Effect of heading date on the morphological characteristics of one-year-old shoots of pear (*Pyrus communis* L.)

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Summary

Pear production has the greatest economic importance next to the apple and plum production in Republic of Srpska (BiH) fruit production. Dominant practice of utilizing wild pear (*Pyrus communis* L.) seedling as a rootstock typically causes an intensive growth and postpones fruiting. Intensive vegetative growth during the early years influences the formation of long shoots where growth is terminated at time when mixed buds are formed on the tips and then regularly come to be bare at the base. The objective of this study was to examine the effect of date of heading back shoots during the growing season on the growth and development characteristics of one-year-old shoots in pear trees. The study was carried out in pear orchard, age 2 years. The study included three varieties 'Williams', 'Abbé Fétel' and 'Packham's Triumph'. All varieties were grafted on the seedlings of wild pear (*Pyrus communis* L). Training system is a slender spindle. Newly formed shoots on the central leader were cut back during 2015, and the resultant year-old shoots were analysed in 2016. The shoots were cut back to 5, 10 and 15 nodes (buds) at three different dates during intensive growth. Control shoots were not cut back. The studied varieties had best reaction regarding initiation of new growth points and intensity of new growths in the later shoot heading dates. Intensity of new growth formation is also variety related.

Key words

variety, pruning, one-year-old shoot

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Introduction

Over the last twenty years, there have been numerous innovations in growing pear trees in general and planting systems in particular. Rootstocks of differing vigour allow the use of various training systems in pear production (*Mićić et al. 1998, Lauri et al., 2002; Ancarani et al., 2004; Musacchi 2011*). The palmette is still the most important training system in low density plantings (1,000-1,500 trees/ha), and the spindle is the standard for medium density plantings (2,000-4,000 trees/ha) (*Musacchi* 2011). Increasing planting density is mostly associated with the use of low-vigour rootstocks (*Cydonia oblonga* Mill. selections). The use of low-vigour rootstocks in pear production requires favourable climatic and soil conditions and a controlled approach to plant nutrition and irrigation to ensure normal plant development and good fruit quality. In Bosnia and Herzegovina, the use of low-vigour rootstocks for pear trees has been limited by unfavourable characteristics of soils, which are mostly pseudogleys, fine-textured, compact and with a low pH. In pear production, 'Williams' is the predominant variety, which is almost solely grafted on wild pear (*Pyrus communis* L.) seedlings. 'Williams' accounts for 54.49% of the total nursery trees produced in the Republic of Srpska (*Davidović, 2015*). Over the last years, the construction of modern storage facilities has been accompanied by an increasing tendency to use the pear variety 'Abbé Fétel', but to a substantially smaller extent than in major fruit producing countries (*Musacchi 2011*). Regardless of the use of seedling rootstock, pears are commonly trained as spindles (*Mićić et al.1998*) at a planting density of 1,000 – 1,250 trees/ha. The production of spindle-trained pear trees planted on seedling rootstock is labour intensive, and requires intensive tree management practices during the first years of tree training, with particular attention given to pruning operations during the growing season. Intensive growth during the growing season promotes the formation of long shoots whose growth is terminated when mixed buds are formed on their tips, which is especially pronounced in 'Williams' (*Gliha, 1997, Musacchi 2011*). Fruit formation at the apex of one-year-old shoots causes the shoots to bend under the crop load and become bare at the base, consequently leading to the fruit-bearing zone moving away from the central leader. The branches supporting fruiting wood thus formed disturb the desired spindle structure, resulting in the need for their earlier replacement. The objective of this study was to examine the effect of date of heading back shoots during the growing season on the growth and development characteristics of one-year-old shoots in pear trees. Specifically, the study focused on the effect of heading cuts on the formation, number and position of mixed buds along the one-year-old shoot.

