

Pruning of plum trees and maintenance of balanced yielding

Gonda, I.

Debrecen University, Centre of Agricultural Sciences, Department of Horticulture and Plant Biotechnology,
H-4015 Debrecen, 138 Böszörményi Street, Hungary

Summary: In this review, we give an overview of the pruning techniques that should be applied in commercial plum orchards. First, a detailed description of pruning for shaping the different crown types for the first, second, third, fourth and fifth years and the phytotechnical works is given for crowns with a circular projection area. Then, pruning for open crown forms, such as the vase form is discussed. Following the shaping of the crown, it should be maintained by pruning. Detailed information is given on pruning for maintenance with special emphasis on the comparison of winter and summer pruning. In the following part of the manuscript, pruning experience is described separately for the major commercial plum cultivars in Hungary such as Čačanska lepotica, President, Bluefre, Stanley. Recommendations for cultivation systems under non-irrigated conditions are also included. Finally, light requirements, growth characteristics and suggested crown forms of the different cultivars are described for cvs. Ageni, Althan ringló, Besztercei szilva Nm. 122, Bluefre, Čačanska lepotica, Čačanska rodna, Debreceni muskotály, Montfort, President, Ruth Gerstetter, Sermina, Stanley, Tuleu gras and Zöld ringló.

Key words: plum, winter and summer pruning, crown shaping, phytotechnical works, light requirements

Introduction

By pruning, we form the crown of the tree and we influence the growth of shoots and yielding according to our purposes. Pruning can be performed partly or completely during the vegetation period in order to achieve a balanced yielding of the trees, to mitigate the sometimes strong shoot growth and to enable the tractors and machines to move freely between the rows. In general, there are two types of pruning, crown shaping and crown maintaining prunings.

For the last decades, pruning recommendations for shaping and maintaining the crown of plum trees have been very general and not cultivar-specific, the considerations were practically applicable for all fruit species. Consequently, the specific recommendations for the species and the cultivars with different habit were missing. Of course, this was related to the common view that plum production is of lower profitability, therefore, growers and researchers were less motivated to establish measures, methods and tools for achieving high and balanced yields.

At the same time, it has turned out that the new cultivars require certain specific measures since the grown cultivars are very diverse and their number is increasing. They are considerably different in the habit of the crown, in their growth vigour, in the formation and rejuvenation of the generative parts, therefore, pruning has to be applied in a different way and at a different extent. Cultivars are different in the nature of pruning due to the shaping of the different crown forms and their different bud features and activity can further modify the necessary methods and tools of pruning.

The present situation of plum production in Hungary would be changed and improved if pruning was applied more regularly and frequently, the profitability of production would be improved, even if pruning has a smaller influence on the size of the fruits than in other fruit species. However, the increase in the ratio of the crown that is well-enlighted has a much larger impact on increasing the amount of yield and improving the inner content parameters of the fruits.

A special feature of plum is that even in a relatively unpruned or unpruned status, there is only a slight difference in the fruit size among trees with a high and low amount of yield. The almost 20-year study of *Surányi* (1980, 1984) has proved that a strong reduction of the number of fruits results in a 20–40% increase in the average fruit weight (in the case of Besztercei plum clones, Stanley and Tuleu gras). Accordingly, pruning should serve the improvement of the enlightenment of the crown, shoot growth assisting the regeneration of fruit-bearing parts, summing up, a high, balanced yield from year to year and excellent inner quality in all parts of the tree, meaning an optimal yielding balance. In the following section, we will describe the pruning methods of four crown shapes.

Pruning for crown shaping

Crown forms with a circular projection area

We will discuss the crown shaping pruning of two- or three-storey, random, combined free spindle and thin spindle

crown shapes together, the differences between the crown shapes will be emphasized in each case.

Pruning in the first year and other phytotechnical works

When planting whip, the planned trunk height is 80–90 cm, in the case of thin spindle, it should be cut back to 4–5 developed buds above 70–80 cm. The plus-minus 10 cm difference is usually necessary and enough to balance the first year growth of graftings with similar degree of development. It is more favourable to perform the pruning not in the dormant period, because in this way, the more developed buds that will surely emerge can be identified.

