Pergola cherry tree cultivation system

For the first time in Greece, the imaginative new pergola cherry tree shaping system is presented, which promises high yields, uniform, large-sized fruit, easy harvesting under favourable conditions, and the long-term maintenance of optimal tree vigour and efficiency.

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1. Introduction.

A new linear cherry tree cultivation system is being tested in several countries around the world, with the participation of several farms mainly in the cherry-growing countries of the southern hemisphere (Chile, New Zealand, South Africa, Australia), but also in a limited number of experimental plots in the countries of the northern hemisphere (e.g. the Netherlands, Hungary, etc.). It is called Pergola (the word pergola is also used in Greek and means an external structure for protection from the sun and wind) but in the main country of experimentation, Chile, it is called Parron.

Its structure involves the transfer of the productive area of the cherry tree to a height of about 1.80 m, with the aid of a suitable support structure similar to that used for growing kiwi fruit. In Chile, it has replaced (in the same support structure) many kiwi fields destroyed by the severe bacterial ulcer epidemic (Pseudomonas syringae pv. actinidiae - PSA).

The scheme supports the following innovative aspects compared to what has been known so far: full exploitation of the field surface area (1000 m2 per hectare), since the entire productive surface area of the trees is above ground, as well as vigour and quality production throughout the life of the trees (the term 'forever young'), with frequent renewal of the fruit-bearing branches.

2. General information on the pergola system

The pergola is a linear system of dense to hyperdense planting, with frequently renewed booms, in a radial arrangement on the vigorous undergrowth, so as to create, with the help of the wires, a productive plane at a height of about 1.70-1.80 m, to create favourable working conditions in the field and increase the yield of harvesting operations, which is the great disadvantage of cherry cultivation compared to other dynamic tree crops. Another current issue that can be largely alleviated is the continuing labour shortage in recent years in our country.

A variant of the pergola with two production levels, the second of which at a lower height, is also being experimented with in order to launch production to very high levels, but it seems to create a bottleneck in the main cultivation operations of the orchard, so we will not deal with it in this article.

In addition to the demands already mentioned in relation to labour, other issues negotiated for improvement are the full utilisation of the orchard area as already mentioned, avoiding the use of ladders or platforms for harvesting, simplifying pruning operations and thus speeding up the time, taking the amount of fruit produced only from young and vigorous fruiting organs for their excellent quality, etc.

The main objective of the system is to produce more than 1.5 tonnes per hectare per year with an average fruit size >28 mm. Being a linear system, a support system is required, which increases the initial installation costs. A fundamental operation for the pergola set-up is the breaking (not bending) of the branches at almost right angles, an operation that will be unfamiliar to many at first and which could lead to fears of loss or damage to the plant stock. But it seems that this action works and works very well!

There are no restrictions on the use of varieties (perhaps orthogonal varieties make the action a little easier), nor on the rootstocks used. At first glance, it seems that trees with a vigorous rootstock are easier to shape in Pergola, but even the very low vigour Gisela 5 is recommended! Of course, it is advisable to avoid the current sub-trees at low altitudes in our country, as empirical practice has shown so far. In mountainous areas, however, where it shows its excellent characteristics, Gisela 5 can also be used.

3. Conditions for implementing the system

The pergola can be applied in any area suitable for cherry cultivation (as long as the plots are not too sloping). In the case of Greek conditions, more attention may be required in terms of irrigation and fertilisation or watering, especially in the first years of tree growth, to create the necessary vegetation.

Since this is a linear system, it will be necessary to install a support system or modify an existing support system of a kiwi crop. Therefore, support columns of any material (wood, metal, concrete poles) are required, at distances of 10-20 m on the line and at least 2 m above the ground (i.e. a total length of 2.5-3 m), if no climbing protection is to be installed. At a height of 1.70-1.80 m from the ground, where the productive surface will be created, it will be necessary to place horizontal sections of metal or wooden beams (T-shaped), where 2-4 wires (Ø 2-2.5 mm) will be placed to support the productive branches on each side (except for the wire located directly on the line), spaced approximately 40-50 cm apart (Photo 1). In the case of using vigorous rootstocks, where the planting distance between rows is greater, it is possible to use a support wire structure perpendicular to the planting rows, in the form of a grid with large squares.

