Comparaison des modes de conduite en fuseaux étroits (Tall Spindle) et en multiaxes (Multiple Leaders)

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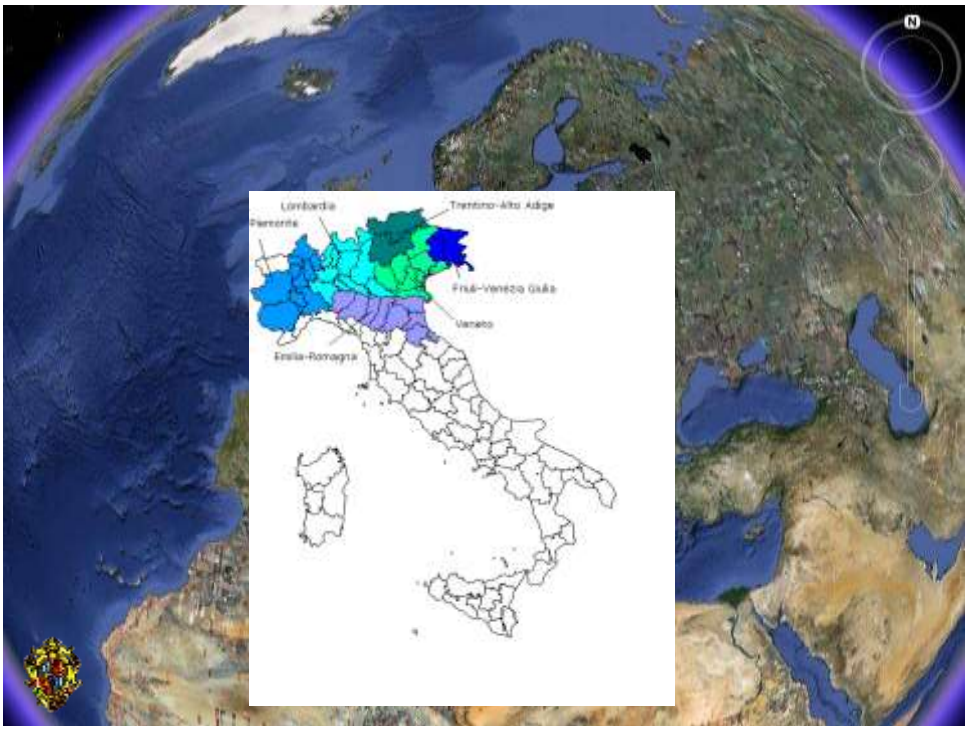
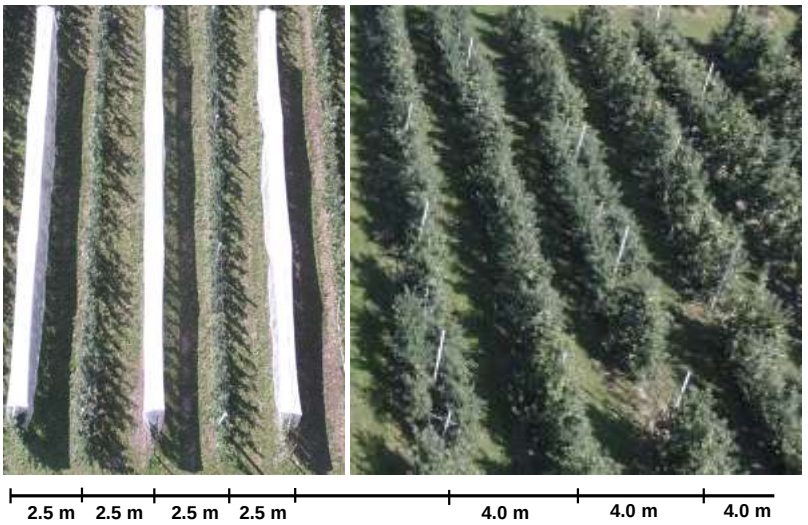


STUDYING TREE ARCHITECTURE

Multi-leader FRUIT WALL **TRADITIONAL**



1968-1990

- First major shift in apple growing from:
- 3D giants to spindle/M9

Harvest in a standard orchard in >Trentino Alto Adige (Italy)

In the last 30 years, yields have grown steadily from 30 to about 70 tons/ha

Now the main goal is to increase economic and ecologic **sustainability** of the apple industry by:

1. Cutting down costs (input of chemicals and labour) while keeping these high yelds
2. Moving towards more environmental benign techniques (less chemicals)

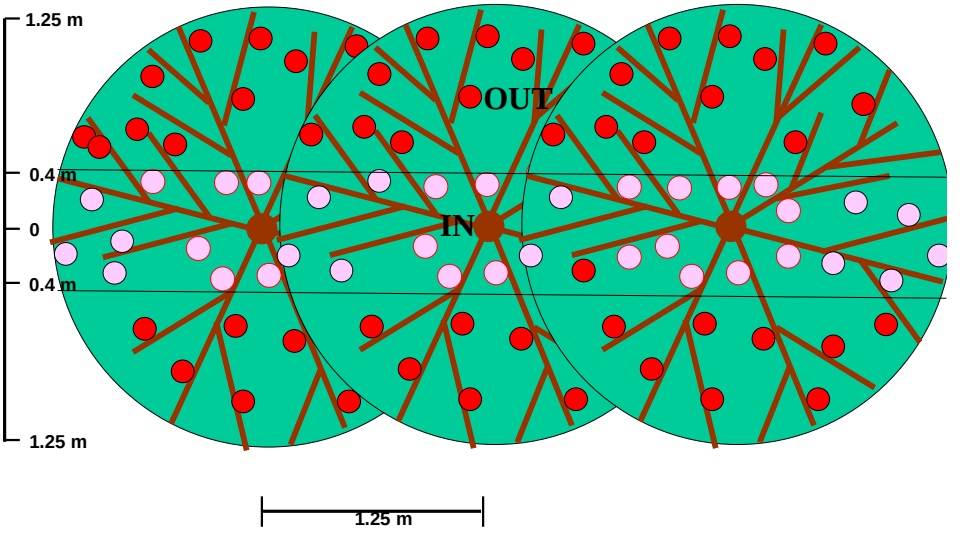
More yield with less input

Can this be achieved by just changing

tree architecture?

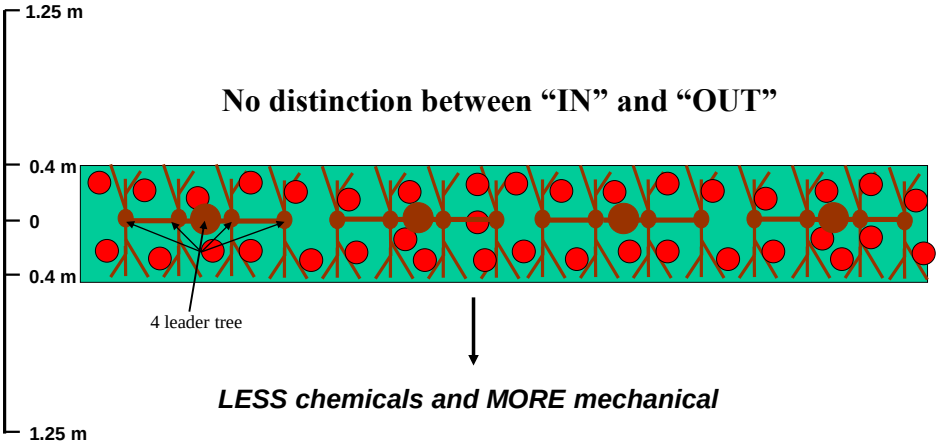
TRADITIONAL TREE ARCHITECTURE

(from above)