If shoot growth is strong, then the shoots competing with the main shoot originating below the main shoot should be removed when they are 20–30 cm long (at the beginning or middle of June). This helps the formation of axis dominance that is it increases the growth chance of the main shoot.

If the number of potential lateral branches (shoots, or twigs in the case of graftings with a crown) is higher than five, then, those very different from the remaining ones in thickness and/or those standing at a steep angle should be removed completely.

The larger the distance between trees is (combined crown or free spindle), the stronger and thicker lateral branches should be kept and *vica versa*, the more dense the orchard is, the weaker and close to horizontal shoots should be left. Of course, in the case of a vase crown (as it will be further verified), the more steep, thick lateral branches should be kept, which can overgrow the main shoot already in the first vegetation period.

At a smaller spacing (thin spindle), it is worthwhile to use a stick to ensure that the main shoot grows in a vertical direction. Tying the central axis and the shoot to this stick can help in the formation of the dominant axis already in the first year.

Rosettes and/or short or long shoots formed on the trunk should be removed during the summer in order to enable a better growth of the upper parts.

Pruning in the second year and other phytotechnical works

In the second half of the dormant period, or if it is possible again at bud burst, the pruning of more extensive trees with a combined and/or free spindle crown shape at a larger spacing should be performed. This is necessary so that by the induced lateral growth the trees fill in the available space as soon as possible and that the stability and thickening of the shoots cut back are increased at the given angle. If the lateral twigs are strong and long, they should be cut back to two-thirds or to half in the case of weaker ones.

If growth was weaker in the former year than as requested by the planned crown size that is the spacing of the orchard, then the twigs should be cut back to less than their halves but to well-developed buds.

If the angle of the lateral twigs is too steep, then they should be cut back to exterior buds by practicing a pruning method opposite to curving pruning (first to the interior bud, then to the later emerging horizontal twig or shoot below). This is necessary, because in many cases buds below the apical bud do not emerge and in this way there is no possibility to apply curving pruning.

Cutting back of the main leader should also be carried out with respect to growth vigour and the chosen crown form. In the case of combined crown, it should be cut back to two-thirds and half in if its growth is strong and moderate, respectively. From the main leader- and lateral leader shoots, primarily the vertical ones should be removed in the case of crown forms with a circular projection area.

In the case of spindle crown forms (thin spindle, free spindle) that is in the case of a smaller spacing, there is no need for cutting back the twigs after a satisfactory growth in the former year. However, if the length and thickness of the main leader shoot or the development of all new parts are not satisfactory, then cutting back as described above might be necessary.

In the vegetation period, similarly to the previous year, shoot selection should be done in June. During this, the shoots with a steep angle competing with the lateral chief and main chief shoots should be removed completely. Similarly, the vertical or almost vertical shoots forming on the lateral branches should also be removed. The lateral parts forming on the lateral arms should be left untouched. The undisturbed vertical growth of the main chief shot should be further ensured in the case of thin spindle crown form by tying the tree to a stick.

Both in forming and maintaining the crown, a harmony between the upper and lower parts of the crown, forming of the crown according to our plans and filling in of the available space by the trees and removal of the excess parts should be aimed. In the case of a combined crown, a cylindrical form should be achieved instead of a spherical shape, the thin and free spindle crown forms should be close or should reach the cone-like or cone form.

Pruning in the third year and other phytotechnical works

By cutting back the shoots of the combined crown form, the shoot growth for filling in the available space should be strengthened. Above the lower lateral branches at 70–90 cm height, 3–4 lateral twigs should be selected, all the other similar or stronger and longer twigs should be completely removed. The shoots serving as a basis for the second storey of branches should be selected in such a way that they are not too close to each other and are arranged in a circular manner. They have to be cut back to the necessary length together with the main leader shoot, the continuation of the central axis. In this year, it is not necessary to assist the vertical growth of the main leader shoot in trees with a thin spindle form with a temporary supporting system as its favoured direction and dominance have already been ensured.