Materials and methods

The research was conducted in a commercial orchard of two-year-old pear trees located at Jasenje (45º 09' 32'', 16º 44' 43'') in the Municipality of Kozarska Dubica (Bosnia and Herzegovina). The orchard soil is slightly acidic in reaction (pH in KCl – 6.21) and relatively well supplied with major nutrients (humus –1.7%, P_2O_5 – 10.8 mg/100 g soil, K_2O – 22.0 mg/100 g soil). The total land area of the orchard is 1.2 ha, with 1,350 trees. 'Williams' is the predominant variety, accompanied by 'Abbé Fétel' and 'Packham's Triumph'. The varieties are grafted on wild pear (*Pyrus communis* L) seedlings. The trees are trained to slender spindle. The orchard receives standard tree management and cultural practices. 'Williams' exhibits a marked preference for bearing fruit on one-year-old wood (*Musacchi 2011*), unlike 'Abbé Fétel' and 'Packham's Triumph' (*Gliha, 1997, Du Ploy et al., 2002, Musacchi 2011*). Regular tree management practices do not include heading back one-year-old shoots. The research was conducted during 2015-2016. Newly formed shoots on the central leader were cut back during 2015, and the resultant year-old shoots were analysed in 2016. The shoots were cut back to 5, 10 and 15 buds at three dates during intensive growth (*Meier, 2001*) i.e. on 25 May 2015 – date I (phenological growth stage BBCH 32 – calendar week 20); 15 June 2015 – date II (stage BBCH 34 – calendar week 23) and 5 July 2015 – date III (stage BBCH 36 – calendar week 25). The control shoots were not subjected to heading cuts. Each treatment involved 30 shoots (on average 10 trees, 3 shoots per tree). The formed one-year-old shoots were analysed in 2016 for growth (the characteristics of shoots subjected to heading cuts and newly formed shoots) and development (number and position of mixed buds formed along the one-year-old shoot). The studied characteristics were assessed by standard analysis of variance, with consequent appropriate pairwise tests in cases where significant difference was observed. The level of significance was set at $p<0.05$. Statistical analyses and visual representation of data were conducted using the software package SPSS 22 (IBM, 2013).

Results and discussion

The average length of shoots subjected to heading cuts indicates that growth rate induced by the seedling rootstock neutralises cultivar specificity as regards vigour (Figure 1). Namely, apart from the difference in the length of shoots subjected to heading cuts among different treatments ($p<0.001$), no statistically significant differences were observed among the tested cultivars ($p=0.375$), nor were there any significant interactions between the treatments and the cultivars ($p=0.124$). Bud density may play an important role in the satisfactory formation of new growth along branches developing fruiting wood, particularly at the base (closer to the leader), and hence provide a basis for more satisfactory and simpler fruiting wood replacement.

The analysis of the base diameter of one-year-old shoots (Figure 2) indicates a highly significant effect of cultivar ($p<0.001$) and a significant effect of heading cut treatment ($p=0.011$). Further analysis shows that the significantly smallest ($p<0.05$) diameter of shoots in the heading cut treatment was observed in 'Abbé Fétel', followed by 'Williams', and the largest in 'Packham's Triumph', which can be associated with its stronger vigour during the first years after planting (*Gliha, 1997*). Cutting back shoots to 10 buds gave the smallest base diameter, as opposed to the largest base diameter in the control shoots, with the difference between the two treatments being statistically highly significant ($p<0.001$). Secondary growth length (Figure 3) was highly significantly affected by both studied factors, i.e. the variety ($F=17.397$, $p<0.001$) and the applied treatments ($F=60.328$, $p <0.001$).

Further analyses using LSD test indicate no statistically significant difference in secondary growth length between 'Williams'

