HEMUA

Higher Education Modernization to boost Uzbekistan Agricultural system and promote excellence and regional development

ERASMUS+ GA number 101179517

TRAINING SYSTEM

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TRAINING SYSTEM according to ARCHITECTURE

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Hedgerow system: develop only in the row (2 spatial dimension)

- Easy to manage (pruning, harvesting, chemical sprays)
- Limited growth (dwarfing rootstocks)
- Possibility to mechanize
- High planting density

Volume shapes: develop in the 3 spatial dimension

- Average – high density
- Free shape
- Vigorous

Musacchi, S., Iglesias, I., & Neri, D. (2021). Training systems and sustainable orchard management for European pear (Pyrus communis L.) in the Mediterranean area: A review. *Agronomy*, *11*(9), 1765.

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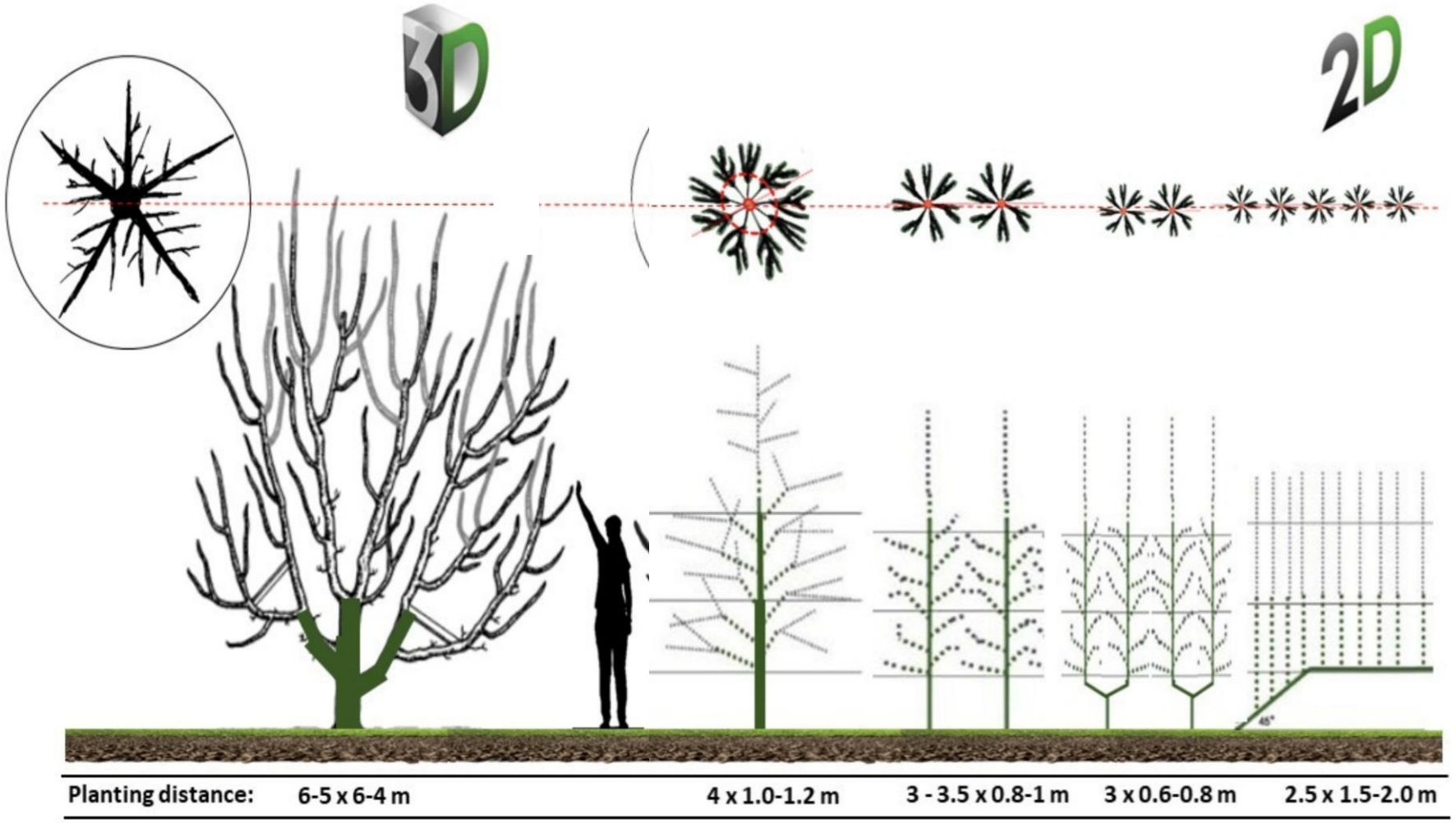

open vase central leader axis bi-axis multi-axis

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TRAINING SYSTEM according to PRUNING

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Free shape: aims at stimulating the natural development of trees, do no impose limited structural hierarchies. Pruning compatible with natural habit of the plant.

Fixed training system : are oriented to assume a certain geometrical structure right from planting and may therefore resemble the natural tree. Require pruning (winter and green) and the use of support structures (poles and wires)

VOLUME SHAPES

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- ✓ Vase: traditional, delayed
- ✓ Spindle
- ✓ Columnar axis
- ✓ Solaxe
- ✓ Transversal epsilon

VASE

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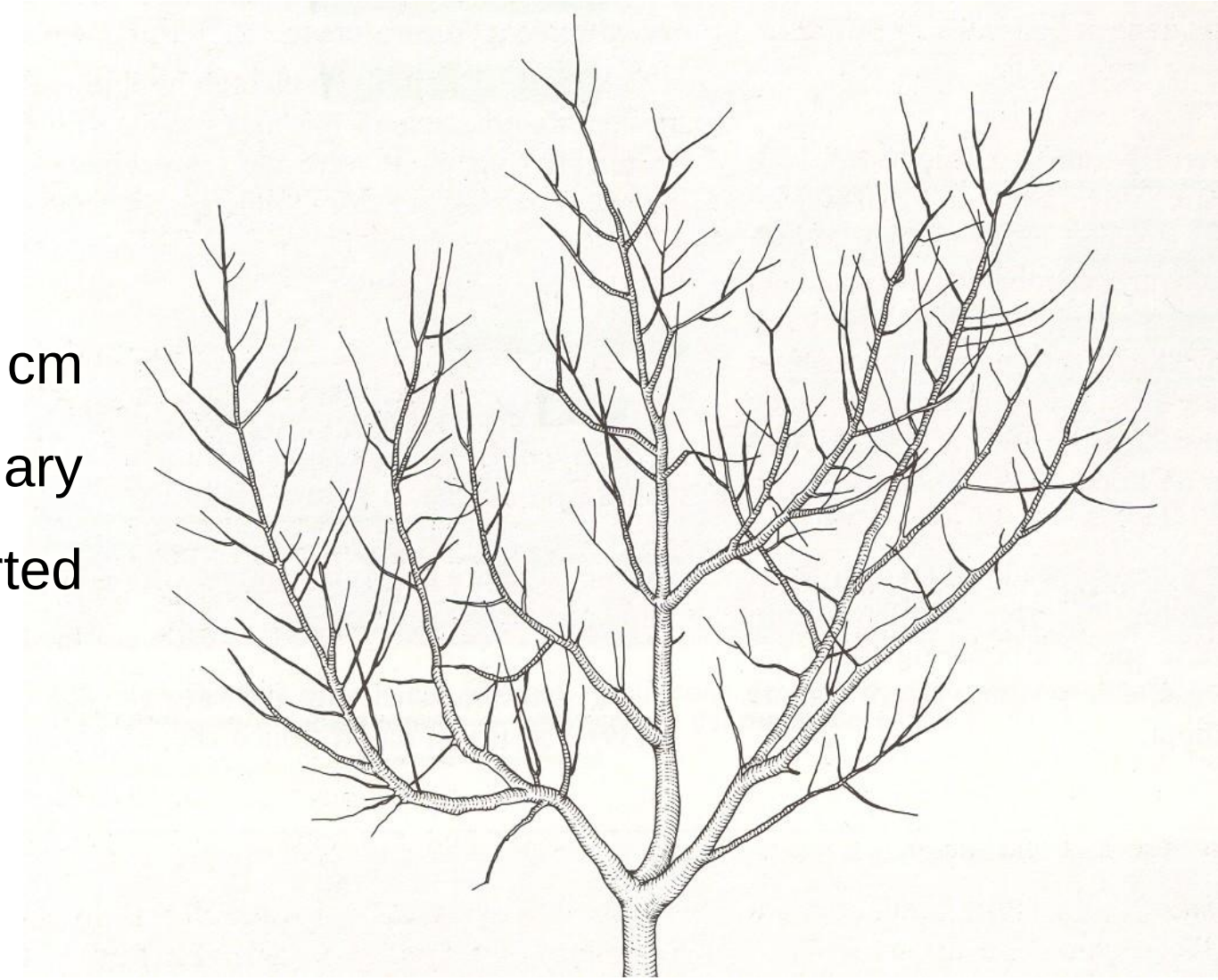
No central axes, trunk at least 50 cm from the ground, with 3-4 primary branches (inclined 35-40°) inserted into the trunk.