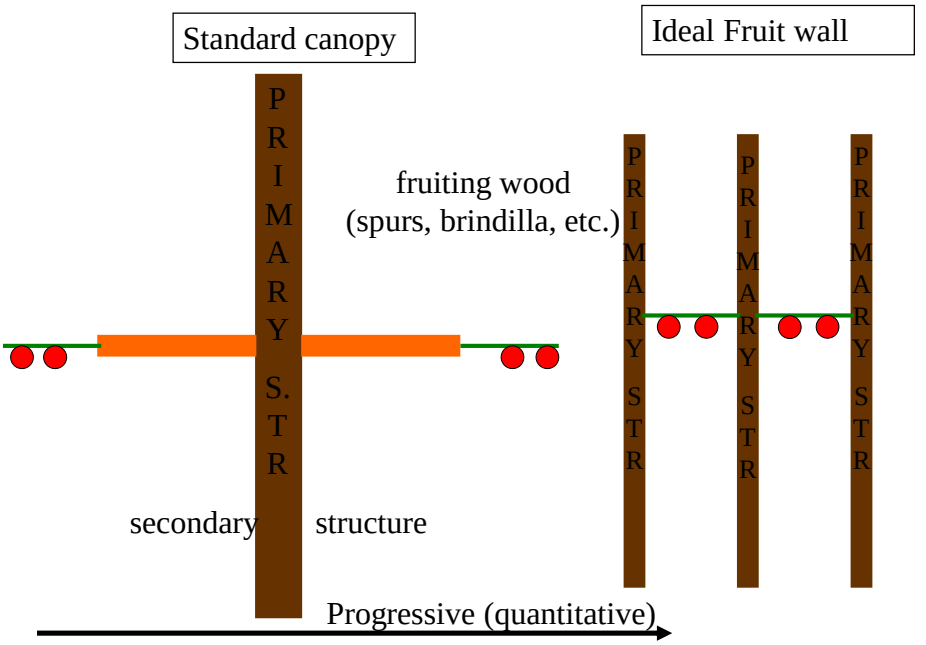


FRUIT WALL TREE ARCHITECTURE

(from above)



Scheme of tree architecture



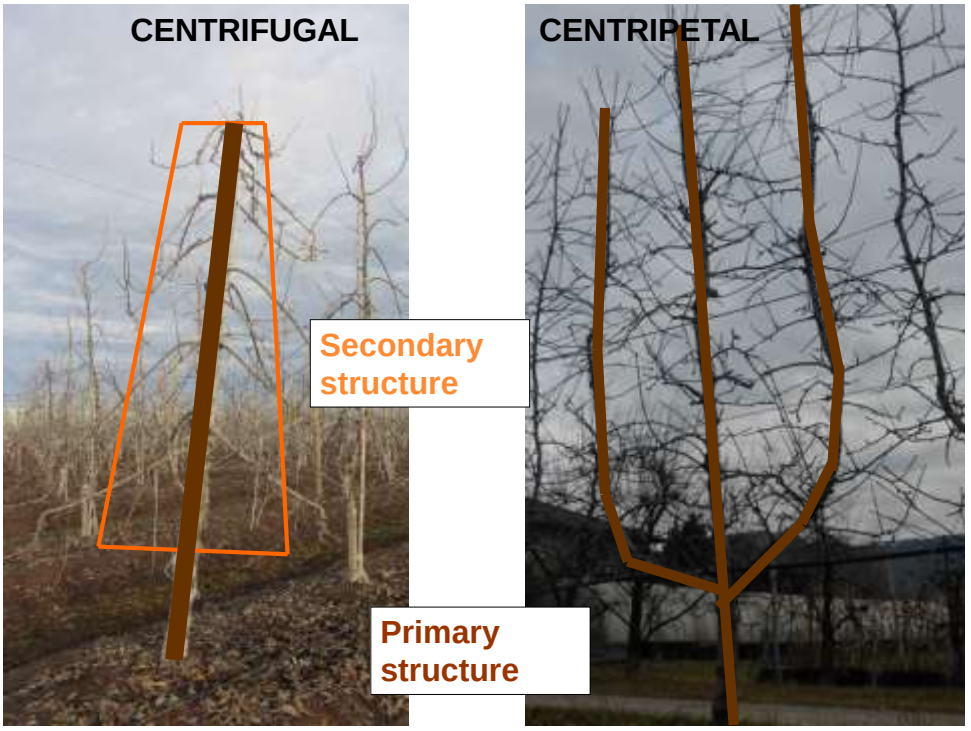
Second shift: the fruit walls (1990- ...)?

Need for

- great **control of vigour** and
- **plasticity**

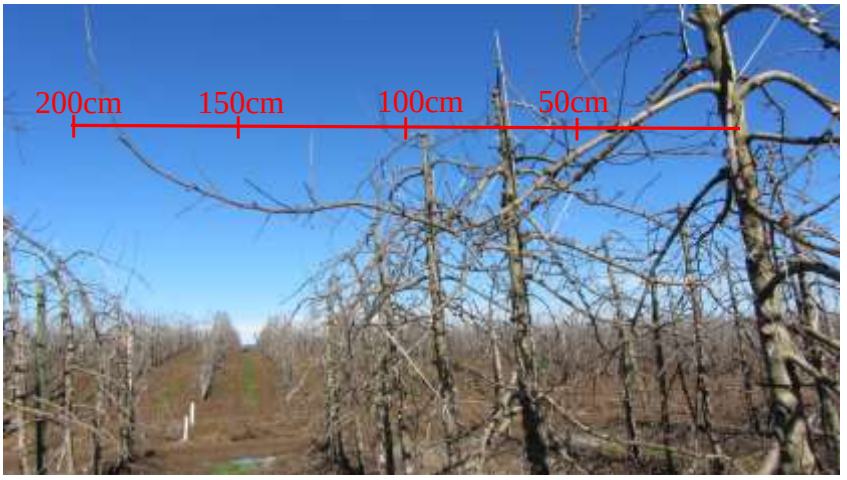
BiBaum®/MLT is a strong tool to achieve vigour control

BiBaum® trees are extremely “plastic”



CENTRIFUGAL effect of long pruning

CENTRIFUGAL effect of long pruning (Chile)



In both training systems the **structural wood** is absent.

Fuji ML trained (IT)

Photo Craig Hornblow – New Zealand

Appletree plasticity

Shape and size of propagated trees are both under major control of the environment (cultural techniques)

How can we build a short fruit wall and get rid of structural wood (secondary structure)?

There are several tools that can be used:

1) Increasing the number of leaders from 1 to 2 or more

2) Short pruning instead of long pruning (not alone!)

3) Replacing dormant pruning with “Lorette” and postharvest cuts

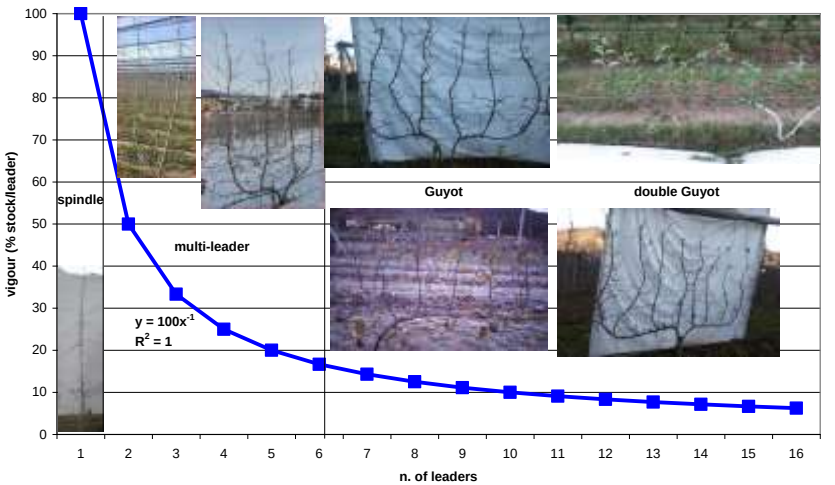
4) Make use of mechanical pruning to shape trees

5) Standard growth control (root pruning, PGRs, etc.)

