

# Innovative Approaches to Enable Rapid Production of Horticultural Crops *Eliminating the Rootstock Bottleneck*

72<sup>nd</sup> North Jersey Fruit Meeting

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# Introductions



# Research Motivation – Lab to Field



# Innovations for Sustainable Food Production

Pre-Production



Pre-harvest



Post-harvest



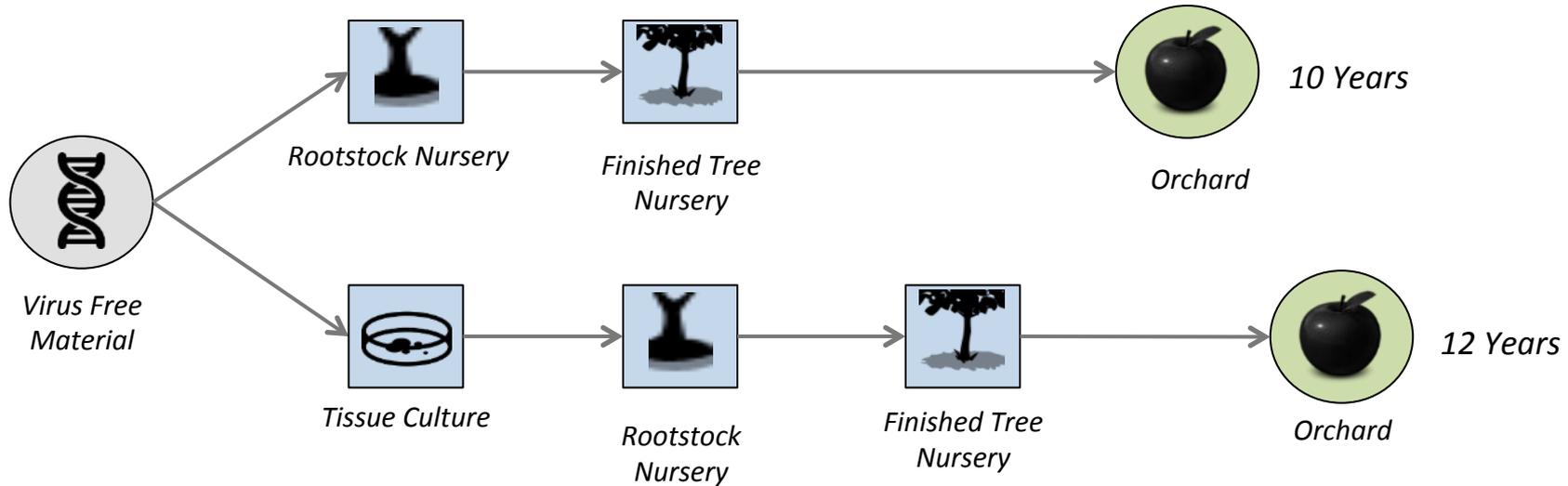


# Rootstock Bottleneck

- New Genetics becoming available at a much faster rate
- Land in the current nursery process is tied up with prior inventory
- Shifting business model – Consumer is asking for new varieties such as HC, Gala and Fuji
- Improving density and efficiency per acre – new architectures
- One size fits all approach in TC – no longer feasible for diverse genetic material
- Market is unpredictable, ability to respond rapidly is the need of the hour

