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The role of pruning in the intensification of plum production

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Summary: In an orchard planted in the spring of 1997, four kinds of spacing have been applied (4.0 m × 1.5 m, 4.0 m × 2.0 m, 5.0 m × 2.5 m and 6.0 m × 3.0 m). Four cultivars (Čačanska lepotitsa', ‚Stanley', ‚Bluefre' and ‚President') grafted on Myrobalan rootstock were studied in the experiment aimed to explore the performance of plums under different spacing and training conditions.
It could be stated that the trees grown on vigorous rootstock are prone to be cultivated much more intensely (smaller tree size, higher tree density) by the consequent use of green pruning technique. The most favourable economic combination (yield and labour costs) was found to be: 4.0 m × 2.0 m and 5.0 m × 2.5 m (800–1200 tree/hectare), whereas the most adapted was the cultivar: 'Stanley'.

Key words: plum, pruning, spacing and forms of training, performance of growth and yield

Introduction

During the last decennia, the changes ensued in training of crown forms hardly touched the production of plum. In relation to other fruit species, the improvement of fruit quality and the reduction of harvest labour costs appeared as an objective recently (e.g. the dwarfing rootstocks, reduced planting distance as presented by *Hrotkó* et al., 2004). This is closely related to the fact that the bulk of the crop was processed, and the quality enjoyed relatively less esteem. Plums for fresh consumption still do not receive the due attention.

The wide spacing (250–350 trees per hectare) of the actual commercial plantations is associated with considerable tree size and variable crown forms depending on the cultivars used. All that was coupled with more dense than desirable crowns, which were rarely or not at all pruned.

The extensive spacing and the erect growth typical for most plum cultivars did not allow the formation of a uniform fruit wall of plum trees. The larger spacing, which may facilitate the all around illumination of trees is compromised by the dense crowns, which keep the inner parts of the canopy inactive because of the deep shadow.

The modern growing technologies concentrating on fruit quality and according to environmentally conscious terms strive to diminish the distance between trees and to build up continuous rows but crowns penetrated by sunshine.

Crown forms introduced earlier and applied up to now are hardly conform with the requirements, even if called combined vase forms.

The fashion of forming "hedgerows" avoided the plum growers as well as the intense crown forms, which require much labour by tying down shoots to the horizontal branches etc.

It is assumed that fresh consumption will be favoured in the future on the markets. This tendency will stimulate the reduction of tree size facilitating the labour of cultivation and hand picking by all possible means including also the use of dwarfing rootstocks. This latter still seems to be a daring expectation because dwarfing stocks are not available yet, therefore, we have to be satisfied with the vigorous Myrabolan rootstocks now and in the near future being compatible with almost all plum cultivars.

The "hedge-hopping" of plum production during the last fifteen-year-period, i.e. the low rentability because of the low producers' prices and masses of unsalable produces put a question mark on the necessity of developing plum technologies.

However, it is out of question that the development of fruit consumption will need an increasing quality either by introducing new cultivars or a more diversified profile of processing, moreover, a maximal exploit of modern growing technologies sustainable even at relatively low producers' prices. The only way to approach these goals is the development of intense plantations, which optimally illuminated crown structures and requiring the possibly lowest labour costs.

For plum orchards, economic and physiologic arguments suggest the adoption of a relatively simple, more natural training of the trees – compared with other fruit species. Changes are expected from the appearance of new cultivars and forms of utilisation but by all means, a reduction and thoughtful modification of the crown volume coupled with higher planting densities. For that purpose more attention

should be paid to the growing and fruiting characters of the respective cultivars in order to find the optimal solution for each of them.

In the present study four cultivars are compared in four different planting systems referring to their vegetative growth and yielding characters at different training and maintaining conditions.

Materials and methods

The experimental orchard was planted at Pallag, Farm of the Debrecen University in the spring of 1997, four kinds of spacing have been applied for four cultivars.

Rootstock:	Myrobalán 'C359'
Cultivars:	Čačanska lepotitsa, Stanley, Bluefre and President
Design and training:	4.0 m × 1.5 m (1670 tree/ hectare), slender spindle 4.0 m × 2.0 m (1250 tree/ hectare), free-slender spindle 5.0 m × 2.5 m (800 tree/ hectare), free spindle 6.0 m × 3.0 m (560 tree/ hectare), combined crown form

During the training and maintenance of the crown forms, winter and green pruning was performed in order to harmonise growth and fruiting of the trees.

