Leader management techniques to induce vegetative bud development in plum

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Abstract

This paper examines the effect of notching technique on the degree of activation of dormant buds and initiation of vegetative winter bud outgrowth in plum (*Prunus domestica*). Shoot growth induced by the treatment was also characterized. In intensive planting systems for stone fruit trees, the main issue in establishing the projected growth-cropping relationship is the formation and positioning of vegetative buds within the crown. Notching is a leader management practice useful in encouraging this process. In this research, notching was performed on the one-year-old portion of the leader of plum trees trained to the spindle planting system. Notching cuts were made on the bottom half of the leader and along the whole length of the leader as two different treatments. The experiment included plum cultivars 'Čačanska Lepotica', 'Čačanska Rodna', 'Stanley' and 'Hanita'. The spontaneous development of vegetative buds on the leader in all tested cultivars was low, ranging from 6.80-9.18%. The induction of vegetative bud development by the notching operation depending on cultivar and method of treatment was high (95.77-98.11%). A statistically highly significant effect of treatment method was observed in the number of activated buds and total shoot growth. Cultivar had a statistically highly significant effect on average shoot length which affects the character of the shoot itself. The position of new shoots on the leader and their total length, as induced by the notching operation, requires the use of this leader management technique during the initial years of training plum trees to spindle planting systems.

Keywords: cultivar, notching, shoot

INTRODUCTION

Modalities to improve the plum growing technology (Weber et al., 1994; Grzyb et al., 1998) are mostly based on using low vigor rootstocks and increasing the number of plants per unit area (Meland, 2005). Plum cultivation in Bosnia and Herzegovina is characterized primarily by the use of myrobalan (*Prunus cerasifera* L.) seedling as a predominant rootstock, due to the lower price of nursery plants and rootstock adaptability to specific soil and climatic conditions. Growing plums on vigorous rootstocks can be intensified through the use of low-intensity pruning and a range of tree management practices that control growth and productivity (Hrotko, 2004; Mićić et al., 2005; Glišić et al., 2007). Although intensive labor is required for management treatments during the training system establishment years, growing plums on vigorous rootstocks in intensive systems with an increased number of plants per unit area is justifiable and cost-effective (Botu et al., 2013). When growing plums trained to spindle systems, vigor and pronounced apical growth lead to a natural tiered structure and poor activation of lateral vegetative buds i.e., non-uniform lateral branching on the central leader. In order to initiate the activation of lateral vegetative buds on the leader, notching treatment is required. Greene and Autio (1994) believe that notching is the most effective technique available to stimulate lateral branching (on apple trees) for several reasons: it is rapid; it stimulates buds to grow in precisely the place where they are needed; growth, fruit set and bud formation are not adversely affected; and shoots that are stimulated to grow with notching are longer and more useful than those induced by

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other means.

The present research examined the effect of notching on the activation of vegetative buds and the resulting characteristics of newly formed shoots.

MATERIAL AND METHODS

The effect of notching on the degree of initiation of bud activation and shoot characteristics in plum was experimentally examined in a privately-owned commercial planting in the Municipality of Srbac (45°05'52"; 17°31'30") in 2011. The research included the most common plum cultivars in Bosnia and Herzegovina: 'Čačanska Lepotica', 'Stanley', 'Čačanska Rodna' and 'Hanita'. All cultivars were grafted on *Prunus cerasifera* L. rootstock. Planting distance was 4.0×1.5-1.8 m (1390-1660 trees ha^{-1}). Orchard floor management consisted of grass in the interrows and 1 m wide herbicide strips in the intrarow space. Notching was performed on the central leader of three-year-old trees being trained to the spindle bush system. The operation was conducted as part of regular pruning in May when the vegetative buds were at growth stage 03 of the BBCH-scale (Meier, 2001). Two notching treatments were used: a) notching along the entire length of the central leader, and b) notching on the bottom half of the leader (50% of the full length of the leader). Notching on the bottom half of the leader rested on the hypothesis that buds on the top half of the leader would be activated spontaneously. Notching was performed using Kuker double-cut pruning shears (art. 72) (Mićić et al., 2005), by making a semicircular incision above the bud. Upon notching, no disinfectants were used. No adverse side effects (resin flow) were observed on notched trees during the growing season. Control trees were not notched. The experiment was laid out in a randomized complete block design with four replications and 10 trees $treatment^{-1}$. Number of activated buds and characteristics of newly formed shoots were analyzed at the beginning of August. Data were subjected to statistical analysis using the SPSS 22 (IBM, 2013) statistical software package.