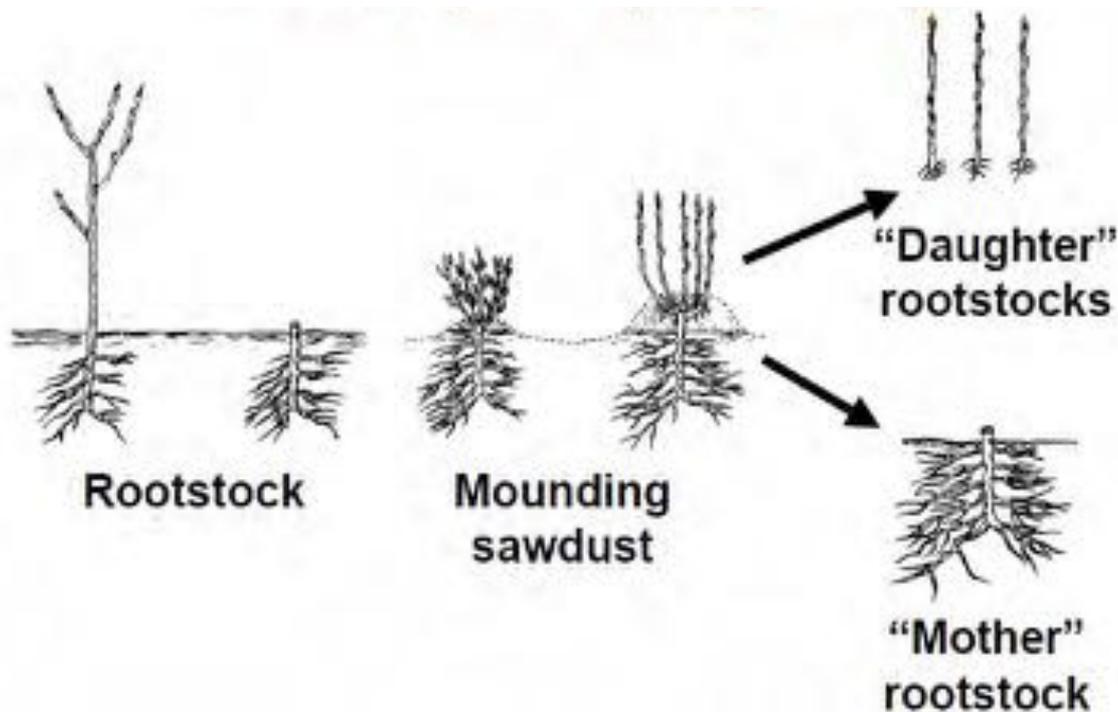
# How it has always been done .....

Traditional  
Processes



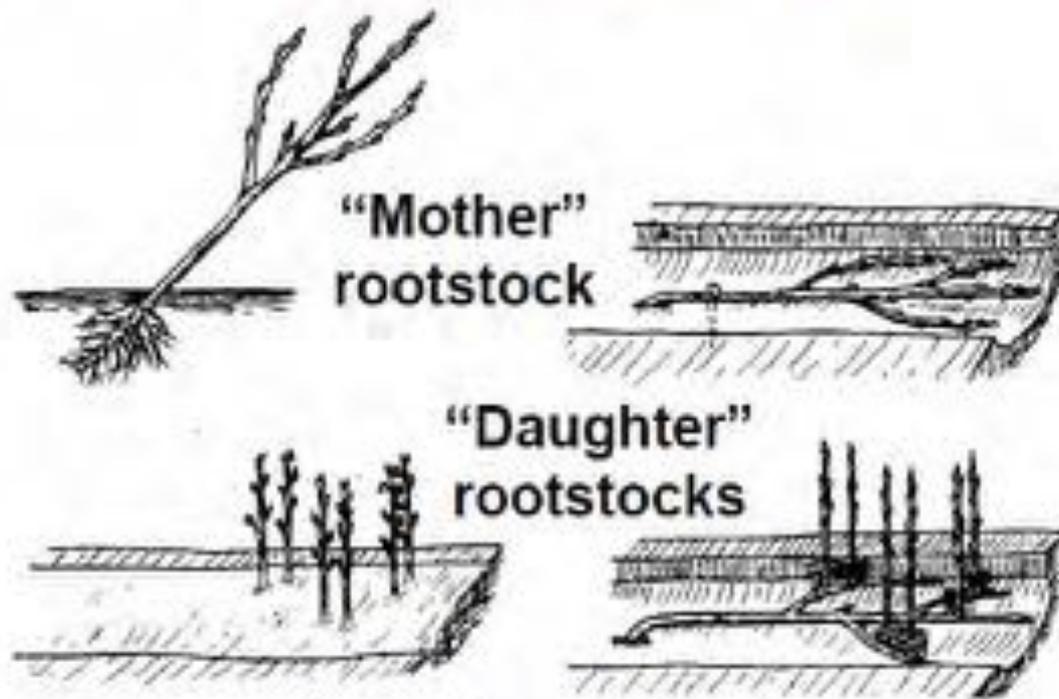
## Rootstock or Plant Material Multiplication (Years 1-4)