If necessary, shoot selection should be performed in June by removing the vertical, shadowing, interior and peripheral shoots. At trees with a larger spacing, the shoots competing with the lateral chief shoots. At crown forms with smaller spacing, if the growth was appropriate, there is no need for assisting the chief shoots.

At the beginning or middle of August, when most of the trees are closed by the apical bud, a moderate green pruning for correction can be performed by which the shoots of unfavourable direction and location resulting from the former operations can be removed without hurting the smaller yield of the trees. Via this, the next year winter pruning is practically also performed that is replaced.

Pruning in the fourth year and other phytotechnical works

In the fourth year at bud burst, pruning is performed for assisting the vertical growth of trees with a combined crown. If necessary, the too thick and/or too steep branches should be thinned or cut back to weaker, almost horizontal lateral branches. Pruning inducing a growth of lateral branches should be reduced or left, depending how the trees fill in the available space.

In the case of spindle forms, it has probably already been achieved by this time. If the branches have already entered the space of the neighbouring tree or the space between the rows thereby limiting cultivation by machines, then they should be cut back to a weaker second- or third-order horizontal shoot or spur. In the case of spindle crown forms, a cone-like or cone-shaped crown should be aimed. This means weaker and shorter lateral branches from the bottom to the top.

If a thin spindle form is planned, but the growth in the former years was too strong and it is questionable whether the tree could be kept in the available space in the long run, the formation of a second storey of arms might be advisable to subvert too strong growth. At 70–100 cm above the lower arms, 3 or 4 lateral branches of similar thickness in a circular arrangement, not too close to each other should be selected and all the other similar branched should be removed completely. These branches should be treated as final remaining parts together with the lower lateral branches and the central axis. These crown forms created out of necessity are called free thin spindle, since a free spindle-shaped crown form is created at a spacing used for the thin spindle crown form.

In this year, depending upon the cultivar, unfavourable thickening of lateral branches can already occur, meaning that their thickness is larger than half of the thickness of the trunk directly below them. These branches, occurring mainly in the upper part of the crown, should be removed completely without leaving a stub. If such parts are left, they disturb the balance between the lower, middle and upper parts of the trees.

In the fourth year, a significant amount of yield can be expected. Depending on the ripening time and/or the dynamics of closing in an apical bud of the different

cultivars, summer pruning should be performed in the period between the end of July and August. After this, a pruning similar to winter pruning can be performed by thinning the vertical, too dense and thick shoots and/or cutting back to weaker horizontal shoots.

It is worthwhile to perform summer pruning also on trees with later ripening by thinning and cutting back the shoots formed in this year and the one-year-old or two-year-old fruitless parts. With this, winter pruning is practically performed and only the removal of a few thicker, steeper parts disturbing the harmony of the crown might be necessary during the dormant period.

Pruning in the fifth year and other phytotechnical works

From the fifth year, practically all cultivars and all crown forms start to yield and pruning for shaping is finished. In the case of combined crowns, it might be necessary to create a third storey of branches depending on the size of the tree and its growth vigour. Similarly to the above, three lateral branches of similar thickness, not too close to each other should be selected 70–80 cm above the second storey, these should preferably be thinner and shorter than the lateral branches of the storey below. The central axis should be cut above these, and thereby, the combined crown form is created. In harmony with the above, we should aim to leave weaker and shorter branches from the bottom to the top on the central axis in order to maintain the cylindrical or cone-like shape.

The yearly pruning for maintaining the crown should be done in the summer and only those thinnings and pruning of thicker parts should be done in the winter which could not be performed in the summer without hurting the fruits. During pruning for maintaining the form, the optimal thickness index of the trunk-axis/lateral branches should be maintained. According to Zahn's definition (1986, 1990), which can be applied well also for plum, no parts can be left on the trunk or on the central axis the diameter of which is larger than half of the diameter of the trunk or axis directly below it.

By thinning the crown, the good illumination of the interior parts should be ensured by forming larger gaps in the peripheral parts. The twigs of the fruit-bearing zone should be thinned to smaller or a larger extent depending on the year and the light conditions with respect to ensuring the best illumination of the crown.

