

EFFECTS OF DIFFERENT TIMES OF SUMMER PRUNING TO PRODUCTIVITY AND FRUITS QUALITY OF APPLE CULTIVAR GALA BROOKFIELD

BOBAN DJORDJEVIĆ, DEJAN DJUROVIĆ, GORDAN ZEC

University of Belgrade, Faculty of Agriculture
b.djordjevic@agrif.bg.ac.rs

Keywords: *apple, summer pruning, fruit quality, yield*

ABSTRACT

Apple (*Malus x domestica* Borkh.) is the most important of the deciduous tree fruits in Serbia in last decade, with annual production of about 450.000 tonnes. The cultivar Gala is one of the most represented cultivar in orchard. Serious problem in increase of profitability of apple producers in Serbia is low fruits quality of this cultivar, especially expressed in decrease of surface blushing. Summer pruning, before fruits harvest is one of possibility to improved their quality. In this paper the aim of examination was to determine effects of three different times of summer pruning to productivity and fruits quality of cultivar Gala Brookfield.

The trees pruning four weeks before harvest (treatment 1) had significantly bigger fruits (138.6 g) with higher diameter (68.4 mm), percent of surface blushing (66.3 %) and content of soluble solid (12.9° Brix) according to other treatments. The trees pruning two weeks before pruning (treatment 3) had the lowest fruits quality in terms of fruits mass (109.5 g), intensity of surface blushing (1.6) and content of soluble solid (11.4° Brix). Mainly, the highest values of fruits quality in all treatments had fruits in upper part of trees. Trees in treatment 1 and treatment 2 (pruning threes weeks before harvest) had fruits with more than 65% of surface blushing and without of sunburn damage

INTRODUCTION

Apple (*Malus x domestica* Borkh.) is the most important of the deciduous tree fruits in Serbia in last decade, with annual production of about 450.000 tonnes. The intensive orchards have been proposed to improve profitability and yield, but possible barrier for increased fruit consumption is insufficient fruit quality (Djordjevic et al., 2018). According to Bushal et al., 2017, planting systems have a strongly effects to improve yield and fruit quality. Pruning is

one of the main management practices in the farming of fruit trees (Demirtas et al., 2010). Nevertheless, tree form like a tall spindle planting system maximizes profitability of apple and producers let them grow up to 4 m in order to produce more fruits (Yang et al., 2015).

However, after a few years, the insufficient amount of sunlight reached the lower canopy due to the shading of the lower parts of the canopy. A thereby reducing fruit yield and quality because of

decreased of light penetration especially in the lower and interior parts of the canopy arises as a consequence of densely planted, tall, and vigorous trees. Also, an intensity of light that reaches the lower parts of the canopy is low, which can cause internal shading of fruiting sites and decrease flower bud initiation and fruit size (Mierowska et al., 2002). According to Iglesias and Alegre, 2009 a well-exposed canopy throughout the growing season produces large and brightly colored fruits.

Summer pruning is a one of most used practices in modern orchard to improve light intensity. Summer pruning, especially of extended and vigorous shoots has been reported to improve light penetration and distribution within the tree canopy (Lakso and Corelli, 1993), which can increase spur leaves (Mierowska et al., 2002), enhance fruit quality, and regulate the size and apple trees (Mika and Buler, 2015). Response of apple trees to summer pruning depended of

cultivar, age, and nutritional status; and by pruninginherent factors, such as time of execution, type, and intensity (Li et al., 2003).

Leaf removal by pruning during the growth cycle reduces the carbohydrate and nutrient accumulation in the remaining organs (Ikinci et al., 2014). The rate of carbohydrate and together with the capacity for photosynthetically active radiation are an essential factors for apple production and fruits quality (Wünsche & Lakso, 2000; Demirtas et al., 2010). However, when summer pruning is performed too early it can be harmful due to the leaf area elimination, and also to the loss of carbohydrate stored in the shoots. This may have a negative impact on apple production (Greer et al., 2002).

The goal of this work was to evaluate the different pruning times, performed before fruits harvest, regarding their effects on the fruits quality of 'Royal Brookfield' apple trees.