Photo 1. Structure of the pergola support system (R. Vermeulen).

4. Recommended rootstocks and varieties.

There is no restriction in the use of the subjects. The entire range of rootstocks is recommended, from very vigorous to dwarfing high-growing rootstocks, depending on the soil and climatic conditions, as suggested:

- Vigorous and medium growth rootstocks (e.g. Maxma 60, Colt, Maxma 14, Gisela 17, Piku 1); 3-4 m between rows and 1.5 m between plants. The above planting distances require 166-222 trees per hectare. Perhaps in our country, as empirical practice has shown, 1.5 m between plants of vigorous rootstocks is a rather small distance.
- Smaller-growing rootstocks (e.g. Gisela 6, Gisela 13, Krymsk 5, Gisela 5) require 3 m between rows and 0.8-1 m between plants. The above planting distances require 333-416 trees per hectare. Perhaps in our country, as empirical practice has shown, 3 m (as well as the suggested 2 m) between rows is marginal for the use of existing cultivation machines (e.g. agricultural tractors, sprayers). The dimensions of the machinery must also be taken into account before any shifting is carried out. In the Gisela 5 rootstock, it is also advisable to avoid self-fertilising varieties, as they bear too much fruit, causing micro-fertilisation and preventing the tree from developing vigorous annual vegetation, which is essential for growth and tree formation.

As far as varieties are concerned, there are no restrictions on their selection. They are selected according to the producers' criteria, based on maturity, quality characteristics, resistance to cracks and diseases and commercial potential.

5. Tree Breeding Operations with Pergola

5.1. Preliminary Operations

In the autumn, all the classic orchard preparation work applicable to all deciduous fruit trees is carried out, such as deep and superficial ploughing with simultaneous incorporation of potassic and phosphatic fertilisation, levelling with tilling, installation of a support system for the trees, opening of planting holes at the pre-established distances depending on the rootstock used, etc.

5.2. Interventions in the first year

Planting seedlings is done throughout the tree maturation period, from December to February. However, it is recommended to do it early, from mid-December to mid-January, for best growth results.

It is also advisable to plant the seedlings at the predetermined distances, on a 20-30 cm high mound (berms) for better drainage of the root growth area and for rapid soil warming during the flowering period.

Once planted, the seedlings are pruned to a height of 1.50 m if the production plane is to be created at 1.70 m (so the horizontal T-beam will also be positioned at 1.70 m) or pruned to a height of 1.60 m if the production plane is to be created at 1.80 m (so the horizontal T-beam will also be positioned at 1.80 m).

In trees with low-growing rootstocks, during the August-September period, the two to four strongest branches (approximately 1-1.20 m long and with a diameter at the base of 8-12 mm) are retained from the sapling's germination, and are broken off in equal numbers bilaterally, in the two opposite directions (right-left), so that they are not completely cut from the growing part of the trunk (Photo 2). This operation, to avoid extensive damage, can be performed by lightly sawing the rear surface of the branch at the point where it is to be broken (Photo 3). The broken branches are tied to support wires. This work is done at this time of year (August-September) because dry and warm conditions usually prevail and the chances of bacterial attack (Pseudomonas sp.) are minimised, and scar tissue is created in a short period of time (7-10 days). If there are other growing branches, these are core drilled on a strong bud, so that they can be regenerated for the following season. Of course, a protective preparation can be applied to the wounds (Photo 4).

For the sceptics, with regard to reserves on the pruning work, we would like to point out that branches broken off in the field due to various causes (e.g. overlapping of a large volume of birds) that have not been detached from the tree continue to grow normally in a downward direction.