Vase characteristics

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- ✓ Self supporting shape
- ✓ Limited height (maximum 2.5 m)
- ✓ Cultural practices managed from the ground
- ✓ Plants entry into production early
- ✓ High susceptibility to late frost
- ✓ Low mechanization
- ✓ Training phase quite laborious

- ✓ Unlike row orientation plants have uniform and optimal light interception
- ✓ average-low density (<800 plants ha^{-1})

Peach:

Vigorous rootstock: 5 x 5 m → 400 plants ha^{-1}

Semi vigorous rootstock : 5,5 x 4 m → 455 plants ha^{-1}

Apricot:

Vigorous rootstock : 5 x 3 m → 667 plants ha^{-1}

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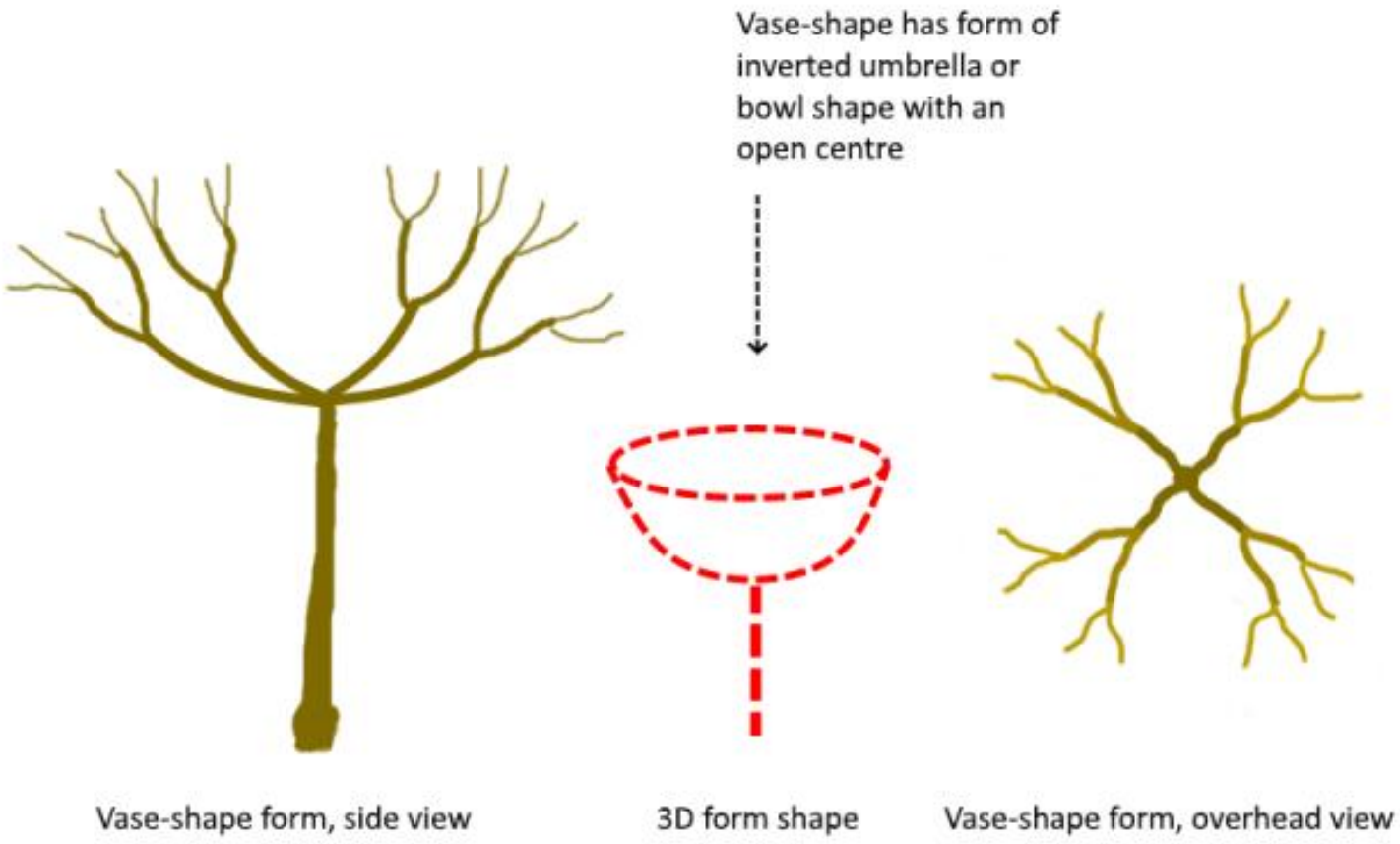
Vase-shape Tree Form - Branching Structure



https://deepgreenpermaculture.com/2019/09/16/formative-pruning-vase-form-how-to-prune-young-fruit-trees-in-the-first-three-years/

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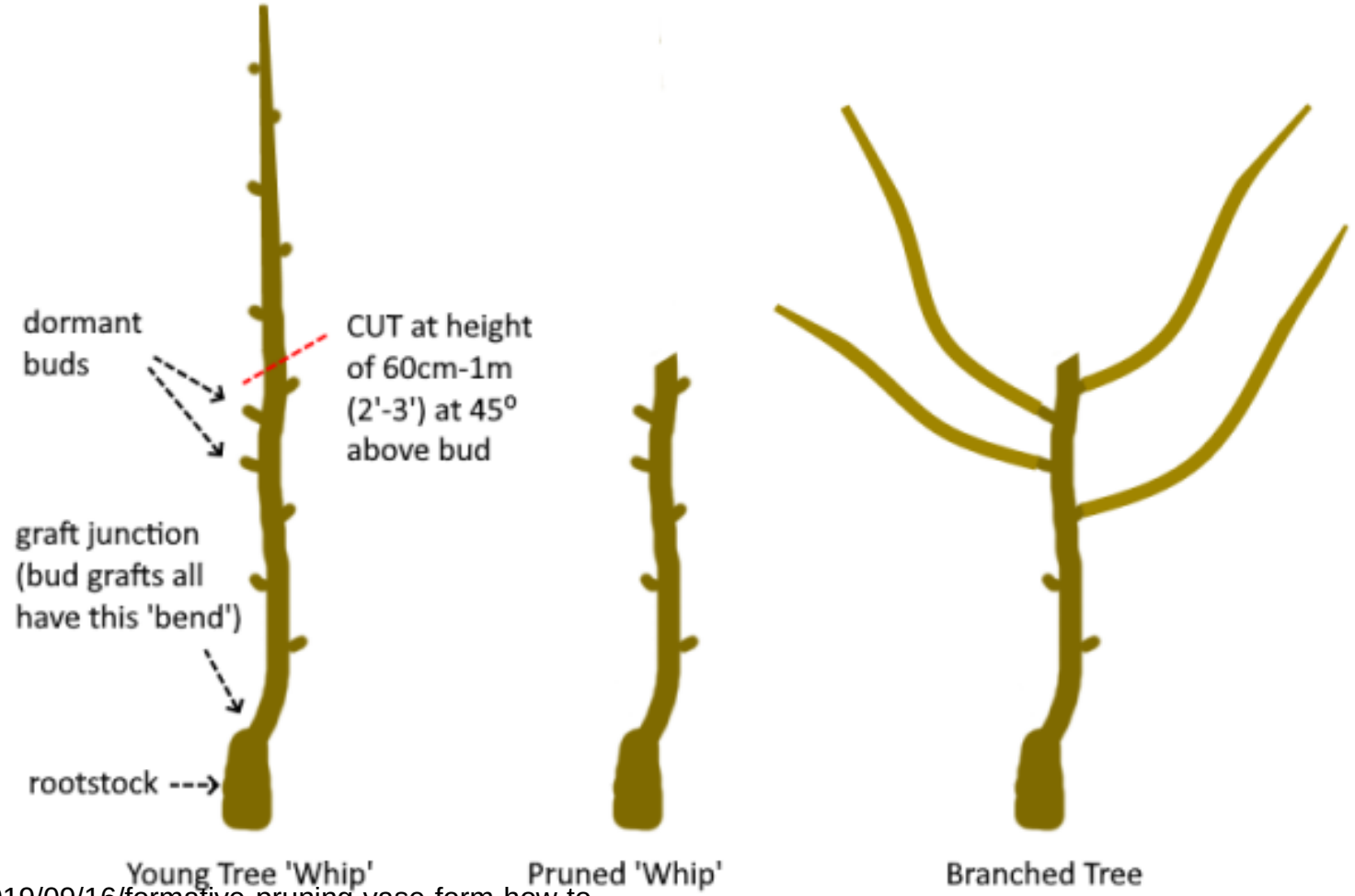
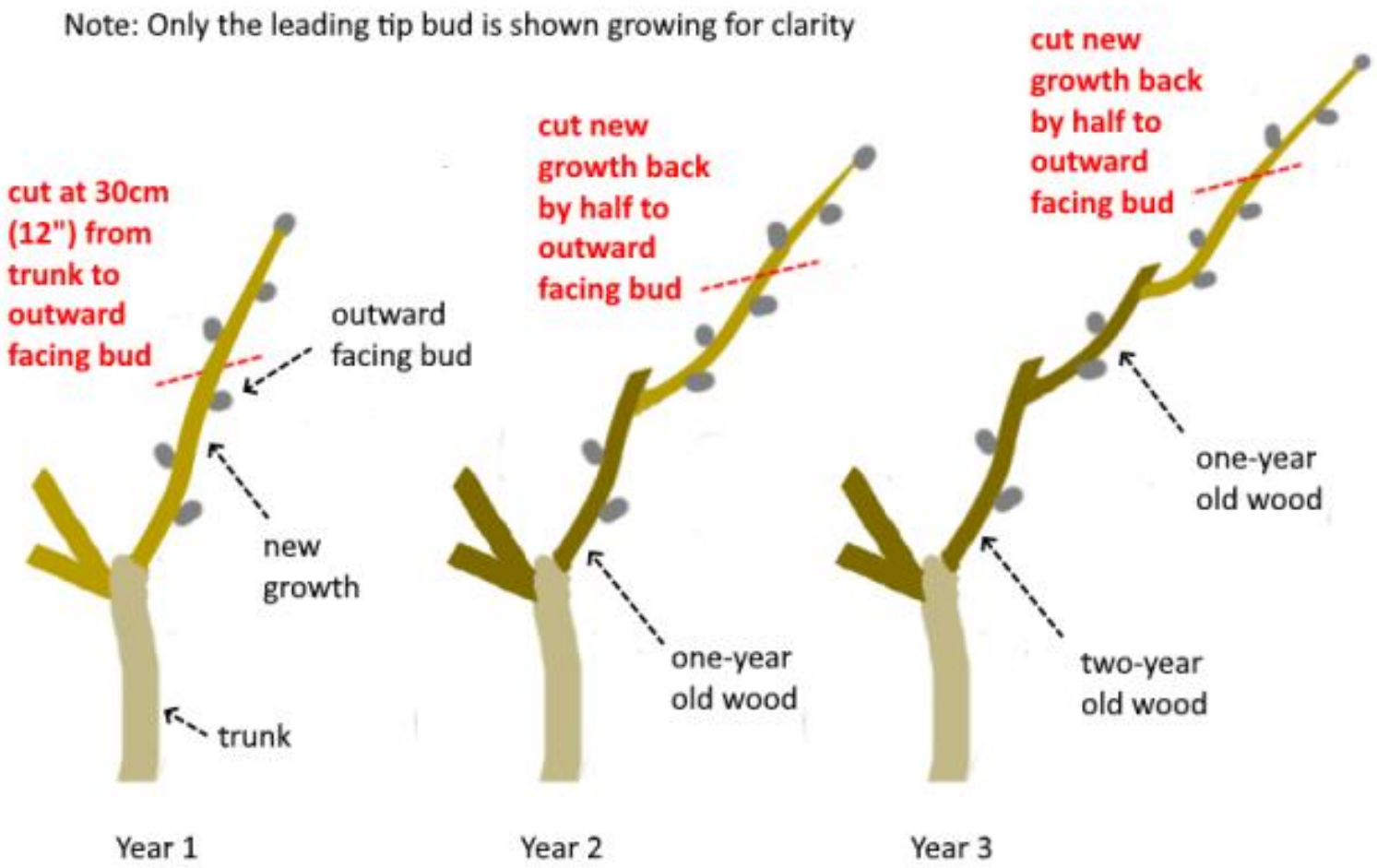
Pruning a Tree 'Whip' to Establish New Branches and Begin Vase Form



