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# Vegetative Rootstock and Finished Apple Tree Production

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# Methods to Produce Rootstock

- Seed
  - Wide genetic differences among plants
  - Mostly full vigor stocks
  - Requires stratification
- Vegetative (clonal)
  - Genetically identically plants produced
  - After “Stool Bed” established – fast and cheap

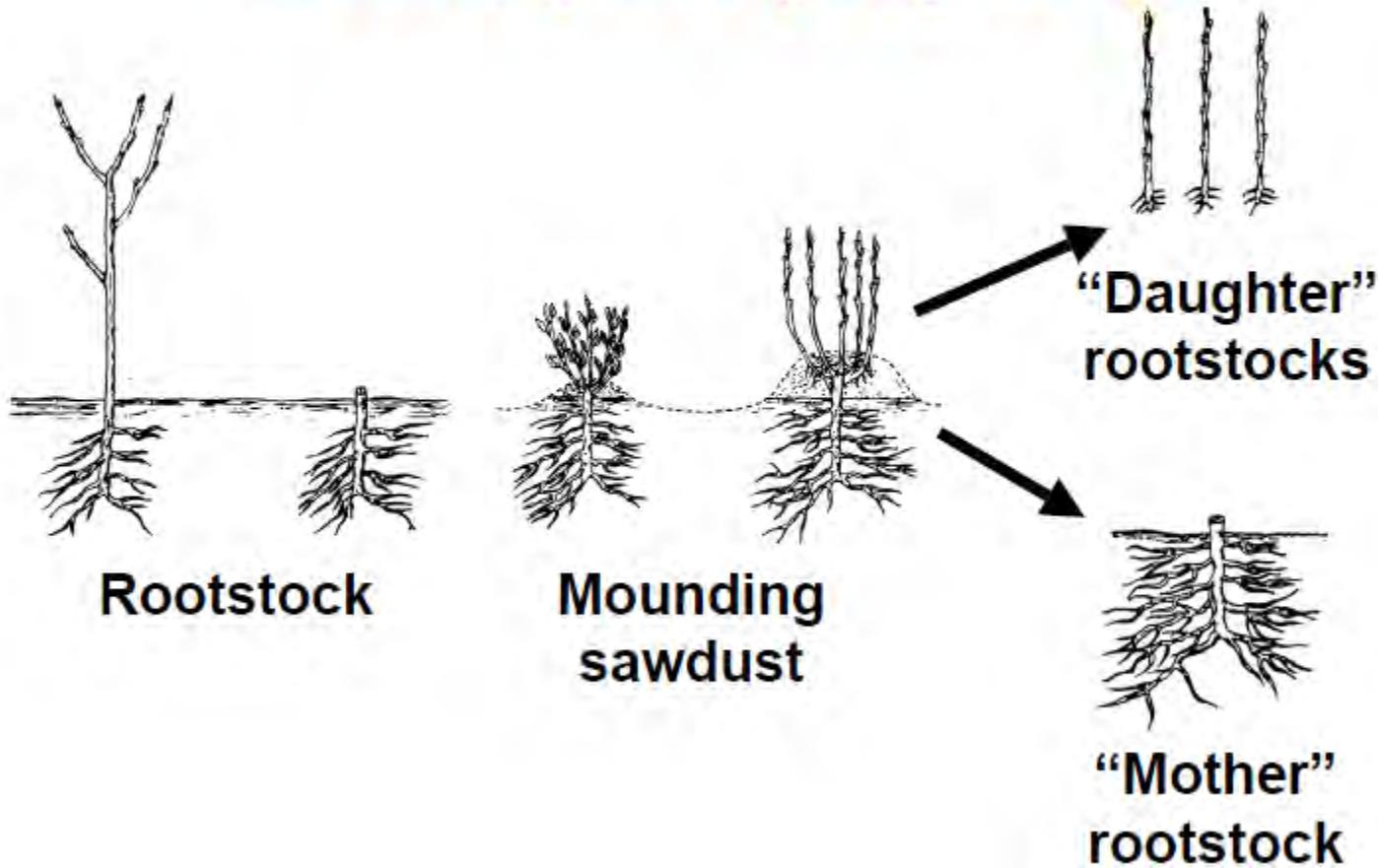
# Propagation Methods

- Vegetative propagation is called “Division”
  - Mounding
    - Slower and fewer plants produced initially
    - Stronger, larger plants
  - Layering
    - Faster production of more plants
    - Weaker, smaller caliper plants, more sort outs
- Micropropagation
  - Specialized equipment and techniques
    - More expensive, requires controlled environment

# Mounding

- Mounding - Initial plants planted upright and cut back after 1<sup>st</sup> year of growth then covered above shoot bases
- Trench Layering – Initial plants planted at an angle in a shallow trench then pinned down and covered around shoot bases.