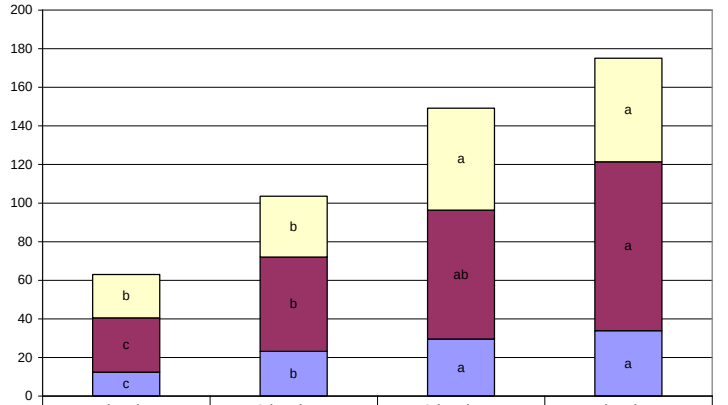
Multi-leader trees are receiving positive evaluation all over the World

A superspindle near Kelowna (B.C.)
Left: spindle Right: 2 leader

Vigour of each leader according to the numer of leaders per tree (model)

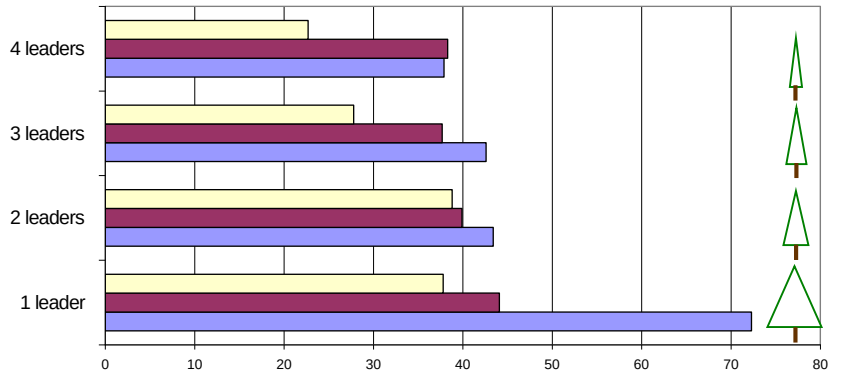


Shoot number distribution at different tree heights (Gala - V. Adige, 2012)



	1 leader	2 leaders	3 leaders	4 leaders
n. of branches (2-3m)	23	32	53	54
n. of branches (1-2m)	28	49	67	88
n. of branches (0-1m)	12	23	30	34

Branch length distribution at different tree heights (Golden - V. Adige)



	1 leader	2 leaders	3 leaders	4 leaders
branch length at 2-3 m	38	39	28	23
branch length at 1-2 m	44	40	38	38
branch length at 0-1 m	72	43	43	38

branch length (cm)

Increasing the n. of leaders is a powerful tool for building a fruit wall

1) By building more than 1 central leader as the only structural wood, vigour is diverted to form a more compex primary structure (more leaders = more dwarfing)

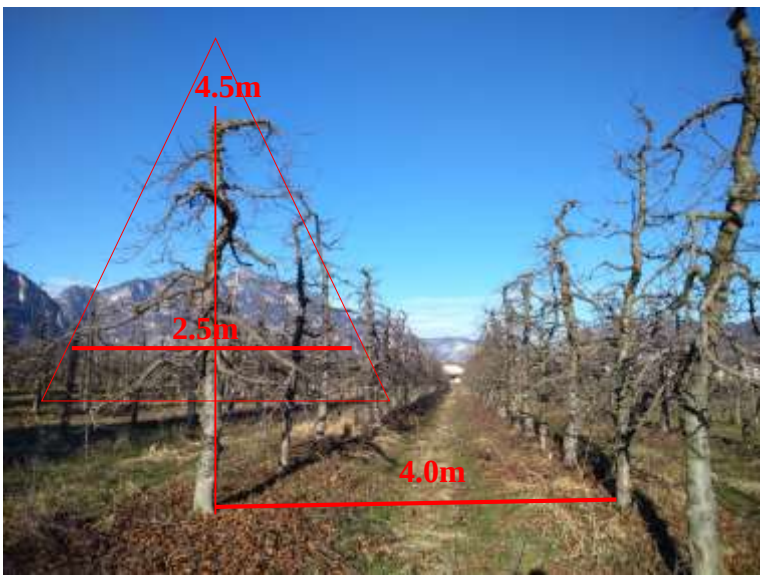
2) Bibaum and ML trees tend to form naturally a fruit wall, with little or no secondary structure, flat and with no gaps

Vigour-wise, increasing the n. of axes "looks like" shifting progressively to more dwarfing rootstocks

↓

N. of leaders: additional variable for chosing the right system in new plantings (beside cv, rootstock and spacing)

Standard free-standing MM 106 at 4 m between rows

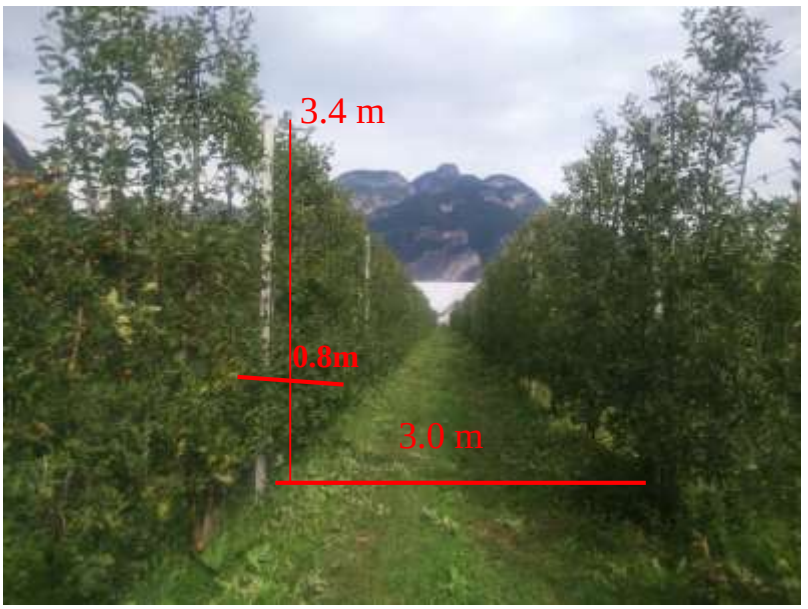


Golden / MM106 at the end of 6th leaf

4.0 m

2 leaders (Bibaum)