The two or three stories or alternate sequence of branches in the combined, free and slender spindle crown forms were pruned according to the same principles, whereas the differences between the crown forms are treated with special emphasis.

Pruning to attain the shape

The first year and green pruning

The height of the spears when planted was trimmed to the expected length of the trunk (80–90 cm, or for slender spindle 70–80 cm) plus 4–5 well developed buds intended to form the crown.

The more or less 10 cm deviations are necessary to homogenise the differences between the individual trees. The trimming was performed preferably in the spring, when the viability of the buds was more obvious. The leading shoots were freed from competitive shoots down to 20–40 cm length (at early and mid of June) at the basis. By that way, the dominance of the main axis was secured.

The future lateral branches (shoots or twigs grown in the nursery) if excessive, more than 5, or growing at a too narrow angle were eliminated.

If planting distance was larger (combined crown and free spindle), stronger or thicker branches were preferred, whereas to narrow designs the weaker, nearly horizontal shoots were chosen.

In dense plantings (slender spindle), the main shoot was supported by a stiff rod or reed in order to secure its perpendicular position. The dominance of the main axis was achieved at the first year with that technique.

Shoots starting on the trunk, either short or long, have to be eliminated consequently over the summer stimulating the growth of the tree.

The second year and green pruning

During the second part of the rest period (end of February), the pruning of the shoots on the combined crowns and free spindles was performed in order to stimulate growth and to secure the earlier aimed position and the stability of the intended angles.

In spindle crowns (slender and free spindles), i.e. narrow plantings, the shoots were not trimmed. In this year too, the selection of shoots was performed in June for all other planting distances. The dominance of the main axis was invariably supported by means of fixing rods in the slender spindle variant.

The third year and green pruning

During winter, in the combined crowns, the trimming of shoots was continued with the purpose to fill out the space. Above the first storey, at 70–90 cm, further 3–4 lateral branches were chosen and the rest of shoots being competitive were eliminated totally. The support of the main shoot was abandoned hitherto.

In early or mid of August, when the majority of cultivars "finished" growth, and after the minor amount of fruit had been spared, green pruning was performed to correct the crown structure. Elimination all shoots of ill orientation substituted essentially the winter pruning for the next season.

The fourth year and green pruning

In the fourth year before bud burst, the combined crowns were prevented to grow further upwards by trimming the perpendicular shoots. At the same time, pruning of the lateral branches was abandoned because a further stimulation of growth was not necessary any more. The spindle type of crowns has to approach the form of a cone. The combined crowns, on the other hand, were forced to adopt a cylinder form instead of a globe.

In the fourth year, the green pruning was timed according to the ripening date and stop of growth of cultivars, and postponed to end of July or end of August. On the picked trees of 'Čačanska lepotica' the pruning was performed like in the winter, whereas in later ripening cultivars also pruning of the new shoots, occasionally, unfruitful, two-year-old branches were eliminated. Thus the substitution of a winter pruning ensued. During the winter, occasionally some steep growing shoots ought to be cut as disturbing the harmony of the crown.

The fifth year needed pruning during the summer as well as in the winter, when more aged branches were cleared out, which bore fruits in the summer. At growing sites stimulating vigorous growth, a third storey of the crown may be initiated or additional laterals could be established (It is the best time to start with that during the winter of the fifth year).

During the maintenance pruning, the cross section relations of trunk or axis per lateral branches are considered as corresponding to the optimal relation. *Zahn* (1986, 1990) suggested it – and it was fitting to the case of plum trees: no branches were tolerated if their diameter was larger than the half of the diameter of the trunk below the branching.

