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European Trends in Apple Tree Density, Rootstocks and Tree Training

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STRUCTURAL CHANGES IN FRUIT GROWING DURING THE LAST DECADE

The price and cost structure has changed dramatically the last few years. First of all, the labor costs (especially the wages for casual labor) have increased enormously. A few years ago, picking labor cost about 5 US$ per hour, nowadays it increased to 8.25 US$ per hour. Other costs (investment, machinery, products) have increased slightly. Very important also is the changing cost structure to produce and commercialize a kg of apples and pears.

In the past, the orchard costs were the most important. Today the balance between orchard costs:postharvest costs moves to 40:60 (Table 1).

The prices on the apple market, however, have had a tendency to decrease. The income for the grower decreased considerably compared with 10 years ago. If he wants to survive, he has to react, but he cannot influence the market and the cost structure very much. He has to try to produce for lower cost. He can hardly reduce his fixed costs (investment, products, postharvest costs) so he will try to reduce the labor input and to increase the production per acre.

Another conclusion that we can make is that only the best quality product can afford this "postharvest cost." Producing and storing second quality fruit does not bring income. On the contrary, it is costing a lot of money.

Since 1990, the use of chemical growth regulators in apples has been forbidden. The immediate consequences for the existing orchards were that the grower had to change his pruning techniques. This involves retaining a few longer, more weeping branches per tree, which gives a better natural balance between growth and production. For new orchards, the grower has to pay a lot of attention to the choice of the most optimal rootstock, planting system and above-ground rootstock length, according to the expected vigor.

In Europe, the introduction of IPM production methods caused growers to abandon multiple row (bed) systems. A lot of attention has to be paid to optimize spraying technique, to decrease the numbers of chemicals and the level of sprayed active ingredients, to the selectivity, to the reduction of the herbicide-sprayed surface under the trees and the possibility for mechanical weed control.

THE SINGLE ROW SYSTEM FOR THE APPLE ORCHARD

The main reasons for this choice can be summarized in three items:

- A good pyramidal shaped tree in a single row gives the best light penetration and distribution in a tree. Smaller trees have a better distribution (Figure 1) which is always better for the fruit and bud quality, resulting in a regular production of optimal quality fruit.
- A single row allows the grower to prune the trees to a good natural balance between vigor and production: pruning to longer, more weeping branches. Above the framework branches (lower tier), we avoid or eliminate strongly growing shoots at their point of attachment (thicker than 50% of the diameter of the central leader). Only weak, productive branches can be cut back to upright spurs to stimulate vitality.
- Efficient and reduced use of chemicals in IPM is favored by a single-row system. It is also the aim of the grower to become more and more structured and mechanized, which is easier to achieve in a single row compared with a multiple row bed.

In addition to fruit quality, another important factor for selecting the planting systems is the early productivity and the production level of an orchard. Experience in practice, experimental trials and economical calculations prove that the optimum tree number has to be somewhere in between 3,000 and 4,500 trees/ha (1200 to 1800 trees/acre), depending on the growth level of the orchard (Table 2).

This means for a single row division a planting distance of 3.25 m x 1 m to 3.00 m x 0.75 m (10.7 x 3.2 ft to 9.8 x 2.5 ft). The maximum tree height, with an alleyway of 3 m (9.8 ft), will be 2.50 m (8.2 ft). If the trees are higher, the light distribution under the trees will be insufficient.

THE CHOICE OF THE ROOTSTOCKS

To obtain a well-balanced tree which has a capacity to produce excellent fruit quality, an optimal vitality is necessary. The vigor of the tree depends very much on the soil quality of the orchard, the climatic conditions, the use of irrigation or fertigation, whether it is a replant situation or a planting in fresh soil. For the most part, the rootstock will influence the vigor and the balance in a tree.

M.9 and Its Selections

The M.9 rootstock is still the most common rootstock in Europe for apple orchards. Especially in replant situations, for orchard with moderate soil quality (loamy-sand) and for semi-intensive orchards (2000-3000 trees/ha), M.9 is still recommended.

Within the M.9 rootstock, different selections (strains) have been identified. The differences between these selections are mainly based on their degree of juvenility in the nursery which is stabilized by vegetative multiplication. In the orchards, the differences between selections are rather limited (maximum of 10% to 15% difference in vigor). The more juvenile types are a bit more vigorous. Some common M.9 selections can be characterized as follows:

More juvenile	More adult
M.9 Nic. 29	M.9 Nic. 8
Pajam 2® Cepiland	M.9 Nic. 319
	Pajam 1® Lancep
	Fleuren 56

Rootstocks Used for Very Intensive Orchards

On the very vigorous soils of the main fruit region in Belgium (Haspengouw) and for intensive orchards (more than 3000 trees/ha) a lot of growers are using M.27 (and some P.22) as a rootstock or interstem. M.27 reduces the growth and the tree volume by at least 30% (Table 3). Stimulating the vitality of the tree is necessary in most of the orchards to make sure that the fruit quality will be optimal (size, color, etc.).