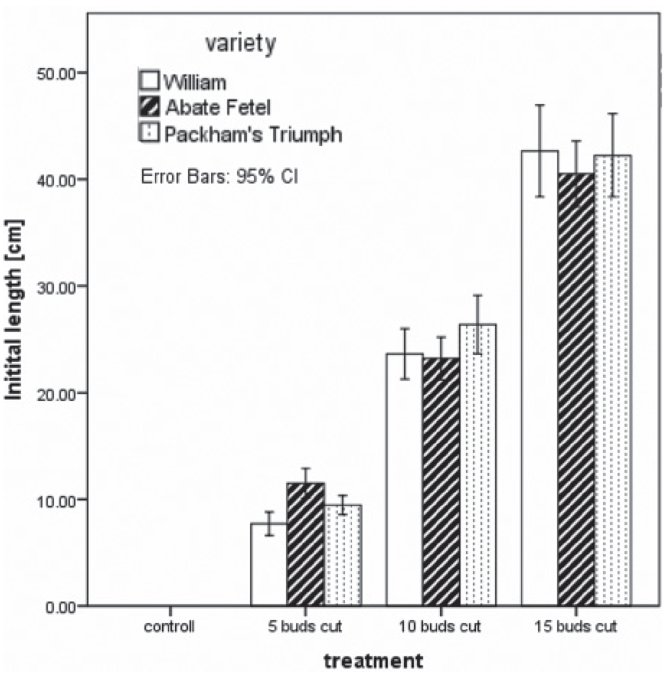

Figure 1. Average length of shoots subjected to heading cuts as a function of the number of buds retained (cm)

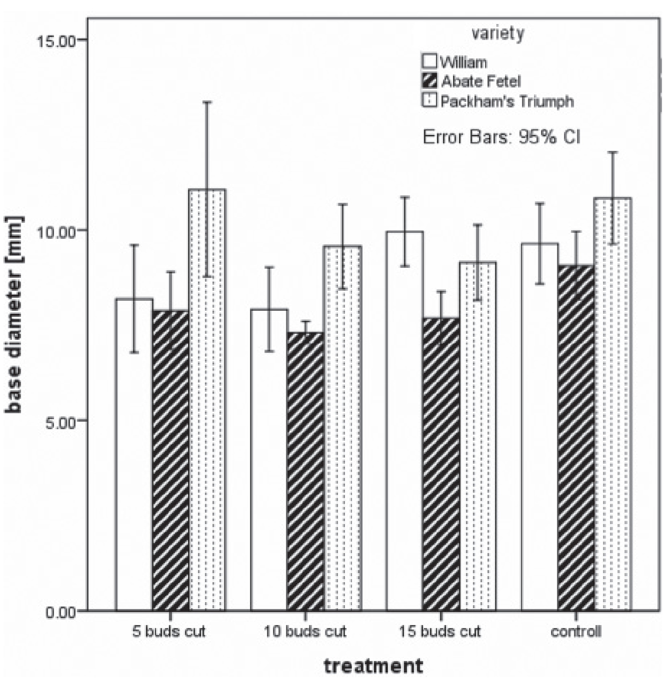

Figure 2. Average base diameter of shoots subjected to heading cuts as a function of the number of buds retained (cm)

and 'Abbé Fétel' (p=0.435), classified as varieties with shorter secondary growth (*Du Ploy et al., 2002*). Short growths in 'Abbé Fétel' are a cultivar-specific trait in the formation of branches

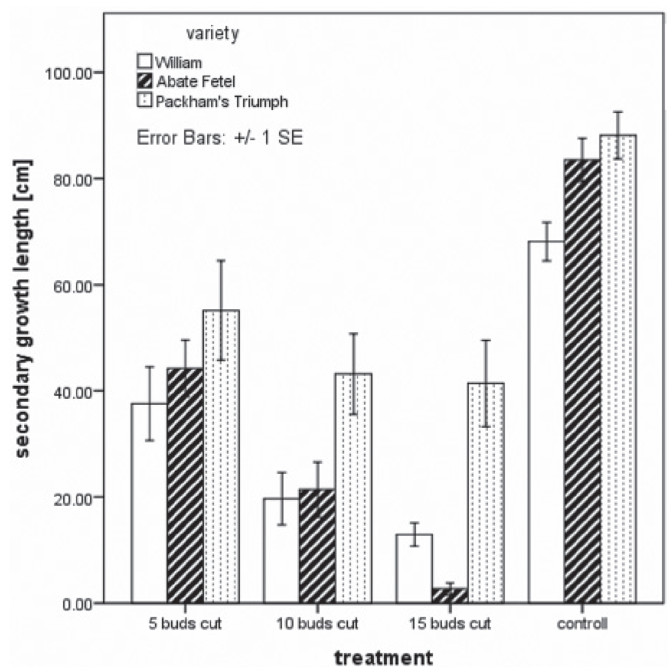

Figure 3. Average secondary growth length in shoots subjected to heading cuts as a function of the number of buds retained (cm)