Open crown forms

Pruning for creating a vase crown form

Pruning is performed higher (at 110–120 cm) than in the case of leader trees, which is adapted to the needs of the mechanical harvest. The forming and maintaining pruning in the first two years is practically the same as for combined and

free spindle forms. The difference is that the lateral twigs of the trees grafted to have a crown in the former year or graftings planted already with a crown should be selected in such a way that they are strong, thick and steep and the weaker ones should be removed. The shoots on the axis should be as distant as possible from each other.

The difference in pruning can be that cultivars with less steep structure (more spreading lateral branches) are cut back to an inward apical bud or branching. In the case of cultivars with a more steep structure, this should be performed for an outer bud.

During the shaping of the crown and after, it frequently happens that the inward or outward apical branching to be left when cutting the lateral branch is at a too high place. In such case, it can be applied for all cultivars that we do not cut back to the second-, third-, etc. order branching that is found too high, but to a fruit-bearing spur found at a lower height because in this way they can be forced to emerge.

No second branch storey is formed on the central axis by pruning in the dormant period of the third year in the case of trees with a vase crown.

The stronger lateral branchings found in a random arrangement should be removed, only the weaker ones should be left, in parallel with the cutting back of the axis to its half. Consequently, the central axis of the trees is not removed completely in the third year as there is a need for it in order to ensure the favourable angle of the lateral branches. If the central axis would be removed completely during the pruning in the first or second year after planting, then the strong vertical growth of the lateral branches compensating for the axis would cause problems. The thickening of the lateral branches is of such degree in the third year that their vertical growth is hardly or not possible at all.

In spite of this, most of the pruning works is done to stop inward and upward growth of shoots and to remove completely the thickened vertical or almost vertical twigs left from previous years. In the winter pruning period of the third year, the central axis is cut back to its half, to a vertical or close-to-vertical branching at its end if possible.

During the summer, between the end of July and August, the regenerative growths on the remaining axis should also be removed simultaneously with pruning the skeleton branches of the crown, especially those that prevent light from entering the inner parts.

During the winter preceding the fourth vegetation period, the final removal of the axis above the top branching can be performed. The wound should be treated with a product inducing callus formation. The shaping of the crown is practically finished with this, and a significant amount of yield can be expected in this year.

Pruning for maintaining the crown shape

In the next section, those elements of summer and winter prunings will be detailed which can be applied for all crown forms.

Winter pruning

A characteristic of cultivars with branch dominance, that is those having relatively thicker primary branches, is the quick thickening of the branches, however, their tendency to branching is generally moderate. The lower degree of branching means less shoots, that is less growth points which is a consequence of a stronger apical dominance.

In general, wound healing and regeneration of the generative parts are also less strong than those of trees with more shoots.

In such trees, exaggerated thickening can occur within the crown (e.g. strengthening of the upper branchings of the axis) within one year by the end of the vegetation period even if a proper winter pruning had been done. After two years without pruning, the former balance of the lower and upper or inner and outer crown parts can completely disappear.

In general, it can be stated that in most plum cultivars the maintenance of the optimal form and structure of the crown requires greater attention than its shaping in the beginning. Those deformations can occur earlier (quick and strong thickening, early balding, local exaggerated growth) which should be regularly prevented by the annual pruning for shape maintenance. It is especially true for rootstocks inducing strong growth (e.g. myrobalan). Of course, by using rootstocks inducing moderate growth, shaping and maintenance of the crown requires much less effort.

The better branching of trees with twig dominance results in numerous growth points, the regeneration ability of which is generally more favourable, therefore, balding occurs later and more slowly. The apical dominance of such trees is moderate.

In the case of plum cultivars with branch dominance, thinning of twigs and cutting back (rejuvenation of the generative parts) are very important elements of pruning in order to increase the amount and vitality of the crown. In trees of such type, regular rejuvenation of the generative parts is inevitable in order to induce a growth of the thinner twigs and more branchings. In general, it can be stated that a more detailed and thorough pruning should be performed to maintain the crown.