Photo 2. Bilateral breakage of four strong branches (right-left), in the first year, on low-growing rootstocks (R. Vermeulen).

Photo 3. Light sawing of branches at the point where they will break, in the first year, on low-growing rootstocks (R. Vermeulen).

Photo 4. Application of protective ointment on laceration wounds (R. Vermeulen).

In trees with vigorous-growing rootstocks, during the August-September period, the four to six strongest branches from the germination of the sapling are kept in a radial arrangement (two on each side and two in opposite directions on the central wire), which are broken off so that they are not completely cut from the growing part of the trunk and tied to the support wires (Photo 5). This operation, to avoid extensive damage, can also be done by slightly sawing the rear surface of the branch at the point where it is to be broken off (Photo 3). If there are other branches developing, they are core drilled on a strong bud to regenerate them for the following season. Of course, a protective preparation can be applied to the wounds (Photo 4).

Photo 5. Radial arrangement of productive branches (R. Vermeulen).

5.3. Interventions in Year 2

In August-September, the previous year's work is repeated only on the trees that have not developed the necessary number of branches for modelling, regardless of the vigour of the rootstock.

On the broken branches, replacement shoots have already sprouted (Photo 6), which will be necessary for the renewal of the tree in subsequent years (called 'forever young').

In early spring, the branches will develop flowering, but will not bear fruit, except for some minimal fruit for sampling on low-growing rootstocks.

Photo 6. Replacement shoots for use in the following year (P. Ulloa).

5.4. Interventions in Year 3

Full production occurs in the spring of the third year in trees with low vigour rootstocks. Fruits are produced from the young biennial fruiting bodies at their optimum potential and are uniform in size and colour, with high standards of organoleptic characteristics. It is also believed that in these productive branches, the ratio of leaf area to fruit is the best that can be achieved.

In August-September, these branches are removed and the previous year's replacements are broken off and tied to wires (Photo 6), so that the following year's conditions for producing top-quality fruit can be repeated.

Trees with vigorous rootstocks, on the other hand, enter the fruiting period with a potential of about 50 per cent of the expected capacity (varying according to the combination of rootstock vigour and grafted variety) and for this reason the productive branches are not removed in the August-September period of the third year, but are left for another year.

5.5. Interventions in the 4th year

Trees with low vigour rootstocks are in full production from the previous year and the August-September operations are repeated every year.

Trees with vigorous growth rootstocks are also brought into full production and harvested in spring. During August-September, the productive branches are removed and the replacement branches from the previous year are broken off and tied to wires (Photo 6), so that the conditions for producing top-quality fruit are repeated the following year. From the following year, these trees are subjected to the same treatments as those with low vigour rootstocks.

Photo 7. Pergola orchard during the winter season (R. Vermeulen).

Photo 8. Pergola orchard during flowering (A. Navarro).

Photo 9. Pergola orchard during the growing season (P. Ulloa).

6. Expected productions

The system is dense/superdense planting. On the basis of the productive branches, with an expected production of one kilogram of quality fruit each (conservative approach), and on the basis of the planting density, we can say that in general we expect

- In vigorous and medium-growing rootstocks: (trees per hectare x expected kg/tree) 166x6=996 to 222x6=1332 kg of quality production per hectare.
- In low vigour rootstocks, with the same reasoning: 333x4=1332 to 416x4=1664 kg quality production per hectare, which can be much higher than 2 tonnes if even shorter planting distances are applied.

Photo 10. Pergola orchard compared to people of average height (P. Ulloa).