supporting fruiting wood (*Du Ploy et al., 2002, Musacchi, 2011*). There was a statistically highly significant difference between both of these varieties and 'Packham's Triumph' (p<0.001), with 'Packham's Triumph' classified separately as having longer secondary growth (*Gliha, 1997, Du Ploy et al., 2002*). As for the effect of treatments on the secondary growth, the control produced the longest growths which were statistically highly significantly longer than the applied heading cut treatments (p<0.001). The control was followed by the 5 buds cut treatment, which gave highly significantly shorter secondary growths than the control, but longer secondary growth compared to the other two treatments (p<0.001). Cutting back shoots during the initial developmental stages did not lead to a reduction in secondary growth length. Cuts above the 10th and 15th buds did not induce significantly different lengths of secondary growths (p=0.092). Cutting back at later dates has a positive effect in reducing the rate of growth, thus contributing to the activation of growth points on the part of the shoot subjected to the heading cut. This approach enables the distribution of intensive vegetative growth and mixed bud formation at the shoot base (on the portion of the shoot subjected to heading cut) as well, thereby providing the basis for growths to be activated at the base of newly formed shoots (Figure 4).

The graph is self-explanatory, as the ratio of the number of mixed buds in different treatments and varieties is presented. There is a general tendency of shoots cut back to 5 buds and the control shoots to form more mixed buds above the initial cut, or at the apical point for control shoots. Shoots cut back to 10 or 15 buds tend to produce greater balance in the number of mixed buds under and above the cut. Mixed bud formation under the cut indicates the redistribution of growth vigour and its substantial

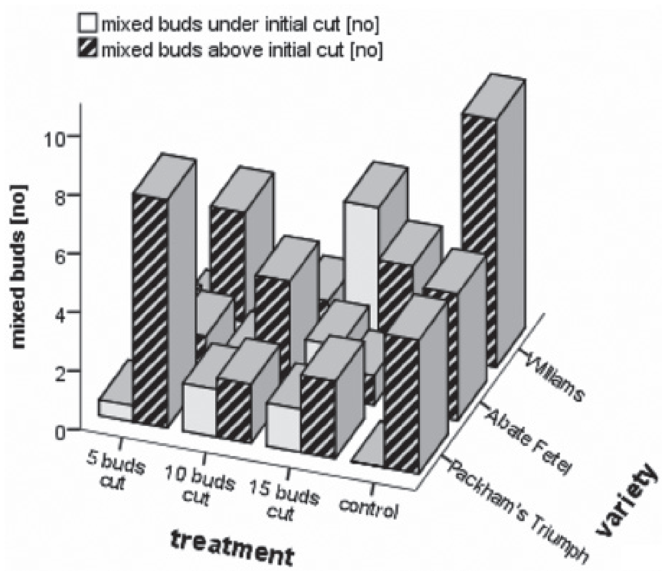

Figure 4. Average number of mixed buds formed on the portion of the shoot subjected to a heading cut and on the secondary growth as a function of the number of buds retained

redirection towards reproductive growth. The formation and position of mixed buds play a part in more even distribution of different categories of growth points. Mixed buds formed on the shoot subjected to heading cut treatment (10 or 15 bud length) ensure the formation of new growth in positions much more suitable for the successful formation and maintenance of the spindle training system in pear trees grown on seedling rootstock (*Mićić et al., 1998*). However, there might be some influence of the variety and a possible interaction between the variety and the applied treatment.

Conclusions

Growing pear trees on seedling rootstock induces intensive shoot growth, with shoots becoming bare at the base due to initial fruit-bearing in the first year and developing into scaffold branches at a faster rate. Cutting back shoots in the second part of the growing season (at the stage of growth reaching 40-60% of final length) is effective in reducing their growth rate. Shoots subjected to heading cuts exhibit a more favourable distribution of mixed buds along their length. Heading back shoots during the initial stages of development (at the stage of growth up to 20 – 30% of final length) is not effective in reducing the intensity of growth. Response to heading cuts is also a cultivar-specific trait.

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