MATERIALS AND METHODS

This research was conducted using six-year-old 'Gala Brookfield'/M.9 tall spindle apple trees (*Malus domestica* Borkh) in a commercial high-density orchard located in Research Station of Faculty of Agriculture during 2018 and 2019. A total of 15 trees (five trees per treatment) were used in this experiment; the trees were approximately 3.5 m tall and planted at a spacing of 3.3 × 0.8 m (3.600 trees/ha) in north to south orientation. The trees were grown in deep loam soil and managed with a conventionally fertilizer and a pest control program. Summer pruning was applied on July 16 (treatment 1), July 23 (treatment 2) and July 30 (treatment 3) in 2018 and 18, 25 and August 1, when the growth of most extension shoots had finished. Thinning cuts and hedging were uniformly used in summer pruning to

remove entire water sprouts and long shoots. Tree height was also divided vertically into three sections from the base of the tree (0.5-1.5 m, 1.5-2.5 m, and ≥ 2.5 m). No pruning trees were used as a control treatment.

Fruits were harvested from each part of the canopy of trees in commercial maturity stage on August 14 in 2018 and 16 in 2019. The yield per canopy was recorded by counting and weighing (g) the fruits per tree. The fruit quality was analyzed by randomly choosing 10 fruits from each part of the canopy and measuring included: fruit color (percentage of surface blushing), soluble solids content (Brix), total acidity (mg/100 g f.w.), iodine-starch test (scala 1-5) and firmness (kg/cm²).

Analysis of variance has been done with STATISTICA 7 software

package. Mean separation was done by Tukey's less significant difference test

(LSD) at a 5% level of significance.

RESULTS AND DISCUSSION

Pruning a 'Gala Brookfield' cultivar in different times had a significant impact to yield per tree (table 1). Trees, included all treatments, had the smallest number of fruits in basic part of canopy. The values were between 15 (treatment 2) to 22 (control) fruits, respectively. All trees had the highest numbers of fruits in upper part of canopy (32 to 38 fruits). Total numbers of fruits per trees were 72 (control) to 84 (treatment 1). According to others authors photosynthetically active

radiation of leaves had significant effects to development of floral buds, fruit set and numbers. Also, this may impact on the carbohydrate accumulation in the plant which have role in floral buds development (Mierowska et al., 2002; Auzmendi et al., 2013; Almeida and Fioravanco, 2018). However, summer pruning increased light penetration within the tree canopy which strengthen spurs and increase flower bud formation (Ashraf and Ashraf, 2014)

Table 1. Effects of summer pruning to productivity properties of Gala Brookfield

Treatment	Part of tree canopy	Number of fruits per tree	Yield per tree (kg)	Mass of fruit (g)	Diameter of fruit (mm)
T1	basic	21.0 bc	2.8 bc	133.3 b	67.1 b
	middle	26.0 b	3.6 b	140.3 a	68.6 a
	upper	37.0 a	5.3 a	142.2 a	69.5 a
T2	basic	15.0 c	1.7 c	110.7 de	63.9 c
	middle	30.0 ab	3.4 b	112.9 d	65.5 bc
	upper	38.0 a	4.9 a	128.2 b	67.0 b
T3	basic	22.0 bc	2.4 c	110.6 d	64.2 c
	middle	25.0 b	2.8 bc	113.1 d	63.4 c
	upper	36.0 a	3.8 b	104.6 e	62.5 c
Control	basic	16.0 c	1.9 c	120.8 c	65.5 bc
	middle	24.0 bc	3.1 bc	130.3 b	67.0 b
	upper	32.0 ab	3.8 b	118.4 cd	63.2 c
lsd		8.5	1.3	5.4	1.8

Following a number of fruits per tree the highest values of yield had trees pruning four weeks before harvest (11.7 kg). Among others treatments did not record significant difference. The biggest average mass of fruits had trees in treatment 1 (138.6 g) and control (123.2 g). Also, upper and middle part of tree canopy in treatment 1 had significant biggest mass of fruits. However, trees in treatments 2 and 3, especially in middle and basic parts of canopy, had significant smallest fruits. Besides that, trees pruned two weeks before harvest had strong

effects to loss of fruit quality, due to average fruits diameter was lower than 65 mm. According to Moatamed 2012, different pruning times in the period close to harvest induced differences in the fruit set and in the yield in the subsequent year.

Also, the time of pruning applied during the growth cycle can affect the capacity of leaves. When apple trees were pruned during summer, leaves showed a fast adaptation to photosynthetically active radiation (PAR) increase (Mierowska et al., 2002; Almeida

and Fioravanco, 2018). However, Li and Lakso (2004) did not observe an increase of photosynthesis in leaves as a result of mid-summer pruning. Also, according to Almeida and Fioravanco 2018, acclimatization of leaves to PAR alterations caused by pruning may vary between the apple tree cultivars, and it is influenced by environmental conditions at the moment of pruning. Approaching times of pruning close to harvest of fruits, have impact to decreased carbohydrate

accumulation in leaves. This occurs because there is a decrease of the leaf area, and the inner leaves of the canopy, previously shaded, tend to not respond to PAR increase caused by pruning. Also, the photosynthetic activity reduces drastically between the beginning and the end of the summer due to decreases in PAR and temperature (Mierowska et al., 2002; Li & Lakso, 2004; Auzmendi et al., 2013).