7. Advantages and disadvantages of the system

The **advantages** of the pergola cherry tree training system are summarised below:

- Full utilisation of the entire field area (1000 m2 per acre), as the entire productive area of the trees is above ground.
- High productivity per unit area (especially in the more densely planted versions).
- Creation of favourable local environmental conditions in the orchard for workers, especially during the summer months (shading), resulting in easy and quick work.
- The use of ladders or platforms for harvesting is avoided and, in combination with the favourable environmental conditions, the efficiency of harvesting operations is increased. Measurements have shown that 36 kg of cherries per hour or 288 kg per day (eight hours) can be easily harvested. This is also a strong compensation for the continuing problem of labour shortages in recent years in our country (less personnel needed or faster completion of work to be directed to other orchards.

- In addition, it creates favourable environmental conditions for a healthy root system, without heat stress in summer and retaining moisture from irrigation for longer.
- Shading is likely to have a favourable impact on the bud differentiation phase, where high temperature stresses are responsible for the presence of twin fruits the following year.
- Most of the fruit produced is produced on young branches and fruiting bodies, which perform to their full potential, so that high quality fruit with large size, uniform colouring and uniform organoleptic characteristics are obtained.
- The productive branches and, of course, the fruiting bodies, are constantly renewed every year, thus maintaining the tree's vigour ('forever young') throughout its life and ensuring the continuous production of a quality load.
- The leaf-to-fruit ratio on pergola trees is considered excellent (20 per cent fruit and 80 per cent leaves), as two well-formed leaves (approximately 100 cm2) are needed to support the production of a large cherry fruit.
- Pruning is considered a simple and easy process (especially considering that breaking and tying new branches is a different cultivation operation).
- The effectiveness and coverage of spraying are considered very good.
- The system creates conditions that support the establishment of the orchard canopy.
- The fruit is better protected than most landscape systems against bird attacks, a phenomenon that is also on the increase in our country every year.
- Of course, any modern production method with automated mechanical or robotic support can be used without any problems.

The **disadvantages** of the pergola cherry tree training system are summarised below:

- Increased installation costs. As it is a linear system, it requires the installation of a support (as already mentioned), which has a cost. The high wire requirement compared to other linear systems also increases costs.
- Added to the increased installation costs is the cost of purchasing the planting material (seedlings), since this is a dense to super-dense planting system.
- Sufficient water must be available in the planting area, since an irrigation system must be installed in the orchard. In particular, when using the Gisela series rootstocks, the need for water for irrigation increases.
- It seems that the system cannot be successfully developed in plots with a steeper than normal slope.
- Although it is claimed that the lighting is sufficient to cover the production process of the system, it is still being investigated whether the shading causes some slight darkening at maturity, which would be a problem when growing super-early cherry varieties.
- The work of tying the branches to the support wires appears to be time-consuming and consequently expensive, as shown below.

8. Completion Time Measurements

Abroad, measurements of the time required to complete the cherry tree cultivation per unit area were made, with a direct impact on production costs. The measurements are summarised in Table 1:

Table 1

Measurements of management time for cherry cultivation in the pergola system, per acre:

Pruning 9 days/acre
Branch tying with twine 27 days/acre (clips are faster)
Branch breakage 11 days/acre
Wound covering with protective bandage 7 days/acre
Harvesting 56 days/acre
Total 110 days/acre

Photo 11. Panoramic photo of a pergola orchard in New Zealand (R. Vermeulen).

9. Final considerations

Efforts to develop cherry cultivation continue to occupy the agricultural world, as it is a generally profitable crop, but with specific characteristics such as difficulties in harvesting, pruning, maintaining tree productivity, etc.
The Pergola system comes with a different perspective, to provide solutions and help the crop. It is still being tested in several countries, particularly in the southern hemisphere, and we do not yet know whether it will fail or eventually become a way forward for the modern version of cultivation.
The Naoussa Department of Deciduous Fruit Trees of the Institute for Genetic Improvement and Plant Genetic Resources (ELGO DIMITRA) had to make an initial presentation to the agricultural public in our country to let them know that this perspective also exists. Of course, this would not have been possible without the help of our partners around the world, whom we thank.
The answers we are looking for are only a matter of time before they are found, and developments are early and rapid.