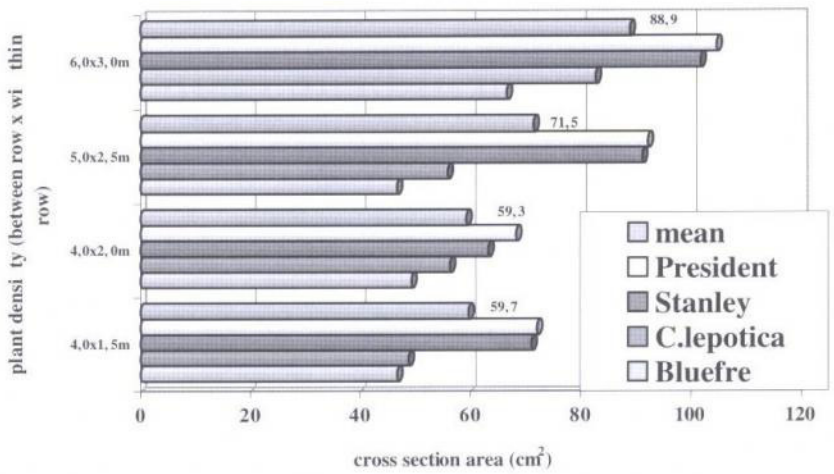

Figure 1 Cross section areas of different plum cultivars and planting (training) systems in the 7-year-old plantation (Debrecen-Pallag, 2004)
Remark: Planting date was the spring of 1997

Results

The cross section area of the 7-year-old plantation are presented in *Figure 1*, comparing the different cultivars and treatments.

It is stated on the Figure that conspicuous differences appear among the cultivars and planting distances regarding growth and cross section areas the parameters of cross section area are positively correlated. With the space assigned to a tree. Cultivars grow at different rates. The 4 m × 1.5 m distance the cross sections of 'Stanley' and 'President' are larger than those of 'Bluefre' and 'Čačanska lepotica'. The same tendency is experienced in the other treatments. The two former cultivars were always more vigorous than the two latter ones.

Figure 2 shows the accumulated fruit yield of the cultivars and the different plantings. The yield data of the last five years (unfortunately, the hail of 2004 destroyed the crop, which could not be evaluated) prove that the trees yield more according to their larger size. 'Bluefre' and 'Čačanska lepotica' differ from each other significantly. 'Stanley' and 'President' yielded in both larger and smaller planting distances.

Accumulated yields per hectare are presented in *Figure 3*. The yield per smaller trees shown in *Figure 2* was counteracted by the higher number of trees. It means that the decline of tree size was amply compensated.

In 'Bluefre' and 'Stanley', the increasing distance diminished at the same rate the yield per area, whereas 'Čačanska lepotica'

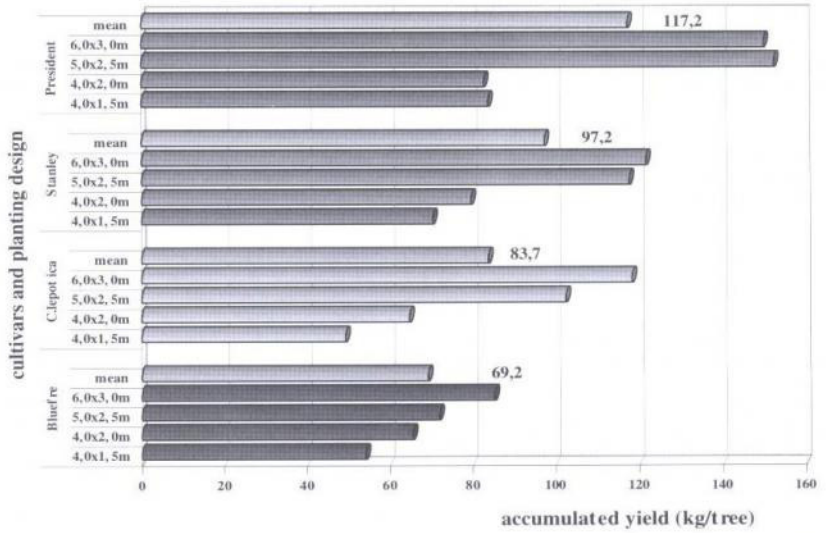

Figure 2 Accumulated fruit yield per tree of different plum cultivars and planting (training) systems (Debrecen-Pallag, 2004)

