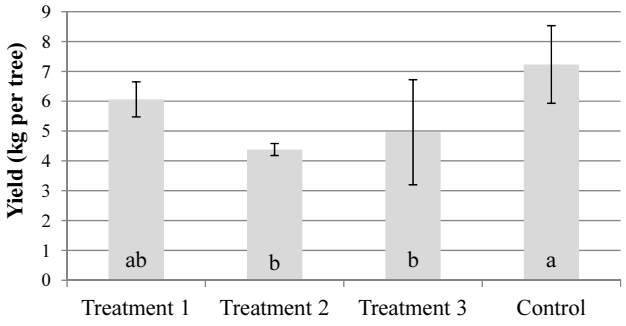

Figure 1. The yield of 'Royal Gem' cultivar depending on the treatment. (Treatment 1 – fruit thinning without summer pruning; Treatment 2 – fruit thinning and summer pruning; Treatment 3 – summer pruning without fruit thinning; Control – without fruit thinning and summer pruning. Data are the means ± SD. Means followed with same letter are not significantly different according to LSD test at P≤0.05.)

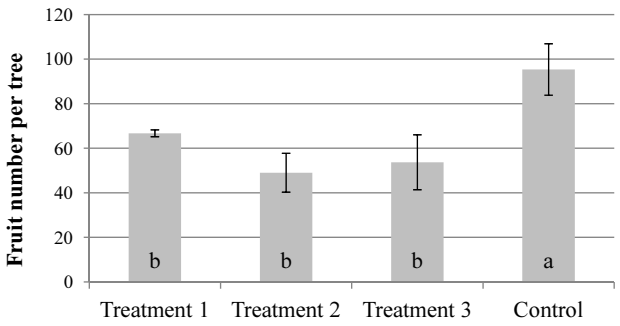

Figure 2. The fruit number of 'Royal Gem' cultivar depending on the treatment. (Treatment 1 – fruit thinning without summer pruning; Treatment 2 – fruit thinning and summer pruning; Treatment 3 – summer pruning without fruit thinning; Control – without fruit thinning and summer pruning. Data are the means ± SD. Means followed with same letter are not significantly different according to LSD test at P≤0.05.)

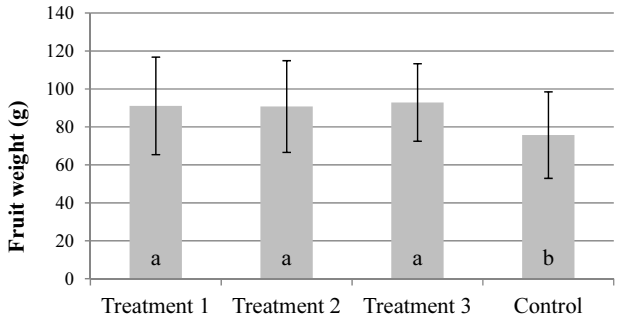

Figure 3. Average fruit weight of 'Royal Gem' cultivar depending on the treatment. (Treatment 1 – fruit thinning without summer pruning; Treatment 2 – fruit thinning and summer pruning; Treatment 3 – summer pruning without fruit thinning; Control – without fruit thinning and summer pruning. Data are the means ± SD. Means followed with same letter are not significantly different according to LSD test at P≤0.05.)

total yield and increase of the fruit quality in cultivars 'Maycrest' i 'Early Red'. The yield reduction by fruit thinning was determined only in the first harvest period because harvesting of first fruits increased the average weight of the rest fruits whereby in later harvest periods the yield was compensate (De Villiers, 2014).

Significantly lowest fruit weight was determined in the control sample while the significantly highest fruit weight was determined in the conducted pomological treatments between which significant difference was not determined (Fig. 3). Jimenez and Royo Diaz (2002), Ikinci (2014) and De Villiers (2014) cited that treatments like fruit thinning and summer pruning have significant influence on the fruit weight increase. Thinning caused a decrease of yield, but in the same time increased the average fruit weight which is significant market characteristic. The results indicates that treatment 3 (summer pruning without fruit thinning) and treatment 1 (thinning without summer pruning) equally influenced on the fruit weight. Byers and Marini (1994) cites the positive influence of summer pruning in the combination with thinning on the fruit weight and size. Also, Hossain et al. (2006) found that summer pruning significantly influenced on the increase of fruit weight compared to the winter pruning.

In Table 1 is shown the impact of treatments on the pomological characteristics of cv. 'Royal Gem'. The highest stone and flesh weight were determined in treatment 2 while the lowest in control. The treatments 1 and 3 were not significantly different in the analyzed characteristics. Significantly lowest fruit height was determined in control while the treatments 1, 2 and 3 were not statistically different. The highest fruit width was determined in treatments 2 and 3 and by the „Rulebook of marketing standards for fruit and vegetables" (NN 47/12, 102/12, 04/12, 80/13 i

Table 1. Pomological characteristics of peaches cv. 'Royal Gem' depending on the treatments.

