Vegetative and Reproductive Traits of Young Peaches and Nectarines Grown under Red Photoselective Net

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Summary

The effect of red photoselective net on yield per tree (g), yield efficiency (g·cm^{-2}) leaf surface (cm^2), fruit diameter (mm), fruit mass (g), fruit firmness (kg·cm^{-2}) and soluble solids concentration (SSC) (%Brix) on young peach ('Sugar Time') and nectarine ('Big Bang') trees was studied. No significant differences were recorded for yield, yield efficiency and SSC on peach as well for all fruit quality parameters on nectarine. Both peach and nectarine trees grown under red net had significantly higher leaf surface (37.82 and 40.72 cm^2, respectively) than in control (23.85 and 26.14 cm^2, respectively). Peach fruits grown under red net had significantly higher fruit diameter (70.97 mm), fruit mass (163.73 g) and lower fruit firmness (2.12 kg·cm^{-2}) than in control (65.24 mm, 135.84 g, and 3.04 kg·cm^{-2}, respectively). It was concluded that red photoselective net has a positive effect on vegetative growth of peach and nectarine, and on majority of fruit quality parameters of peach, while on nectarine fruit quality there are no evident differences. Further research must be continued to verify these preliminary findings.

Key words

nectarine, peach, photoselective net, fruit quality

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Introduction

The use of nets in fruit production to cover fruit trees is of prime importance nowadays. The industrial production of nets used in agriculture has been constantly increased in Europe. Just for example, in Italy, the annual production of HDPE nets for agriculture application is more than 5300 t (Castellano et al., 2008). The traditional usage of nets in agricultural practices was mainly for protection against hail and wind (Middleton and McWaters, 2002). According to Briassoulis et al. (2007), the oldest usage of nets in protected cultivation was in vineyards, peach, apricot, apple and cherry orchards as well as in production of cut flowers.

Besides its traditional usage for protection against hail and wind, nets are nowadays particularly used for protection against rain, insects, birds and excessive solar radiation (Briassoulis et al., 2007). The usage of photoselective nets for protection against pests has been explored in recent years (Sauphanor et al., 2012). For protection against pests, the whole orchard is closed with nets that present mechanical barrier. Even if the both sides of orchards are left open, there is significant reduction of population of codling moth (*Cydia pomonella* (Linnaeus, 1758) in apple orchards (Graf et al., 1999).

Peach (*Prunus persica* (L.) Batsch.) and nectarine (*Prunus persica* (L.) Batsch. var. *nucipersica* (Suckow) C.K. Schneid) are very popular fruits. In many production areas of peach and nectarine hail presents one of main threats in production. Therefore, many producers protect their orchard by nets. If orchard is protected against hail, it can also be protected against pests with little more effort.

Quality of any fruit is mainly related to their biochemical composition and hence it is of special importance for consumer satisfaction e.g. as in case of peaches (Crisosto et al., 2003; Crisosto and Crisosto, 2005). According to Basile et al. (2012), photoselective nets are made up of materials that affects light specter that passes through them and causes light scattering. Iglesias and Alegre (2006) and Solomakhin and Blanke (2008) have reported that the photoselective nets can have quantitative and qualitative effect on light that reaches to the fruit trees. Few studies have proved that quantitative and qualitative modification of light can affect physiology, yield and vegetative growth of many fruit species (Erez and Kadman-Zahavi, 1972; Rapparini et al., 1999; Jifon and Syversten, 2003) which are directly or indirectly related to the quality of fruits. Their possible effect in increasing yield and fruit quality in young orchards is of special importance due to faster economic return of investment in orchard plantation.

However, there is scarcity of studies available regarding the effect of such photoselective nets on fruit quality as well on vegetative growth of peaches and nectarines. For example, Schettini (2011) investigated effect of five coloured nets on one-year-old bare root peach 'Messapia' trees grown in plastic pots. Similarly, Giaccone et al. (2012) studied the effect of red and white photoselective net on mature 'Laura' nectarine trees. In addition, Shahak et al. (2004) investigated the effect of five different coloured nets on 7-year-old 'Hermosa' peach trees.

The main goal of this study was to investigate effect of red photoselective net used for hail and pest protection on fruit quality and vegetative growth of young peach and nectarine trees. In this study red net was used because, in comparison with other nets, it showed mainly positive effects on apple ('Cripps Pink') yield and fruit quality in same environmental conditions (Brkljača et al., 2016).

Materials and methods

Plant material

The trial was established in private orchard near Donji Kašić (44°09′04″N 15°28′23″E) in season 2016 on the 3 years old fruit trees of peach ('Sugar Time') and nectarine ('Big Bang') grafted on rootstock GF 677. Peach and nectarine trees were trained as spindle bush with a spacing of 0.8 m in row and 3 m between rows. Covering the trees with red photoselective net (AGRITECH S.r.l., Eboly, Italy) with mesh size of 2.4 × 4.8 mm was used as a treatment and uncovered trees served as control. Peaches and nectarines were harvested on 16 June 2016.