Mounding - slower and fewer plants produced initially - stronger, larger plants



# Rootstock or Plant Material Multiplication (Years 1-4)

Layering Faster production of more plants - Weaker, smaller caliper plants, more sort outs



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



# Mature Stool Bed Ready for Harvest



# 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.



# Stool bed Multiplication Rate

- 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
- 100-fold multiplication  
in 4 years/meter
- More plant variability in younger stoolbeds
  - Greater number of “sort outs” plants on younger beds

**Cost per unit low – long time for ROI + cost of lost opportunity**

**No longer realistic**

# Starting Point – Geneva 41



Media and plants received  
from a commercial TC lab



Phytelligence Founding Team

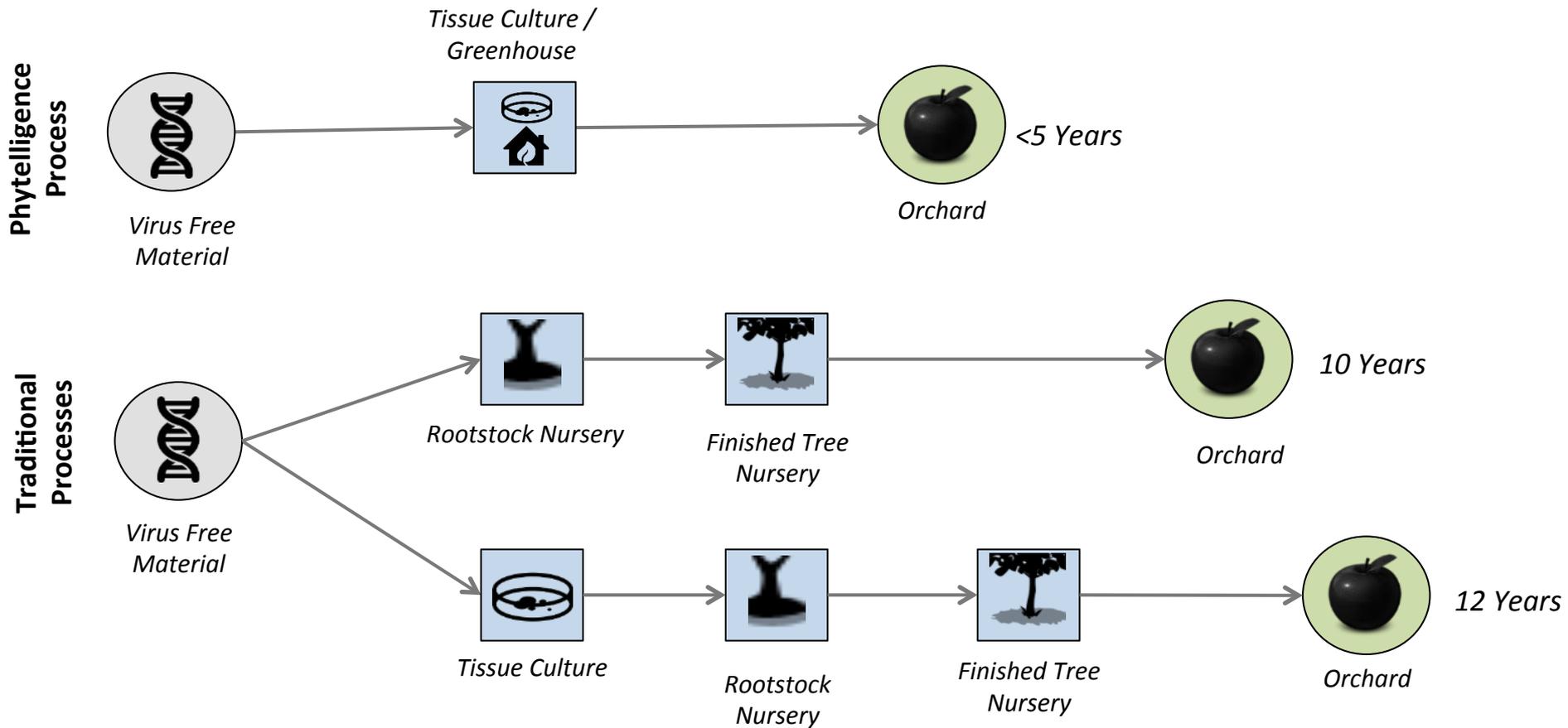
Nathan Tarlyn, Lab manager; Kathie Nicholson, Ph.D. Candidate  
Tyson Koepke, Ph.D. 2012; Derick Jiwan, Ph.D. 2012  
Scott Schaeffer, Ph.D. 2013