https://deepgreenpermaculture.com/2019/09/16/formative-pruning-vase-form-how-to-prune-young-fruit-trees-in-the-first-three-years/

Formative Pruning in First Three Years to Establish Vase Tree Form



https://deepgreenpermaculture.com/2019/09/16/formative-pruning-vase-form-how-to-prune-young-fruit-trees-in-the-first-three-years/

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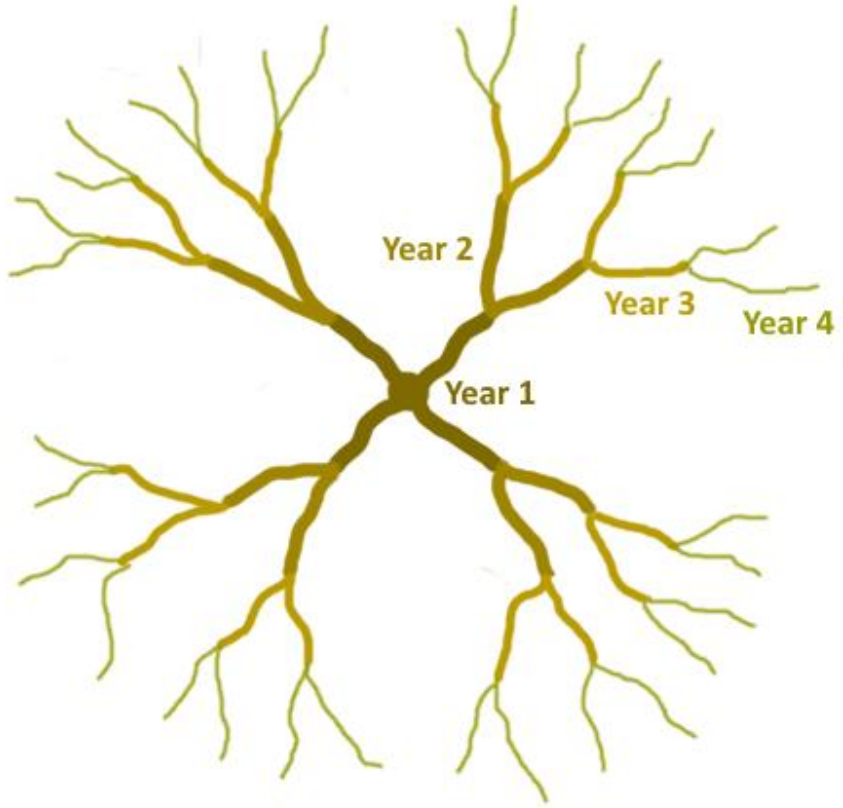
Framework Pruning Vase-shape Tree Form

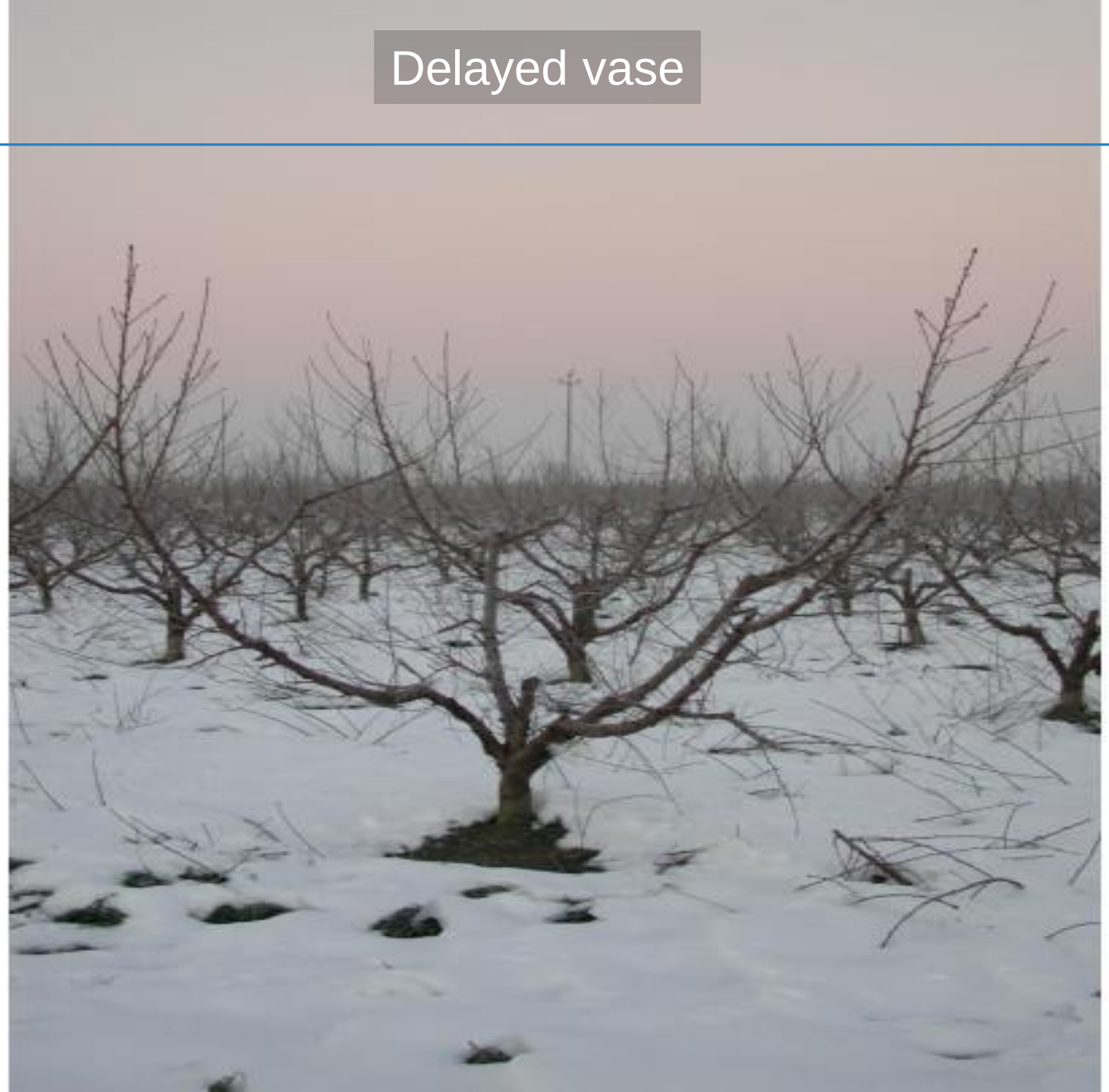


First-year scaffold branches pruned to 30cm length

https://deepgreenpermaculture.com/2019/09/16/formative-pruning-vase-form-how-to-prune-young-fruit-trees-in-the-first-three-years/

Delayed vase

Delayed vase



Vase/Delayed vase

SPINDLE (or spindlebush)

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Semi-free volume shape, central axis heigh
2.5-3 m, small number of primary branches
(not necessary permanent) arranged as a
spiral around the stem. The primary branches
bear very short twigs, brindles and spurs.

