DEPENDANCE OF GROWTH OF APPLE TREES MEASURED BY OFF-SEASON PRUNING IN KOSOVO CLIMATE CONDITIONS

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Abstract

Apple fruit productivity is depended in many factors such as is the influence of pruning for apple fruit productivity. "Red Delicious" and "Idared" apple varieties growth can differ even though they are planted in same year. This can cause as well different fruit production and vegetative growth. How many fruits are produced depends as well from the vegetative growth of the trees, calculation the volume of canopy determine what is the growth of the trees and what can be the fruit production. As we evaluated the growth of the apple orchard in the previous years with pruning we gave the crown shape and later to determine which would be the canopy growth, lowering the bearing volume so in next year we would see the tree response, directed in fruit bearing or vegetative growth. Canopy volume of "Idared" was higher compared to "Red Delicious" and in this case we would have higher fruit production in the first fruit than the second variety. Apple orchard had a normal growth in the first years, from the results of measurement that in the coming years fruit productivity will be according to the variety. Orchard is expected to have average fruit production and growth, even though varieties had different growth on previous years.

Key words: apple orchard, pruning, tree growth, productivity, MM-106

INTRODUCTION

Apple fruit productivity is depended in factors such as rainfall, irrigation, soil type, wind, but as much as in the agricultural practices applied in the orchard.

The performance of cereals and vegetable in recent year has been decreased, farmers find themselves into a new market, changing from cereals to fruit trees is promising. There are many factors which define a good fruit to be sold in the market.

Seedling use for planting is not a common practice anymore, where use of combination of rootstock and variety is better (Di Vaio et al., 2009). Root pruning can be used to reduce control growth of trees in orchards (Ferree, 1997), which is an effective method of reducing tree size in an ultra-high density planting system (Khan et al., 1998).

Interaction between fruit load and water stress must be taken into account when studying the responses of fruit tree to regulated deficit irrigation (RDI) (Ruiz-Sanchez et al., 2010).

Thinning increases the efficiency of nitrogen and light use of leaves in densely planted orchard (Sun et al., 2016), this will result in higher biomass

production, where composting of tree biomass increase the overall sustainability of fruit production (Fiore et al., 2018). The interaction between young apple trees are obviously complex, orchards as well provide food and shelter for predatory beetles (Merwin, 1994; Markó et al., 2017).

Suitable technique for mitigation the adverse effects of a water deficit on fruit growth should produce an improvement in tree water status and least maintain assimilation capacity (Lopez et al., 2006). There was a significant irrigation x cropland interaction on fruit weight at harvest (Ebel, Proebsting, & Evans, 1995) and using irrigation could be used to save significant amounts of water.

Correct use of drip irrigation can save water, reduce groundwater pollution, and improve water use efficiency and harvest index, irrigation-deprivation treatments made significant enhancing effects on fruit quality (Lampinen et al., 2001). The smaller canopy volume per tree of "Delicious" variety in each system indicates the planting density for this cultivar should have been closer than for "Empire" for optimum performance which resulted with losses for "Delicious"(T. L. Robinson, Lakso, & Carpenter, 1991).

Correspondingly, greater light penetration was positively related to redness of the bark, total leaf (N), flower bud, fruit yield, fruit skin colour, soluble solids, and firmness as well as reduced diseases occurrences in the leaves of "Fuji" apple (Jung & Choi, 2010). The equation which should be used to predict weight from crown volume depends upon the plant species and the sampling date. For robust species with ample edible biomass per plant but with inherent variability among plants, the log-log function may yield best results (Bryant & Kothmann, 1979).

One-year tree growth determines productivity of the orchards, but to consolidate a good orchard one should maintain tree growth and crown shape and apple productivity, measurements should be made. Tree canopy growth and other relevant factors will define how will be the productivity of the orchard. I evaluated the vegetative growth of apple trees hence I will observe in the coming year the yield response which would come from the effects of pruning.

MATERIAL AND METHOD

Orchard management require process to reach the productivity. On the researched orchard which was planted in the fall of 2013 are planted apple varieties Idared and Red Delicious grafted in vegetative rootstock with average of growth MM-106 (Malling-Merton 106). Planting distance were 3.80 by 2.0 m. Crown type formation is with "Central Leader".

