Scientific Papers. Series B, Horticulture. Vol. LXII, 2018
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

TWENTY YEARS OF EXPERIENCE IN INTENSIVE PLUM PRODUCTION ON *PRUNUS CERASIFERA* EHRH. ROOTSTOCK

Miljan CVETKOVIĆ[1], Nikola MICIC[1, 2]

[1]University of Banja Luka, Faculty of Agriculture, Bulevar Vojvode Petra Bojovića 1A, 78000 Banja Luka, Bosnia and Herzegovina
[2]University of Banja Luka, Genetic Resources Institute, Bulevar Vojvode Petra Bojovića 1A, 78000 Banja Luka, Bosnia and Herzegovina

Corresponding author email: miljan.cvetkovic@agro.unibl.org

Abstract

As a result of two decades long research this paper provides basic parameters and characteristics of training system plum spindle on Myrobalan (Prunus cerasifera Ehrh.) seedling rootstock. Utilization of Myrobalan rootstock induces intensive plum growth in initial years of production. This growth can only be controlled by application of adequate and precise pomotechnics and induction of early fruiting as a result of applied treatments. Obtained results indicate that training principles for plum spindle system are similar for most analyzed cultivars. On the other hand, cultivar specifics concerning biological predispositions for this training system may greatly influence success of production. Certain cultivars ('Čačanska Lepotica' and 'Stanley') can serve as model plants for correct and successful high intensity plum production in spindle system. All factors should be taken into consideration, when defining training systems adequate for plum (Prunus domestica L.) on Myrobalan rootstock, so the optimal combination could be defined depending on growing conditions and level of application of agrotechnical measures. Level of applied measures in orchard needs to be one of the most important elements of financial feasibility of plum production in spindle system. Planting density depending on the cultivar and growing conditions is between 1000 and 2000 trees per hectare. Increase in number of individual spindles per hectare is possible by modification of planting system ("V" spindle planting) or modification of training system (multi-leader spindle systems), which implies different approach to production.

***Key words**: canopy management practices, cultivar, density.*

PLUM PRODUCTION ON MYROBALAN SEEDLING ROOTSTOCK

The introduction of dwarfing rootstocks in fruit production has led to its intensification, primarily through changes in orchard systems and increases in planting density and yield per unit area (Hrotko et al., 1998; Achim et al., 2017). Apart from significant initial investments, vegetative rootstocks of weak vigor require optimum growing conditions and proper cultural and tree management practices to manifest their positive characteristics. Impressive results in improving orchard systems for apple and pear have given rise to intensive research in dwarfing rootstock selection for stone fruits as well. However, intensive systems of production on dwarfing rootstocks have not been as successful for stone fruits as for pome fruits (Paunović et al., 2011). This can be explained by the fact that dwarfing rootstocks modify scion growth and development through physiological growth suppression and initiation of greater generative bud differentiation. In pome fruits, this results in enhanced fruiting potential, and the fact that pome fruit generative buds contain vegetative cones means that an increase in the total number of generative buds per tree does not induce a decrease in leaf surface area per fruit i.e. there is no decrease in the total number of leaves required for successful fruit development in trees bearing a high crop load (Lučić et al., 1996). On the other hand, in stone fruits, growth suppression and increased generative bud differentiation lead to a decrease in vegetative buds per tree and, hence, leaf biomass per fruit. There is the impression that intensive production systems for stone fruits can be successfully established on semi-dwarfing rootstocks using specific canopy management practices that enable fruiting each year. Regardless of the development of plum vegetative rootstocks, the Myrobalan *Prunus cerasifera* Ehrh. seedling is still a predominant rootstock in the Bosnia and Herzegovina and