# Efficient and Reduced Risk Process



 Phytelligence

# Phytelligence Growing Cycle Versus Traditional Processes



Delivery May 28, 2015 – Planting May 29, 2015  
~18 inch, actively growing, well rooted plants



July 7, 2015  
Plants  
doubled in  
size



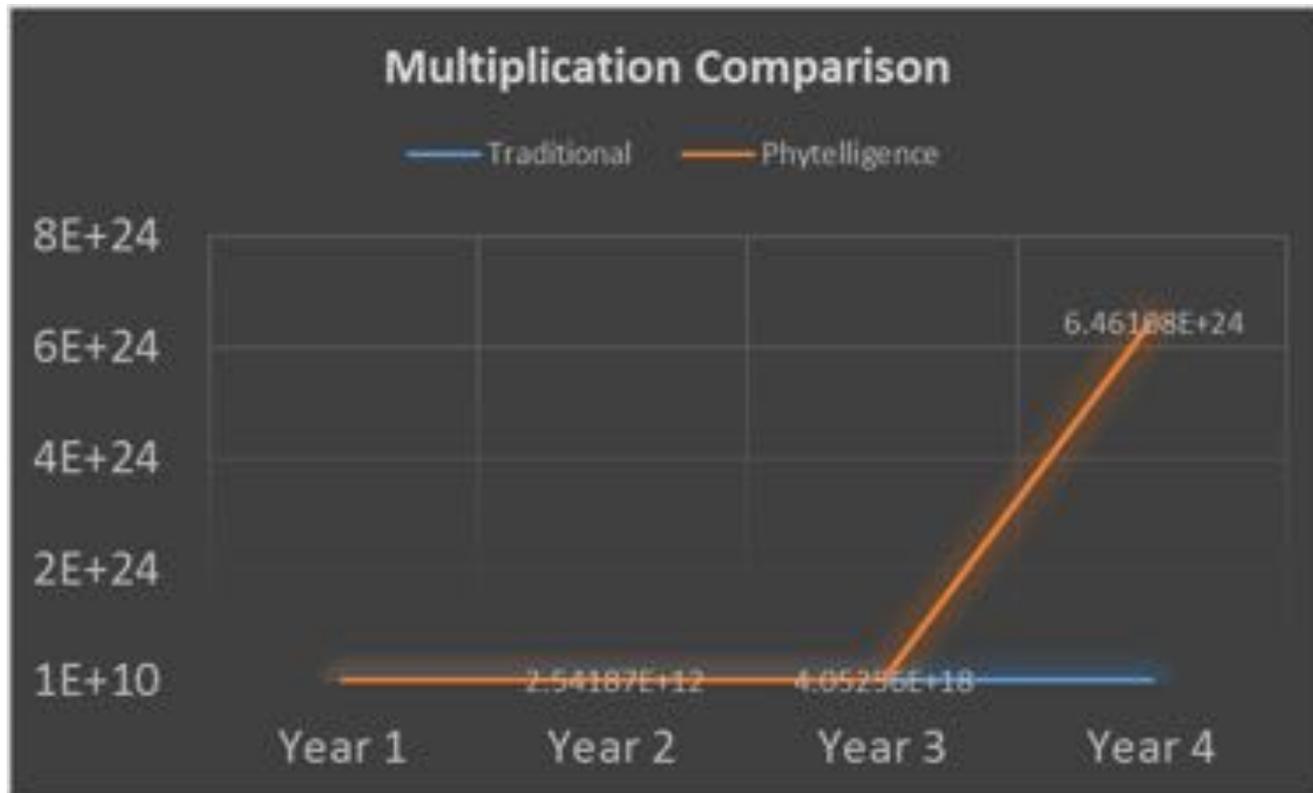


September 4, 2015

Uniform caliper achieved in late August – budded rootstocks

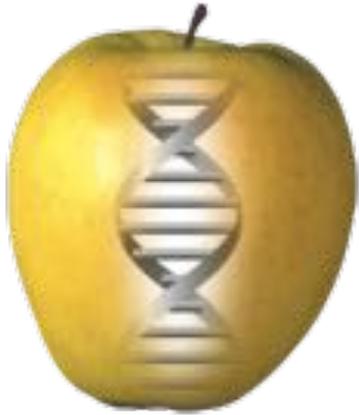
# Multiplication Comparison

	Year 1	Year 2	Year 3	Year 4	
Traditional		1	15	50	100
Phytelligence		1594323	2.5419E+12	4.05256E+18	6.46E+24



# **Risk – Mixed up Identity**

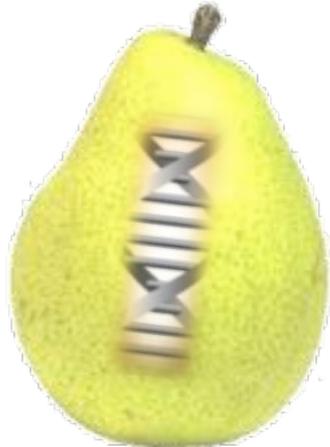
# WSU – Genomes Sequenced



**~79 x draft**  
**Double Haploid Apple Support/  
Collaboration**  
**WSU, IASMA, USDA-NIFA, WTFRC**



**84X draft**  
**Support/collaboration WSU,  
WTFRC, Universidad Andreas  
Bello, Chile**  