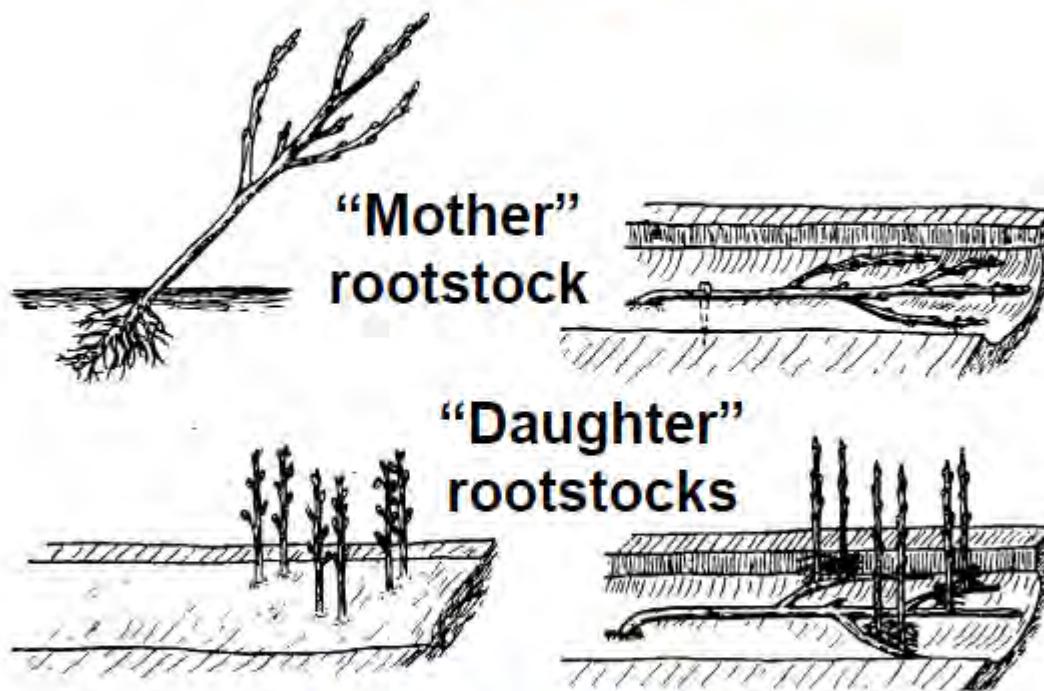
## Mound (Stool) Layering



# Layering

- Trench Layering – Initial plants planted at an angle in a shallow trench then pinned down and covered around shoot bases.
- Plant Spacing 15cm X 15cm X 15cm
- Bed width is usually 6 rows but depends on equipment and grower preference.

# Trench Layering



Layering with  
soil or sawdust



# Trench layered Plants Tucked down



**2<sup>nd</sup> Year Stool Bed with 1<sup>st</sup> hilling**



# Mature Stool Bed Ready for Harvest



# Production per Meter of Row

- Year of Planting      -      0 plants
- 2<sup>nd</sup> leaf                -      15 plants
- 3<sup>rd</sup> leaf                -      50 plants
- 4<sup>th</sup> leaf                -      100 plants
  
- More plant variability in younger stoolbeds
- Greater number of “sort outs” plants on younger beds.

# Harvested Layers with Good Root System



# Rootstock

- Optimum Size for Summer T- and Chip Budding is 6.25mm diameter at planting in spring.
- Optimum Size for Winter and Spring grafting is 12.5mm when grafted.

# Rootstock Harvest

- Wait until trees defoliate naturally or defoliate chemically (2.25kg ZnSO<sub>4</sub> per 378 l H<sub>2</sub>O) and/or manually if layer it is to be stored.
- Cut plants below new roots being careful not to damage mother plant.



Cut liners here!

# Rootstock

- Store as you would any nursery tree – 1° C. in an ethylene free environment.
- Never with apples or other produce.
- Keep moist
- Just prior to grafting or lining out trim off excess roots
- Line out in nursery row using a small planter or sub-soiling and planting by hand.

# Producing the Finished Nursery Tree

1. Graft rootstock with the variety of choice, plant in nursery or orchard.
2. Plant rootstock in nursery and bud with the variety of choice.







**Table 6.3.** Tree-quality parameters of 'Jonagold' (J) and 'Gloster' (G)<sup>a</sup> on M.9 rootstock at various planting distances in the nursery. Rootstocks (6–8 mm diameter) planted spring 1985 at 16 different spacings (combinations of four row and four tree spacings). Budding August 1985. Measurements autumn 1986. (Adapted from Wertheim, 1986a.)

Spacings (cm)	Tree height above union (cm)	Stem diameter 10 cm above union (mm)	Laterals per tree higher than 40 cm above soil level (no.)	Total lateral length per tree (cm)
Within-row tree spacings: data averaged for row distances				
15	121.7	9.4	2.0	41.5
30	124.7	11.0	4.7	147.8
45	125.0	11.2	5.7	202.0
60	125.8	11.9	5.8	207.8
F test	NS	*	*	*
LSD <sub>0.05</sub>	—	0.7	1.5	72.5
Between-row spacings: data averaged for tree distances				
60	121.9	10.5	4.3	129.5
70	124.1	10.9	5.0	157.2
80	127.7	11.4	4.4	146.9
100	123.0	10.8	4.9	165.8
F test	NS	NS	NS	NS
LSD <sub>0.05</sub>	—	—	—	—

<sup>a</sup>No laterals with 'Gloster'.

F test: cultivar × distance NS; tree distance × row distance NS; thus 16 tree spacings combined.

NS, not significant; \*, significant ( $P < 0.05$ ).