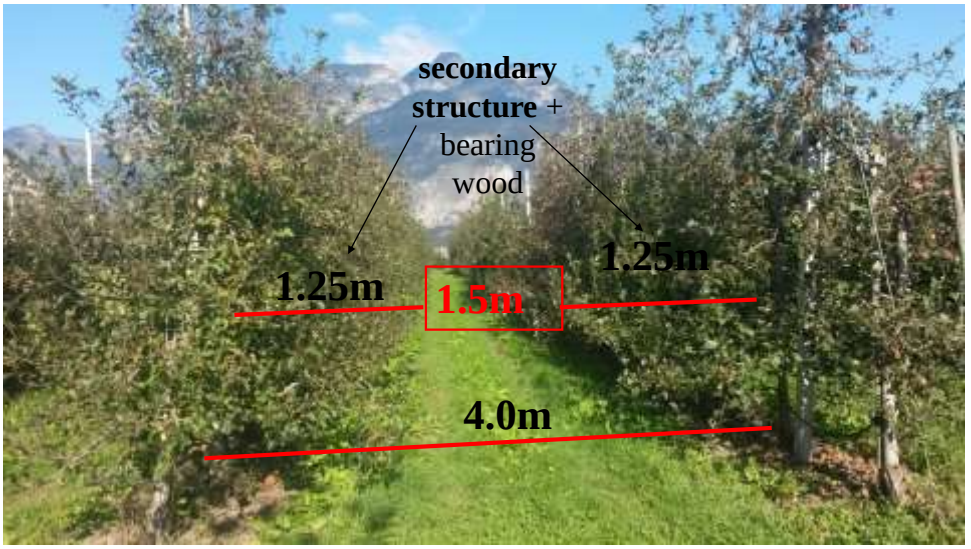
8 leader MM 106 at 3 m between rows



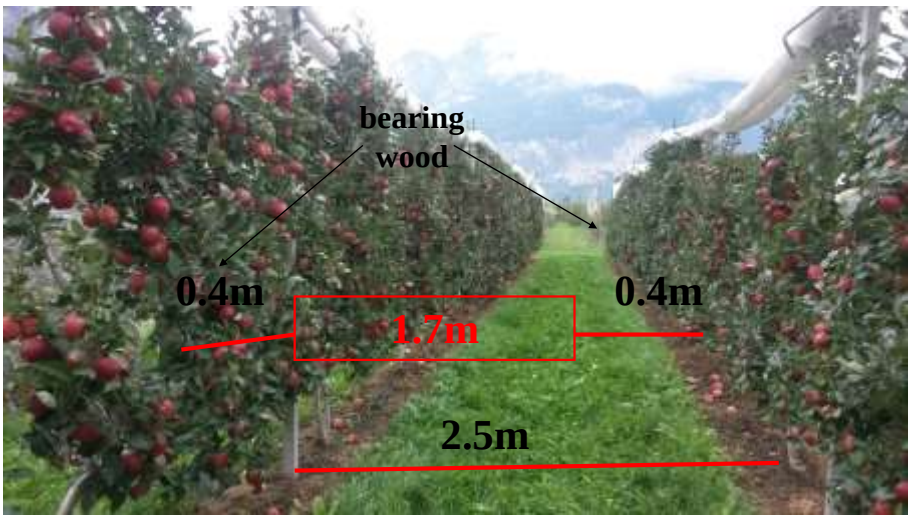
A 3 and 4 leader tree of Golden / MM106 at the end of 6th leaf

A 6 leader tree of Golden / MM106 at the end of 6th leaf

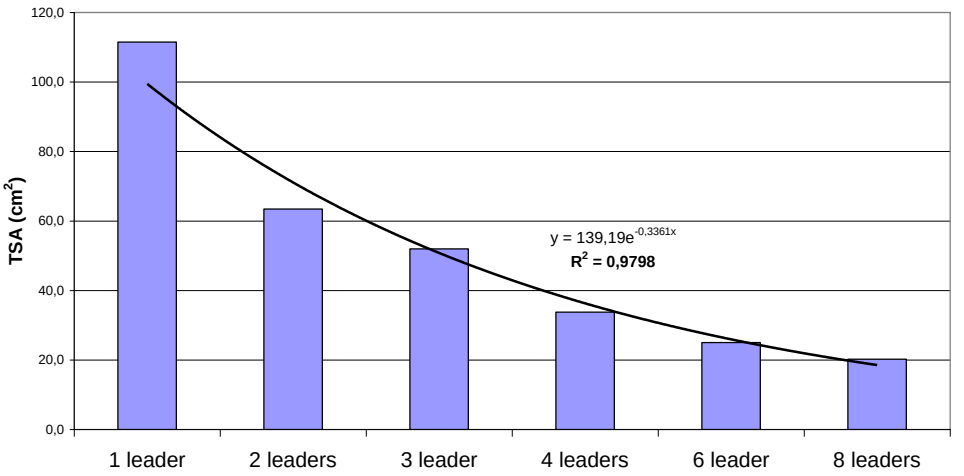
Fuji trained with Spindle / long pruning



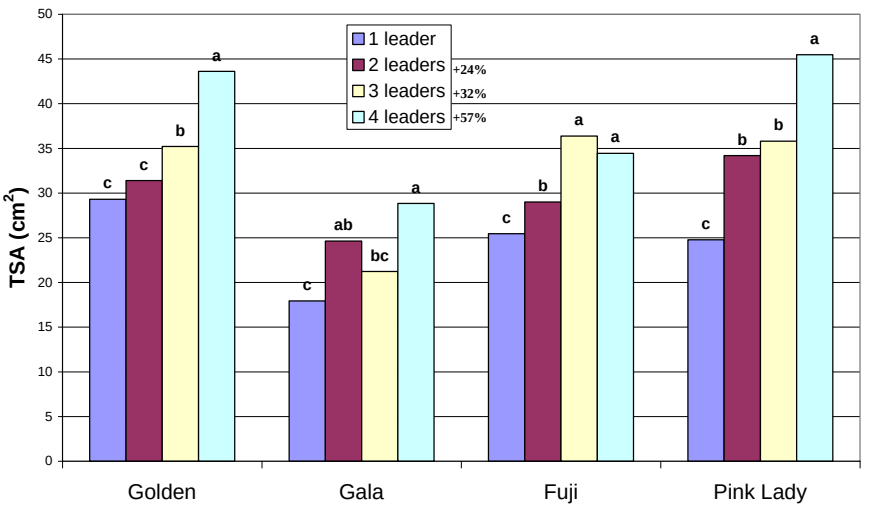
Multi-leader fruit wall of Gala



TSA of each leader in spindle and multi-leader trees after 7 years
Fuji trained with 1-6 leaders



TSA of trees trained with different number of leaders 7 years after planting



Yield of a semi-pedestrian 8-leader Fuji orchard at 2.75 m between rows (52 kg from 238 apples in the 6° leaf)

Semi-pedestrian 8-leader Fuji orchard at 2.75 m between rows

Spindle

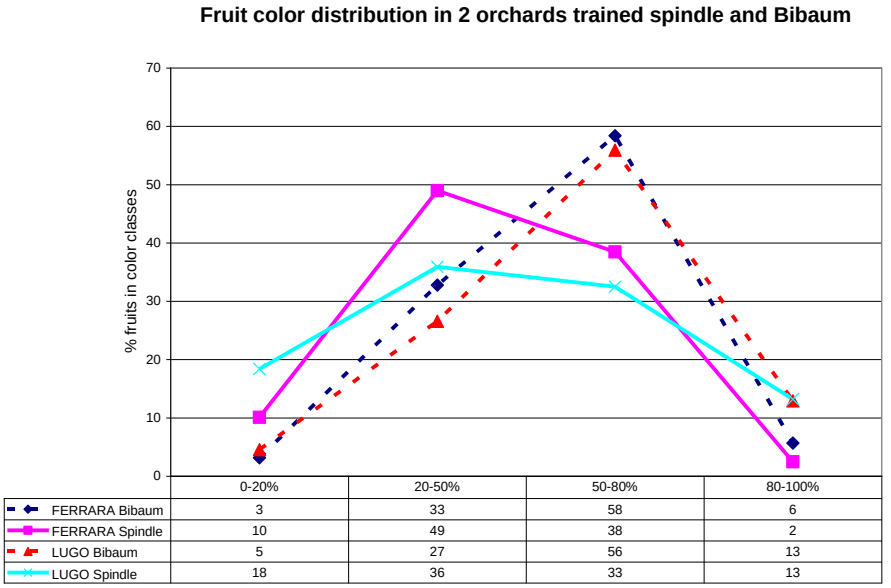
Bibaum (2-stemmed trees)

