

Training systems of fruit trees in Hungary

Soltész M.¹, Szabó Z.² and Nyéki J.²

¹*Kecskemét College, Faculty of Horticulture, H-6000 Kecskemét*

²*Debrecen University, Faculty of Agric. Science, H-4236 Debrecen*

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Summary: Growing sites and soil conditions of Hungary warrant profitable production of several temperate fruits at elevated levels of quality. The climate of the Carpathian basin is a mixture of three main climatic zones the prevalence of which may change seasonally: Atlantic, continental and Mediterranean, therefore, growing sites are rather various. Temperature minima of the winter and late spring frosts are the main elements of risk. In choice of the system of cultivation, regularity of yields and intensity are to be observed equally. Regular yields are particularly aimed in stone fruit cultures.

For apple and pear plantations of high density required for intense production are promoted favourably. Accessories of intense orchards (irrigation, supporting system, rootstocks, phytotechniques, etc.) are important. In peach and plum trees are trained to funnel-shape crowns, in general, intense-types are possible in plum, only. In apricots, a Hungarian speciality, the "umbrella" type of crown is applied, almost exclusively, according to Papp. In sweet and sour cherry, the harvest technique, manual or mechanised, according to the intended utilisation, are determining the form of training.

Red and black currants as small fruits are grown mostly as bushes or hedgerows without any supporting system designed to facilitate mechanical harvest. Raspberries and blackberries are grown as hedges on trellis. Gooseberry is a special case, being a low, thorny bush difficult to be picked. Thus grafted small trees are attached to a wire-trellis which helps to solve problems of plant protection too.

Introduction

The geographic position of Hungary is defined by the 16–23° longitude and the 45–49° latitude. Climatic and soil conditions are suitable for a successful production and for excellent fruit qualities in an abundant diversity of temperate fruit crops. The climate is a mixture of maritime and continental elements with some Mediterranean influence too (Gyuró, 1974). Fruit growing areas of the country are classified into four main regions according to hydro-thermal coefficients: dry, moderately dry, moderately humid and humid (Soltész et al., 1999). Most of the orchards are located in regions considered as moderately dry and moderately humid.

The two regions mentioned are especially advantageous because of their relatively high rate of sunny hours and the safely warm summer. The sunny hours guarantee a high quality of the fruits. In some seasons, accidentally, the unreliable distribution of rainfall cannot be an obstacle of fruit production. Water reserves are sufficient to apply up to date methods of irrigation. Production systems are to be adapted to the local frequencies of hail-storms (Gyuró, 1980).

Heavy damages are accidentally caused by winter minima below –20 °C and by late spring frosts. Those risks are to be considered in the choice of micro-regions and production systems. The intensification and promotion of regular yields are equally important objectives of development (Soltész,

1997). Priority should be given to secure regularity of yielding over the intensification especially of growing stone fruits (Szabó et al., 1997). For some stone fruits (almond, peach, apricot), the Carpathian basin is near to the northern boundary of commercial production. That fact should be also considered in the choice of growing system and phytotechniques. The most decisive feature of those favourable growing sites is the luminosity of the summer which is, in turn, closely coupled with a higher incidence of drought and of low winter temperature minima.

Materials and methods

The agro-climatological classification of areas of Hungary follows the principles set by Varga-Haszonits (1977). The thermal zones are determined by the temperature sum during the growing season when the daily means rose above 10 °C. The hydrothermal coefficient is a quotient of the sum of precipitation during the growing season, defined above, and the temperature sum of the same period. According to that system:

Growing zone	Temperature sum	Hydrothermal coeffic.
Dry	>3400	< 1
Moderately dry	3200-3400	1 – 1.3
Moderately humid	3000-3200	1.3 – 1.6
Humid	<3000	> 1.6

According to our assessment the distribution of fruit species and their prevailing production systems is presented, separately, in each of the four climatic regions. As for the elements of the systems of cultivation, rootstock, planting density (distance between and within rows), trunk height and training (form of crown) are registered. Results of research and local experiments supplemented with experiences gained by growers are summarised as prevailing systems and phytotechniques applied in the particular regions of Hungarian fruit production.

Results and conclusions

One fifth of fruit Hungarian plantations is located in the dry zone, where leading species are peach and apricot. The largest area of orchards is, however, concentrated on the moderately dry zone. Somewhat less than that is the area in the moderately humid area (Table 1). In the moderately dry zone sour and sweet cherries as well as gooseberry prevail. Pear, raspberry, blackberry and currants are preferred in moderately humid sites. Apple, plum and walnut are equally found in the both latter regions with equal weight. Regions classified as humid are but few in Hungary. Precipitation is there suffi-

cient, however, soil conditions are limiting fruit production.