# Nursery Tree Types

- Sleeping eye Tree – 1 year in the nursery
- 1 Year Grafted Tree – 1 year in the nursery
- Traditional – 2 years in the nursery tree
- Knip Tree – 2 or 3 years in the nursery

# The Ideal Tree for High Density Plantings



# Summer Budding Begins with Budwood Collection



08.24.2009



Cut and  
store in a  
cooler

# Budding Knives



- Budding knives are beveled on one side and flat on the other to provide a smooth clean cut.
- Sharpen knives regularly to ensure clean cuts.



08.24.2009

# T-Budding

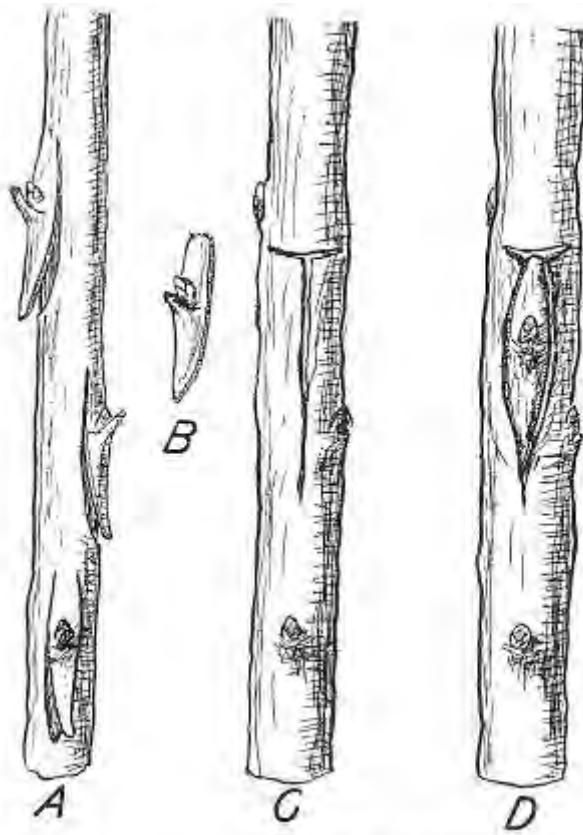


FIG. 9.—BUDDING.

# Chip Budding



The “chip” should be the same size and shape as the notch made in the



Insert the “chip” into the notch firmly seating it and matching exposed tissue.



08.24.2009



Good Match!



Poorer match!

Use special rubber bands to cover the entire bud keeping moisture in and air out!

The bands completely rot off with exposure to UV light.



# Overwintering Budded Trees in the Field



# “Sleeping Eye”

- Year 1 – Rootstock in nursery budded in Fall using either T-bud or Chip Bud (Chip budding best).
- Year 1 – After buds heal, trees dug and stored for planting immediately in the orchard or the following spring.

Quality depends on grower management and care. Very slow to bear – 4-5<sup>th</sup> leaf

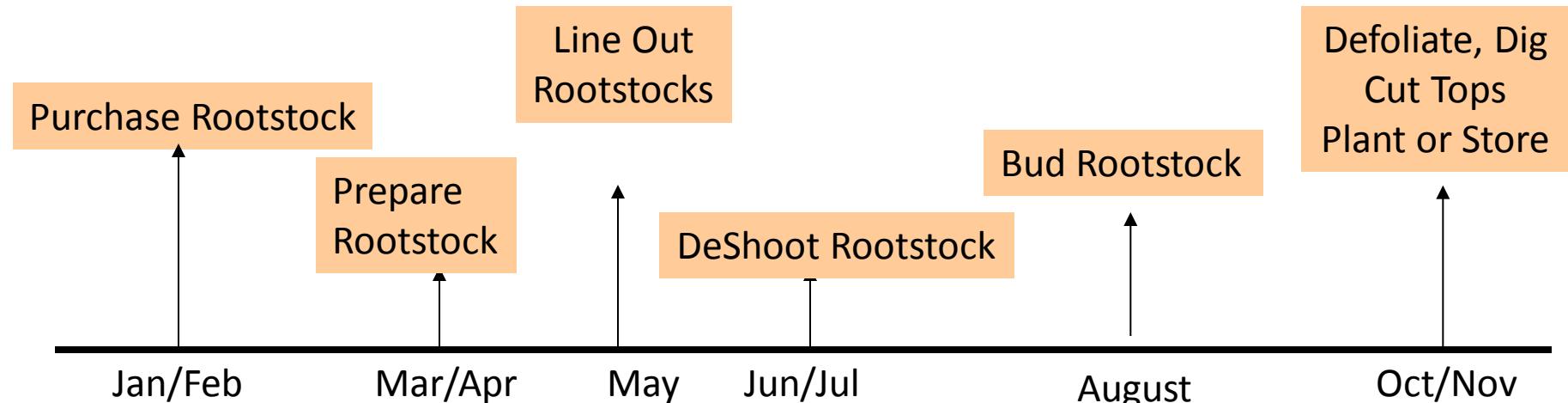


# “Sleeping Eye”

- **Strategy 1**
  - Use the traditional method to produce a budded tree
  - Dig tree just prior to planting. There is no advantage over other methods.
- **Strategy 2**
  - Buy “Sleeping Eye” from commercial nursery
  - Plant into on-farm nursery and grow out tree using traditional method
- **Strategy 3**
  - Grow-out season 1 then follow “Knip” method in second season in the nursery

# “Sleeping Eye”

## Year One



Resting bud



# Bench Grafting

- Done before any growth in late winter or early spring.
- Dormant scion wood, dormant rootstock.
- Prepare rootstock by removing all but  $\frac{1}{4}$  inch of existing roots.
- After grafting store at 10 C until callused.
- Then store in cold room until lining out.