In cultivars with twig dominance, a thinning (thinning of branches and twigs), partial elimination or very moderate application of cutting back are the proper annual operations. However, the proper enlightenment of all parts of the crown should be ensured even by this less thorough pruning.

By observing the trees after leaf fall, the ratio and amount of branches and twigs can be determined. In addition to the necessary complete removal of the vertical or almost vertical inner and/or exterior new parts, a decision should be made upon the degree of the thinning of branches and twigs complemented by or without cutting back.

In the case of vase or funnel crowns, inward thickening should also be prevented by pruning for maintenance in addition to keeping the crown within the available space. In the case of spindle forms, pruning should promote the formation of gaps enabling light to enter the crown.

Summer pruning

In the case of plum, higher than optimal yield does not result in such a reduction of shoot growth as in the case of apple, pear or peach. Local exaggerated growth (formation of water sprouts, exaggerated thickening, dense sectors in the crown) happens also in years with a high yield. Therefore, the fact that the time of pruning can be selected freely enables or makes it necessary to perform a summer pruning in order to enhance the light conditions in the crown, the uniform ripening of fruits and the movement of the machines between the rows.

If pruning is performed only in the dormant period, then the crown is enlightened well only in the first half of the vegetation period. Depending on the cultivar, the crown size, the strength of pruning, the crown is closed in the period between the end of May and the middle of June, which results in a shadowing of the inner and lower parts. From July until leaf fall at the end of October that is for 4–4.5 months, the inner parts of the crown are developing under shadow, primarily because of self-shadowing and due to the shadowing effect of the neighbouring rows.

The products originating from the higher assimilation intensity of the outer parts with better light conditions are diluted continuously as they are used for maintaining the inner shadowed parts poor in assimilates. Consequently, regarding the shadowing, the trees pruned in the winter are similar to a certain extent to the absolutely unpruned trees with too dense crown.

By pruning the plum trees in the summer, the above negative effects of pruning during the dormant period can be completely prevented. Trees pruned in the previous summer (between the end of July and August) have as light crown at the beginning of the vegetation period as those pruned in the winter. By the end of June (a bit later and less strongly), the edge of the crown becomes dense also in these trees. Until the optimal pruning period (end of July-end of August), there are two or three months (depending on the cultivar) from the end of May during which the inner parts of the trees are shadowed.

By applying summer pruning each year, that is by replacing winter pruning with summer pruning, the period of good light conditions is elongated in all parts of the crown, which results in higher yields. In addition, the inner content of the fruits does not change in spite of the fact that a reduced canopy supplies the fruits until harvest resulting from the pruning. The better light conditions, higher assimilation intensity and higher amount of assimilates compensate for the disadvantages caused by the lack of canopy. This is supported by the results of our study performed in 2002 on 2 cultivars where some inner content parameters of winter-pruned, summer-pruned and unpruned trees were compared (Table 1).

Table 1. Inner content parameters of six-year-old pruned and unpruned plum trees on myrobalan rootstock at harvest (Debrecen-Pallag, 2002)

Cultivar	Treatment	Dry matter %	Invert sugar %	Acid content %	Vitamin C mg%
Stanley	Summer pruning (25 July)	13.58	12.80	0.62	2.82
	Winter pruning (February)	13.33	12.60	0.59	2.82
	Unpruned control	11.34	10.60	0.59	2.82
President	Summer pruning (10 August)	18.18	17.10	0.80	0.82
	Winter pruning (February)	18.17	17.20	0.80	0.82
	Unpruned control	16.30	15.40	0.87	0.82

The frequently recommended summer pruning after harvest should be applied only in the case of cultivars with relatively early ripening (e.g. Ruth Gerstetter, Čačanska lepotica etc.). In the case of these cultivars there is sufficient time until leaf fall during which the favourable effects of pruning can occur, thereby, it can result in better light conditions of the canopy, increase in the intensity of assimilation, higher accumulation and better quality of assimilates in the tree parts.