Table 2. Effects of summer pruning to fruits quality of Gala Brookfield

Treatment	Part of tree canopy	Surface blushing (%)	Intensively of color (1-5)	Firmness (kg/cm ²)	Iodine-starch test (1-5)	SSC (Brix°)	Total acids (mg/100 g f.w.)
T1	basic	66.0 a	2.9 ab	8.6 ab	3.1	11.3 d	0.25 b
	middle	61.0 a	2.6 b	8.8 a	3.2	13.0 bc	0.23 bc
	upper	72.0 a	3.1 a	8.1 b	3.6	14.4 a	0.21 c
	<i>average</i>	<i>66.3</i>	<i>2.9</i>	<i>8.5</i>	<i>3.3</i>	<i>12.9</i>	<i>0.23</i>
T2	basic	45.5 b	2.1 c	8.6 a	3.3	11.3 d	0.22 c
	middle	46.0 b	2.2 bc	8.2 b	3.5	11.0 d	0.22 c
	upper	71.0 a	3.3 a	8.4 b	2.8	12.4 bc	0.21 c
	<i>average</i>	<i>54.2</i>	<i>2.5</i>	<i>8.4</i>	<i>3.2</i>	<i>11.6</i>	<i>0.22</i>
T3	basic	19.0 c	1.3 d	8.2 b	3.3	12.2 c	0.25 b
	middle	40.0 bc	1.5 d	8.3 b	3.4	11.3 d	0.23 bc
	upper	41.0 bc	1.9 cd	8.1 b	3.6	10.6 d	0.23 bc
	<i>average</i>	<i>33.3</i>	<i>1.6</i>	<i>8.2</i>	<i>3.4</i>	<i>11.4</i>	<i>0.24</i>
Control	basic	30.0 c	2.1 c	8.6 ab	3.2	11.3 d	0.31 a
	middle	37.5 bc	2.1 c	8.3 b	3.1	13.2 b	0.26 b
	upper	30.0 c	1.1 d	8.6 ab	3.1	12.2 c	0.25 b
	<i>average</i>	<i>32.5</i>	<i>1.8</i>	<i>8.5</i>	<i>3.1</i>	<i>12.2</i>	<i>0.27</i>
	lsd	12.5	0.4	0.3		0.8	0.03

Fruits in treatment 1 had significantly the highest percentage of surface blushing (table 2). In all treatments, except control trees, fruit in upper part of canopy had bigger surface blushing. Also, authors recorded that intensively of color of fruits was higher in treatment 1. At harvest time fruits in all treatment had similar values of firmness. The firmest fruit had middle part of canopy in treatment 1 (8.8 kg/cm²) and the softest fruits from upper part.

Times of summer pruning had significantly impact to solid soluble content (SSC). Average, the highest SSC

had fruits from trees pruned four weeks before harvest (12.9°Brix), while the smallest had trees pruned two weeks before harvest (11.4°Brix). fruits with higher contents of total acids had control trees (0.27 mg/100 g f.w.). However, fruits from upper part of canopy in all treatment had lower contents of total acids.

According to Guerra and Casquero 2010, summer pruning had strongly influence to apple fruits color. The earlier pruning time resulted in the highest values for pulp firmness, soluble solids, and titratable acidity (Almeida and

Fioravanco, 2018) which was confirmed in our study. Rather (2006) reported that SSC and total sugar was found superior by medium pruning and acidity was noticed more in control in both years of study in 'Red Delicious' apple. Apple tree response to summer pruning is often

variable and depends on the type of cuts (heading cuts or thinning cuts) and on the exact time of pruning in the growing season. Tree response to summer pruning is also influenced by cultivar, rootstock, tree vigor, and age (Ikinci et al., 2014).

CONCLUSION

The summer pruning had strongly influence to productivity and fruits quality of apple cultivar Gala Brookfield. Also, different times of summer pruning had significantly impact to more examined traits. Trees pruned four weeks before harvest had the highest yield, and fruits with higher mass and diameter than

others treatments. Also, those fruits had significantly higher percentage of surface blushing and soluble solid content. Authors recommended treatment 1 (summer pruning apple Gala Brookfield four weeks before harvest) like a practice in modern apples orchards.