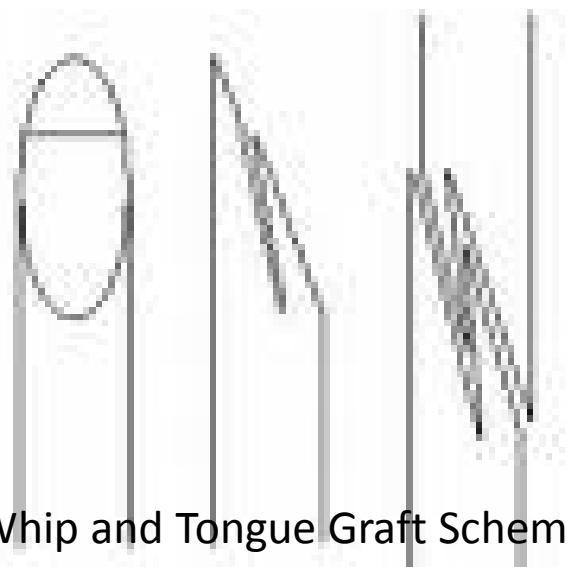
# Hand and Benchtop Grafting Machines



- Several hand-held or bench top models are available:
- Ho-Cheng Co
- CJ Industries
- Revco
- Graftec



# Grafting Knives



Whip and Tongue Graft Schematic

- Grafting knives are beveled on one side and flat on the other to provide a smooth clean cut.
- Sharpen knives regularly to ensure clean cuts.



# One-year-graft (One-season-tree)

- Both rootstock and scion 1 growing season in the nursery
- Bench grafted – 2-4 inch piece of dormant wood
- Carefully lined out and grown vigorously
- Usually produces a smaller un-feathered tree



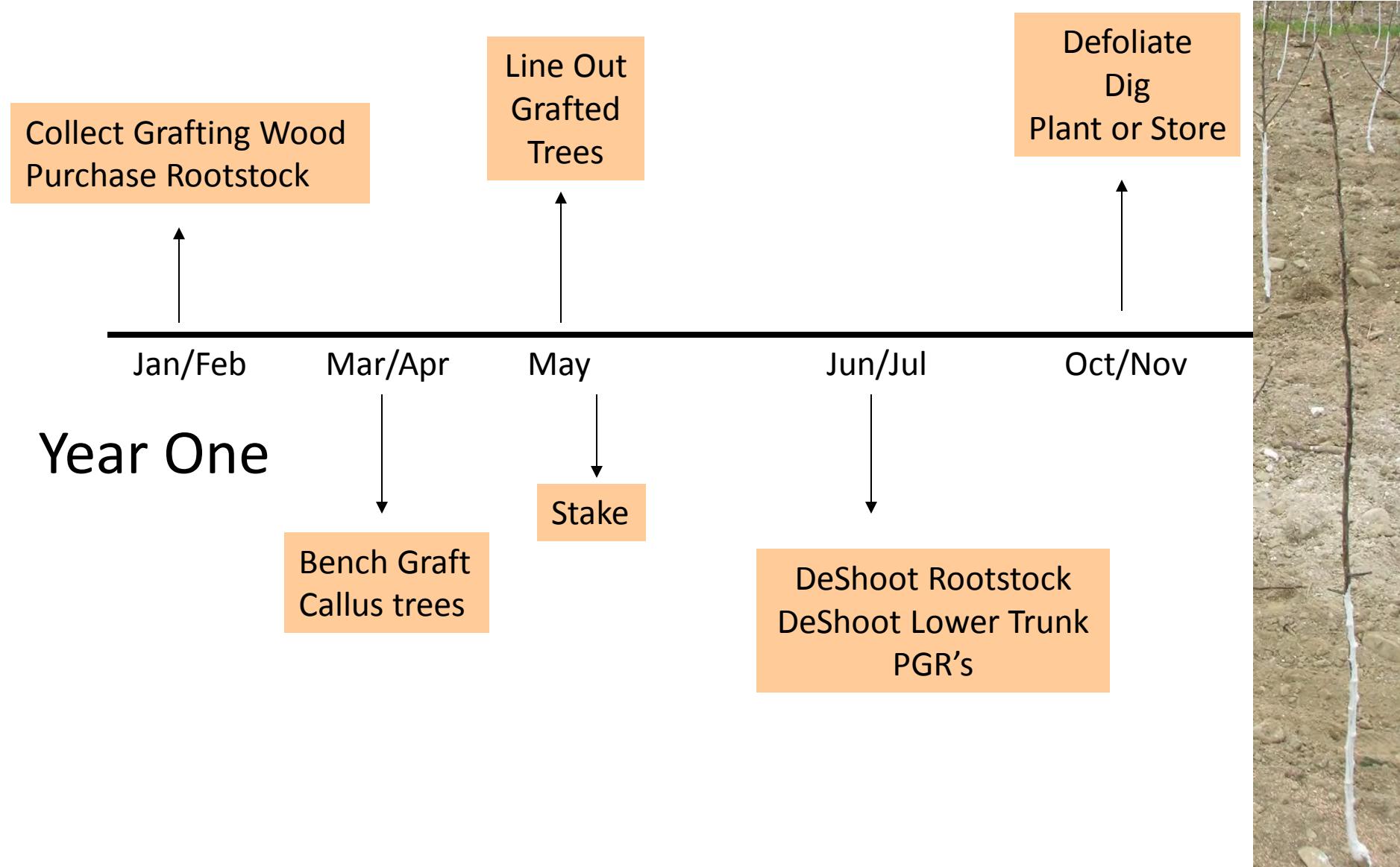
# “One-Year Grafted Tree”