**University of Chile, Chile**  
**Roche, Florigenex**



**~65X draft**  
**Support/collaboration Pear**  
**Bureau NW, WSU,**  
**IASMA, Italy**  
**University of Chile, Chile;**  
**Universidad Andreas Bello, Chile;**  
**INRA, France**



**55X draft**  
**Support/collaboration CSIC**  
**Spain, WSU,**  
**Southern Cross University,**  
**Australia**

**With IRTA – Spain –  
40 varieties**

# DNA technology can eliminate losses

## Mixup delays rootstock production

Nurseries propagating the new Geneva 214 rootstock found that it was actually the more vigorous G.222.

RICHARD LEHNERT



Loss of \$300,000 in sales...  
Who paid the bill?

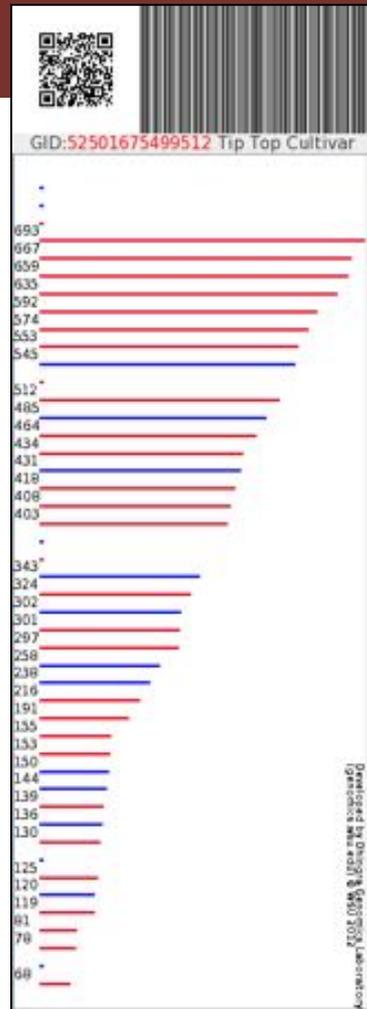
Many growers saw the Geneva 214 rootstock (formerly known as CG4214) for the first time in the orchard of Ed and Mike Witt in the field in Michigan during the International Fruit Tree Association meeting in February 2010 when its... place