When looking for growth habit (vigor) between the growth of M.27 and M.9, we often used M.27 as an interstem or P.22 as a rootstock. During the first 2 or 3 years, the volume of the trees increases more than with M.27, but after some production, the vitality of the M.27 interstems or

P.22 trees is comparable with M.27 trees (Table 3). Other negative aspects of interstems are an increase of the root suckers and the susceptibility to drought of the P.22 rootstock.

Alternative Rootstocks for the Future

We are still looking for rootstocks with a growth habit in between M.27 and M.9 which have a positive influence on the pomological characteristics of the variety. The selection from Holobousy, Czech Republic (J.TE.G., J.TE.E. and J.TE.F.), the new Polish selection (P.16 and P.59 and P.60) as well as some new Geneva clones (CG.30/2, G65/12) are of interest. We are following carefully the trials (Tables 4 and 5) and practical experiences with these rootstocks. Maybe within a few years some of these will be widely used in our orchards.

TREE QUALITY, THE IMPORTANT START FOR AN INTENSIVE ORCHARD

Early productivity and a good balanced tree are the most important factors for a successful intensive orchard. The practice shows us that high quality "cut trees" (knip boom) are the most optimal trees to plant. We grow these trees as a 2-year-old nursery tree with a 1-year-old crown. In the nursery, the whips (1 year old) are cut back to 60 cm (2 ft) above soil level. In year 2, the young shoots are removed except for the upper shoot. This shoot grows very vigorously to become a well-feathered crown with 5 to 8 branches (feathers) with wide branch angles. For these "cut trees" on M.9, the variety is budded or grafted relatively high at ±25 cm (10 inches) above soil level. Trees with a longer rootstock shank and planted rather shallowly grow less vigorously than trees with less rootstock shank above ground.

In summary, the keys to successful orchard management in Belgium are 1) plant trees in single rows, 2) choose M.9 or less vigorous rootstocks, 3) plant between 1200 and 1800 trees/acre (3000 to 4500 trees/ha) and 4) plant well-branched nursery trees.

Table 1. General production costs in Belgian funds (Bfr) per kg with a production of 45 tons/ha.

	Bfr/kg
Orchard costs:	
Investment (writing-off, rents)	3.25
Labor and machinery (pruning)	5.50
Products (chemicals)	1.25
Picking	2.50
Total	12.50 (46%)
Postharvest costs:	
Bins	1.00
Storage and manipulation	5.00
Grading	3.50
Packaging	3.00
Marketing	2.00
Total	14.50 (54%)

Table 2. Anticipated apple production (kg/tree) by year for three tree densities.

	Between tree spacing and tree density		
Year	1.35 m (4.4 ft) 2000 trees/ha (810 trees/acre)	1.00 m (3.2 ft) 3000 trees/ha (1215 trees/acre)	0.75 m (2.5 ft) 4500 trees/ha (1822 trees/acre)
0	-	-	-
1	6	6	6
2	10	10	10
3	12	12	12
4	16	14	12
5	20	16	12
6	20	16	12
7	20	16	12
8	20	16	12

Table 3. Elstar tree growth and productivity with three rootstocks.

	M.9	M.9/M.27 (15 cm M.27 interstem)	M.27
Total production/tree (kg) 1988-1996	159	149	167
% of M.9	100	94	105
Fruit weight (g)	158	140	144
Apple surface colored[z]	46.7	55.9	51.6
Fruit color intensity[y]	67.0	72.5	70.3
Shoot growth (cm) 1991-1996	218	110	129
% of M.9	100	50	59

[z]0 = all green, 100 is >90% colored surface.

[y]0 = no red color, 100 = highest red color intensity.

Table 4. Shoot growth of 1-year-old shoots of King Jonagold and Smoothee Golden Delicious trees on 6 dwarfing rootstocks.

	King Jonagold		Smoothee Golden Delicious	
Rootstock	Shoot growth (cm)	% of M.9	Shoot growth (cm)	% of M.9
P.59	58.2	75.8	58.8	79.3
P.22	61.1	79.9	62.4	84.2
J.TE.G	72.1	94.0	63.1	85.1
J.TE.F	59.9	78.1	63.4	85.5
J.TE.E	59.4	77.5	54.0	72.9
M.9 Nic. 29	76.7	100.0	74.1	100.0

Table 5. Production of King Jonagold trees (1994-1996) on 6 dwarfing rootstocks.