Bibaum planting tend to form naturally a Fruiting wall

Yield of a spindle and of a 2 leader tree

spindle height 2 leader tree

Yield of Fuji spindle trained and 2 leader trained



	0-20%	20-50%	50-80%	80-100%
FERRARA Bibaum	3	33	58	6
FERRARA Spindle	10	49	38	2
LUGO Bibaum	5	27	56	13
LUGO Spindle	18	36	33	13

Tall fruit wall of Golden Delicious (4 leaders)

n. trees/ha	1800
fruits/tree	248
kg/tree	64
tons/ha	122
fruit weight (g)	261

Tall fruit wall of Bibaum of Gala

n. trees/ha	2600
fruits/tree	196
kg/tree	39
tons/ha	103
fruit weight (g)	202
red overcolor %	95

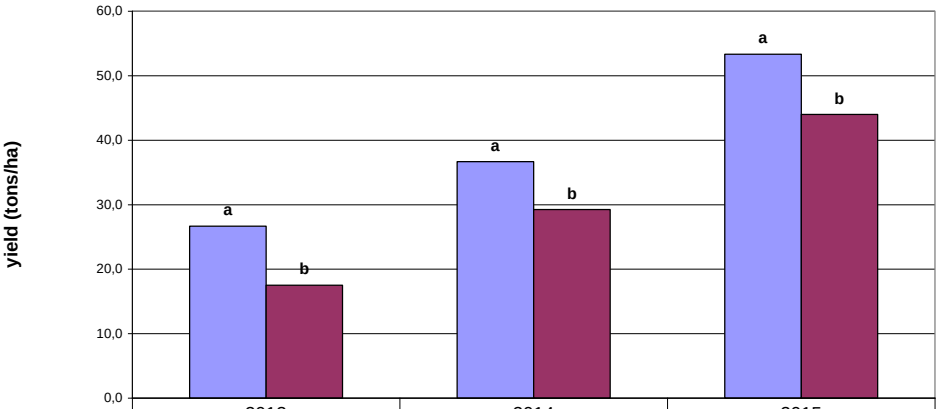
Tall fruit wall of Pink Lady

n. trees/ha	3070
fruits/tree	294
kg/tree	61
fruit weight (g)	211
red overcolor %	74

Yield of semi-pedestrian Gala planted in 2012

2 leaders at 2.5x1.2m - 4 leaders at 2.5x1.6m

(3333 trees/ha) (2500 trees/ha)

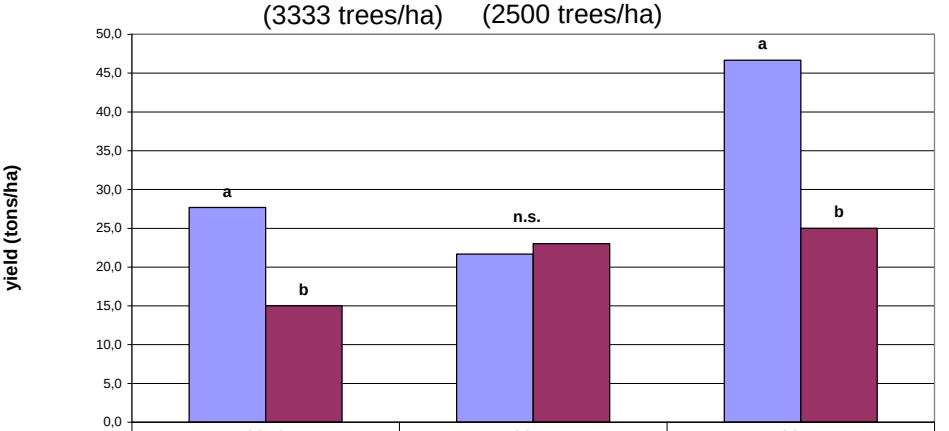


	2013	2014	2015
2 leaders	26,7	36,7	53,3
4 leaders	17,5	29,3	44,0

Yield of semi-pedestrian Fuji planted in 2012

2 leaders at 2.5x1.2m - 4 leaders at 2.5x1.6m

(3333 trees/ha) (2500 trees/ha)



	2013	2014	2015
2 leaders	27,7	21,7	46,7
4 leaders	15,0	23,0	25,0

4 leaders Fuji 2 years old - Spacing: 2.25 m (between rows) x 1.6 (btw. trees)

3 and 4 leader Golden / M9 at the end of 6th leaf

A 4 leader tree of Fuji at the end of 3rd leaf

A 6 leader tree of Fuji at the end of 3rd leaf

A 8 leader tree of Fuji at the end of 3rd leaf

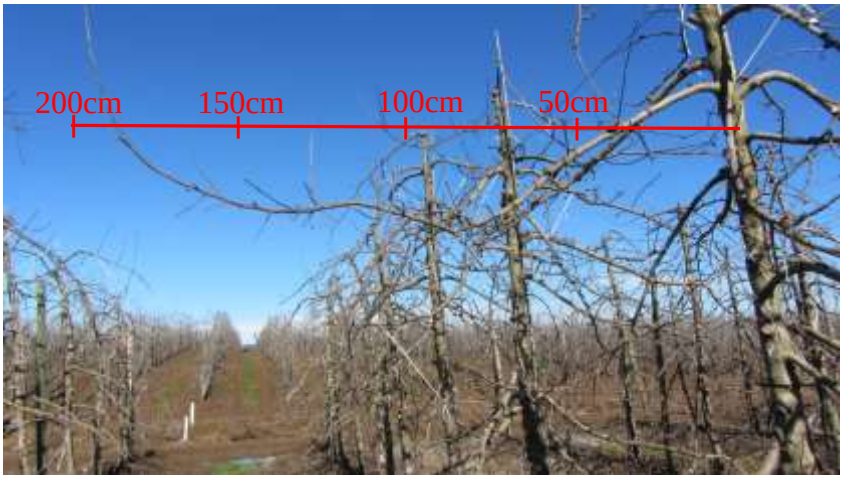
A 6 leader tree of Fuji at the end of 7th leaf

A 8 leader tree of Fuji at the end of 7th leaf

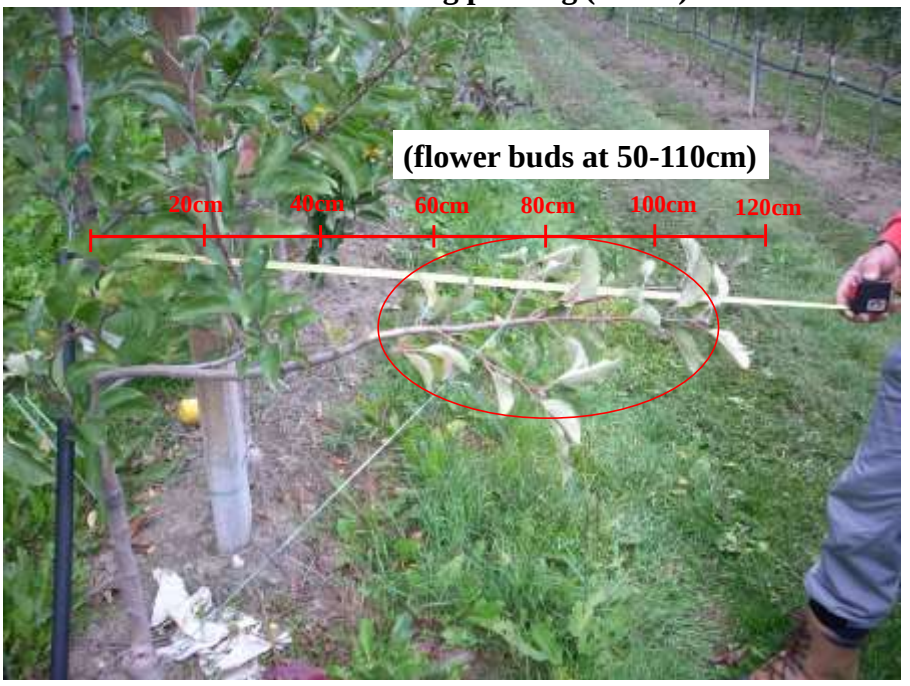
A 8 leader tree of Red Del spur/MM106 at the end of 7th leaf