Strong **single basal scaffolds** of branches
with very open angle, above which there are
shorter branches arranged in spiral.

Spindle characteristics

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- ✓ Typical of modern orchards with high panting density
- ✓ Derives from old pyramid shape
- ✓ Limited tree vigour
- ✓ Cultural practices managed from the ground
- ✓ Plants entry into production early
- ✓ Uniform and optimal light interception if oriented north-south
- ✓ Needs care
- ✓ Needs support
- ✓ Dwarfing rootstocks

✓ High planting density

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Peach :

Semi vigorous rootstock : 4,5 x 2,5 m → 890 plants ha^{-1}

4,0 x 2,0 m → 1250 plants ha^{-1}

Apple:

Dwarfing rootstock: 4,0 x 3,0 m → 833 plants ha^{-1}

3,5 x 1,0 m → 2857 plants ha^{-1}

Pear:

Dwarfing rootstock : 4,0 x 1,5 m → 1667 plants ha^{-1}

3,5 x 1,0 m → 2857 plants ha^{-1}

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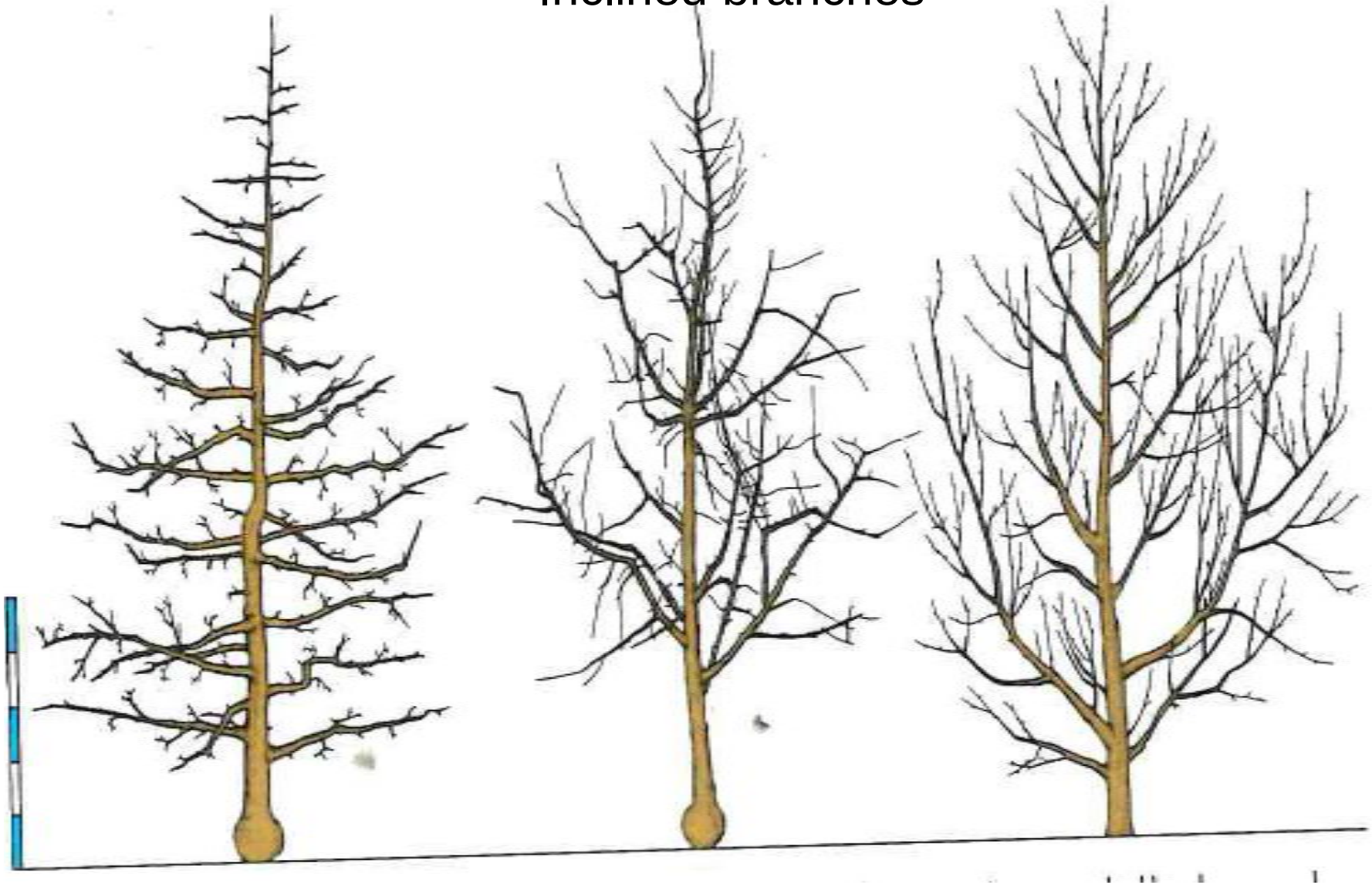
Horizontal branches

Inclined branches

Unshorten branches



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SOLAXE

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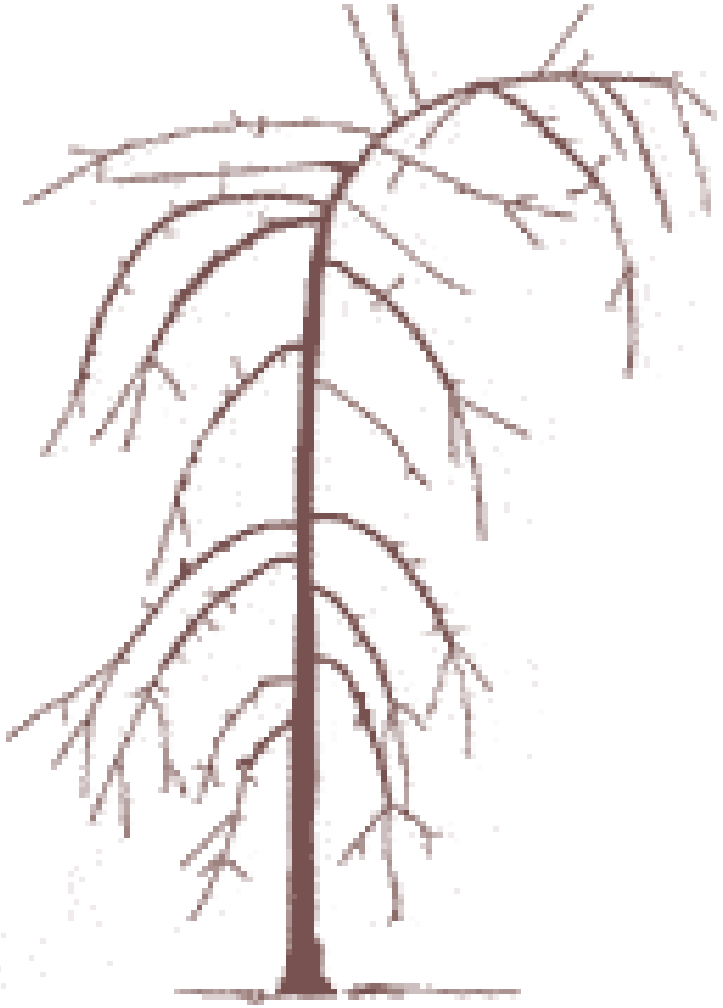
Unshorten branches managed by long pruning with the upper part bent to limit the height of the tree



www.jardinsfruitiersdelaquenexy.com

iaraosta.it

pomaceas.utalca.cl

COLUMNAR AXIS

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Consists in a trunk/stem (central axis) with very short primary branches (few tens of cm long) that are inserted freely in a spiral without a well defined gradient of vegetation

Columnar axis characteristics

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- ✓ Very high planting density (3/3,5 x 0,8/0,5 → 3571/6666 plants ha^{-1})
- ✓ In apples and pears the stem a the branches (if present) result in presence of only bearing structures (cluster of spurs brindles or short shoots)
- ✓ Plants entry into production early
- ✓ Dwarfing rootstocks
- ✓ Management need care

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SUPERSPINDLE

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Derives from a slender spindle that is planted very thickly on the row (30-60 cm).