RICHARD LEHNERT

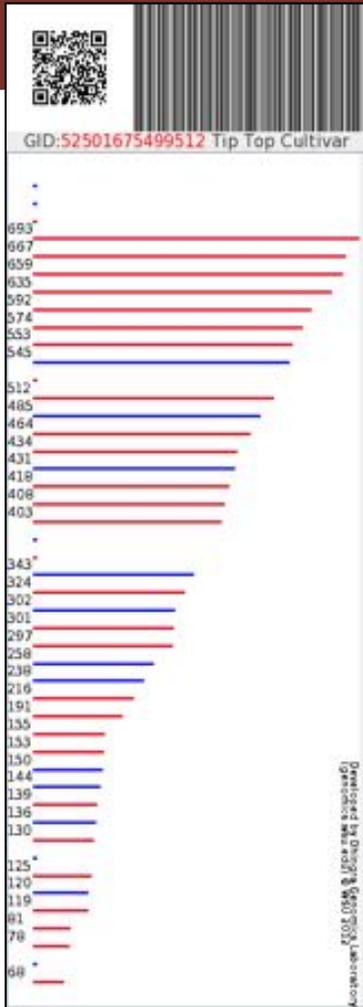
# Guaranteed Identity



Helping you safeguard your investment  
With immutable evidence based on DNA information



# Unique Genetic Identity Barcode



CONSISTENCY is key



- Avoid a mix up before it happens. Genetic identity does not change... UPC labels do. Insurance against risk.
- Consistency – Ensure each and every of the thousands of plants are genetically identical during propagation.
- Unique genetic identity can help in settling infringement issues if any arise. Think managed varieties.

# Pear Rootstock Mix up addressed



Over a dozen genetic analysis projects completed

# Innovations for Sustainable Food Production

Pre-Production



Pre-harvest



Post-harvest



# It started on the orchard....

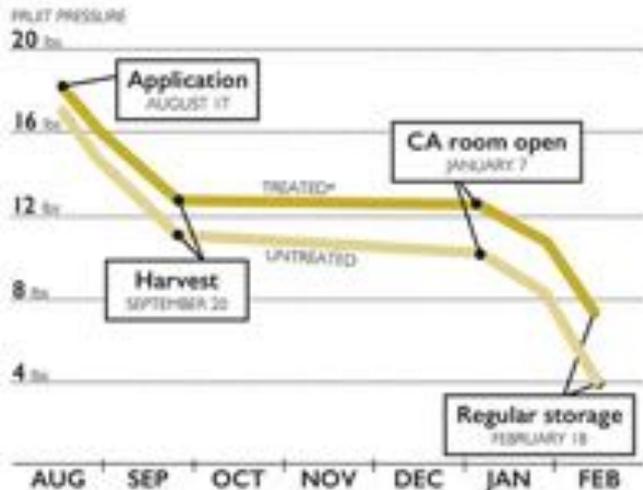
Can we keep the pears green longer on the tree and on the shelf?

Done,  
Sensei Ray!