- Year 1 – Rootstock bought in and grafted inside in late winter.
- Year 1 – Grafted trees planted in the nursery when conditions are appropriate.
- Year 1 – Trees dug and either stored over winter and planted in the orchard the following spring or planted in the orchard immediately.

Lower quality with smaller caliper and whips without feathers – bears in 3<sup>rd</sup> or 4<sup>th</sup> leaf

# One-year-graft or One-season-tree



# The Traditional Tree

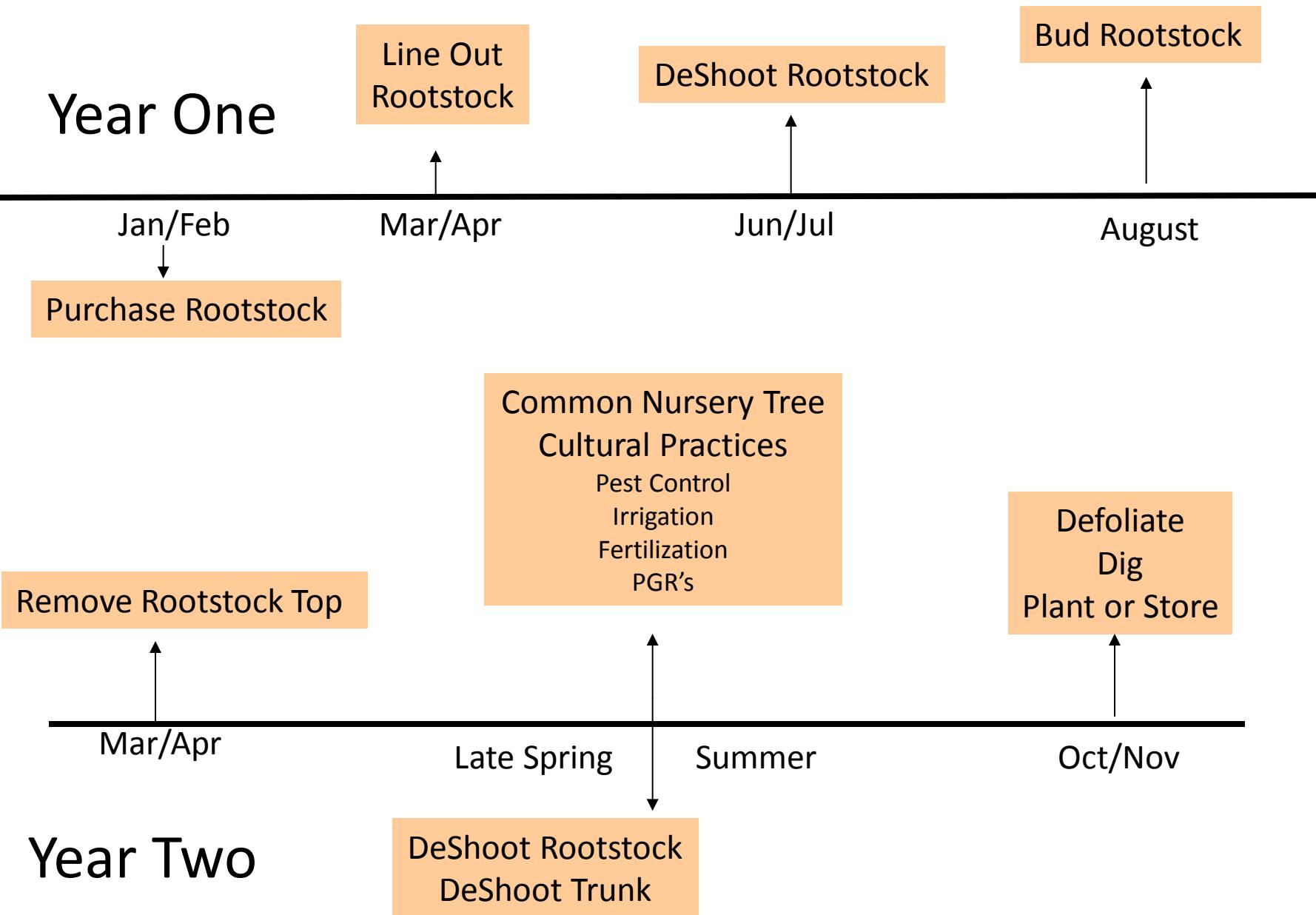
- Two seasons in the nursery
- 2 year root and 1 year scion
- Rootstock lined out
- Chip or T-Budded
- Can produce acceptable caliper tree
- Side branching depends on variety and sophisticated nursery manipulations.