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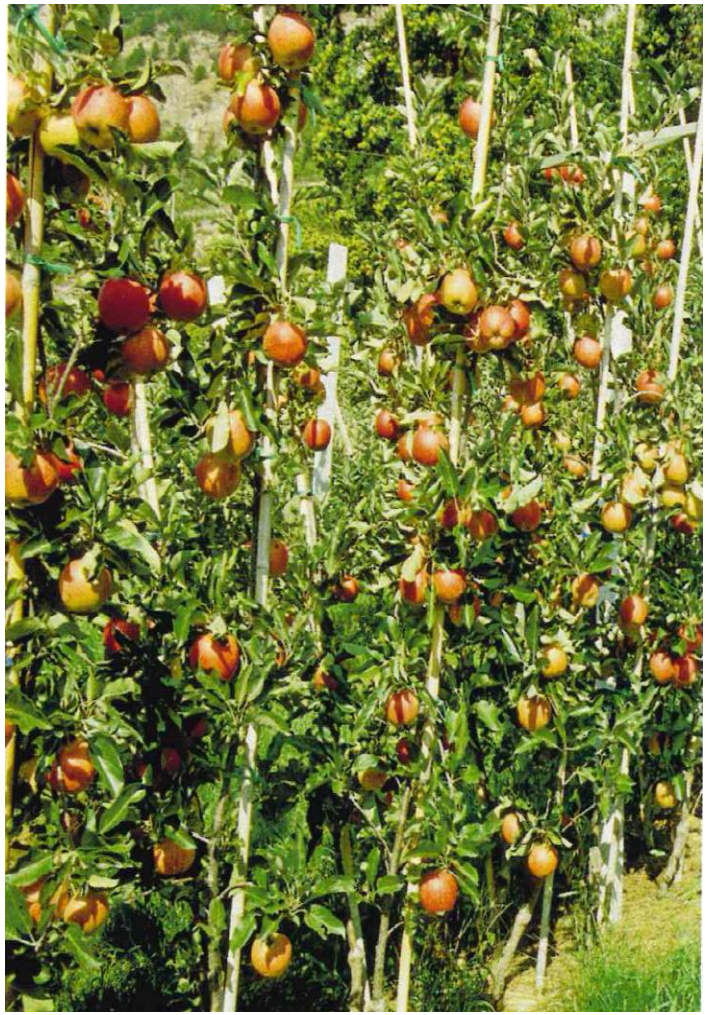

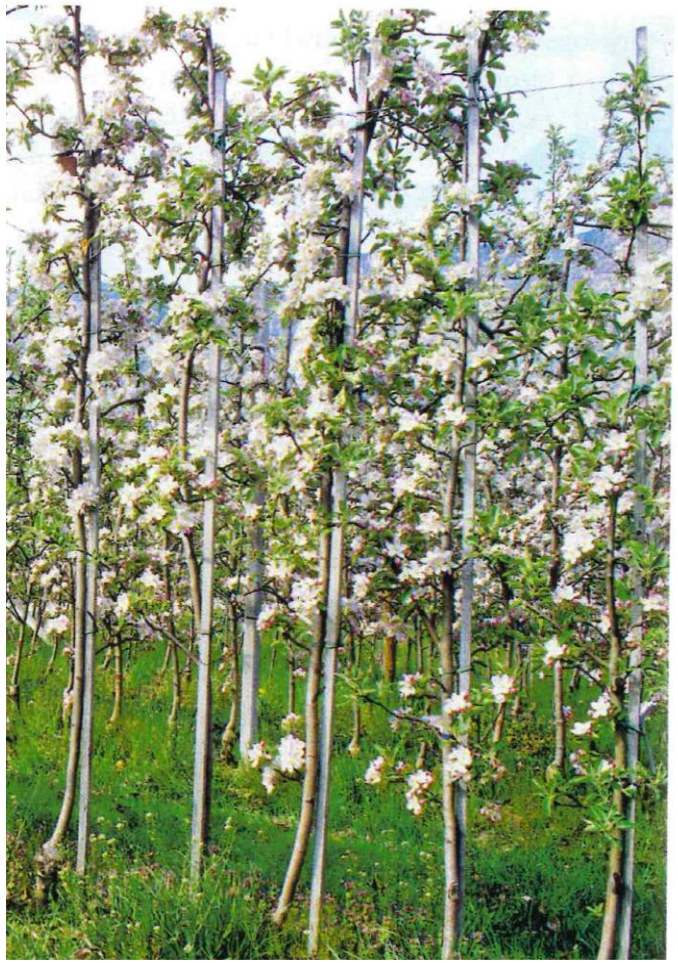

There are no branches and used for pears and apple that are able to produce on spurs or on a cluster of spurs or brindils

Superspindle characteristics

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- ✓ Ultra high density (3/3,5 x 0,3/0,6 → 4761/11111 plant ha^{-1})
- ✓ Apple and pear
- ✓ Plants entry into production early
- ✓ Dwarfing rootstocks
- ✓ Management need care
- ✓ Needs supports

TRANSVERSAL EPSILON

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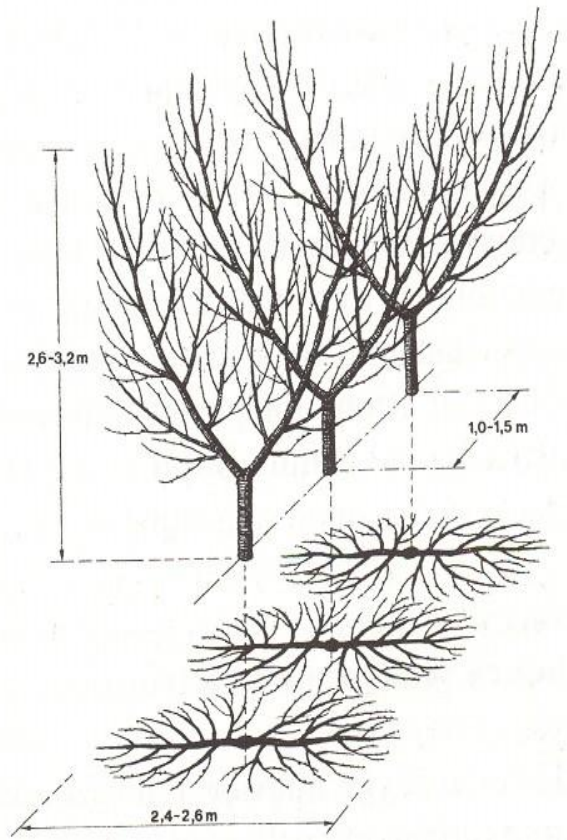
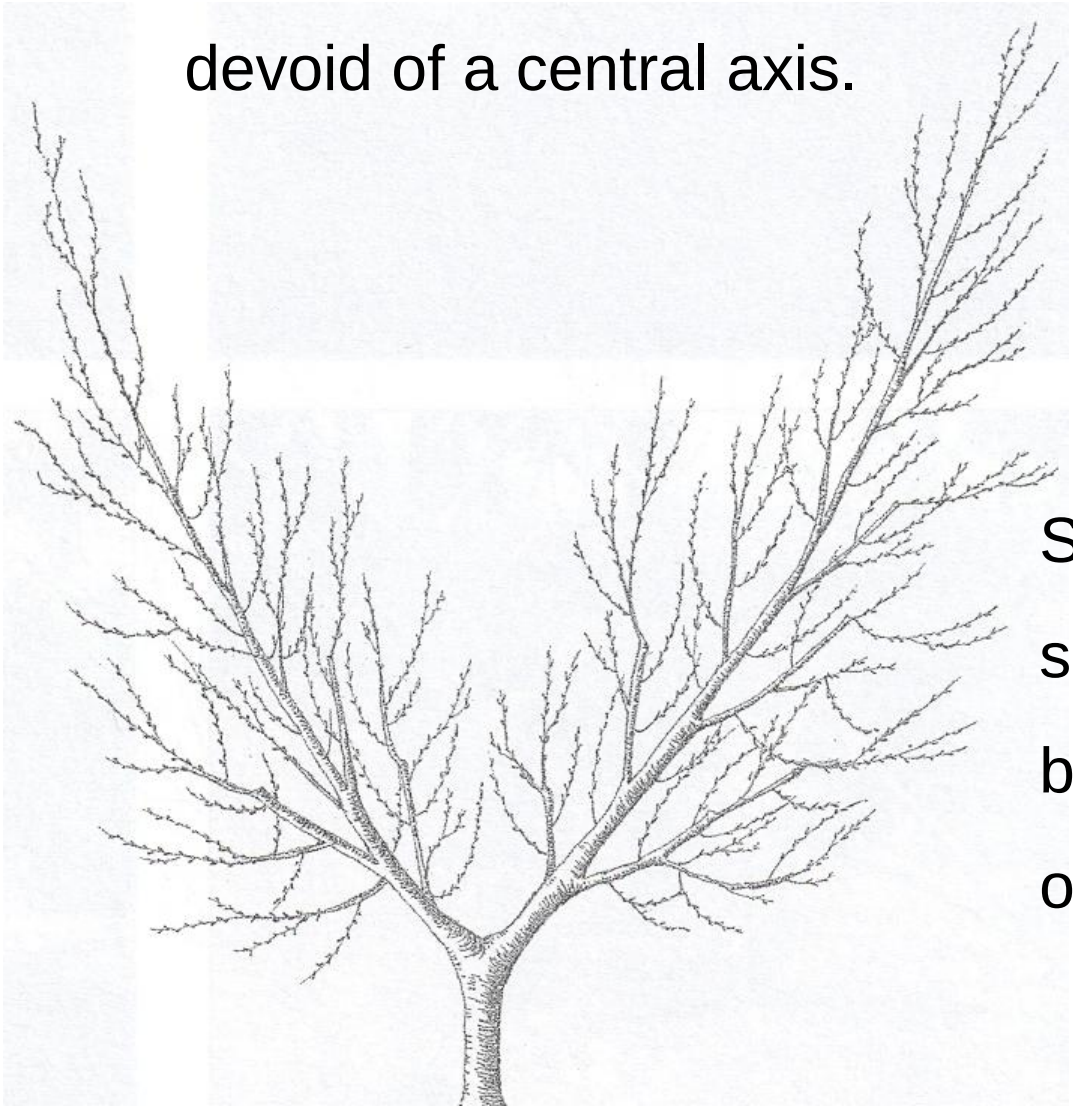
Double wall inclined about 30-40° (on the vertical) and devoid of a central axis.