4 leader Pink Lady 5 leaf at 2m spacing between trees

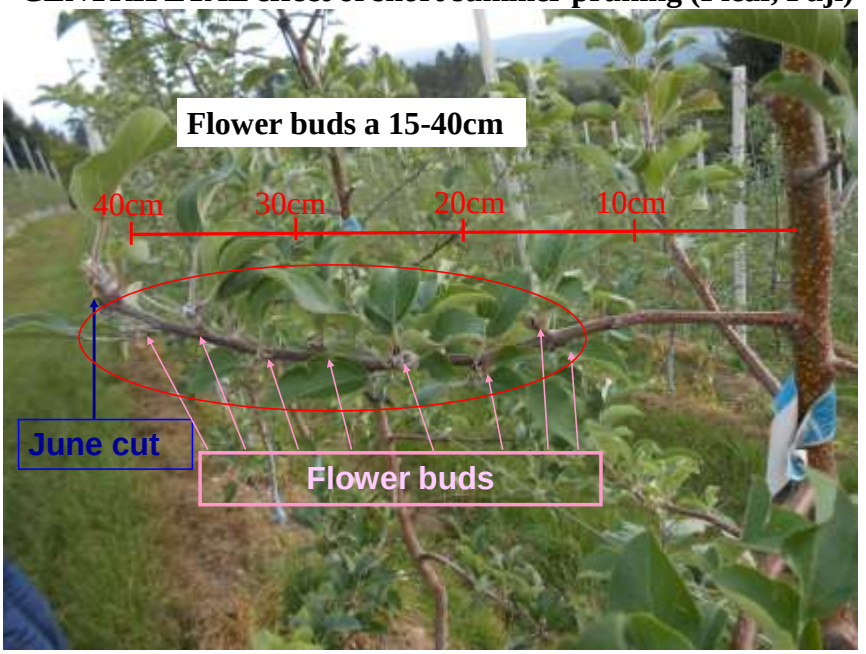
CENTRIFUGAL effect of long pruning (Chile)



CENTRIFUGAL effect of long pruning (II leaf)



CENTRIPETAL effect of short summer pruning (I leaf, Fuji)



1 year old Fuji pruned in June (V. Non, Italy 27/9/13)

THE

LORETTE SYSTEM OF PRUNING

By LOUIS LORETTE, Professor of Arboriculture, late Chief Instructor in Practical Horticulture at the School of Agriculture, Wageningen, near Dinan

& COMPANY LTD: 14 HENRIETTA STREET, COVENT GARDEN, W.C. 1925

PREFACE TO THE FIRST EDITION.

In my opinion the greatest merit of M. Lorette's new system of pruning will be that it will enable gardeners

"This year we have gathered four pears" or "I haven't a single pear this year."

But why this pitiful result? Because the majority of garden owners, if they have their trees pruned in winter by more or less competent professional gardeners, almost always omit to carry out summer pruning and the pinching back of shoots during the growing season. The result is great confusion among

lack of light and air which makes fruit-bearing impossible.

Since pruning by the Lorette system must be carried out in June, the amateur is, in a way, forced to carry

Lorette pear trees (1919)

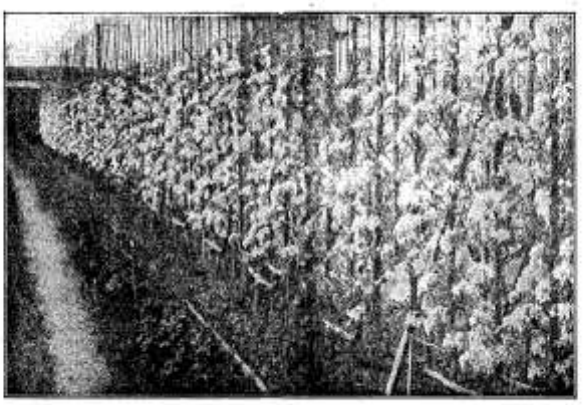


Fig. 69. Appearance in April 1919, of a double row of double U's. Photograph taken in the front garden of M. Eugène Chauffour at Versailles-Porchefontaine. Trees trained on the Lorette system.

S. Maria pear reaction after June cut (2013)

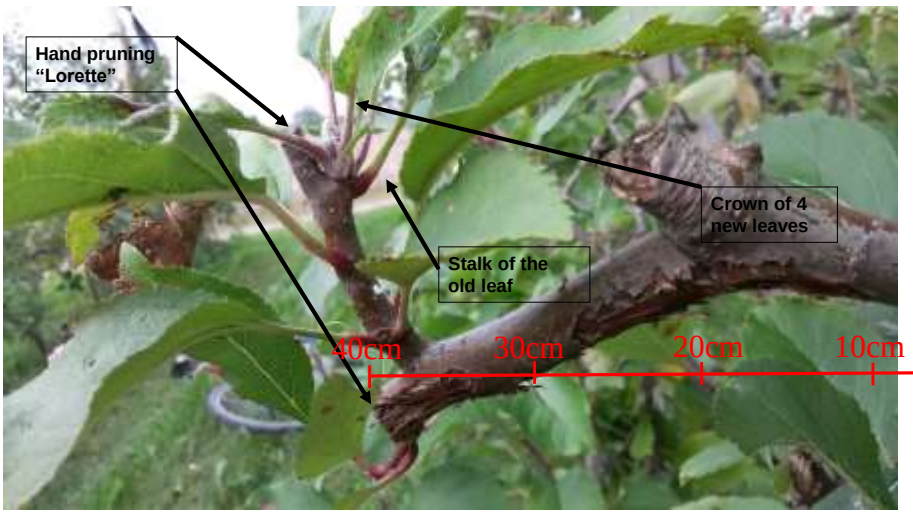
“De-constructing” effect of early June pruning

Principle: divert sap towards fruits and buds at the expense of new unnecessary growth and direct light into the canopy