RESULTS AND DISCUSSION

The average length of the notched leader, regardless of cultivar and notching treatment, ranged from 57.60±5.08 to 69.60±4.47 cm, with an average of 9.80±1.18 to 15.70±1.51 vegetative buds (data not presented). The percentage of spontaneously activated vegetative buds on control trees (Table 1) was very low and varied from 6.80 to 9.18% in 'Čačanska Lepotica' and 'Čačanska Rodna'.

Table 1. Percentage of vegetative buds activated after notching treatment.

Cultivar	Entire leader notched	Half leader notched	Control
Čačanska Lepotica	98.11	97.50	9.18
Čačanska Rodna	96.83	96.83	8.21
Hanita	95.77	95.77	9.18
Stanley	97.50	98.11	6.80

The percentage of vegetative buds that were activated after notching along the whole length of the leader was very high, within the range 95.77% in 'Hanita' to 98.11% in 'Čačanska Lepotica'. Similar data were reported by Glišić et al. (2007) on the activation of growth points in 'Stanley' and 'Čačanska Rodna', which had 78.8-85.5% of activated buds depending on treatment dates. The activation percentage was also high in the notching treatment of the bottom half of the leader, but only in notched buds. Unnotched buds in the top half of the leader showed no significant percentage of spontaneous activation (Figure 1). The analysis revealed a highly significant effect of notching treatments ($F=7.57$, $p=0.008$) on the number of activated buds. The number of activated buds was not statistically significantly affected by either cultivar ($F=0.62$, $p=0.607$) or the cultivar-notching treatment interaction ($F=0.89$, $p=0.467$).

The number of activated buds was statistically highly significantly greater in the notching treatment along the entire leader (12.87±0.57, corrected total: 9.99±0.096) than in

that on the bottom half of the leader (6.67±0.31, corrected total: 9.55±0.096). The average corrected effect of notching along the entire leader was better by 0.5 activated buds compared to notching on the bottom half of the leader i.e., by 5% on average (Figure 2).

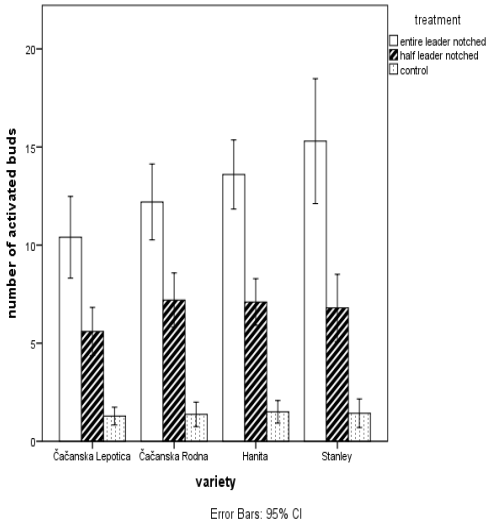

Figure 1. Effect of cultivar on the number of activated buds after notching treatment.

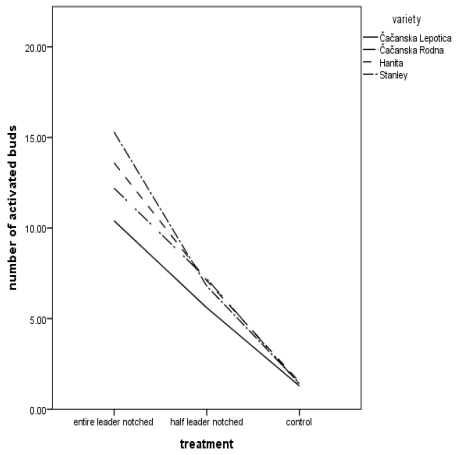

Figure 2. Effect of treatment on the number of activated buds after notching.

Obviously, the untreated control had no significant effect on the number of activated buds compared to notching treatments. Moreover, no differences were observed among cultivars. A chi-square test confirmed a constantly even ratio of notched to activated buds in both notching treatments in all tested cultivars. This result confirms the necessity to use notching for buds that are to be activated in order to stimulate the growth of shoots in precisely the place where they are wanted for a successful training system (Greene and Autio, 1994). The analysis of the average length of new shoots induced by notching (Figure 3) suggests a statistically highly significant effect of cultivar ($F=8.56$, $p<0.000$) and no statistically significant effect of either notching treatment ($F=0.293$, $p=0.004$) or the cultivar-notching treatment interaction ($F=1.12$, $p=0.352$). The average shoot length was highest in 'Čačanska Rodna' (107.83 cm) and 'Stanley' (103.11 cm), which exhibited no statistically significant difference, and lowest in 'Čačanska Lepotica' (89.79 cm), which statistically significantly differed in average shoot length from the other tested cultivars (Figure 4).