Short branches and secondary bearing branches are inserted onto primary branches

Transversal epsilon characteristics

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- ✓ Maximum light interception
- ✓ Difficult cultural practices
- ✓ Need supports and a lot of work during the training phase
- ✓ Dwarfing rootstocks
- ✓ Little mechanization
- ✓ North-south orientation

5,0/6,0 x 1,0/1,5 m → 1111/2000 plants ha^{-1}


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HEDGEROW SYSTEM

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- ✓ Palmette
- ✓ Candelabrum
- ✓ Longitudinal epsilon

PALMETTE

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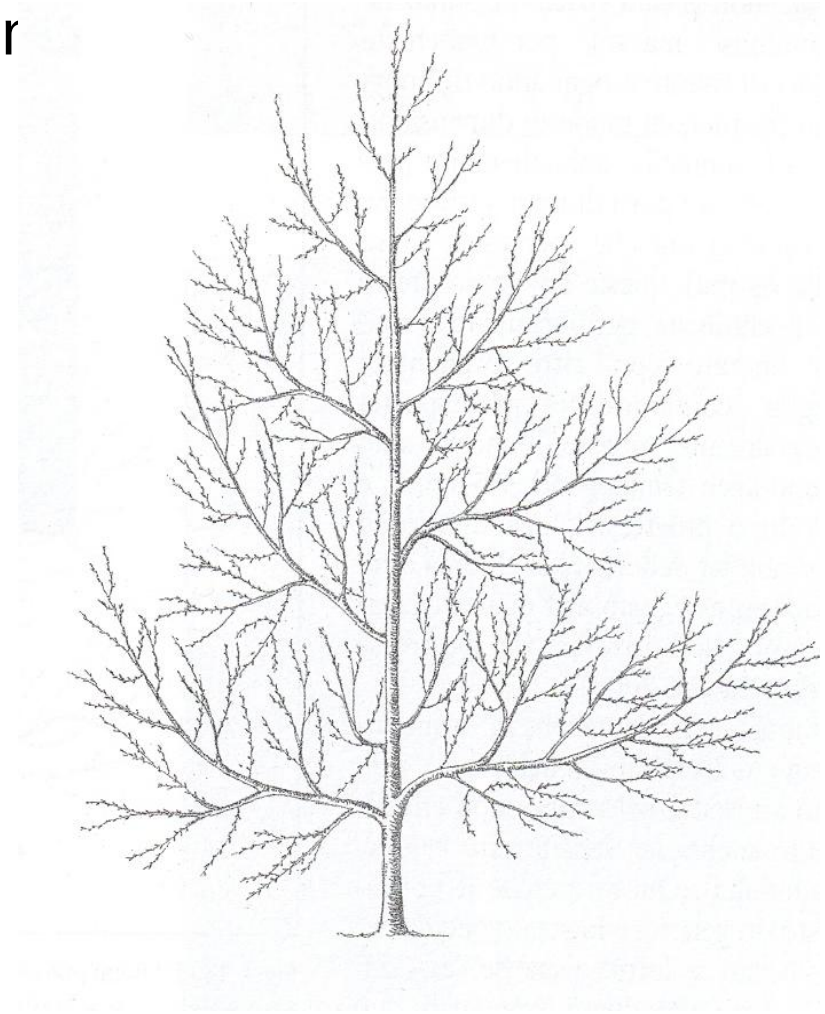
Flattened profile. Consists of 3-4 levels stages of primary branches oriented in the direction



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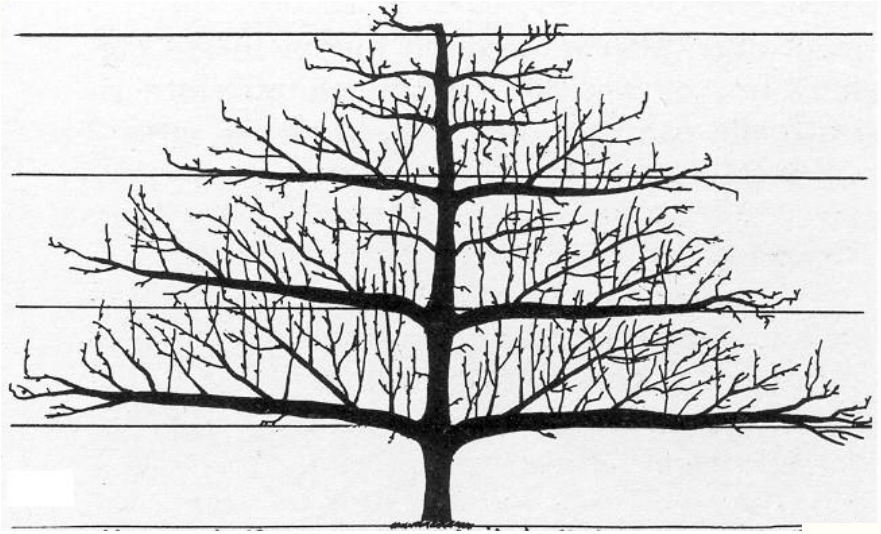
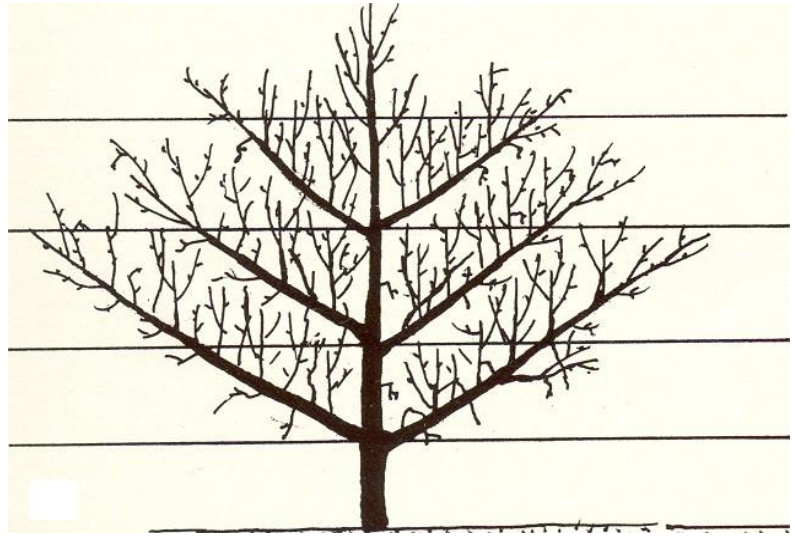
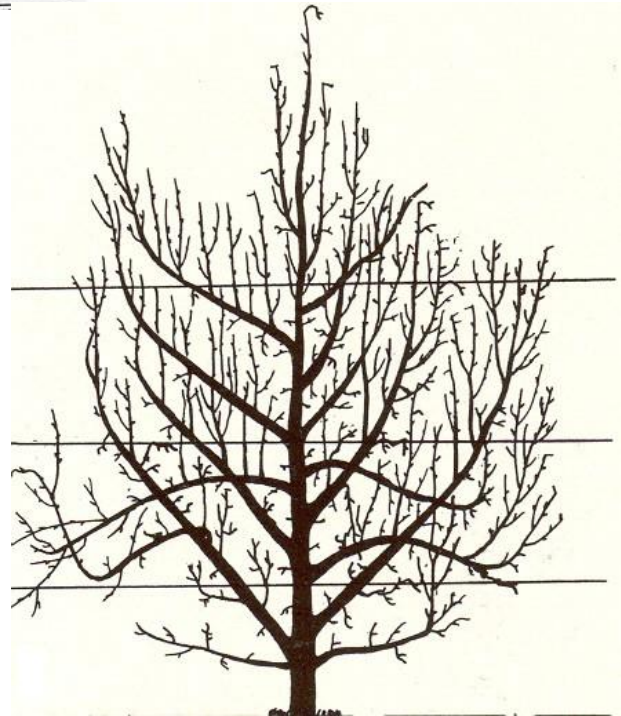


Regula palmette with horizontal branches



Regular palmette with oblique branches



Irregular palmette with oblique branches

Palmette characteristics

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- ✓ Height 4/4.5 m (almost the same of the distance between rows)
- ✓ Needs supports
- ✓ Could be mechanized
- ✓ North-South orientation
- ✓ Average-low planting density
- ✓ Implementation is laborious

Peach:

Vigorous rootstock : 5,5 x 4,0 m → 455 plant ha^{-1}

Semi vigorous /dwarfing rootstock : 4,5 x 2,5 m → 889 plant ha^{-1}

Apple:

Semi vigorous/dwarfing rootstock : 4,0 x 2,0 m → 1250 plant ha^{-1}

Pear:

Average vigour rootstock : 3,6 x 1,5 m → 1852 plant ha^{-1}

CANDELABRUM

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Characterized by three vertical branches (at the same stage level) that are trained instead of the normal oblique branches.