Morphological and chemical analysis or measurements

Yield was measured on site in orchard, while the samples were collected for determining the fruit quality parameters at the lab of University of Zadar, Croatia.

Leaf surface (cm^2) was measured on 10 randomly selected leaves from middle part of one-year old shoots before leaf fall using planimeter. Trunk cross sectional area (TCSA) was calculated from trunk diameter measured with digital caliper at the end of vegetation on the height of 25 cm from soil surface. Yield was measured on five trees per each treatment. TCSA measurements were taken from the same trees on which yield was measured. Yield efficiency was calculated from yield and TCSA and expressed as $g \cdot cm^{-2}$.

Fruit quality parameters that were measured were: fruit diameter, fruit mass, fruit firmness and total soluble solids concentration (SSC). Fruit diameter, fruit mass, fruit firmness and SSC were measured on 15 fruit samples per each treatment. Fruit diameter was measured with digital caliper, fruit mass on analytical balance (OHAUS Adventurer AX2202, Ohaus Corporation Parsippani, NJ, USA) with accuracy of 0.01 g. SSC was measured using ATAGO 3810 PAL-1 digital refractometer (ATAGO, Tokyo, Japan) and expressed as %Brix. Firmness was measured using PCE - PTR-200 (PCE Instruments, Jupiter/Palm Beach, USA) fitted with 7.9 mm diameter plunger and expressed in $kg \cdot cm^{-2}$.

Statistical analysis

Data were analyzed using analysis of variance (ANOVA) and the significance of differences between treatment and control were obtained with Student's t-test using SAS statistical software ver. 9.4 (SAS Institute, NC).

Results and discussion

The ANOVA revealed that the fruit type (T) was significant for yield, yield efficiency, fruit diameter, fruit mass, fruit firmness and SSC. Netting (N) was significant for leaf surface, fruit diameter and fruit mass. T × N interaction was significant for yield and fruit firmness only (Table 1). TCSA was not significant and hence data is not shown here. Despite the low number of traits significantly affected by T × N interaction, to better elucidate the

Table 1. ANOVA table for vegetative and reproductive traits of young peach 'Sugar Top' and nectarine 'Big Bang' grown under red photoselective net

Source of variability	Leaf surface (cm^2)	Yield (g)	Yield efficiency ($g{\cdot}cm^{-2}$)	Fruit diameter (mm)	Fruit mass (g)	Firmness ($kg{\cdot}cm^{-2}$)	SSC (% Brix)
Fruit type (T)	n.s.	***	***	***	***	***	**
Netting (N)	***	n.s.	n.s.	*	*	n. s.	n.s.
T × N	n.s.	*	n.s.	n.s.	n.s.	*	n.s.
			Fruit type (mean±SD)				
Peach	29.76±9.08	937.13±379.50	27.97±15.07	68.11±6.94	149.79±38.93	2.58±1.15	8.19±1.17
Nectarine	35.75±9.73	2146.27±624.55	57.61±11.03	58.65±4.52	115.53±12.98	3.75±0.75	8.94±1.19
			Netting (mean±SD)				
Control	24.99±5.25	1571.29±1063.02	40.88±22.18	61.69±6.21	124.50±30.41	3.33±1.04	8.46±1.29
Red net	39.92±7.33	1517.04±539.01	44.37±18.65	65.07±8.39	140.82±35.05	3.00±1.21	8.68±1.17

n.s., *, **, *** - not significant or significant at $P \leq 0.05$, 0.01 and 0.001, respectively.

effects of red photoselective nets on peach and nectarine, further analysis was performed on each fruit tree species separately.

Both peach and nectarine trees had significantly higher leaf surface under red net (37.82±5.41 and 40.72±7.87 cm^2, respectively) than in control (23.85±6.16 and 26.14±4.04 cm^2, respectively) (Figure 1). Giaccone et al. (2012) reported that mean leaf size of nectarine trees was higher under the red net than under white net. However, they did not compare their results with the control trees (uncovered trees), and hence can be partly comparable with our findings. However, it still can be said that the red photoselective net had positive effect on leaf surface, which can further increase the photosynthetic capacity.

TCSA showed no significant differences between red net and control in both peach and nectarine (data not shown).

Peach trees under red net had higher yield (1130.00±340.00 g) than in control (710.00±300.00 g) whereas nectarine trees in control had higher yield (2440.00±760.00 g) than under red net (1900.00±400.00 g), but no significant differences were recorded. According to Schettini (2011), peach trees under red net had significantly higher yield than trees in control, which is in agreement to our results. Giaccone et al. (2012) reported that fruit yield of nectarine 'Laura' was not significantly affected by the type of anti-hail net. However, due to the preliminary status of this study, and possible effect of red net on bud differentiation, the true effect of red net on yield will be possible to evaluate next year. Another important factor influencing our results is high yield variability (Table 1) caused by young fruit age. We expect that when yield will be stabilized, red netting might positively influence the yield of peach and nectarine.

