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Training and Pruning of Apple and Modern Trends of Development - An Overview

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Abstract

Since Second stage of intensification of apple industry in Europe started during early of 1970`s with Dutch `Slender spindle` training system for high density plantations. Other systems such as `Verical axis', V and Y- shaped system,`Tatura trellis`,`Solen`, `Solax`, `Cone` etc. were developed in different countries of the world. Planting systems were classified at five group as low to ultra high density, that is since less 1000 to more than 8000 trees per hectare.

According to studies in France during the last 40 years, apple tree cultivars have been classified in four group depend of their fruiting type - I type Starkrimson, II- Reine des Reinettes, III-Golden Delicious and IV-Granny Smith. This classification give us the answer why we have biennial bearing for the apple cultivars in type I and regular bearing for type IV, and why is very important to maintain good balance between vegetative growth and reproductive shoots as a part of apple canopy architecture.

Keywords: *Malus domestica* (Borkh), training and pruning systems, fruiting type and habit

Introduction

The evolution of apple industry in different countries from 1950 to 1970, apple training (goblets, structured hedgerow) and pruning have resulted in good fruit production in terms of yield and fruit quality. Since 1970 this evolution occured with an increase in single-row tree densities per hectare.

In this situation the old forms were not suited to this:

– Tree forms used are not always appropriate to the branching and fruiting type of the cultivar.

– Keeping tree low in height by pruning causes a state of imbalance and rapid aging of the production zone. Because of inadequate light exposure, it is unable to renew itself.

When in France `Granny Smith` appered (1968) with its particular fruiting type Lespinasse and Delort (1986) proposed a different way for training the tree. There are three factors in orchard management of concern to the fruit grower:

- reduction in the time needed for pruning and harvesting;
- the rapid attainment of a commercial production;
- an annual production and better quality fruit which requires a balance between fruiting and vegetation vigour.

High yield performance of fruit crops results from the integration of various components, which pieced together, constitute the `orchard system puzzle` (Barritt,1992). They are implemented at two different time scales: a set of initial choices determines the basic componets of the orchard during its life-span (support system, tree arrangement and quality, density, rootstock and cultivar), and a set of annual procedures that is closely related to the training system but evolves from one year to the next (pruning, training, and thinning practices).

It is therefore of major importance to develop training concepts that optimally combine training and managemnet systems at the orchard scale and training methods at the tree scale (pruning, bending).

At both levels, an accurate knowledge of growith, branching, and flowering processes within the tree canopy, i.e. tree architecture, is thus required to optimize tree manipulation adapted to the plant material (Costes at a., 2006).

Apple training and pruning systems development during the last 40 years

In the 1980`s through observational naturally grown trees - forms, ramification organisation and fruiting type, he has classified apple cultivars in four group:

-Type I-Spur type – like cv. `Starkrimson`. In these cultivars, the majority of the fruiting spurs are on branches 2 years old or older.

-Type II-like cv. `Reine des Reinettes`. These trees normally show greater dominace of the central leader than do spur types. The majority of fruiting age are 3 and 4 years old.

-Type III-like cv. `Golden Deliciuos`. These cultivars there are numerous coronate twigs (short shoots) and the mojority of fruiting age are one, 2 and 3 years old.

-Type IV-like cv.`Granny Smith`. These cultivars rarely develops lateral shoots in the lower portion of their wood. The fruiting zone moves towards the outside of the tree, and more rapidly than in the case of `Golden Delicious`. The majority of fruiting age are one and 2 years old (Lespinasse and Delort, 1986).

`SLENDER SPINDLE` is the first new training system developed by Werheim (1978) in The Nederlands for high-density plantings during second half of the last century and very fast have been introduced in many coutries in the world. The reason for this change was the need to achieve early cropping, regular high yields, and low labour requirements in order to meet the continually increasing costs of production. That this intensification yielded the desired results can be seen from some Dutch figures: in the 1950–1977 period the average yield from an apple orchard increased from 16 to 38 tons per hectar, and the man-hours required per hectar for cultural practices (excluding picking) decreased from 550 to 175. For high-density plantings with many small spindle-type trees per hectar on dwarfing rootstocks, he recomended mainly M9 rootstock. Wertheim noted also that the advantages of the single-row design are obvious: it gives a reasonably light distribution within the canopy (favourable for the average fruit quality) and easy management due to the many alleyways. One drawback of this design is that with very high tree numbers per ha, light interception is far from maximal due to the many alleys and so is the yield capacity of the orchard. Moreover, average fruit size may be reduced when tree distances within the row become small. Now that the market is making ever-higher demands with respect to fruit size and colour, the planting system and the number of trees per ha must be chosen with care to provide the maximum yield of easily marketable fruits. This requires even more careful planning by the grower of the planting density and arrangement in relation to site and cultivar vigour.