↓

Corresponds to three branches as if they were single stems with small bearing structures

Candelabrum characteristics

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- ✓ Fruiting hedge closer to the top
- ✓ Reduced impact of late frost
- ✓ Agronomic practised mainly not from the ground
- ✓ Needs supports
- ✓ Could be mechanized
- ✓ Orientation north-south

<u>Peach</u>:

Semi vigorous : 4,0 x 3,0 m → 833 plant ha^{-1}

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Candelabrus

Candelabrus

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LONGITUDINAL EPSILON (bi-baum/bi-axis)

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Dual axis trees oriented in the same line of the row. Used for apple and pear. May cut by half the number of trees


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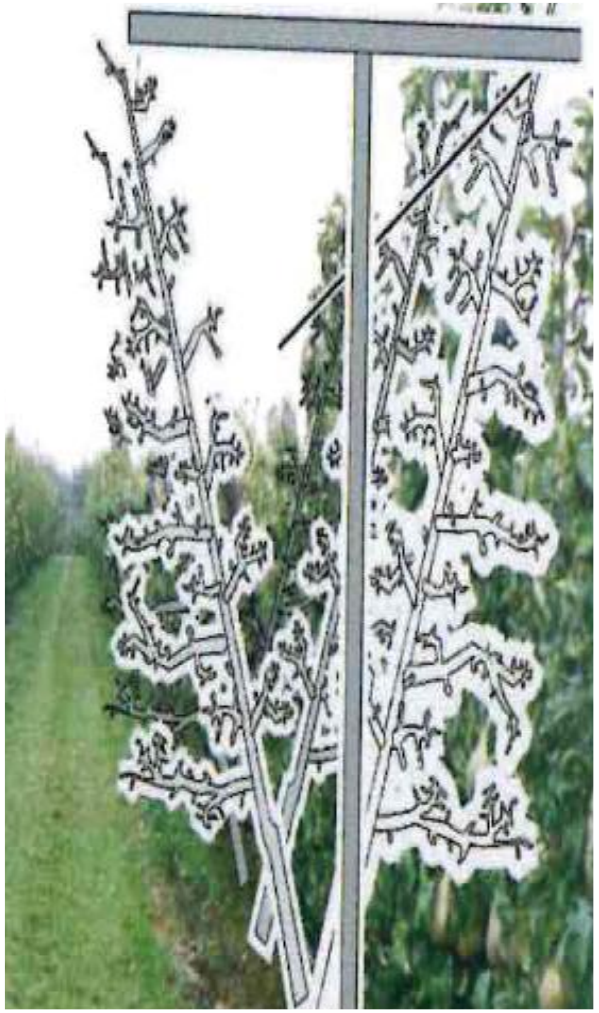
V shape → is a cordon or oblique axis. Much lower and less inclined walls than transverse epsilon. Fruiting hedge closer to the ground. Very high planting density (6000/7000 plant ha^{-1})



“WALKABLE” ORCHARD

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Very thin fruiting wall, not higher than 2,5 m. usually Multi-leader trees

http://apal.org.au/multi-leader-trees-mechanical-pruning-europe/

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ADVANTAGES:

- ✓ All practices can be managed from the ground
- ✓ It could be mechanized
- ✓ Homogeneous yield
- ✓ Solid-Set Canopy Delivery System

  (https://www.youtube.com/watch?v=FYRL9i4kiAo&t=15s)
- ✓ Low volume of phytochemicals and reduce drift
- ✓ Fast drying of the wall

PRUNING

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✓ Refers to all the operations with or without pruning shears (scissors, clippers, cutters, bars) which affect the tree canopy or the root system.

✓ Aims at accelerating the development of plants, shape scaffolds and quickly get over the unproductive phase.

✓ Different type of pruning: **training**, **fruit formation** (mature tree), **rejuvenation**, **sanitation**, **structural reformation**.

TRAINING PRUNING

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- ✓ Done on young trees to obtain the desires shape
- ✓ Includes *nursery* and *transplantation* pruning

controls the formation of the future branches and influence their type and placements along the main axis

aims at removing any misshapen or diseased shoot or roots and poorly placed or weak branches

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www.geoplantvivai.com

FRUIT FORMATION PRUNING

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- ✓ Adjust crop load and fruit quality
- ✓ Maintain the shape and size of the tree
- ✓ Delay natural aging of plants

Could be:

- Winter → done during dormant period
- Summer → done during vegetative period
- Long → leaves long shoots/branches
- Short → leaves short shoots/branches creating a spur or a short shoot with flowering-vegetative buds
- Heavy → leaves a lot of fertile buds
- Poor → leaves a few fertile buds

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Summer pruning

SANITATION PRUNING

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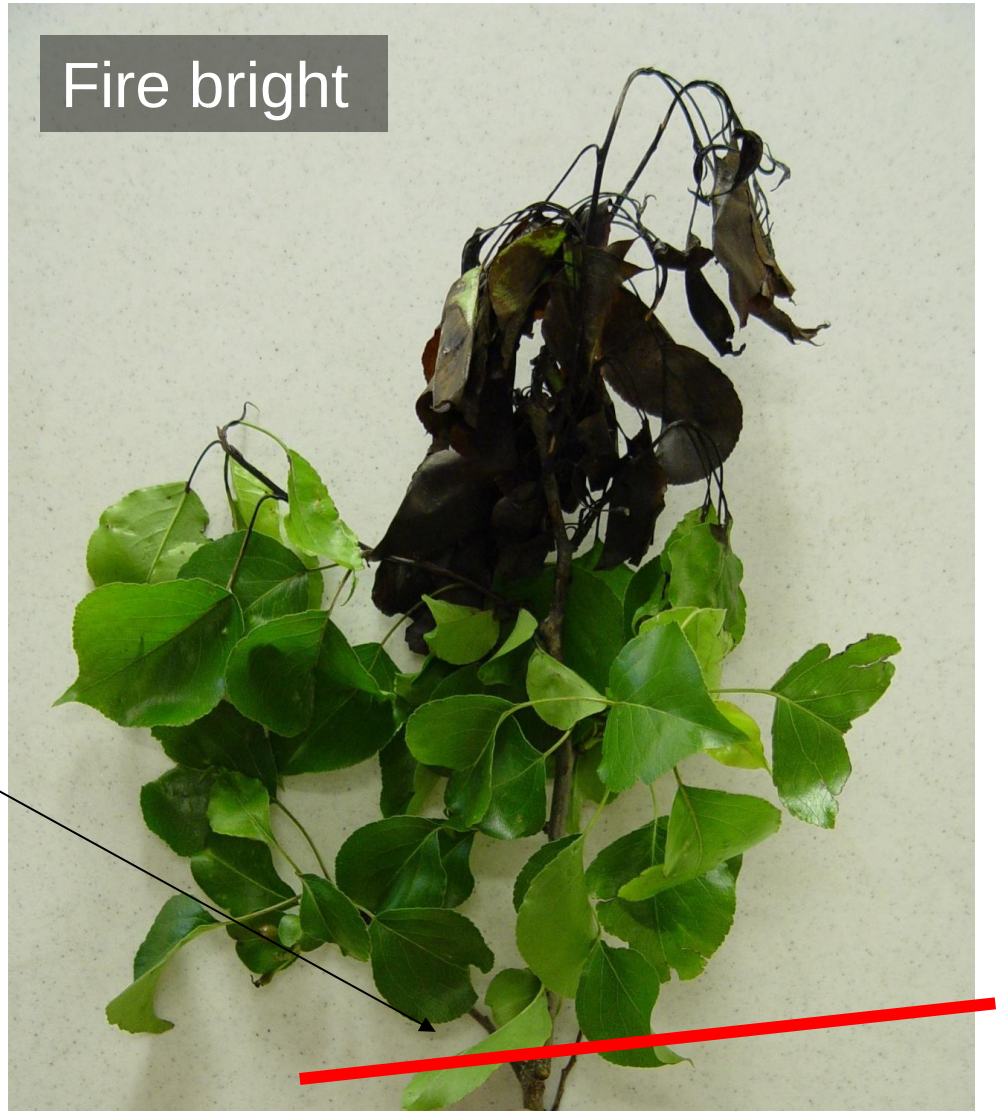
40 cm below symptoms

disinfect scissors after each cut

Close the wound (glue + copper sulphate)



http://www.extension.iastate.edu

TYPE OF CUTS

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- THINNING CUT → removal, at the base, of an entire shoot/branch.

TYPE OF CUTS

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- HEADING BACK CUT → partial removal of the distal part of a branch to shorten it

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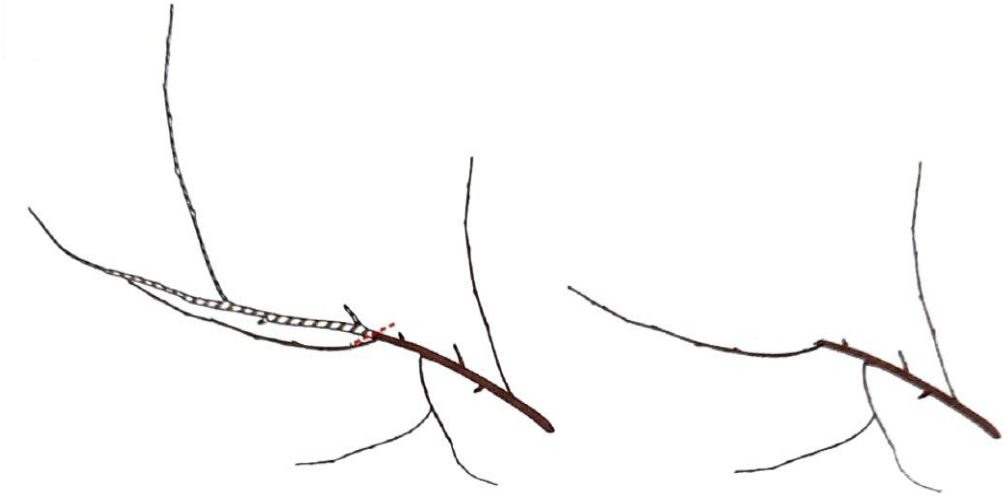

Bring the branch back to its natural position

Restrain the development of the branch

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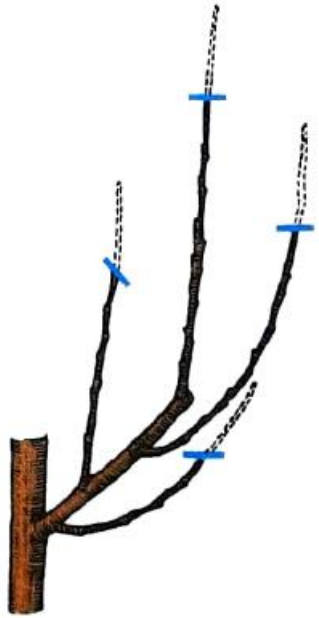
- TRIMMING → the cut takes place a few centimetres from the shoot apex