For the growth and development of fruit trees are important climatic and soil conditions and applied common agricultural techniques. For the place where orchard is an average yearly temperature of 10.4 ◦C average of rainfall of 600 mm. In June we have and average of temperature of 30 ◦C while in January from -0.6 ◦C.

Based on the agro-pedological research which has been done in the area where the orchard has been planted, that the soil type is alluvium. Other chemical soil factors like pH is weak acidic, favourable for the orchard, good infiltration rate, water holding capacity.

Rootstock MM-106 is an apple rootstock with average growth. MM-106 is the best vegetative rootstock. It is resistant against bloody tree louse Erisoma Lanigerum and its easy multiplied. Apple varieties which are grafted in MM-106 rootstock have average growth. Rootstock MM-106 is relatively resistant against Fire Blight (Erwinia amyllovora) and frost. Sensitive to apple collar rot (phytophthora Cactorum) and apple powdery mildew (podosphaera leocotricha).

Idared and Red Delicious variety are well spread varieties and likely planted tree types from farmers. Have an average close blooming time it is well spread variety around the world. They are diploid varieties with average early blooming an important factor for fruit production. Variety has average growth. Its fruits are ripened at the end of September and successfully can be saved for a long period of time. These trees have good growth in narrow crown, until goes into fruitification.

Measurement of the growth of the apple orchard was done at the end to vegetation, estimation of their growth was done. As further research in the same trees where the samples were taken we will follow for the next coming year their growth. Measurements were done for their canopy volume growth, numbers of fruits and their weight and number of new shoot found in the new places where the pruning has been applied. Canopy is a factor which determines how much fruit can a tree can hold. Depending on the volume of the apple canopy the higher it will be the higher the productivity of the fruits will be.

RESULTS AND DISCUSSION

Orchards with the passage of time have changed the way of cultivation of crown type, needs of farmers and creativity made them and researchers finding the best crown by the request of the farmer and economising. “Central Leader” crown type is a new crown type which is being applied where it is more favourable for farming since it takes less time to form it per tree and harvesting quicker. The system has a pyramid-shaped tree with its tiers of branches spaced along the trunk, each

distribution of the branches makes impact on fruit quality and production (T. Robinson, Lakso, & Ren, 1991).

The consistent production of the fruits in the trees and their quality can be accomplished when we have done the right pruning. Researched orchard resulted for crown formation of "Central leader" and the influence of pruning at apple trees, has included data for vegetative growth parameters before and after apple pruning (Table 1).

Table 1

Apple tree measurements

Variety	Rootstock	Trunk diameter	Trunk height	Width between rows	Width in rows	Crown heights
Idared	MM106	44.1	66.6	166.5	192.8	208.8
		44.1	66.6	132.3	154.3	192.7
				20.5%	19.9%	7.7%
Red Delicious	MM106	43.93	59.1	161.1	187.7	201.9
		43.93	59.1	130.6	163.1	188.3
				18.9%	13.1%	6.7%

Trunk diameter is continuously thickening. Its width is depended from parent's traits and rootstock where variety has been grafted. The biggest diameter of trunk had Idared variety and thinnest Red Delicious. On the table can be seen that an average they had a close thickness of trunk in two varieties.

Trunk height, it determines the height between the grafted place to the first tree branches coming out of trunk. Highest height of trunk was at Idared variety while lowest was for Red Delicious in average. "Central leader" is crown type with average height of the trunk. Based on the research of Zajmi et al. (2006) "Central leader" crown has trunk height of 50 – 60 cm above soil surface. Where in our research we can see that there is a significant increase of trunk height which be a change from the crown height.

Crown width between rows – highest width between apple trees was at Idared variety while smaller at Red Delicious has been decreased for 18.89 %. In this case is important to have smaller numbers since this is the path between rows where gives the ability to easily access the orchard.

Crown width in row – the highest width in the row has been at Idared variety for 192.7 cm while it was smaller at Red Delicious for 209.7 cm. We must consider to now have large number of stems in-rows, but we can leave branches longer as much this does not cause any problem.