- Year 1 – Rootstock in nursery budded in fall using either T-bud or Chip Bud (Chip budding best). Over-wintered in nursery.
- Year 2 – Rootstocks cut off just above bud, grown in the nursery for one year. Feathers either encouraged and present or not.
- Year 2 cont. – Finished tree dug and planted in the orchard immediately or stored over-winter and planted the following spring.

Quality determined by caliper and number of feathers in 2<sup>nd</sup> or 3<sup>rd</sup> leaf



# Traditional Budded Tree



# “Leaf Twisting” And Growth Regulators For Branching



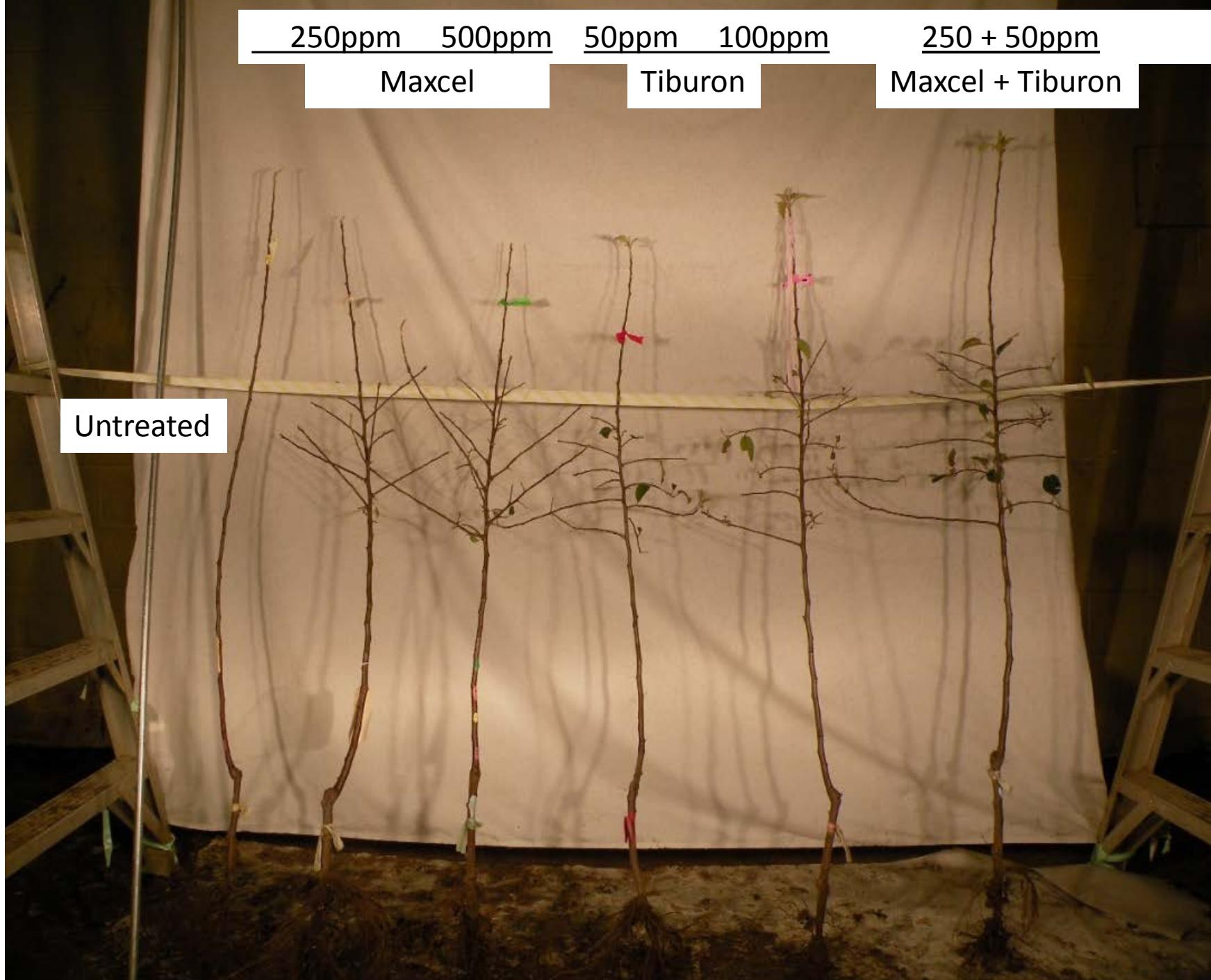
250ppm   500ppm   50ppm   100ppm   250 + 50ppm