The relationship between fruit quality and tree density is not a simple one as it depends not only on site, rootstock/scion combination and age of tree but also on tree arrangement. The advantages of close between-row spacing as a more effective way of increasing yield of large fruit compared to close within-row spacings.

`VERTICAL AXIS` was developed in 1975 by J.M. Lespinasse (1977, 1980) in France based on studies that apple tree training systems take three main characteristics into consideration:

- the branching habit of the cultivar and the influence of apical dominace on branch development,
- how fruiting occurs and progeress on the tree form one year to the following (the fruiting types),
- the relationship between the position of the fruit and it is quality

The `Vertical axis` tree is made up of a vertical trunk, along which fruiting branches are regularly distributed. The tree shape tends to be conical. It is based on two principales:

- The terminal buds of the central axis and of fruitinh branches are of primordial importance to reach an optimal balance between vegetative growth and fruiting at the tree and branch levels.
- Tree fruiting zones exist in fruiting limb. `Zone A` (from 0-30^o from vertical) is characterised by the best light interseption. This zone favours the development of strong vegetative shoots which are able to bear fruits of good quality one or two years later. `Zone B` which is below the former between 30^o and 120^o from the vertical, is the prime fruiting zone, whith good light distribution and moderate shoot growth.`Zone C`underneath the first two zones, does not allow good fruit production because of the deleterious effect of within-tree shading on fruit quality. This training system aims to develop limbs in `Zone B`, which produce the best fruit quality.

The practical guidelines are: at planting and during the development years the scion is not headed back. At the end of the third year after planting, usually at hight of 2 to 2.5 m (Golden Delicious on M26). For a tree on M9, a good balance between vegetative growth and fruiting is usually abtained with 12 to 16 fruiting branches. The number and distribution of branches are controlled by summer pruning.

`V and Y` -SHAPED SYSTEMS. European gardeners have trained V-shaped apple canopies for centuries but it was not until the 1970`s that V-shaped fruit trees were

popularized for commercial orchards by Chalmers and van den Ende (1975) as the `Tatura trellis`. A number of variations of the Tatura trellis were developed which include the Mini -Tatura trellis and Y-trellis (Robinson et al., 1989), the Mikado system (Widmer and Krebs, 1997), the Drilling (Triplet) system (Widmer and Krebs, 1997), the V-Slender spindle (Krebs, 1988) and the V-Super spindle. The V systems utilize dwarfing rootstocks sach as M9 and M27. With all V systems the objective has been to improve yield by inproving light interception and to inprove fruit quality by inproving light penetration to the center of the canopy. The primary advantage of V system is that they have high yields at maturity. This has been related to high levels of light interseption. It is found a linear relationship between yield and tree density over the first 10 years of the orchard life. The optimum angle for fruit size were also around 60^o while fruit color was best on the most vertical angles. The best yield efficiency was at intermediate angles of around 60^o. This resulted in the best balance of vegetative growth and croping. The primary disadvantage of V-systems is that the cost of establishment and initial tree training are expensive. Trellis costs of V-systems arew generaly more than vertical systems. Other disadvantage is the greater cost to train the treees over the first 4 years compared to the central leader or vertical axis systems and the next is smaller fruit size than from vertical systems (Robinson, 2000).