- SHORTENING → the cut is made in the central part of the shoot or branch

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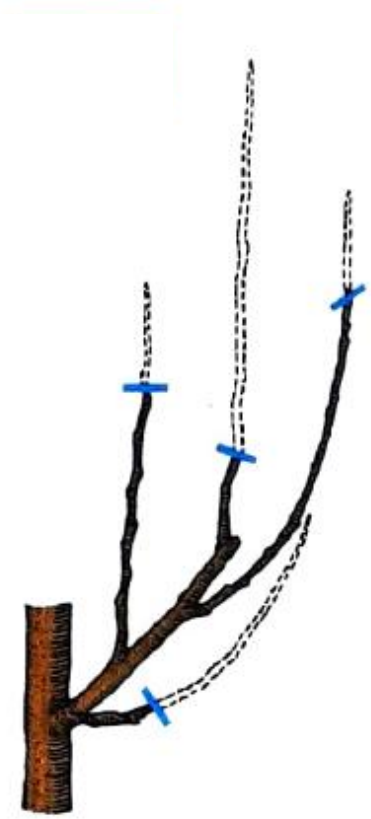
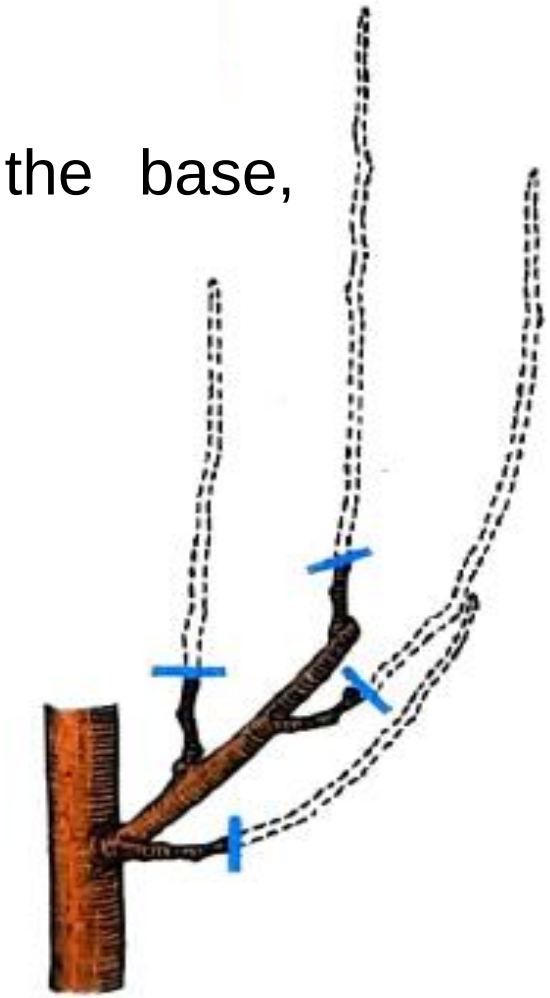
- SPUR PRUNING (renewal cut) → made at the base, leaving stumps with few surviving buds.



- MIXED PRUNING



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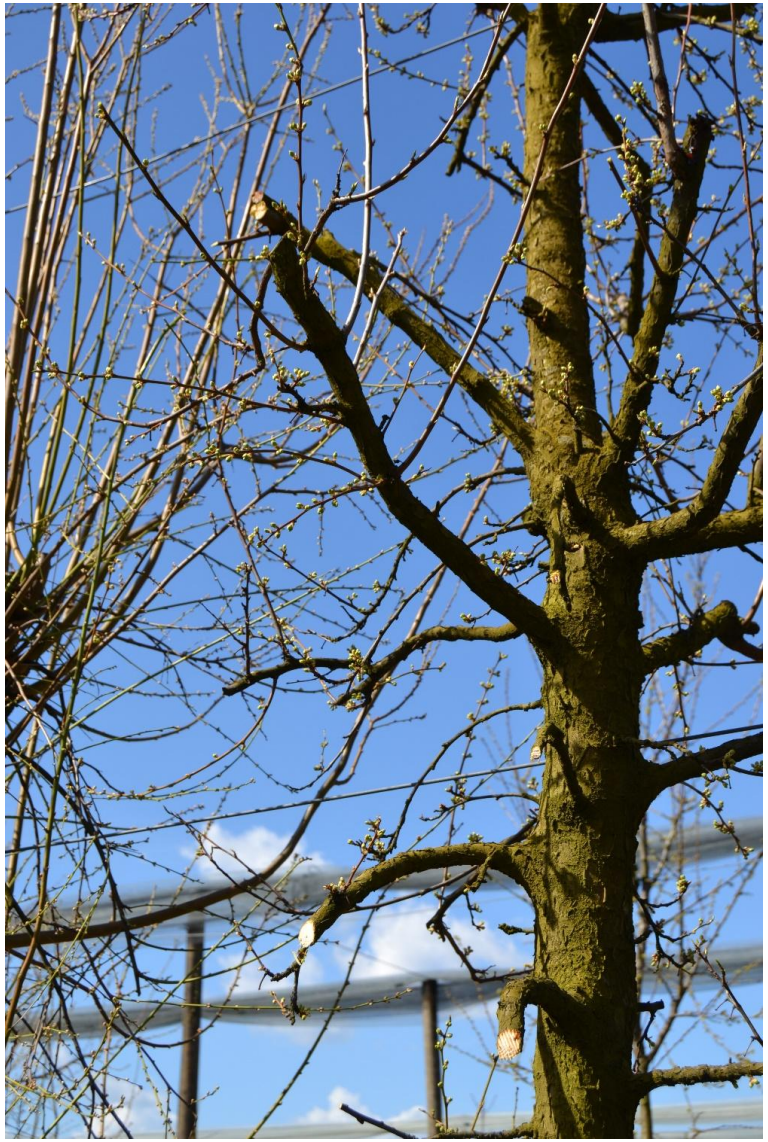

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Productive habit on one-year old branches - PEACH

Thinning cut of mixed slender: removal of the inner and weak ones

Maintenance of training system: removal of sticking out branches/shoots

Fruit thinning: as soon as possible

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Productive habit on one-year old branches - KIWIFRUIT

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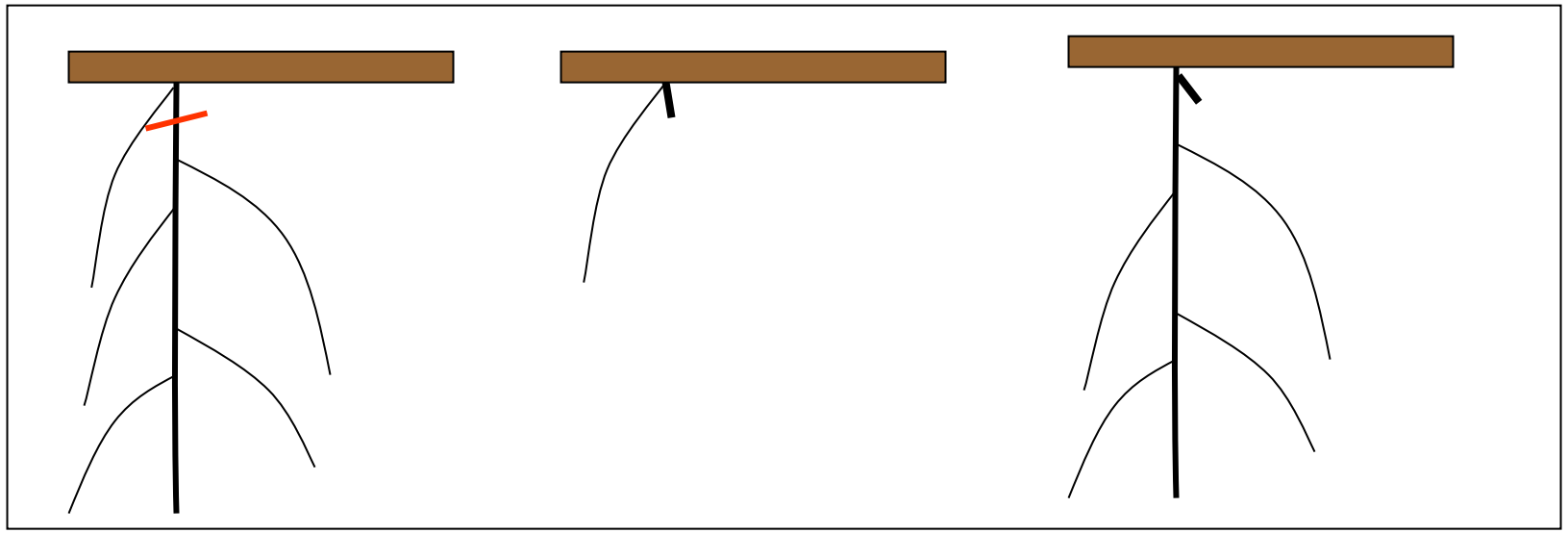
Thinning cut of old shoot: removal of all shoots older than 1 year that supported fruiting vines

Selection of new vine: definition of the number of mixed buds (100.000-130.000 buds ha^{-1})



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Productive habit on old branches (lamburde/darts)

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Choice of betters shoots: that will produce the following year

Removal of lamburde that have already produced: substituted by new brachiblast

If vigorous no shortening cuts: prefer renewal cuts

Green pruning: during the entire vegetative season when needed