Serbia, and some other Balkan countries as well (Botu and Botu, 2017). Less favorable soil conditions for plums grown in this area, partial use of cultural and tree management practices in orchards, higher costs of vegetative rootstocks and the resulting nursery trees, as well as the marked presence of the traditional approach to plum production are just some of the reasons for the current state. Plum is grown on Myrobalan rootstock mostly in extensive or semi-intensive orchards, with an average planting density of 400 to 800 trees per hectare (Micic et al., 2005; Botu and Botu, 2017), and using only minimum tree management practices (pruning during dormancy). Nevertheless, experience indicates that the intensification of plum production on Myrobalan rootstock is possible and justified, if all necessary tree management practices are used, especially in the initial years of production (Cvetkovic et al., 2017b). Considering the high fruiting potential of currently grown plum cultivars, the specific manner of formation and character of fruiting wood, as well as the pronounced tendency for decreased generative bud differentiation in certain cultivars (regardless of rootstock type), strong vegetative growth of the Myrobalan seedling rootstock can have a significant effect on the regular formation and renewal of fruiting wood. This paper presents 20 years of experience in intensive plum production on Myrobalan rootstock, specific characteristics of the "plum spindle" training system, as well as the biological predisposition of certain cultivars to this training system.

CHARACTERISTICS OF MODERN "PLUM SPINDLE" TRAINING SYSTEMS

It is possible to train plum trees to a modified spindle system, slightly higher (3.2-3.5 m) than the standard spindle, with a trunk height of up to 0.5 m, and with more pronounced main lateral branches at the base of the tree. The branches should be distributed irregularly, spirally along the central leader, taking care that their length is shortened towards the top so that the tree takes the final form of a "conical frustum" (Mićić et al., 2005). During the first 2 or 3 years after planting, trees are trained according to the spindle training principles. During the period, it is necessary to use all tree management treatments which, apart from having a role in tree architecture, ensure the fastest possible formation of fruiting wood and fruit-bearing branches, as the best procedure for initial vigor suppression. Successful plum production is only possible if intensive summer pruning operations are used (during the growing season), which is not the case in conventional training systems. To this end, all pruning treatments should be used at optimum dates. Notching is applied during dormancy or immediately before the growing season (Lučić et al.,1988; Glisic, 2012; Cvetković et al., 2017a). Plum has a biological predisposition to creating "floors" i.e. branches growing in several blocks along the central leader; therefore, notching provides great results in balanced targeted positioning of the shoots along the central leader. Effects of notching are not related to its timing, and the cultivar-dependent response to growing point initiation ranges from 95.77-98.11% (Cvetković et al., 2017a). The formation of a crotch angle of approximately 90° relative to the central leader provides the best predisposition to the creation of quality growth of main lateral branches and fruit-bearing branches. In some cultivars ('Čačanska Lepotica'), this procedure is sufficient for the formation of main lateral branches properly positioned relative to the central leader; however, this is not the case for most cultivars. Spreading the branches and maintaining their position at an initial crotch angle of approximately 90° is usually performed with different types of wires and twines (Mićić et al., 2005; Cvetković et al., 2017b), keeping in mind the timing. Maintaining crotch angles by shoot twisting must be applied successively during the growing season before the newly formed shoots are lignified at the base. Twisting is uniquely and highly effectively used in plum (Mićić et al., 2005; Glisic, 2012; Cvetković et al., 2017b). Pruning during dormancy is applied in accordance with standard principles and cultivar specificity. Succession of old lateral branches is usually done by "stub cuts" and successive use of undercutting to initiate the growth of lateral shoots which will take the role of main lateral branches. Training plum trees to a spindle system ensures satisfactory yields

(25-40 t/h), high quality fruit and ease of access for fruit harvest, thus increasing the number of extra quality fruits in the total production structure.