Crown height is important for crown formation. The differences could be seen to be minimal before and after pruning. Decrease of the height after pruning for Idared variety was from 7.72 %, while at Red Delicious was 6.74%. In case of applying manual pruning it should be kept at the level of human reach height for easily/faster harvesting. Light distribution generally improves as tree size and canopy depth decrease. Efficiency of fruit management and biological efficiency are greater for small trees (T. Robinson et al., 1991).

One-year growth of the branches, it has been proved that because of not being in a relationship of the one-year growth and fruit-bearing it brings trees to the condition, so they produce one year and another one is failure for fruit production. In this case without successful vegetative growth we would not have fruit production. Based on the analysis of vegetative growth of one vegetation of the apple varieties, Idared and Red Delicious we have concluded that: Idared had higher number of shoots but shorter while Delicious had less shoot but longer.

Idared variety had better shoot growth and smaller number of their growth, while Red Delicious had bit less shoot and their growth in length was longer. In this case in one-year vegetation growth was found higher at Red Delicious (sample 2) compared to Idared variety (sample 1) (Figure 1).

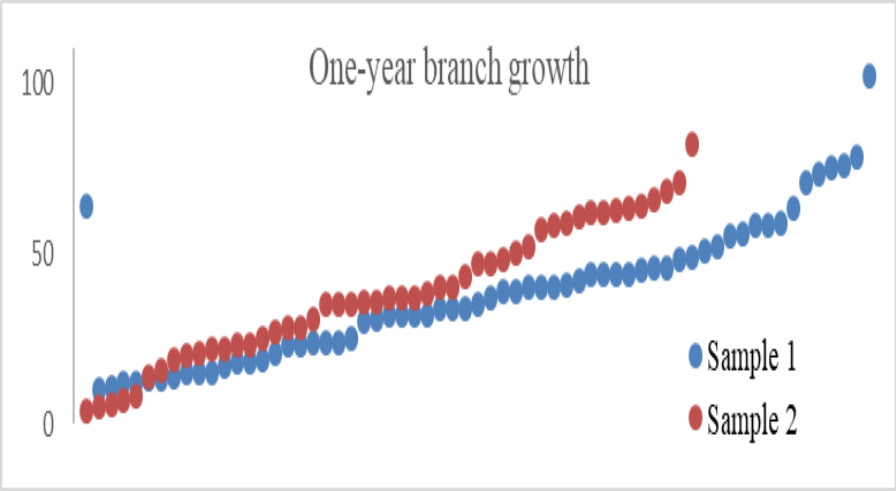

Fig. 1. One year branch growth of apple trees

With random selection from each cultivar has been taken 5 apple trees in three repetition respectively 15 apple trees from each cultivar, and based on the measurement of some parameters where we considered as important to determine tree growth:

Trunk diameter of 20 cm from the grafted place, height of trunk from grafted place to first branches, crown width between rows, crown width in the rows, crown height, crown dimension of apple varieties before and after pruning, one-year growth of branches.

From our starting point of the research to determine the growth of apple cultivars and find how will be their response to the growth we need to calculate what is the canopy volume of apple crown for fruit bearing. Since our crown type is with central leader the shape can be considered as circular cone which the formula for calculation is relevant for the measurement which has been done (Bryant & Kothmann, 1979).

$$V = \pi r^2 \frac{h}{3}$$

ig. 2. Equation for volume calculation

Results for "Red Delicious" variety, respectively the radius average and the volume of canopy after and before pruning.

Table 2

Measurements on Red Delicious variety

Radius average	**Before Pruning**	**Radius average**	**After Pruning**
146	3.0	128	2.3
110	2.3	119	2.2
100	1.9	99	1.6
132	2.6	127	2.3
170	4.5	172	4.3
147	3.2	145	3.0
130	2.9	138	2.9
175	4.1	166	3.8
107	2.1	123	2.3
122	2.3	128	2.4
cm	square metre	cm	square metre

Table 3

Measurements on Idared variety

Radius average	Before Pruning	Radius average	After Pruning
138	2.6	132	2.3
158	3.5	140	2.7
162	3.6	114	2.5
120	2.9	89	1.9
147	3.4	115	2.4
135	2.5	96	1.8
142	3.3	112	2.4
115	2.2	90	1.7
122	2.8	96	2.1
137	3.5	114	2.5
cm	square metre	cm	square metre

Results above show us that the decrease of the crown on the each varities prunned although has been in an increased value at Idared Variety for 80% compared to Red Delicious where it has been for 16 % in average.