Pruning can be done by hand or by machine

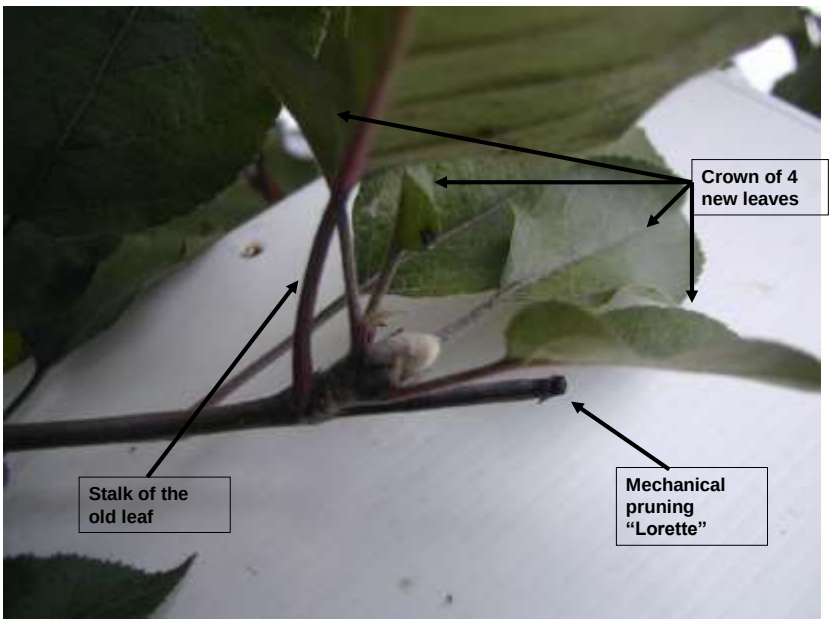
“Lorette” as well as other forms of non-dormant pruning helps “**de-structuring**” canopies: getting rid of old structural wood and turning it back into bearing wood

Strong “reset effect” of Summer pruning on the scaffold of Empire



MECHANICAL PRUNING of 4 leader pedestrian orchard at 2.5 m between rows (May 22/2015)

At the end of Summer, 3-4 months after the "Lorette" pruning, the terminal stipulary eyes at the base of the leaf on 1-year old wood produce new spurs near the cut.



Fruits of Golden set in May 2010 on flowerbuds formed by “Lorette” pruning of 1/6/09

4 leaders Gala 3 years old - Spacing: 2.25 m between rows

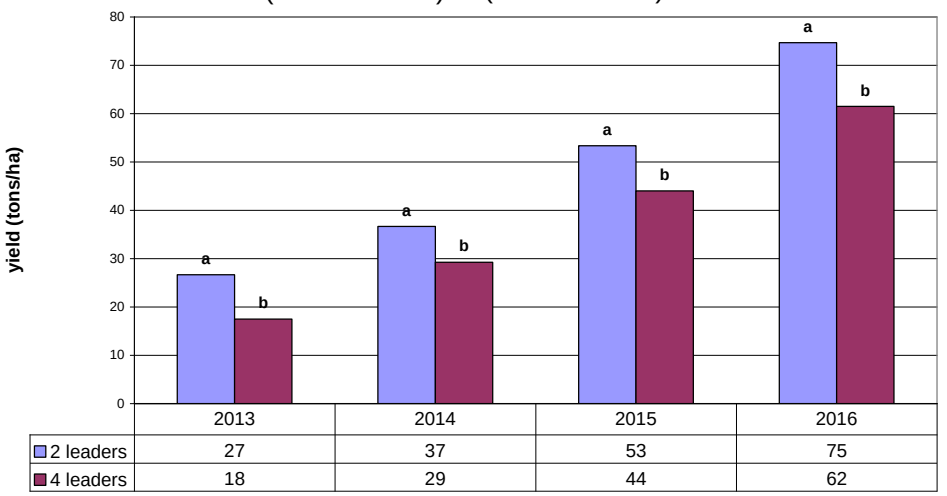
2 and 4 leader semi-pedestrian Golden Delicious at 2.5 m between rows, 5° leaf

Treatm.	tons/ha	kg/tree	fruit/tree	fruit weight (g)	fruit size (mm)
2 leaders	99	30	118	251	87.6
4 leaders	91	36	142	256	88.2

Yield of semi-pedestrian Gala planted in 2012

2 leaders at 2.5x1.2m - 4 leaders at 2.5x1.6m

(3333 trees/ha) (2500 trees/ha)

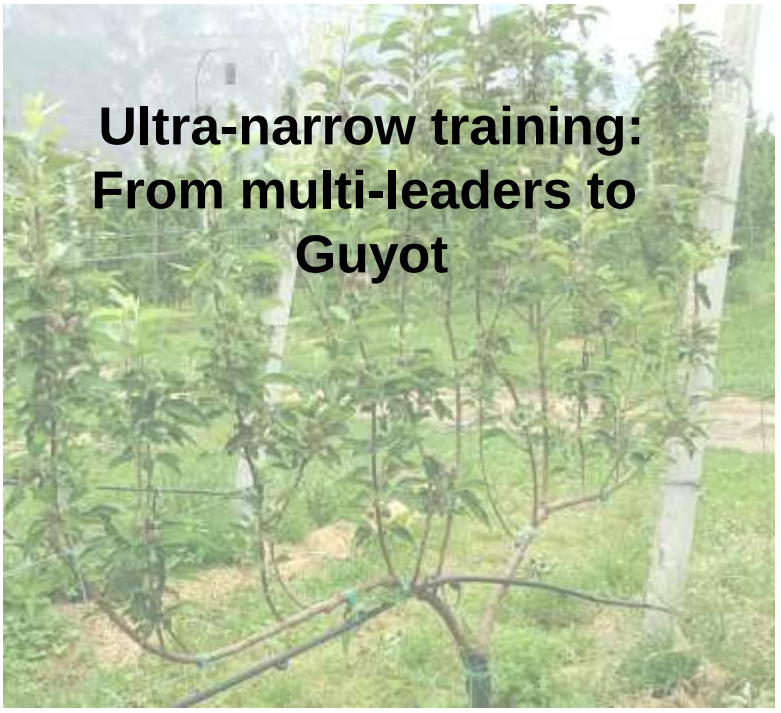


	2013	2014	2015	2016
2 leaders	27	37	53	75
4 leaders	18	29	44	62

Multi-leader fruit wall of Gala

inerbito nel sottofila

diserbato nel sottofila



Potential for Bibaum trees

Plasticity def.*: "the capability of being molded, …or assume a desired form"*

Bibaum trees can be easily molded into different shapes

Guyot training: beyond the permanent multi-leader

The geometry of trees is rotated of 90°

S**econdary structure**: upright semi-permanent branches (**suckers**/leaders)

Guyot training: beyond the permanent multi-leader

The geometry of trees is rotated of 90°

S**econdary structure**: upright semi-permanent branches (**suckers**/leaders)

primary structure:
1 or 2 semi-horizontal stems

2 year old double Guyot of Gala

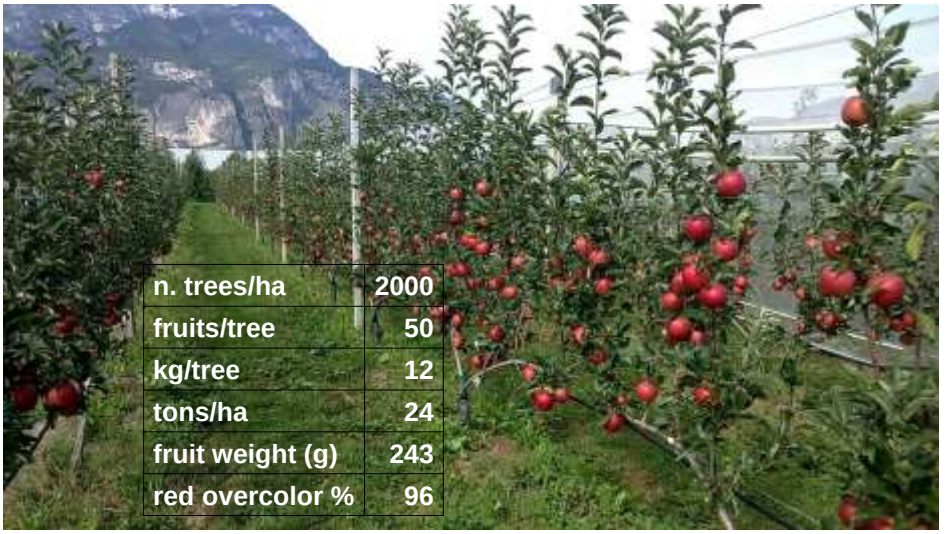
April 2015

Planting at 2m between rows

(2000 Bibaum® /ha)