Treatment	Stone weight (g)	Flesh weight (g)	Fruit height (mm)	Fruit width (mm)	Fruit shape index
	*	*	*	*	*
Treatment 1	5.87±0.62ab	87.76±29.87ab	54.08±4.22a	55.46±5.80ab	0.98±0.05a
Treatment 2	6.15±1.49a	88.56±25.38a	53.16±3.79a	56.47±5.84a	0.95±0.05b
Treatment 3	5.52±0.94ab	85.09±21.31ab	54.33±3.54a	57.69±5.36a	0.95±0.05b
Control	5.08±1.31b	68.24±23.38b	50.66±4.96b	52.59±5.38b	0.97±0.05ab

Treatment 1 – fruit thinning without summer pruning; Treatment 2 – fruit thinning and summer pruning; Treatment 3 – summer pruning without fruit thinning; Control – without fruit thinning and summer pruning; Data are the means ± SD; Means followed with same letter are not significantly different according to LSD test at P ≤ 0.05

Table 2. Physical and chemical properties of peach fruit cv. 'Royal Gem' depending on the treatments.

Treatment	Fruit firmness (kg/cm^2)	Soluble solids content (°Brix)	Total acid (as malic acid %)	pH value (juice)
	*	n.s.	n.s.	n.s
Treatment 1	4.14±2.18a	9.43±0.38	0.44±0.06	3.29±0.03
Treatment 2	2.99±1.38b	9.83±0.81	0.47±0.02	3.34±0.03
Treatment 3	2.89±1.84b	10.20±0.20	0.47±0.03	3.33±0.02
Control	3.56±2.18ab	10.30±1.15	0.46±0.07	3.33±0.05

Treatment 1 – fruit thinning without summer pruning; Treatment 2 – fruit thinning and summer pruning; Treatment 3 – summer pruning without fruit thinning; Control – without fruit thinning and summer pruning; Data are the means ± SD; Means followed with same letter are not significantly different according to LSD test at $P \leq 0.05$

157/1) fruits of these dimensions can be classified as Extra Class (fruits wider than 56 mm). The lowest fruit width was determined in fruits of control which classifies them as a class I and II. The same result of summer pruning impact on the increase of the fruit diameter was obtained by Hossain et al. (2006). Fruit shape index was the highest in treatment 1 and the lowest in the treatments 2 and 3. According to the obtained results can be concluded that the smaller fruit shape index was determined in treatments in which summer pruning was conducted; fruits are mildly flattened while in control and treatment 1 fruits have more proper round shape.

The physical and chemical properties of peach *cv.* 'Royal Gem' depending on the treatment are shown in Table 2. The treatments significantly affected on fruit firmness while no statistically significant differences between treatments in the analyzed fruit chemical properties (soluble solids, total acids and pH) were not determined. The highest fruit firmness was determined in treatment 1 (thinning without summer pruning) while the lowest in treatment 3 (summer pruning without thinning). Results of this study indicate a significant difference in fruit firmness and the positive effect of thinning compared to control, while thinning combined with summer pruning affected on the reduction of fruit firmness. De Villiers (2014) obtained the same result of the impact of mechanical thinning on the fruit firmness of nectarines where increasing the thinning intensity has the positive effect on fruit firmness. In this research no statistically significant differences on the chemical properties were found, which partially coincides with the results of this research. Hossain et al. (2006) determined that summer pruning significantly effects on the chemical composition of fruit juice, the total soluble solids increase and total acid content decrease respectively. The same impact of summer pruning on the chemical properties was obtained in research by Crisosto and Costa (2008) and Ikinci et al. (2014). Such differences between presented results may be a consequence of various factors such as, different environmental conditions and the reaction of the cultivar on the pomotechnical treatments.

Conclusions

In this research the influence of summer pruning and fruit thinning on the yield, pomological characteristics and fruit firmness of peach cv. 'Royal Gem' was determined. All conducted pomological treatments influenced on the fruit weight increase but also on the decrease of the yield and fruit number per tree. Treatment 1 positively influenced on the fruit firmness, while its impact on the chemical properties of fruits was not determined. The positive impact of fruit thinning on the majority of analyzed fruit properties confirms the importance of such treatment in the intensive peach cultivation. Summer pruning indicates the positive and negative effects on the analyzed fruit properties which can be the result of cultivation area and climatic-edaphic conditions. Based on the obtained results can be concluded that fruit thinning and summer pruning are obligatory pomotechnical treatments in peach cultivation. In the further researches is necessary to determine the effect of the above combination of pomotechnical treatments on the different varieties and in different locations in order to achieve higher and more uniform yields as well as fruits with higher market value.

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