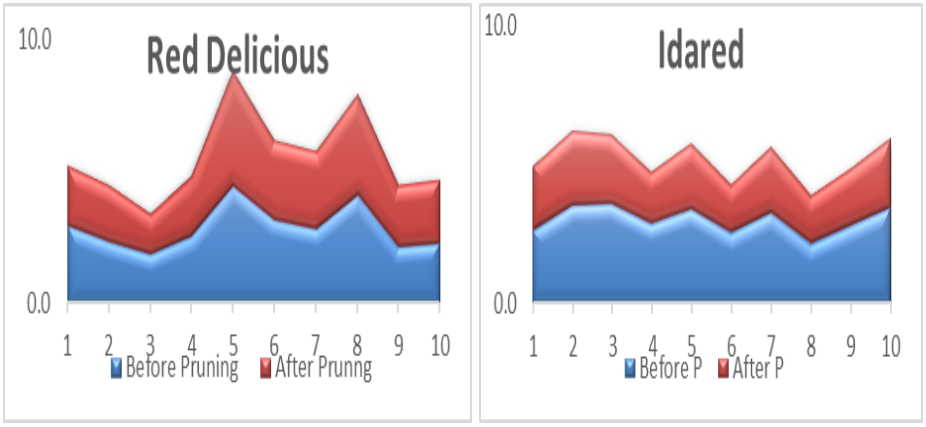

Fig. 3. Differences between tree growth of varieties

In both cases where has been applied pruning the canopy of crown was done higher and in some less as seen in the graph where the samples have been shown.

Since the intensity of pruning was achieved at this point and the orchard was planned to get into production in the next vegetation the pruning was done properly. From this we achieve a normal growth of the crown and the fruit bearing can be at the maximum capacity.

Fruit quality of these two cultivars might the highest quality which can represent the market demand of these two apple cultivars. And the percentage distribution of the apples in the size classes on the fruit trees which is randomly the weight of the fruits it is bigger in lower canopy and lower in higher canopy but in the case when we would apply this specific pruning method we would have the same amount of the weight for each fruit in the same position inside the canopy. Considering relevant weather conditions we would have a proper growth of apple trees, a continuous fruit production in the coming year and renewing each apple branches with new tree shoots.

CONCLUSIONS

The researched vegetative parameters from pruning of apple varieties of Idared and Red Delicious grafted in vegetative apple rootstock MM-106, we can conclude that:

- Diameter and height of the trunk was bigger at Idared variety compared to Red Delicious variety which had the diameter and trunk height also crown diameter in rows and height was higher at Idared variety compared to Red Delicious variety. Crown dimensions after pruning at Idared variety has been decreased on average of 17%, while at Red Delicious has been decreased for 13%.
- Annual growth of the shoots has been higher at Red Delicious while for Idared variety had shorter shoot length.
- Since the canopy of the orchard was different and the after pruning we would expect a higher production in the orchard for each varieties
- Volume of the crown has been decreased in both varieties after pruning concluding that orchard is well developed in the previous years.
- Apple fruit growth depends on the leaves which are found in the canopy, best developed canopy of fruit trees higher the productivity of fruits
- Fruit bearing of the trees might be higher in Idared variety since from the plantation date we had more vegetative growth, trees are well developed they can support fruit production in higher rate.

Based on the measurement we could have seen that the growth of trees was the same on the year when we started our research, orchard varieties had different growth in previous year which might be an indicator that the orchard had varied growth.