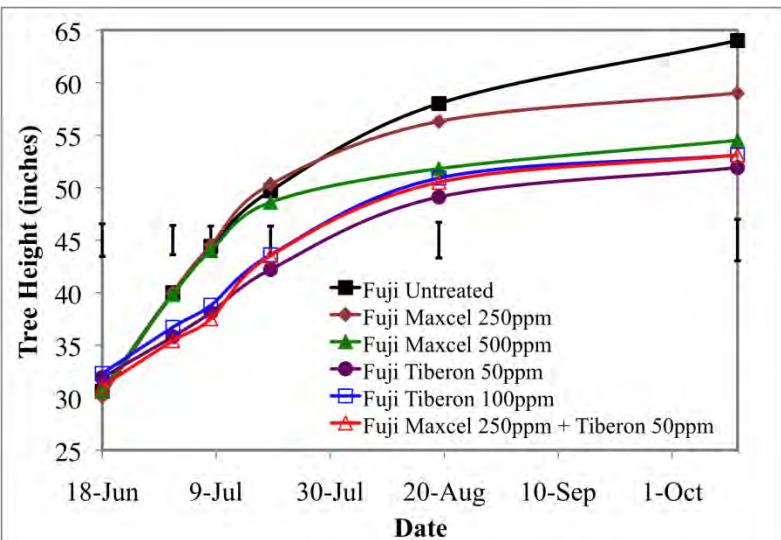
Maxcel

Tiburon

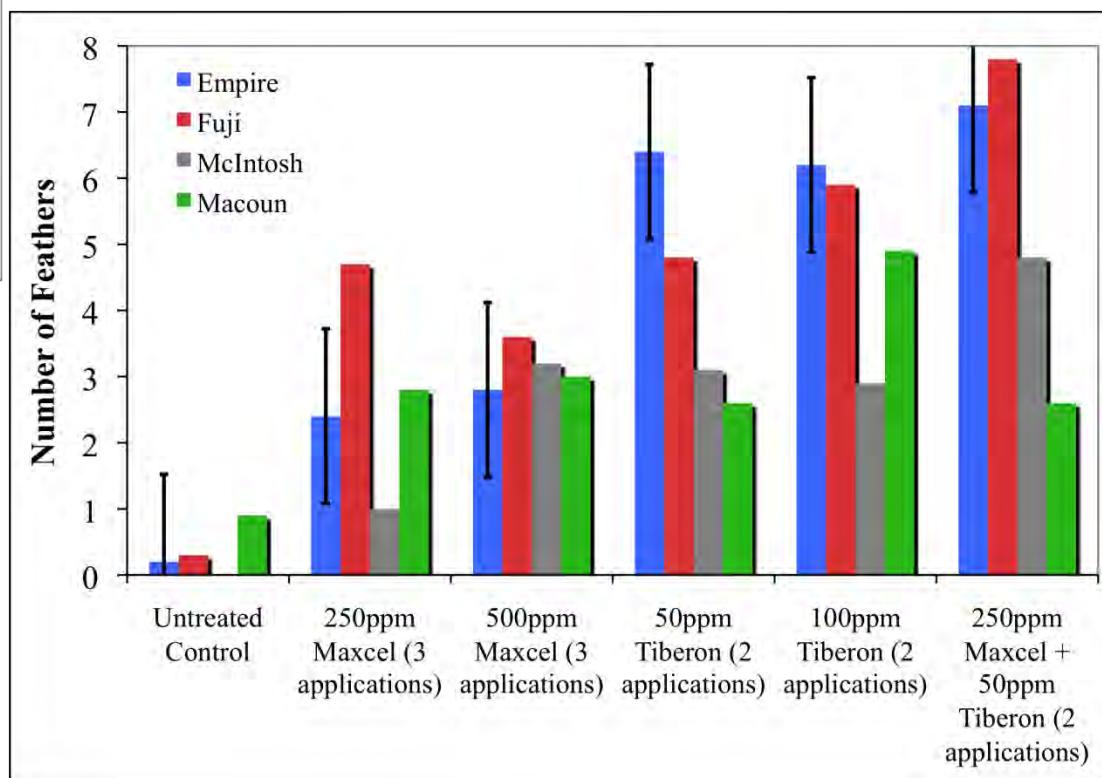
Maxcel + Tiburon

Untreated





**Figure 1.** Effects of cyclanilide (Tiberon) and/or benzyl adenine (Maxcel) on central leader growth (inches) of 'Sun Fuji'/B.9, apple trees in the nursery during 2010 growing season (Wolcott, NY).



**Figure 2.** Effects of cyclanilide (Tiberon) and/or benzyl adenine (Maxcel) on final number of feathers of Empire, Fuji, McIntosh, and Macoun apple trees grafted on B.9 rootstocks (Sazo and Robinson, 2011)



Growing Tree Out in the Nursery



# Knipboom

## (Snip or Cut Tree)

- Can be bench grafted or budded
- Bench grafts take 2 years in the nursery
- Budded trees take 3 years in the nursery
- Strong root system help force side branching
- Side branching with flat crotch angles
- Highest quality tree