Rootstock	Production/tree (kg)	% of M.9	Fruit weight (g)
P.59	26.67	124.5	165
P.22	28.57	133.4	169
J.TE.G	17.77	82.9	154
J.TE.F	27.46	128.2	166
J.TE.E	26.82	125.2	177
M.9 Nic. 29	21.42	100.0	198

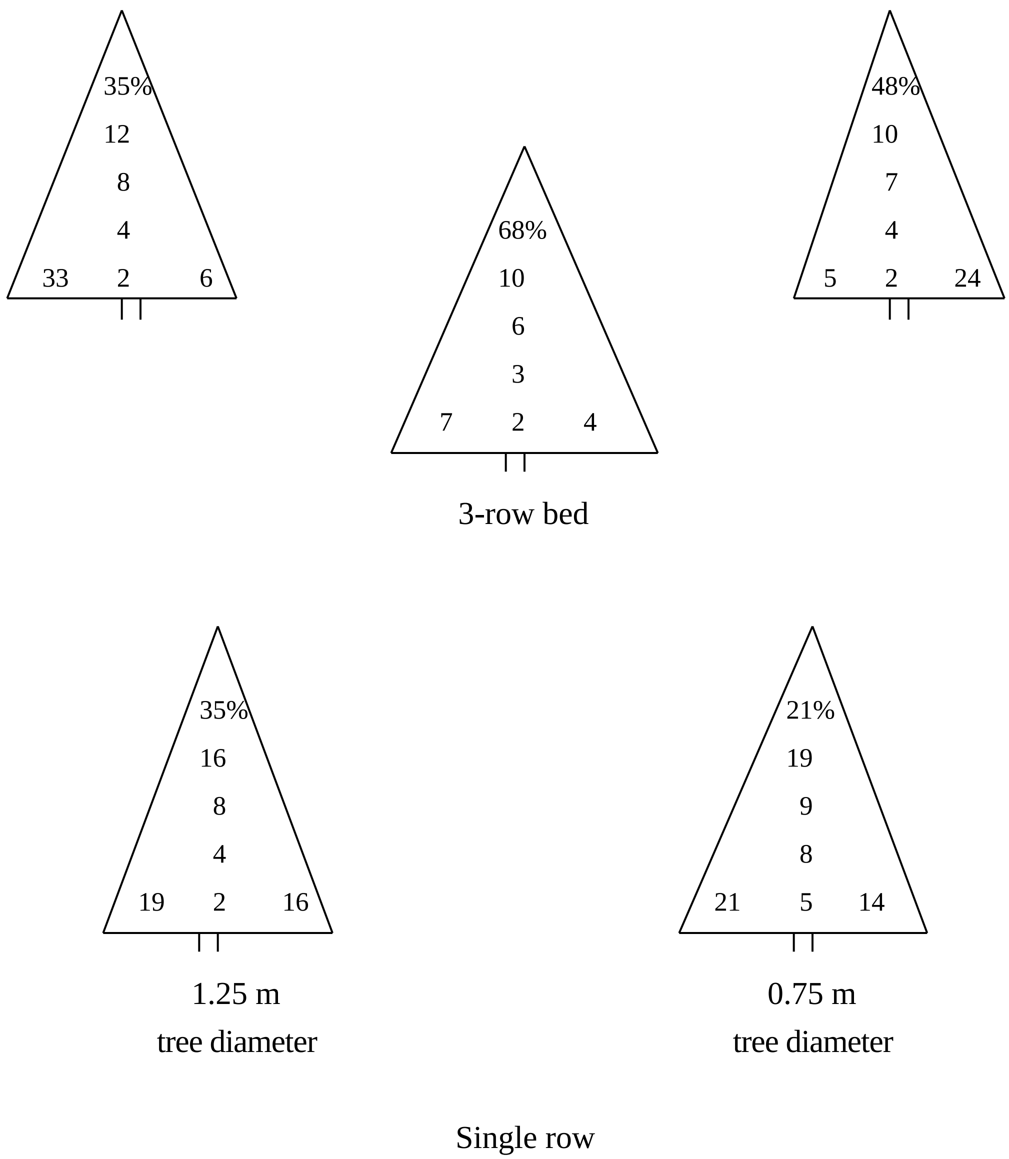

Figure 1. Light penetration and distribution in a tree. Values are percent of full sunlight (100) above the tree.