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REFERENCES

1. Bryant, F., & Kothmann, M. (1979). Variability in predicting edible browse from crown volume. Journal of Range Management, 32(2), 144–146. Retrieved from https://journals.uair.arizona.edu/index.php/jrm/article/download/12794/12071#page=67
2. Di Vaio, C., Cirillo, C., Buccheri, M., & Limongelli, F. (2009). Effect of interstock (M.9 and M.27) on vegetative growth and yield of apple trees (cv "Annurca"). Scientia Horticulturae, 119(3), 270–274. https://doi.org/10.1016/j.scienta.2008.08.019
3. Ebel, R. C., Proebsting, E. L., & Evans, R. G. (1995). Deficit irrigation to control vegetative growth in apple and monitoring fruit growth to schedule irrigation. HortScience, 30(6), 1229–1232.
4. Fiore, A., Lardo, E., Montanaro, G., Laterza, D., Loiudice, C., Berloco, T., … Xiloyannis, C. (2018). Mitigation of global warming impact of fresh fruit production through climate smart management. Journal of Cleaner Production, 172, 3634–3643. https://doi.org/10.1016/j.jclepro.2017.08.062
5. Influence on Growth of root pruning apple cultivars.pdf. (n.d.).
6. Jung, S. K., & Choi, H. S. (2010). Light penetration, growth, and fruit productivity in "Fuji" apple trees trained to four growing systems. Scientia Horticulturae, 125(4), 672–678. https://doi.org/10.1016/j.scienta.2010.05.027
7. Khan, Z. U., McNeil, D. L., & Samad, A. (1998). Root pruning reduces the vegetative and reproductive growth of apple trees growing under an ultra high density planting system. Scientia Horticulturae, 77(3–4), 165–176. https://doi.org/10.1016/S0304-4238(98)00164-2
8. Lampinen, B. D., Shackel, K. A., Southwick, S. M., & Olson, W. H. (2001). Deficit irrigation strategies using midday stem water potential in prune. Irrigation Science, 20(2), 47–54. https://doi.org/10.1007/s002710000028
9. Lopez, G., Mata, M., Arbones, A., Solans, J. R., Girona, J., & Marsal, J. (2006). Mitigation of effects of extreme drought during stage III of peach fruit development by summer pruning and fruit thinning. Tree Physiology, 26(4), 469–477. https://doi.org/10.1093/treephys/26.4.469
10. Markó, V., Elek, Z., Kovács-Hostyánszki, A., Kőrösi, Á., Somay, L., Földesi, R., … Báldi, A. (2017). Landscapes, orchards, pesticides–Abundance of beetles (Coleoptera) in apple orchards along pesticide toxicity and landscape complexity gradients. Agriculture, Ecosystems and Environment, 247(December 2016), 246–254. https://doi.org/10.1016/j.agee.2017.06.038
11. Merwin, I. A. (1994). Orchard Groundcover Management Impacts on Apple Tree Growth and Yield, and Nutrient Availability and Uptake. J. Amer. Soc. Hort. Sci. , 119(2), 1–7. Retrieved from papers2://publication/uuid/33E04A2A-B29C-4812-B441-E9BC43DB18F3
12. Robinson, T. L., Lakso, A. N., & Carpenter, S. G. (1991). Canopy Development, Yield, and Fruit Quality of 'Empire' and 'Delicious' Apple Trees Grown in Four Orchard Production Systems for Ten Years. Journal of the American Society for Horticultureal Science, 116(2), 179–187. Retrieved from http://journal.ashspublications.org/content/116/2/179.abstract

13. Robinson, T., Lakso, an, & Ren, Z. (1991). Modifying apple tree canopies for improved production efficiency. HortScience, 26(1973), 1005–1012. Retrieved from http://hortsci.ashspublications.org/content/26/8/1005.full.pdf
14. Ruiz-Sanchez, M. C., Domingo, R., & Castel, J. R. (2010). Introduction. Spanish Journal of Agricultural Research, 8(2), 5–20. Retrieved from http://repositorio.upct.es/bitstream/handle/10317/1554/dif.pdf?sequence=1&isAllowed=y
15. Sun, Y., Zhang, Y., Jiang, Y., Song, K., Gao, J., Zhang, D., & Zhang, J. (2016). Leaf Potential Productivity at Different Canopy Levels in Densely-Planted and Intermediately-Thinned Apple Orchards. Horticultural Plant Journal, 2(4), 181–187. https://doi.org/10.1016/j.hpj.2016.07.003