Growing systems of pomaceous fruits are characterised in Table 2. *Slender spindle* is still scarcely represented in the actual orchards, but new plantations of both species are predominantly trained to this form of crown. In the near future, the slender spindle will be the most recommended form for apple and pear in Hungary. For quince the free spindle is recommended as before.

Peach orchards are trained to crown with an open centre, i.e. *kettle* form is preferred. It will keep the leading role, but some spread of the vase or *funnel* as well as the *slender spindle* will be expected.

For apricot, a Hungarian speciality, the *umbrella* designed by Papp is prevalent, and it will keep to be applied in the future.

In plums the *funnel* type of crown is adopted as favourable to mechanical harvest (shaking). For hand picking, however, the intense-type crowns, as *retarded vase*, *free spindle*, are dependent on the introduction of new systems in utilisation of the varieties.

For sour cherry, the mechanical harvest, as a main method of harvest will stabilise the use of the funnel type crown against other types.

Table 1 The actual fruit growing area of Hungary according to its distribution in different climatic zones

Fruit species	Total area Ha	Dry %	Moderately dry %	Moderately humid %	Humid %
Apple	42 000	15.5	42.8	41.7	—
Pear	3 000	10.0	23.3	60.0	6.7
Quince	250	40.4	59.6	—	—
Sour cherry	12 600	27.8	56.3	15.9	—
Sweet cherry	1 560	32.7	41.7	25.6	—
Plum	9 200	15.2	49.3	39.3	3.2
Peach	7 000	50.0	30.0	20.0	—
Apricot	6 100	52.4	24.6	23.0	—
Walnut	2 200	6.8	40.9	47.8	4.5
Raspberry	1 600	—	43.7	56.3	—
Blackberry	400	—	30.0	70.0	—
Currants	1 600	1.8	31.2	67.0	—
Gooseberry	700	35.7	57.1	21.4	—
Strawberry	800	31.2	37.6	31.2	—
Other fruits	4 250	7.0	37.6	54.2	1.2

Table 2 Characteristic figures of the different production systems in the Hungarian fruit industry of pomaceous species

Fruit species	Crown forms	Present relative frequencies (%)	Used since (years)	Row distance (m)	Within row distance (m)	Mean density (tree per ha)
Apple	Medium trunk, crow with leader	20	90	8-10	7-10	130
	Spindle with bearing branches	27	45	6-7	4-4.5	362
	Free spindle	20	35	4.5-5.5	2-3	800
	Slender spindle	25	25	3-3.5	0.8-1.5	2675
	Super spindle	2	8	2.8-3.2	0.6-1.0	4167
	Hedges	6	38	4.5-6.5	2.0-3.0	727
Pear	Medium trunk, crow with leader	0	90	8-10	8-10	123
	Spindle with bearing branches	40	40	6.5-7.0	3-4	423
	Free spindle	15	35	4.5-6.0	2.2-3	733
	Slender spindle	5	5	3.2-3.6	1.0-1.6	2262
	Hedges	10	35	4.5-6.0	2.0-3.0	762
Quince	Free spindle	100	40	5.5-7.0	2.5-3.5	533

Table 3 Characteristic figures of the different production systems in the Hungarian fruit industry of stone fruit species

Fruit species	Crown forms	Present relative frequencies (%)	Used since (years)	Row distance (m)	Within row distance (m)	Mean density (tree per ha)
Peach	Vase	2	3	5	3	667
	Funnel	20	25	6	4	417
	Kettle	73	80	6.5	4-4.5	362
	Slender spindle	5	10	4.5-5	1.5-2	1203
Apricot	Combined	25	50	7.5-8.0	4.5-5	272
	Funnel	15	25	7.0-7.5	4-5	307
	Umbrella (Papp)	60	15	5.5-6.5	3.5-4.25	430
Plum	Combined	15	45	7.5-8	4.5-4.75	279
	Vase	5	3	5.5-6.5	3.5-4	444
	Funnel	78	25	6.8-7.25	4.1-4.5	335
	Free spindle	2	3	4.5-5.5	2.8-3.2	667
Sour cherry	Combined	15	40	7-8	4-5	296
	Vase	5	4	5-7	3-5	417
	Funnel	80	30	6.5-7	3.5-4.5	370
Sweet cherry	Combined	26	30	7-8	4-5	296
	Vase	5	3	5-6	3-4	519
	Funnel	64	25	7-7.5	4-4.5	324
	Free spindle	5	6	4-5	2-3	889

Table 4 Characteristic figures of the different production systems in the Hungarian fruit industry of small fruit species