ACKNOWLEDGMENT

This study was supported by the Serbian Ministry of Education, Science, and Technological Development projects TR31063.

BIBLIOGRAPHY

- Almeida, G.K., Fioravanco, J.C. (2018). Yield of 'Royal Gala' apple trees in response to pruning before or after leaf drop. *Pesquisa Agropecuária Brasileira*, 53(4): 427-434.
- Ashraf, N., Ashraf, M. (2014). Summer pruning in fruit trees. *African Journal of Agricultural Research*, 9(2): 206-210.
- Auzmendi, I., Marsal, J., Girona, J., Lopez, G. (2013). Daily photosynthetic radiation use efficiency for apple and pear leaves: seasonal changes and estimation of canopy net carbon exchange rate. *European Journal of Agronomy*, 51: 1-8.
- Bhusal, N., Han, S.G., Yoon, T.M. (2017). Summer pruning and reflective film enhance fruit quality in excessively tall spindle apple trees. *Horticulture, Environment, and Biotechnology*, 58(6): 560-567.
- Demirtas, M.N.; Bolat, I.; Ercisli, S.; Ikinci, A.; Olmez, H.A.; Sahin, M.; Altindag, M.; Celik, B. (2010). The effects of different pruning treatments on the growth, fruit quality and yield of 'Hacihaliloglu' apricot. *Acta Scientiarum Polonorum, Hortorum Cultus*, 9: 183-192.
- Djordjević, B., Djurović, D., Zec, G. (2018). Effects of plant bioregulators on thinning of young apple trees cultivar 'Golden delicious Reinders'. *Annals of the University of Craiova - Agriculture*, 48: 26-31.
- Greer, D.H., Wünsche, J.N., Halligan, E.A. (2002). Influence of postharvest temperatures on leaf gas exchange, carbohydrate reserves and allocations, subsequent bud break and fruit yield of 'Braeburn' apple (*Malus domestica*) trees. *New Zealand Journal of Crop and Horticultural Science*, 30: 175-185.
- Guerra, M., Casquero, P.A. (2010). Summer Pruning: An Ecological Alternative to Postharvest Calcium Treatment to Improve Storability of High Quality Apple cv. 'Reinette du Canada'. *Food Science and Technology International*, 16(4): 343-350.
- Iglesias, I., Alegre, S. (2009). The effects of reflective film on fruit color, quality, canopy light distribution, and profitability of 'Mondial Gala' apples. *Horttechnology* 19: 488-498.

- Ikinci, A.; Kuden, A.; Ak, B.E. (2014). Effects of summer and dormant pruning time on the vegetative growth, yield, fruit quality and carbohydrate contents of two peach cultivars. *African Journal of Biotechnology*, 13: 84-90.
- Lakso, A.N., Corelli, G.L. (1993). Implications of pruning and training practices to carbon partitioning and fruit development in apple. *Acta Horticulturae*, 332: 231–240
- Li, K.T., Lakso, A.N., Piccioni, R., Robinson, T. (2003). Summer pruning effects on fruit size, fruit quality, return bloom and fine root survival in apple trees. *The Journal of Horticultural Science and Biotechnology*, 78: 755-761.
- Li, K.T., Lakso, A.N. (2004). Photosynthetic characteristics of apple spur leaves after summer pruning to improve exposure to light. *HortScience*, 39: 969-972.
- Mierowska, A, Keutgen, N., Huysamer, M., Smith, V. (2002). Photosynthetic acclimation of apple spur leaves to summer pruning. *Scientia Horticulturae*, 92: 9–27.
- Mika, A., Buler, Z. 2015. Modifying apple spindle trees to improve fruit quality. *Acta Scientiarum Polonorum, Hortorum Cultus*, 14: 13–24.
- Moatamed, A.M.H. (2012). Effect of summer pruning on vegetative growth, yield and fruit quality of 'Le-Conte' pear trees. *Journal of American Science*, 8: 640-647.
- Rather, G.H. 2006. Combined influence of pruning regimes and fertilizer application on production and quality of apple (*Malus x domestica* Borkh.) cv. Red Delicious. Ph. D Thesis submitted to Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Srinagar, India.
- Yang, S.J., Sagong, D.H. Yoon, T.M., Song, Y.Y., Park, M.Y., Kweon, H.J. (2015). Vegetative growth, productivity, and fruit quality in tall spindle of 'Fuji'/M.9 apple trees. *Korean Journal of Horticultural Science and Technology*, 33: 155–165.
- Wünsche, J.N.; Lakso, A.N. (2000). Apple tree physiology: implications for orchard and tree management. *Compact Fruit Tree*, 33: 82-88.