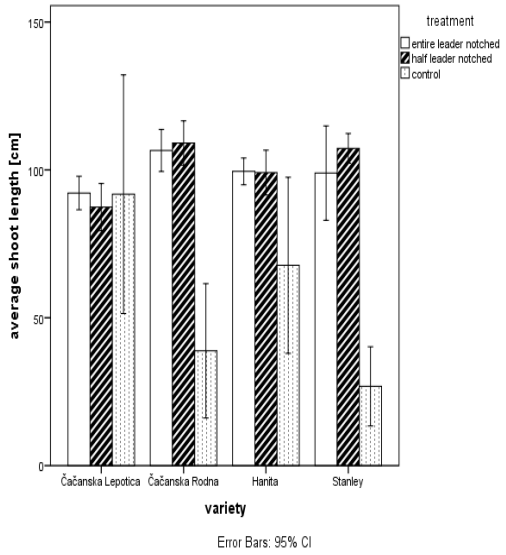

Figure 3. Effect of cultivar on average shoot length after notching treatment.

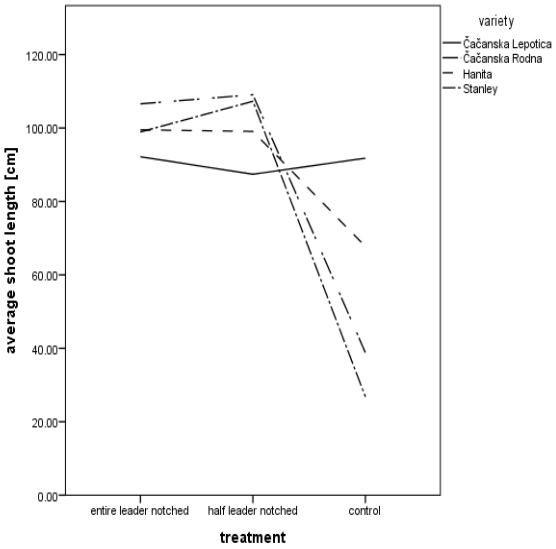

Figure 4. Effect of treatment on average shoot length after notching.

The formation of shorter (more desirable) shoots in 'Čačanska Lepotica' indicates the predisposition to more uniform lateral branching of the central leader and easier control of shoots which do not require any growth control treatments until the end of the growing season (Greene and Autio, 1994).

Total shoot growth is highly important not only in terms of proper tree training (Mićić et al., 2005; Botu et al., 2013), but also in terms of establishing the fruiting potential in the following growing seasons. The effect of cultivar (Figure 5) on total shoot growth was statistically highly significant ($F=7.84$, $p<0.000$). A statistically highly significant difference in total shoot growth was determined between 'Čačanska Lepotica' (724.00 cm) and the other tested cultivars which showed no statistically significant difference ('Čačanska Rodna' 1044.00 cm, 'Hanita' 1028.00 cm and 'Stanley' 1084.00 cm). Total shoot growth in 'Čačanska Lepotica' was 328.00 cm shorter on average (31.2%) compared to the other three cultivars. Evidently, there was a highly significant effect of notching treatments ($F=99.55$, $p<0.000$) on total shoot growth (Figure 6).

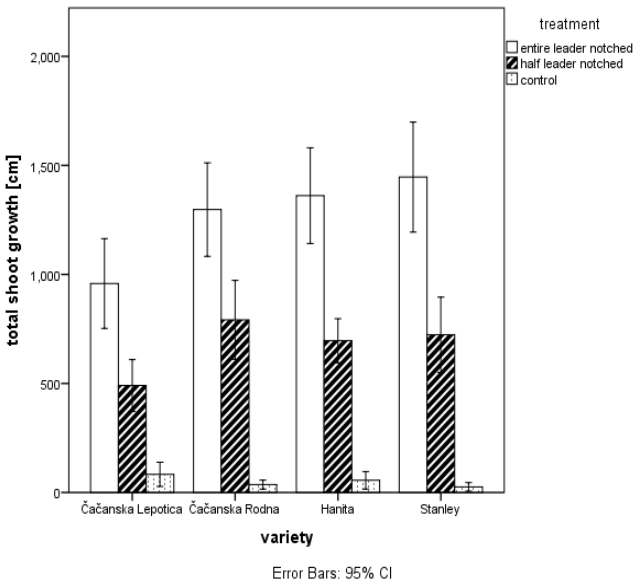

Figure 5. Effect of cultivar on total shoot growth after notching treatment.