Peach trees under red net had higher yield efficiency (0.03±0.02 $g{\cdot}cm^{-2}$) than in control (0.02±0.01 $g{\cdot}cm^{-2}$) whereas nectarine fruits under red net and in control had same value (0.06±0.01 $g{\cdot}cm^{-2}$). For this parameter, no significant differences were recorded. Giaccone et al. (2012) reported that crop load of nectarine 'Laura' was not significantly affected by the type of anti-hail net which is in agreement with our findings.

Peach fruit grown under red net had significantly higher fruit diameter (70.97±6.15 mm) than in control (65.24±6.67 mm). Nectarine fruit grown under red net had slightly higher fruit diameter (59.16±5.77 mm) than in control (58.15±2.9 mm), but no significant differences were recorded (Figure 2).

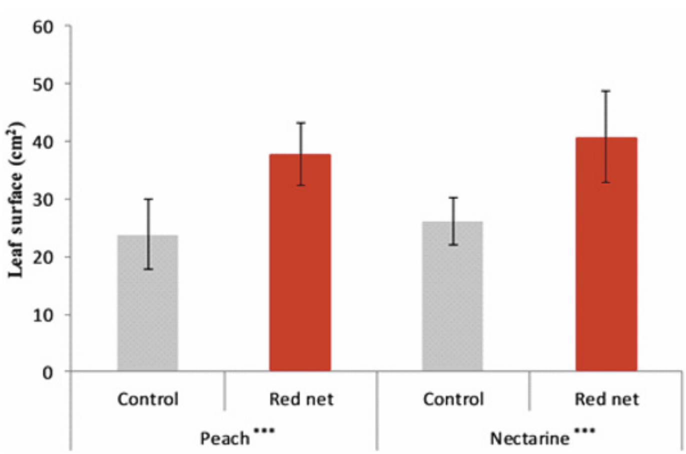

Figure 1. Leaf surface (cm^2) of young peach 'Sugar Top' and nectarine 'Big Bang' grown under red photoselective net. (***- significant at $P \leq 0.001$ level, according to Student's t-test within fruit species)

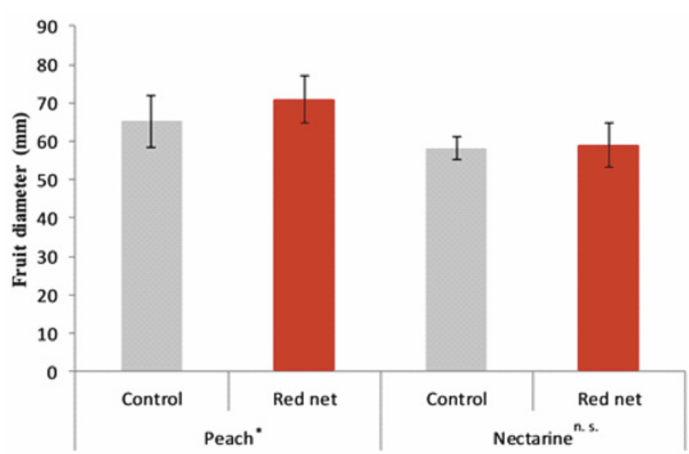

Figure 2. Fruit diameter (mm) of young peach 'Sugar Top' and nectarine 'Big Bang' grown under red photoselective net. (n.s., * –nonsignificant or significant at $P \leq 0.05$ level, according to Student's t-test within fruit species)

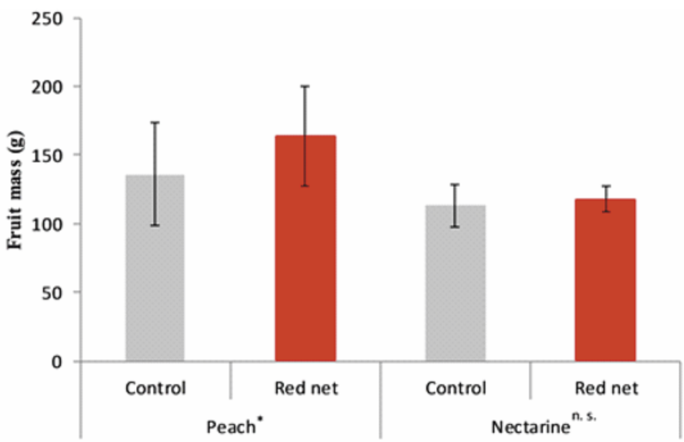

Figure 3. Fruit mass (g) of young peach 'Sugar Top' and nectarine 'Big Bang' grown under red photoselective net. (n.s., * –nonsignificant or significant at P ≤ 0.05 level, according to Student's t-test within fruit species)