For cultivars with later ripening (e.g. Stanley, Bluefre, President etc.), pruning should be performed in the period before harvest between the end of July and end of August in order to increase the period of better light conditions. Within this period, the earlier and later ripening cultivars should be pruned earlier and later, respectively. Of course, in this case, only those parts of the crown can be removed which do not bear fruits. Such parts include the vertical inward-growing parts, shoots growing inside and at the edge of the crown and the fruitless shoots or shoots to be cut back until the fruit and all those parts regardless of age which do not bear fruit.

According to our experience and survey, in spite of the varying amount of yield from year to year, 20% of the tree canopy (excess growth parts) can be removed without removing even one fruit, thereby, the light conditions of the crown are improved.

For cultivars with later ripening, pruning after harvest is not recommended, since there would be a very short time for exploiting the advantages of better light conditions. Pruning shortly before natural leaf fall results in a reduction in the accumulation of assimilates due to the reduced leaf area, that is the effect of pruning would be negative.

In orchards where there are many older, thicker parts to be removed after summer pruning, these parts should be removed in the second half of the dormant period (February-March).

Pruning for the maintenance of vase crown form

Pruning for maintenance of the vase crown form can be described simply as follows. During pruning, we should aim to prevent inward thickening of the crown that is the upward-growing vertical or close-to-vertical parts reducing the light reaching the inner parts should be removed during the winter and/or summer. Trees should be kept within the available space and the alleys between the rows should be kept free.

The lateral branchings of the skeleton branches, together with the collar branches should be arranged in a structure like that of fishbone, at a distance enabling proper light conditions. Canopy in the space between the trees cannot be more dense than canopy in the space between the rows.

Pruning experience related to the major commercial cultivars

Our experience on intensive crown forms and summer pruning of five-year-old trees of some popular plum cultivars is detailed below.

Čačanska leptotica

The crown is rather cylindrical, of less spreading nature. The canopy in the space between the trees does not become too dense even at the smallest spacing (4×1.5 m), that is it can be kept within the available space relatively easily. The lateral branchings of the central axis (the arms) and the shoots forming on them grow upward at a steep angle and they are almost parallel with the central axis. The number of shoots and branchings is relatively low, which renders to make the crown more spreading and to fill in the available space quickly at larger spacings (5×2.5 m and 6×3 m). Trees form only few water sprouts, which results in good light conditions inside the crown. The lateral branches and the central axis are bearing fruits at their whole lengths. Summer pruning is made difficult by the fact that there are a lot of fruits on both the central axis and the lateral branches.

Due to the upright growth of the lateral branches, a proper thin spindle form cannot be created, in spite of the fact that it would ease to keep the trees at a small spacing. When applying larger spacings, lateral branches should be tied at 40–45° in order to help the trees fill in the available space.

President

This cultivar with strong growth tends to form a spherical or elliptical crown. On its dominant central axis, very strong and thick lateral branches are formed. In many cases, they hinder the dominance of the central axis. More branchings can be found on the lateral branches than in the case of *Čačanska leptotica*, therefore, it can be made spreading more easily by pruning. The top of the tree is prone to strong, vertical shoot growth, which has a strong shadowing effect. At larger tree spacings, the trees fill in quickly the available space. At smaller spacing, trees can grow into the space of the neighbouring tree, which can result in a too dense canopy without summer pruning.

Bluefre

The central axis of the cultivars is of very weak growth as compared to other cultivars, in many cases, it disappears

completely, that is it becomes equivalent to lateral branches. However, lateral branches can become so strong that they take over the role of the central axis which frequently bends due to the large weight of its yield. The trees produce a lot of water sprouts, which make the crown very dense, therefore, it requires regular summer pruning. It can be easily grown in a thin spindle form, its crown seems to be a bit rigid at the smallest tree spacing.

Stanley

From the studied four cultivars, it is the easiest to manage, its branching system can be shaped easily. The central axis has the dominance necessary for the spindle forms and the lateral branchings can be spread easily. Even at smaller tree spacing, well-illuminated, airy spindle forms can be created and maintained by summer pruning.