CULTIVAR SPECIFICITY AND SUITABILITY FOR THE "PLUM SPINDLE" TRAINING SYSTEM

The biological specificity regarding the growth and development of individual cultivars, as well as their response to tree management treatments are of special importance for defining a proper approach to training certain cultivars to the spindle system. Morphological characteristics of growth and development largely affect the formation of the "plum spindle" training system and high-density planting. Tree architecture, type of growth of fruit-bearing branches, intensity of formation and character of fruiting wood, dominant type of fruit-bearing branches, fruit positioning on the tree, degree of fruit-bearing branch shedding and moving further from the central leader after fruiting and the specific activation of new points of growth for the scheduled succession of main lateral branches are just some of the cultivar-specific morphological characteristics of growth and development that greatly affect the spindle training approach taken for individual cultivars. Certain biological characteristics of cultivars (Table 1) can pose significant difficulty to the approach taken to the formation and maintenance of the training system, which has to be taken into consideration while designing the training system. Experience indicates that the above listed cultivars can be conditionally classified in three groups (Table 2), based on their biological predisposition to spindle training as well as on treatment intensity for the satisfactory formation and maintenance of the training system. 'Čačanska Lepotica' and 'Stanley' are in the first group as model cultivars for intensive production; their characteristics are suitable for spindle system training. All treatments are highly effective and successful, even though they are somewhat more extensive and demanding in 'Stanley'. A more complex approach is necessary for 'Čačanska Najbolja', 'Čačanska Rana' and 'Katinka'. The greatest difficulty in the production of 'Čačanska Najbolja' and 'Čačanska Rana' is strong initial vigor and self-sterility issues which very often additionally contribute to strong vigor. 'Katinka' requires more precise pruning combined with some other measures to achieve the satisfactory fruit size.

Table 1. Biological specificity of growth and development that impede spindle training system

Cultivar	Specificity
'Čačanska Najbolja'	vigorous self-sterile late first bearing very intensive shoot growth in initial years of production insufficient number of strong shoots adequate for main lateral branches non-uniform lateral branching of the central leader acute crotch angles of the lateral branches relative to the central leader lack of response to treatments inducing the succession of main lateral branches
'Elena'	vigorous very intensive shoot growth in initial years of production long shoots extremely acute crotch angles of lateral branches relative to the central leader fast shoot lignification at the base highly intensive transfer of growth points to top parts of the tree unfavorable response to the succession of main lateral branches
'Čačanska Rana'	self-sterile occurrence of alternate bearing late first bearing shoots have specific growth dynamics insufficient number of strong shoots adequate for main lateral branches relatively unfavorable response to the succession of main lateral branches
'Stanley'	intensive shoot growth in initial years of production too high percentage of short fruit-bearing branches in the total fruit-bearing branch structure
'Katinka'	alternate and partially alternate bearing tendency to form thin long fruit-bearing branches dominant short fruit-bearing branches on main lateral branches affinity towards shedding of the base of main lateral branches transfer of growth points to top parts of the tree
'Čačanska Rodna'	alternate bearing intensive growth of new shoots – longer treatment period long elastic shoots inappropriate for treatments during the growing season relatively unfavorable branching angles relative to the central leader extreme shedding of main lateral branches after fruiting intensive transfer of growth points to the periphery of the tree
'Čačanska Lepotica'	lack of formation of long main lateral branches

'Čačanska Rodna' and 'Elena' belong to a separate group as they are highly demanding as regards training to the spindle system and require high-intensity treatment regardless of orchard age.

Table 2. Cultivar predisposition to spindle training and treatment intensity for proper training (more pluses indicate better predisposition i.e. greater treatment intensity)

Cultivar	Predisposition	Treatment intensity
'Čačanska Najbolja'	++	+++
'Elena'	+	+++
'Čačanska Rana'	++	++
'Stanley'	+++	+
'Katinka'	++	++
'Čačanska Rodna'	+	+++
'Čačanska Lepotica'	+++	+

PLANTING DENSITY

Planting density is dependent on the expression of cultivar vigor in combination with myrobalan rootstock, as well as on cultivar specificity regarding tree architecture (Table 3).