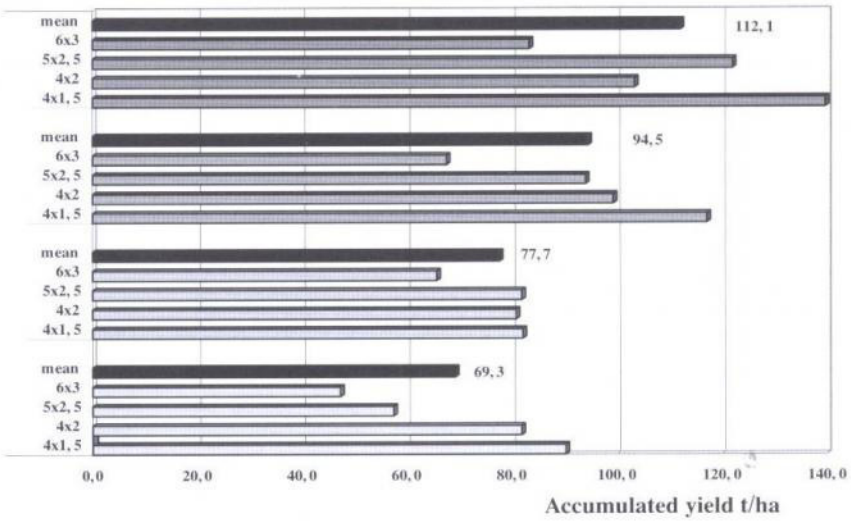

Figure 3 Accumulated fruit yield per hectare of different plum cultivars and planting (training) systems (Debrecen-Pallag, 2004)
Remark: Planting date was the spring of 1997

showed that at the largest distance only. 'President' did not display clearly that effect because the density of 5.0 m×2.5 m was exceptionally yielding.

'Bluefre' and 'President' tended to overcompensate in the 4.0 m×2.0 m and 5.0 m×2.5 m treatment, whereas 'Čačanska lepotica' and 'Stanley' seem to produce at a stable level.

Conclusions

Our investigations proved the expected effects in experiments of that type. The planting distance influences a couple of phenomena (root competition, radical pruning policy required, etc.). The size of trees as well as the cross section area of the trunk diminishes with planting density (*Jackson* et al. 1987, *Mika* et al. 1998, *Morgas* et al. 1998, *Hrotkó* et al. 2004).

The present experiment proves that the crown form is adjusted by phytotechnical means to exploit the space.

The 6.0×3.0 m is the largest planting distance included in the experiment with combined crowns, moreover, 5.0×2.5 m with free spindle and 4.0×2.0 and 4.0× 1.5 m with slender spindle crown. The comparison of the performance of the different planting systems was also aimed from the point of view of sustainability to establish the timing and the manner of the operations.

The 4.0×1.5 m system was beneficial for all cultivars examined but at different degrees. In the praxis, however, all cultivars require interventions as green pruning, which may become deleterious physiologically, but necessary to secure the traffic on service ways. More severe and more frequent trimming was needed in order to clear the crowns sufficiently.

The 4.0×2.0 m and 5.0×2.5 m systems needed yearly one intervention of green pruning, consequently, they are positive examples of an intensification of plum production. They secured a balanced growth and yields. On sites stimulating vigorous growth, the system of 5.0×2.5 m, on less productive sites, 4.0×2.0 m should be preferred both planted on Myrabolan rootstock.

The planting density of 800 tree/hectare, i.e. the system of 5.0×2.5 m planting with Myrabolan rootstock will be suitable for all plum cultivars. In that case, the training to free spindle is recommended, for very productive cultivars (e.g. 'Stanley') the slender spindle. On soils causing vigorous growth or for cultivars with stronger branches the establishment of a second storey or more individual branches would be actual. Those could be called "free spindle" or "slender free spindle" in the same order as slender spindles.

With the system of 6.0×3.0 m, the consequent application of green pruning the density of the plantation could be increased from the customary 300 tree/hectare of the last years to 500 tree/hectare or more. The smaller trees trained to two or three stories of the combined crown form would mean substantial progress towards more intense plantations.

The care of intense crown forms include a couple of technological elements, first the training for the desired form, then the green pruning, at the same time other green operations (as the selection of shoots, pinching and trimming, etc.). Those are not treated in the present paper.

Summarising the results of the experiments, plum plantations grafted on Myrabolan rootstock should be planted and cared according the following standards:

- Combined crown
  6.0–7.0 m×3.0–4.0 m (360–550 tree/hectare)
- Free spindle crown
  4.5–5.5 m×2.0–2.5 m (700–1100 tree/hectare)
- Slender spindle crown
  4.0–4.5 m×1.5–2.0 m (1100–1700 tree/hectare)

The crown form to be chosen depends on the respective soil quality or cultivars chosen; fertile soils and vigorous cultivars need more space than trees on poor soils and weak growing cultivars. Further moments ought to be considered too, as nutrition, irrigation and the intensity of labour needed on the particular site.

Acknowledgements

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