Cultivation systems under non-irrigated conditions

Under non-irrigated (dry) conditions, there are much smaller possibilities for reducing tree spacing than under irrigation, in spite of the fact that the growth vigour of the same rootstock-grafting combinations is larger under irrigated conditions. The distance between trees should be determined in such a way that in the lower third of the crown a hedge-like canopy wall is formed. This can be achieved by spindle-shaped crown with a strong central axis and a circular or oval (elongated in the direction of the row) projection area.

The requirements toward the crown form are the same as in irrigated orchards, the best possible light conditions should be ensured even if it brings on more difficulties in shaping and maintaining the crown.

In contrast to cylindrical or spherical crowns, cone or cone-like forms have a bigger assimilation performance at the same crown volume. In this respect, cultivars with a strong central axis can be regarded more suitable for production. The higher amount of assimilates results in a higher root activity that is it necessitates that the roots reach a larger volume of soil, thereby, the possibilities of water and nutrient uptake are improved.

On easily warming, loose sandy soils, a higher trunk is more favourable in reducing the harmful effects of radiation temperature. By increasing trunk height with 20–30%, the lower parts of the crown serving as an umbrella for protection are elevated from the hot layer near the ground and the harmful effects are mitigated or compensated in this way. (This physical phenomenon is also valid in cold winter times, although the trees are dormant.) Simultaneously with this, it is recommended to increase the number of the lowest lateral branchings and the density of the final skeleton branches (arms). By absorbing the harmful high temperature (heat), the lower parts protect the upper parts of the crown.

Summing up, it can be stated that under non-irrigated conditions the most favourable are:

- the application of relatively larger spacings which still ensure a hedge-like status,
- cone or cone-like crown forms,
- more dense system of lower arms and
- trees with higher trunks than under irrigated or rainy conditions.

Light requirements, growth characteristics and suggested crown forms of the different cultivars

In the following section, the “natural” crown structure of the commercial cultivars is presented after several years without pruning. The bud density of generative shoots, the ratio of flower and shoot buds and the balding tendency related to light requirement and shadow tolerance are illustrated and described.

Ageni

It has a dominant central axis. Its lateral branches stand in 40–60°, having a 60% branch and 40% twig structure. It has high light requirements, therefore, significant balding occurs in its lower and inner parts. The fruit-bearing parts are well-branched with a medium or good regeneration ability. The crown forms applied are primarily combined or free spindle form.

Althan ringló

A characteristic of this cultivar is branch dominance, they compete with the central axis. The weaker lateral branchings are becoming thin and bald, which indicates their high light requirement. At an older age, the lower two thirds of the natural crown are bald and inactive. The ratio of branches and twigs is 50–50%. This cultivar is suitable for both open and combined crown forms.

Besztercei plum Nm. 122

The cultivar has a natural tent-like crown without a central axis with 70% twig dominance. It is shadow-tolerant, not prone to balding with excellent regenerative ability. Its branches are absolutely equivalent, standing at 60–75°. The cultivar is suitable for open and spindle crown forms. In the case of a spindle form, the formation and maintenance of the dominant axis should be ensured by cutting back the central axis and by phytotechnical operations aimed at eliminating the competing branches.

Bluefre

It is not prone to forming a central axis, its arms can be considered equivalent. It is characterized by lateral branches of 30–50°. The dominance of branches and twigs is 50–50%. It has high light requirements, it is prone to balding. At larger spacings, balding inside the crown is of smaller extent than at

smaller spacings and smaller crown size. The regeneration of generative parts in the illuminated crown parts is satisfactory. The cultivar is excellent for open crown form. In the case of spindle or spindle-like crown forms, great attention has to be paid to maintaining the dominance of the axis.

Čačanska leptica

The cultivar has a dominant central axis, its moderate apical dominance is indicated by the fact that it has good branching ability and there are short fruit-bearing parts at the whole length of even the vertical branches. When the tree is young, the lateral branchings are at 60–80° angles, which become less steep later. The structure of the crown is dominated by twigs in 60–70%, which are shadow-tolerant with moderate tendency to balding. At a larger spacing, it is necessary to tie down the branches and cut back the lateral leader shoots until the tree starts to yield. Combined and free spindle crown forms can be easily managed at this cultivar. In cultivars prone to balding, longer bald parts can form without cutting back and these cannot really be corrected later.