Table 3. Planting density

Cultivar	Spacing between rows (m)	Spacing within the row (m)	Number of plants/ha
'Čačanska Najbolja'	4.2 – 4.6	2.0 – 2.4	900 – 1190
'Elena'	4.2 – 4.6	2.0 – 2.2	980 – 1190
'Čačanska Rana'	4.0 – 4.4	1.8 – 2.0	1130 – 1380
'Stanley'	3.8 – 4.2	1.6 – 1.8	1320 – 1640
'Katinka'	3.8 – 4.0	1.6 – 1.8	1380 – 1640
'Čačanska Rodna'	3.8 – 4.2	1.4 – 1.6	1480 – 1870
'Čačanska Lepotica'	3.6 – 4.0	1.4 – 1.6	1560 – 1980

The highest spacing is required for cultivars with strong vigor, which require more complex tree management treatments. Experience shows that 'Stanley' can be grown successfully at a narrower spacing within the row (1.5 m), which is also true for 'Čačanska Lepotica' (1.2-1.4 m). The intensification of plum production using the spindle training system is additionally possible through the "V" planting system (Mićić et al., 2005), which allows an increase in planting density by additional 25-30%, thus increasing crop yield (Mitrovic et al., 2005). On the other hand, the need to use complex trellises in this training system makes investment more expensive. At the same time, difficulty in pruning areas of the tree facing inwards of the row and the frequent inability to use adequate disease control imply the necessity to move the intensification of plum training systems on Myrobalan rootstock in some other direction.

CONCLUSIONS

Myrobalan (*Prunus cerasifera* Ehrh.) seedling is the dominant rootstock for plum in the Western Balkans. Even though it induces stronger vigor, with adequate and timely use of all necessary tree management treatments, it is possible to control growth and establish an appropriate balance of vegetative and generative growth in initial years.

Plums can be successfully grown in a modified spindle system, with a planting density of 900 to 2000 trees per hectare, which is largely affected by cultivar-specific growth and development.

Cultivars demonstrate significant differences in their response to intensive tree management treatments, which should be considered when designing an orchard.

Tree management treatments during the growing season are essential for plums to be trained to the spindle system.

Treatments during dormancy should be corrective and less severe so as to prevent additional vigor.

Plum production using this system involves more manual labor in the total cost structure, but it ensures higher yields and optimal quality of the fruit.

REFERENCES

Achim G., Botu I., Botu M., Duţu I., Stănică F., Mazilu C., 2017. The rootstok's role in modernizing plum culture. Acta Horticulturae, 1175: 49-54.

Botu M., Botu I., 2017. Evaluation of intensive plum culture system in the north of Oltenia - Romania. Acta Horticulturae, 1175: 55-60.

Cvetković M., Mićić N., Đurić G., Bosančić B., 2017a. Leader management techniques to induce vegetative bud development in plum. Acta Horticulturae, 1175: 41-47.

Cvetkovic M., Djuric G., Micic N., 2017b. Canopy management practices in modern plum (*Prunus domestica* L.) production on vigorous rootstocks. Scientific Papers. Series B, Horticulture. Vol. LXI, 117-122.

Glišić I., 2012. Pomotehničke specifičnosti šljive gajene u gustoj sadnji. Doktorska disertacija. Agronomski fakultet, Čačak.

Hrotkó K., Magyar L., Simon G., Klenyán T., 1998. Effect of rootstocks on growth of plum cultivars in a young orchard. Acta Horticulturae, 478: 95-98

Lučić P., Đurić Gordana, Mićić N., 1996. Voćarstvo I. Institut za istraživanja u poljoprivredi Srbija: Nolit-Partenon.

Mićić N., Đurić G., Cvetković M., 2005. Sistemi gajenja i rezidba šljive. Ministarstvo poljoprivrede, šumarstva i vodoprivrede Republike Srbije, Beograd, 1-60.

Mitrović M., Blagojević M., Karaklajić-Stajić Ž., Rakićević M., 2005. Sistem guste sadnje u savremenoj tehnologiji gajenja šljive. Traktori i pogonske mašine, 10 (2): 103-107.

Paunovic G., Milosevic T., Glisic I., 2011. Morphometric traits of newly bred rootstocks suckers in domestic and cherry plum. Acta Scientiarum Polonorum, Hortorum Cultus, 10 (2): 203-212.

EX·TERRA·AVRVM