Fruit species	Production system	Present relative frequencies (%)	Row distance (m)	Within row distance (m)	Mean density (tree per ha)	Raspberry
Blackberry	Without supporting	5	1-1.2	0.8-1.0	10100	
	Hills with stakes	10	1.8-2.2	0.7-1.0	5882	
	Hedge with trellis	85	1.8-2.4	0.4-0.5	10582	
Blackberry	Hedge with wire trellis	100	3-3.5	2-2.5	1368	
Gooseberry	Bush	5	3	1-1.2	3226	
	Small tree, trellis	95	2.5-3	0.6-1.0	4545	
Currants	Bush	10	2.0-2.5	1.0-1.2	4040	
	Hedge	90	3	0.7	4762	

In *Table 3*, the main growing systems of stone fruits are characterised.

For raspberry, the wire-trellis system is promoted and it is expected to be the only growing method in the future. The same is true for the growing system as hedgerows of currants. The gooseberry grafted as *small trees* is Hungarian speciality (*Table 4*).

Below, the fruit species are individually treated as objects of growing systems, their training systems and phytotechniques observed in Hungary.

Apple

The spindle form with bearing branches was leading in apple production. The classic form (where the branches are located spirally on the main axe) favoured the early yielding of the young tree, but the balance of growing and yielding was unstable. The leader loses gradually its dominant function, the lower branches dwindle, the tree become denuded, yields dwindle and the quality of fruit declines. The wounds of larger branches cut open way for the penetration of parasites. The spindles are grown on Malling 4 understocks

which adapted well to the growing conditions. Today, the practice changed, in contrast to the classical form, it is approaching to the free spindle which allows more for the special properties of the varieties. Less branches are left, and they are not grown horizontally, referred mainly the lower branches. Recently, MM 106 stocks are preferred. The improved spindle is, first of all, recommended for industrially utilised apples in the future.

During the epoch of hedge-type crowns forwarded by *Bouché-Thomas*, also local variants of Palmetta have been adopted. The hedge recommended by *Haag* was modified by suppressing the distinct floors of branches resulted in defining the Hungaria-hedge which may be interpreted as a spindle with branches spread out in one plane. A quick start of fructification was achieved, but the balance needed for regular yields cannot be maintained without careful pruning, mainly in older trees. It turned out that hedges of trees with central leaders and transversally inclined branches are viable in Hungary, though their use disappeared, gradually. The slender spindle and the super spindle were adopted instead. For those Malling 9 and Malling 26 rootstocks are used. In the moderately humid regions, the classic form of the

slender spindle is easy to grow. In moderately dry regions the stronger shoot growth needed to be compensated by the application of the pruning system according to Zahn. For the training and maintenance of slender spindle trees, summer pruning is successfully applied.

Pear

The intensification of training and crown forms of pear started later than of apple. One of the reasons of that the pear seedlings as rootstock is to be mentioned. The use of quince for rootstock was braked by the fact that important commercial varieties (*Beurré de Bosc*, *Clapp's Favourite*) are incompatible with quince. The intensification of pear cultivation cannot be realised but in the moderately humid regions, acceptably. Further conditions are to be observed in addition, i.e. new rootstocks (new quince, vegetatively multiplied pears, etc.) selections introduced from abroad. *Pyrus betuliifolia* was accepted favourably in Hungary. Experiences on the utility of other Asian pear species as rootstocks are lacking.

Peach

The main tasks of peach production are to provide for sufficient illumination and to avoid spring frost damage. Both aims are pursued by the crowns with open centres, as the "funnel" crown which was easy to raise in Hungary. Earlier, the "kettle" was widely used but as requiring frequently repeated pruning operations it lost much interest. Some regions applied the flat or the so called dish crown. It needs even more care and the fertility as well as the security of yields are impaired. For the funnel shape, three main branches need to be raised at a declination of 60–70°, and at the collar region branches of 30° are allowed. It is difficult in Hungary to extend the growth of main branches from buds on the end. The leader of the tree must be eliminated after the establishment of the third main branch. No need of later modifications. The retarded elimination of the leader risks the inhibition of the proliferation of the main branches.

Different types of fruit hedges did not prove their utility in Hungary. In the Y-system, the frequent branch necroses diminished susceptibly the fruiting capacity. Spindle trees are endangered by winter frosts. Slender spindles are raised possibly by summer pruning, only. Allowance should be given, however, for the winter frosts which show up only after bud-burst. Better chances should have the free spindle, provided high luminosity is secured by some micro environmental conditions without the danger of the decline in lower part of the crown.

Whatever crown type is used in Hungary, summer pruning should not be finished but rather anticipated, only, and a final adjustment should be delayed to the spring period until blooming. About one and a half to two times as many shoots must be saved from being cut as the number of cm-s in the circumference of the respective trunk or branch.