# Kniptree

50 cm Heading height

Scion/Rootstock  
Graft



# Kniptree - Budded

## Year One

Jan/Feb

Purchase Rootstock

Line Out  
Rootstock

DeShoot Rootstock

Bud Rootstock

Jun/Jul

August

Common Nursery Tree  
Cultural Practices

Pest Control  
Irrigation  
Fertilization  
PGR's

Remove Rootstock Top

Mar/Apr

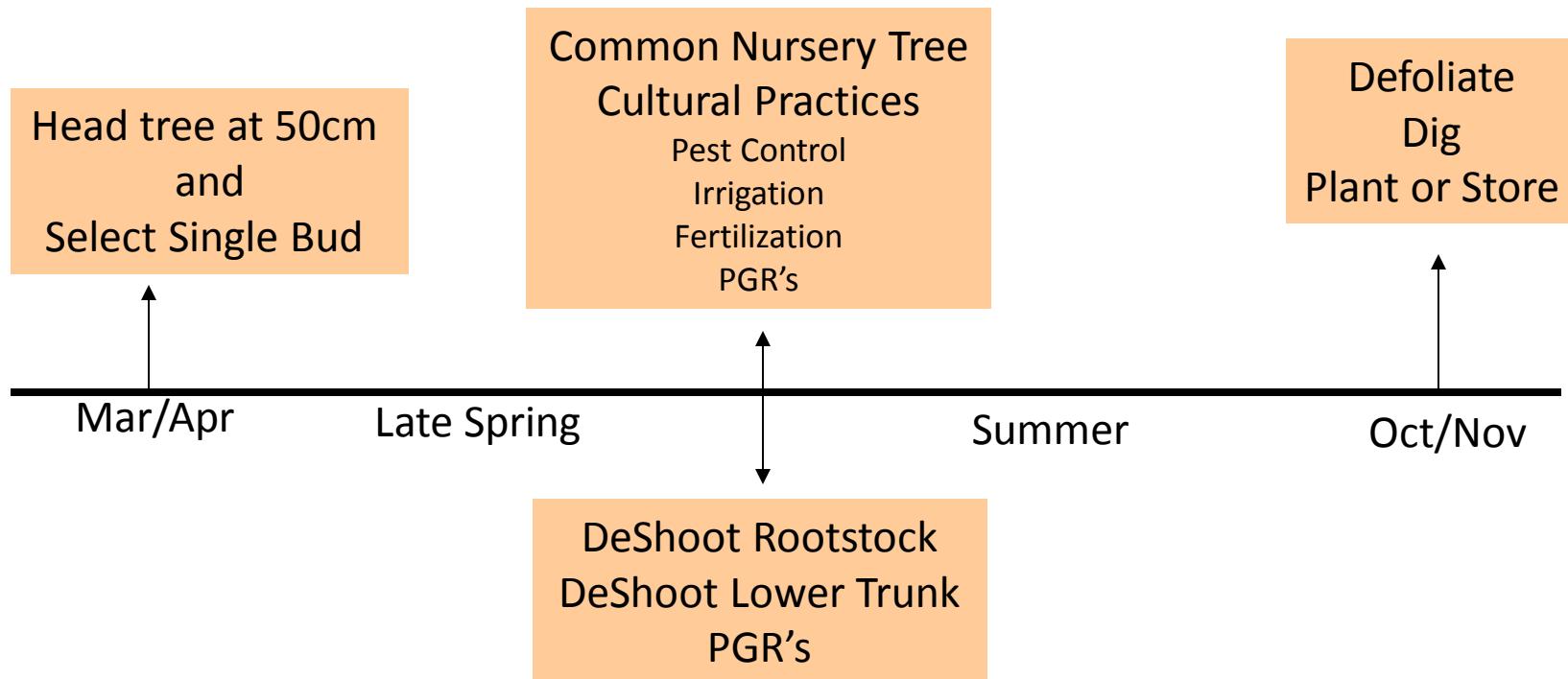
Late Spring/Summer

DeShoot Rootstock  
DeShoot Trunk

## Year Two

# Kniptree - Budded

## Year 3



# Kniptree - Grafted

## Year One

Jan/Feb

Bench Graft  
Callus trees

Collect Grafting Wood  
Purchase Rootstock

Mar/Apr

Line Out  
Grafted  
Trees

May

Stake

DeShoot Rootstock  
DeShoot Lower Trunk

## Year Two

Head tree at 50cm  
And  
Select Single Bud

Common Nursery Tree  
Cultural Practices  
Pest Control  
Irrigation  
Fertilization  
PGR's

Defoliate  
Dig  
Plant or Store

Mar/Apr

Oct/Nov



# Plant-in-place Strategy

- Traditional budded tree – 4-5 growing seasons to first fruiting
- Grafted Tree – 3-4 growing seasons to first fruiting
- “Sleeping eye” – 3-4 growing seasons to first fruiting
  
- Less land is tied up

# Risks of Plant-in-place

1. Poor growth. Delay in bearing, insufficient mature yield. You get what you get in the orchard for life!
2. Poor bud or graft take. Skips in the orchard!
3. Weed control failures. See # 1!
4. Insect and disease problems (mildew and plant bug and many others!) See # 1!
5. Deer and mice. See #1, delay in bearing, skips in the orchard
6. Higher labor costs, inability to sort for best trees.
7. Balance between growth and winter hardiness

# Specialized Nursery Equipment



# Tree Storage



01.12.2006 09:47

Bundle  
trees of like  
variety and  
rootstock

Label with  
tag or  
designate  
paint color  
for variety  
and  
rootstock



Store in aged  
sawdust or peat  
moss mix in cooler  
until planting.  
Keep dormant.

Alternately  
keep in the  
nursery  
until just  
before  
planting