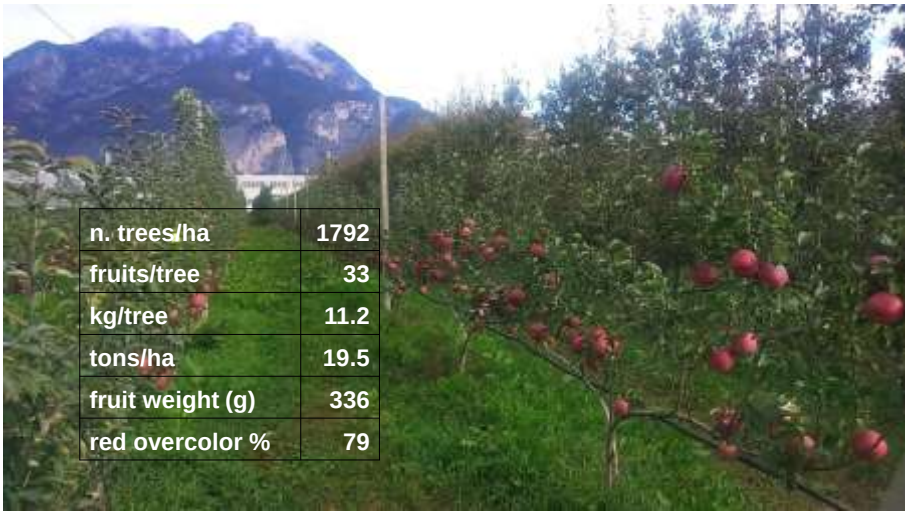
April 2015: Bending the main stems to the **horizontal**

Bibaum plasticity: double Guyot of Gala at 2 m between rows (August 2016, 2° leaf) with about 15 **vertical** limbs/tree



n. trees/ha	2000
fruits/tree	50
kg/tree	12
tons/ha	24
fruit weight (g)	243
red overcolor %	96

Same trees of Fuji. Weed control: only mechanical



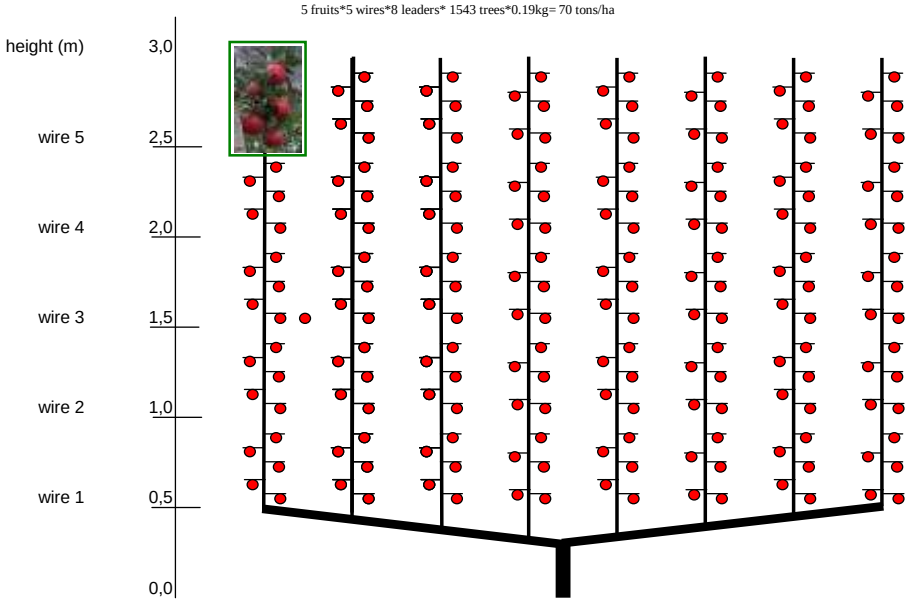
n. trees/ha	1792
fruits/tree	33
kg/tree	11.2
tons/ha	19.5
fruit weight (g)	336
red overcolor %	79

Short trees of double Guyot of Golden at 2.2 m between rows

Weed control: only mechanical

Machines can pass even with 2 meters between the rows

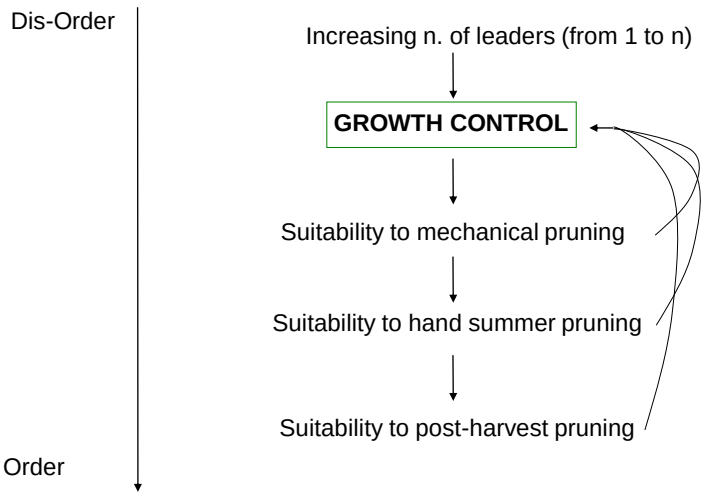
Precision horticulture: multi-leader trees are suitable to **segmentation**



Before and after thinning to 8 fruits/ml

The equilifruit can be also used for assessing the right crop on ultra-narrow canopies

There is a positive feed-back loop among the different tools to achieve growth control



A single Guyot of Fuji

A single Guyot tree of Gala at the end of 1st leaf

Double Guyot of Gala 2016 in the second leaf

Spacing: 2m (between rows) x 2.4 (between trees)

Pedestrian multi-leader Fuji orchard at 1 m from Davor Baum (3° leaf)

Double rows of double Guyot in the second leaf (2.3+1.3m btw. rows)

Conclusions

•After 50 years of single leader training (spindle, solaxe) preformed MLT is an option that can alter fruit tree architecture.

•MLT *productivity* and *quality* is as good or better than the best spindle trained orchards. Its *management* is much simpler for the grower and projected toward the future.

•Multi-leader though not suitable for every grower, can result in viticulture-like tree heights, spacing and machinery.

•New techniques are made possible by pedestrian fruit walls, including mechanization, microclimatic modification trough anti-rain nets and multi-task microsprayers on the canopy.

Thanks to:

•Franco Micheli and Piero Malfatti, who run the 2 experimental farms (Maso Part in valle dell'Adige and Maso Maiano in valle di Non),
•the staff of the two "Masi"
•Daniel Bondesan and Claudio Rizzi for the efficacy study on tunnels and fixed spraying systems
•Luisa Mattedi for the pest control in the new orchard system
•The "meteo" staff for the microclimatic data
•Boscato Reti s.r.l. and Keep In Touch 'system' for the AltCarpò and the anti-rain nets
•Bertoni and Lochman for the tunnel sprayers
•Poppi and Netafim for the fixed spraying systems on the canopy
•FAMA for the window pruning machine
•Agri Com for the support in any mechanization
•Anselmi Brothers for the AltCarpò net movimentation
•Agricenter for the tools for alternative weed control
•Mingozzi for the support in the alternative weed control trough fire

Thank you for your attention!