Earlier, almond and peach seedlings were used for rootstock, whereas inter-specific hybrids of almond x peach are preferred, recently.

Apricot

Main objectives are enhanced luminosity, prevention of frost damage and, in addition, securing conditions of mechanical harvest. Those are achieved by a special crown, the umbrella, developed by Papp for that purpose. Graft of three components are used: the root is myrabolan (*P. cerasifera* v. *myrabolana*), the trunk is an intermediary of plum with a smooth bark of light colour which used to be more resistant to frost damage than apricots, moreover the vigour of the tree will be moderated in order to increase planting density required for intensive orchards with a reduced requirement of pruning throughout the training period. Earlier the Brompton variety was used, recently, some local Hungarian clones (Fehér besztercei, Kiszánai lószemű) proved to be preferred.

At a reduced extent, for mechanically harvested apricot, high trunks and funnel crowns are raised. The majority of varieties grown in Hungary do not need to be cut for the retarded elimination of the leader. Varieties with large fruit at safe growing sites will be eligible to form low-trunk and retarded vase crowns suitable for hand picking. The dangers of die-back and frost damages the hedges and spindle forms have little chances in the future, neither. The vigour of varieties grown in Hungary, at the moment, are not allowing the use spindle type crowns.

Plum

Plum plantations for mechanical harvest are mainly represented by longer (120–140 cm) trunks and funnel crowns. The latter is achieved by the retarded elimination of the leader. In contrast to peach and apricot, the tip of branches of plums are able to continue growing. The plum varieties which are reluctant in branching are excepted from that rule.

In orchards for hand picking (large European and Chino-Japanese plums) on low trunks and with a crown of retarded vase and spindle trees are also grown. Further concern is associated with the growth of hand picked reine-claude (large and round plums) because their vigour does not allow the use of crowns required in the intense plantations.

Sweet and sour cherries

Those two related species used to be grown with the same form of crown. In sour cherry, the mechanical harvest preferred high trunk and open (funnel or Y) crown. The vigour of varieties grown in Hungary do not facilitate the use of spindle trees. Some varieties are difficult to raise to a funnel crown and also to shake because the shoots are pendant. The aim to get an open crown is achieved by the maintenance of the leader (or refrain of its retarded elimination). In more vigorous (sweet cherry type) varieties are easier grown with to the funnel-shape crown.

In the future, sour cherry varieties suitable for multiple use in the industry and growth types similar to the sweet cherry are preferred (breeding of those types is in progress). Cultures for hand picking are dependent on the use of rootstocks causing reduced vigour, thus intensive plantations should be established.

Sweet cherry varieties are almost without exception grown for fresh consumption, thus intensive crown forms are preferred which facilitate hand picking, and allow the penetration of light. The speeding up of fructification is achieved applying a method developed in Hungary by *Brunner*: the segmental double pruning. The free spindle is used safely at all growing sites. The use of the slender spindle and the super spindle are limited by late frosts at blooming. In growing sites of mild climate the repeated cuttings of the main leader are practised in order to maintain vigorous growth. In Hungary the risk of parasites penetrating the wounds is prohibitive. That is the reason to refrain of pruning near to the leader or to branches of larger diameter. The use of rootstocks depends on the growing system applied, thus distinct for sweet and sour cherry.

Small fruits

For raspberry the hedge system is prevalent. The planting distance within the row is generally 50 cm. Mechanical cultivation requires the distance between rows around 2.2-2.4 m at least, but reduces to a minimum of 0.4 m the within row distance. The width of hedge should be kept within 0.3-0.4 m measured on the sprouts at the surface of soil. In wider strips, the sprouts cannot grow to full size, harvest operations are delayed and hampered. In plantations, the first generation of sprouts are eliminated, as a rule. The cultivation in hills lost interest because yield and quality was inferior.

Raspberries need special supporting systems where sprouts and bearing shoots are handled separately. Gooseberries are grown traditionally as low bushes, but as a favourable solution of picking difficulties and plant protection procedures, a method has been developed and gained general acceptance in commercial orchards: small, grafted trees are planted along a single-wire trellis and attached with strings. The fruiting structure is kept at a height of 80-150 cm being handled and sprayed easily. The handicap is, however, its inaccessibility for mechanical harvest. Meanwhile, currants grown as bushes are harvested successfully by machines which should be utilised in gooseberries too. Currants are also grafted to trees but, especially black currants give inferior yields on grafted trees thus gained some space in the home garden only. For mechanical harvest, continuous hedges are needed with a planting distance of 70 cm. At higher density the ageing of bushes is speeded up.

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