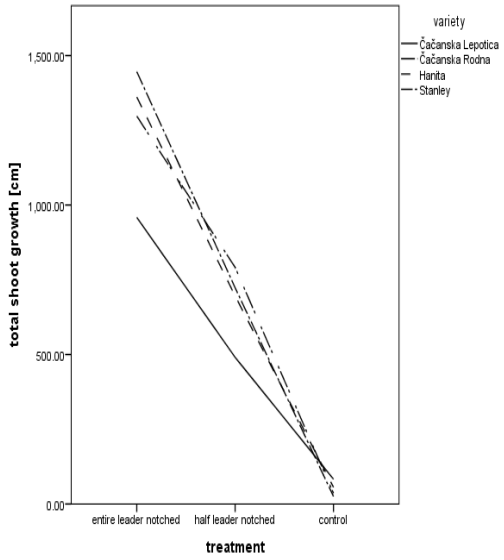

Figure 6. Effect of treatment on total shoot growth after notching.

Notching along the whole leader resulted in significantly greater total shoot growth (1266.00 cm) compared to partial notching (675.00 cm). The average effect of notching along the entire leader on total shoot growth compared to the notching treatment of one half of the leader was 591.00 cm (87.5%). The unnotched control obviously had no significant effect on total shoot growth compared to notching treatments. No statistically significant interactive effect of these two factors was observed ($F=1.08$, $p=0.363$).

Cultivar had a highly significant effect ($F=8.86$, $p<0.000$) on maximum shoot length (Figure 7). Likewise, the same effect was observed for notching treatments ($F=6.61$, $p=0.012$) (Figure 8), while no significant effect was induced by the interaction between the two tested factors. 'Čačanska Rodna' and 'Stanley' had significantly greater maximum shoot lengths compared to 'Čačanska Lepotica' and 'Hanita'. The untreated control was not included in further analysis and comparison with notching treatments due to the small number of activated buds and the high variation observed.

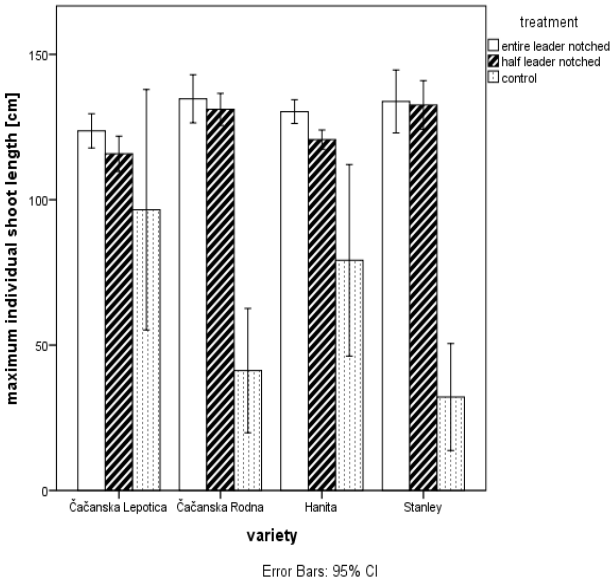

Figure 7. Effect of cultivar on maximum shoot length after notching treatment.

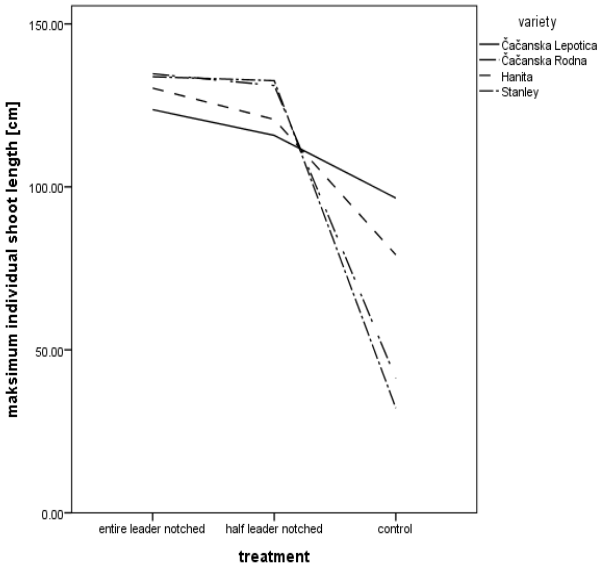

Figure 8. Effect of treatment on maximum shoot length after notching.

CONCLUSION

Growing plums (*Prunus domestica* L.) on vigorous rootstocks under spindle system ensures cost-effectiveness if a range of tree management practices are used during dormancy and particularly during the growing season. Notching plays an important role in initiating the development of vegetative growth points in precisely the position where they are wanted along the central leader for uniform lateral branching of the central leader in spindle training systems. 'Čačanska Lepotica', 'Čačanska Rodna', 'Hanita' and 'Stanley' respond positively to notching treatments. The percentage of activated buds after notching is very high i.e., within the range 95.77-98.11%, and it is not a cultivar-specific characteristic. The spontaneous development of buds in the tested cultivars is very low. Cultivar has a significant effect on both the average shoot length and total shoot growth induced by notching.

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