`TATURA TRELLIS` is a Y-shaped system with arms of the trellis at 60^o above the horizontal. This system was originally developed for peaches to increase yields and to allow mechanical harvesting but was later adapted for apples. Each tree has 2 main scafold arms and secondary branches are trained as a palmette. Semi-vigorouse stocks sach as M7, MM106 and MM111 are usualy used. The trellis is 3 m high with 6 wires per side. Spasing is 1 m in row and 5 m between rows. Trees are trained by heading the tree at 50 cm height at planting. Only 2 shoots are allowed to develop with one trained to each side of the trellis. Secondary branches are trained about 45^o from the leader and are attached to the wires (Chalmers and van den Ende, 1975). The Mini Tatura Trellis is similar to the Tatura trellis in shape and branch training except that dwarfing rootstock such as M9 and M26 are used and mach smaler trellis is needed (2 m high with 4 wires per side). The trees are planted at 1 m inrow spacings and 4 m between rows. Secondary branches are trained about 45^o or in some cases at 90^o from the leaders (horizontal along the wires) and are attached to the wires (Robinson, 2000).

`SOLEN` is a french training system developed by J.M. Lespinasse during the 1980`s. The spacing is 2 m in rows and 3,5 -4,0 m between rows and the hight of the trees are 1,6 m for M9EMLA and M26 rootstocks, i.e.about 1500 trees per hectar. It is good system for cultivars from fruiting type III and IV like Golden Delicious, Gala, Granny Smith, Fuji etc. The number of fruiting branches are 12-16 for bicolor cultivars and up to 20 for monocolor sach as Golden Delicious and Granny Smith. All branches are bended like weeping position (Monney and Evequoz,2000).

`SOLAXE` is a combination between `Solen` + `Vertical axe` and developed in France. It involved combining the bending of the central axis and the fruiting branches from the `Solen` and developing free growing fruiting branches and removing the competing vegetative branches on this fruiting branch from the `Vertical axis` (Lespinasse, 1996). The practical guidelines are:

- At planting, feathers along the trank are strongly bent into an arch. Branches which are below 1.2 m have a narrow angle or which are positioned poorly along the trunk, are removed.
- The main stem is attached to a support system either in the fall of the first growing season, or at the end of spring of the second season. Depending of the cultivar and the rootstock, bending of the leader is naturally obtained by fruiting, or has to be artificially obtained by bending the leader to the wire at the top of the support system.
- The bending of the fruiting branches is achived naturally through the weight of the fruits, as early as the second (cv. Braeburn) or third (Gala, Fuji) year. In the case of well positioned but more upright shoots, bending is done artificially.
- Excess branches are removed by pruning beginning in the fourth leaf.
- The best balance between vegetative and fruiting on mature Solaxe tree is obtained with 12 to 16 fruiting branches spirally arranged along the trunk (Lauri and Lespinasse, 2000).

`CONE` as a system for training and pruning has been developed by Gandev (2009), because under bulgarian conditions the MM106 was the main rootstock in apple orchards when the orchardists use predominantly spur type cultivars sach as `Starkrison` and `Yellowspur` during the 1970-1980`s. Nowadays after planting apple cultivars grafted on MM 106 rootstock, sach as `Granny Smith`, `Melrose`, `Jonagold`, `Fuji`, `Florina` etc., faced some difficulties for control of vigor and regular yield of the cultivars. Because for new orchards needs lot of investments for individual stiks

on M9 rootstock, the `Cone` system is suitable for moderate and vigorouse cultivars on MM106 rootstock with out support systems and wires and spacing 4.5 x 2.5 m. This system goes throuth two training types, convetionally called a `layered cone` and `step-like cone`. The aims is:1) to reduce the tree grouth vigor in the period of vigorous growth and in the period of their initial rapidly increasing fruiting and 2) to maintain a balance between tree growth and fruiting in the full fruiting period. The transition from one training type into the other was realized by pruning for fruiting according to the branch thickness.

Conclusion: The evaluations of economic point of view the V-systems can be more profitable than most other systems but not more profitable than the best vertical tree system like the `Vertical axis`. V-systems will likely better than vertical tree systems under conditions of high sunburn and high winds or where all the fruits must be picked from the ground since the V systems can intersept more light with short stature systems than pyramid shaped systems (Robinson, 2000).

Orchards of the future will likely be 2,5-2,8 m tall and with very narrow canopies that can be maintained by mechanical side-wall shearing to reduce labor costs and to improve fruit quality and harvested and pruned with harvest assist platforms. We expect such orchards to have very high yields (73 t/ha) with uniformly high fruit quality. We propose that such future orchards can be managed with significantly less total annual labor hours and with 1500trees/ha, to small central leader trees on M.9/MM stocks (Robinson,2013).

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