Čačanska rodna

It has a spreading crown with 70–80% twig dominance, the ratio of branches is only 20–30%. It is moderately tolerant to shadowing, it has rather high light requirements. Due to its relatively solid tissue culture, the twigs remain horizontal or close-to-horizontal. A central axis can be formed only by methodical pruning. Any crown form is suitable for this cultivar.

Debreceni muskotály

It has a dominant central axis with 60–70° lateral branchings and 60%–40% twig-branch structure. It is shadow-tolerant and less prone to balding. Its generative parts have a moderate regeneration ability. Due to the balding of the fruit-bearing parts, it requires regular pruning for the rejuvenation of twigs. Its suitable crown forms are combined and spindle forms.

Montfort

It has a naturally spreading crown form without a central axis. Its branches stand in a 20–40° angle, the ratio of twigs and branches is 50–50%. It has high light requirements, the middle, inner part of the crown and the fruit-bearing parts tend to bald, its regeneration is medium or weak. Based on its light requirement and growth characteristics, it is excellent for intensive spindle forms.

President

It has extremely strong growth, the lateral branches stand at 50–70° angle. At a younger age, the inner parts are less

prone to balding if they receive enough light, there are short fruit-bearing parts at the whole length of the twigs and branches. The branching ability of the branches is weak, the crown is dominated by branches, they compete with the central axis. At an older age, the lower and inner shadowed parts start to bald. It is suitable for creating a vase crown, but due to its weak branching ability, more skeleton branches are necessary than in other cultivars. It is also suitable for combined and free spindle crown forms.

Ruth Gerstetter

It is a cultivar that is easy to manage, it has a central axis with lateral branches standing at 45–60° angle. It has moderate light requirements, the ratio of twigs is 60%, the regeneration ability of the fruit-bearing parts is excellent. It is suitable for any crown form, both for extensive and intensive types.

Sermina

It has a natural cone-like shape without a central axis. The ratio of twigs and branches is 50–50%. It has high light requirements and good branching ability, which helps regeneration in places with good light conditions. It is suitable for both funnel and intensive crown forms.

Stanley

A dominant central axis can be easily formed. It has excellent branching ability with secondary, tertiary and quaternary branches. Lateral branches are formed on the central axis at 20–30° angle. There are short fruit-bearing parts at the whole length of the twigs and branches. The structure of the tree can be described by 60–70% twig and 30–40% branch dominance. It tolerates shadowing, its inner parts are active for a long period even if they are shadowed.

In order to prevent spreading of the branches and the crown due to the high fruit load, cutting back should be applied on the lateral twigs to increase their thickening and stability. This cultivar is very suitable for planting intensive orchards.

Tuleu gras

It is a cultivar with strong twig dominance with thin equivalent branches. The regeneration of the fruit-bearing parts is moderately weak, which is manifested in the balding of the twigs. A characteristic of the cultivar is that the twigs drying due to shadowing will remain for years on the tree. The cultivar is suitable both for open and spindle crown forms.

Zöld ringló

It has a dominant central axis. The lateral branches are not steep, its structure is 50–50% twigs and branches. It has very high light requirements and it is suitable for both intensive and extensive crown forms.

References

- Gonda I. (2006):** A szilvafák metszése és a termőegyensúly fenntartása. 212–229. pp. In: Surányi D. (ed.): Szilvatermesztés. Mezőgazda Kiadó, Budapest.
- Surányi D. (1980):** Comparative morphological and phenological study on plum varieties. Acta Agron. Hung. 29: 79–89.
- Surányi D. (1984):** Csonthéjas gyümölcsűek növekedésszabályozása. Mezőgazdasági Kiadó, Budapest.
- Zahn, F.G. (1986):** Intensivierung von Steinobstanlagen durch Starkenbezogene Schnittbehandlung. Erwerbsobstbau 28: 124–140.
- Zahn, F. G. (1990):** Die Spindel beim Steinobst. Erwerbsobstbau 32 (3): 60–66.