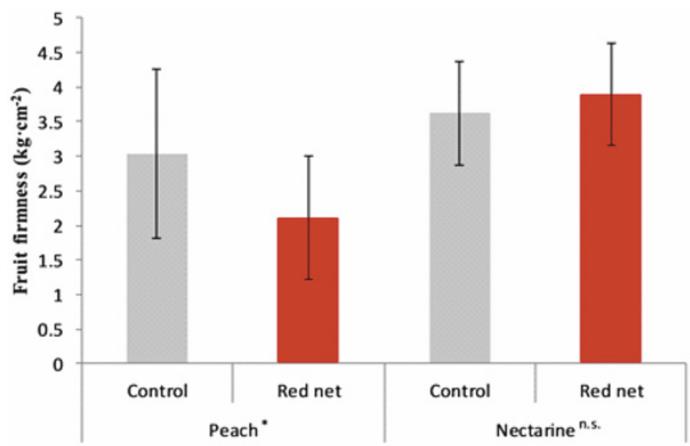

Figure 4. Fruit firmness (kg·cm^{-2}) of young 'Sugar Top' and nectarine 'Big Bang' grown under red photoselective net. (n.s., * –nonsignificant or significant at P ≤ 0.05 level, according to Student's t-test within fruit species)

Peach fruit grown under red net had significantly higher fruit mass (163.73±36.42 g) than in control (135.84±37.37 g). Nectarine fruits under red net also had higher fruit mass (117.91±9.71 g) than in control (113.16±15.59 g), but no significant differences were recorded (Figure 3). According to Shahak et al. (2004), fruits of peach 'Hermosa' had higher fruit mass under red net (153.4 g) than in control (141.7 g), but no significant differences were recorded between them. Schettini (2011) reported that peach 'Messapia' trees grown under red net had higher fruit weight (210 g) than in control (207 g), however no significant differences were recorded between them. Giaccone et al. (2012) reported that fruit mass of nectarine 'Laura' was not significantly affected by the type of anti-hail net (red and white). Possible explanation of significant difference in peach fruit mass obtained in our study might be the genetic differences and/or climatic conditions that in combination with red photoselective net and young tree age caused changes on peach fruit. As, the results obtained in kiwifruit and reported by Basile et al. (2012) confirm our findings with peaches. The authors found that the fruit mass of kiwifruit 'Hayward' grown under red net was significantly higher than in control in first year of study, although in second year no significant differences were recorded. Therefore, our results need to be validated during few seasons and on multiple locations to bring final conclusions in this regard.

Peach fruit harvested from control trees had significantly higher firmness (3.04±1.22 kg·cm^{-2}) than those harvested from trees grown under the red net (2.12±0.89 kg·cm^{-2}) suggesting fruit ripening acceleration in fruits grown under red net, contrary to results reported by Schettini (2011) who found that peach fruit grown under red net had significantly higher flesh firmness (4.56 kg·cm^{-2}) than fruit harvested from control trees (3.2 kg·cm^{-2}). Similarly, Giaccone et al. (2012) reported that flesh firmness of nectarine fruits was significantly lower under white net than under red net, which is also contrary to our results. Our results on nectarine show that, although fruits grown under the red net had higher firmness (3.89±0.74 kg·cm^{-2}) than those grown in control (3.62±0.75 kg·cm^{-2}), no significant difference was recorded (Figure 4). However, Basile et al. (2012) reported significantly lower fruit firmness of kiwifruit 'Hayward' grown under red net in comparison to control or uncovered trees, which is in agreement with our results obtained in peaches.

Peach fruits in control had higher SSC (8.23±1.48 %Brix) than under red net (8.15±0.79 %Brix) while nectarine fruits under red net had higher SSC (9.2±1.28 %Brix) than in control (8.69±1.07 %Brix), but differences were not significant. Giaccone et al. (2012) reported that fruit SSC was significantly higher in trees under the white net than under the red net which is contrary to our results. Similar results were reported by Basile et. al (2012) who found that significantly higher fruit SSC of kiwifruit 'Hayward' under red net than in control. Possible differences in fruit reaction to red netting found in our study might be also explained by genetic and/or climatic differences, as well by tree age.

Conclusion

The obtained results have shown that red nets have significant influence on vegetative (leaf surface) and some fruit quality parameters (fruit diameter, fruit mass and firmness). Majority of significant differences were recorded on peach fruit quality parameters while on nectarine only minor number of parameters was significantly affected. It is probably due to young tree age and therefore red photoselective nets didn't show their whole effect. Hence, further research is needed to validate these preliminary findings as the red photoselective nets have shown some good trends towards vegetative and some fruit quality parameters of young peach trees.

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