## Compound improves firmness, color for d'Anjou pears

### Firmness



\*D'Anjou pears treated with glycinebetain (GB) at 10 pounds per acre

### Postharvest color



# **Field trials performed by Professor David Sugar OSU Medford**

- **Fruit quality/Firmness**
  - **Russet**
  - **Internal decay**
    - **Scab**
- **Post-harvest decay**

## Comice pear: Harvest September 15, 2011

Treatment	Rate	Fruit firmness (lbf) 7 DBH	Fruit firmness (lbf) at harvest	Soluble solids (°Brix) at harvest
Untreated	-	14.0 a	12.1 a	13.8 a
30 DBH	10 lb/acre	12.4 a	11.7 a	13.7 a

Untreated - ~34.2% decrease in firmness starting from 7 DBH and during storage

GB treated - ~ 4% decrease in firmness starting from 7 DBG and during storage

30 DBH	10 lb/ac	11.9 b	15.2	0.0
30 + 7 DBH	10 lb/ac	12.0 b	16.1	0.0
	P value	0.056	0.116	

# Internal Browning Eliminated

Comice pear: 6 months storage at -0.5 °C

Treatment	Rate	Fruit firmness (lb)	Soluble solids (°Brix)	Internal browning (%)
Untreated	-	7.9	15.2	33.2
30 DBH	10 lb/ac	8.3	16.1	1.1
30 + 7 DBH	10 lb/ac	8.7	15.4	0.0
	P value	0.738	0.288	0.111

## **Field trials performed by Professor David Sugar OSU Medford**

- **Fruit quality/Firmness**  
**Comice remained firmer during storage**
- **Internal decay**  
**Internal decay eliminated in Comice**
- **Scab**  
**Scab reduced but not eliminated**
- **Post-harvest decay**  
**Significant decrease in post-harvest decay**

# Implications of Delayed Ripening

- Fruit can stay longer on trees
  - Longer picking season
  - Increased fruit weight
- Effects on storage
  - Longer storage/shelf lives
  - Increased market
- Firmer fruit for packing/transport
  - Less damage

# Commercial Trials

- Commercial trials started with a local Ag Chemical company Fall 2015
- Encouraging results at harvest
- Post harvest fruit quality will be evaluated in March 2016
- Continued trials in 2016-2019

# Innovations for Sustainable Food Production

Pre-Production



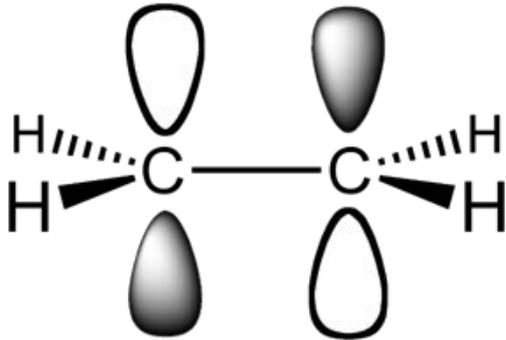
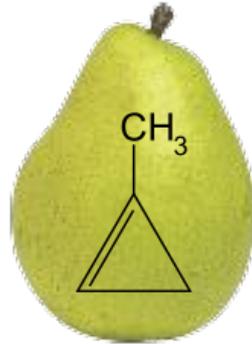
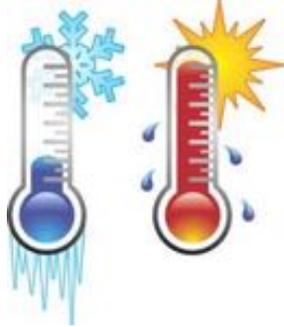
Pre-harvest



Post-harvest



# Regulation of Ripening



1-MCP completely suspends ripening. It also blocks cold-induced ripening.

Predominant hypothesis – Ethylene receptors are occupied by 1-MCP and there is no turnover of receptor proteins

Is the non-responsiveness to 1-MCP due to the non-ethylene pathways?

Indicators of metabolic limitations in gene expression study.

# Metabolic Override Approach to Reactivate Ripening



- Potential Ripening Compounds (RCs) were dissolved in water
- Pears were immersed for 24 hours
- They were placed in air flow chambers for measurement of ethylene and CO<sub>2</sub>

# Results

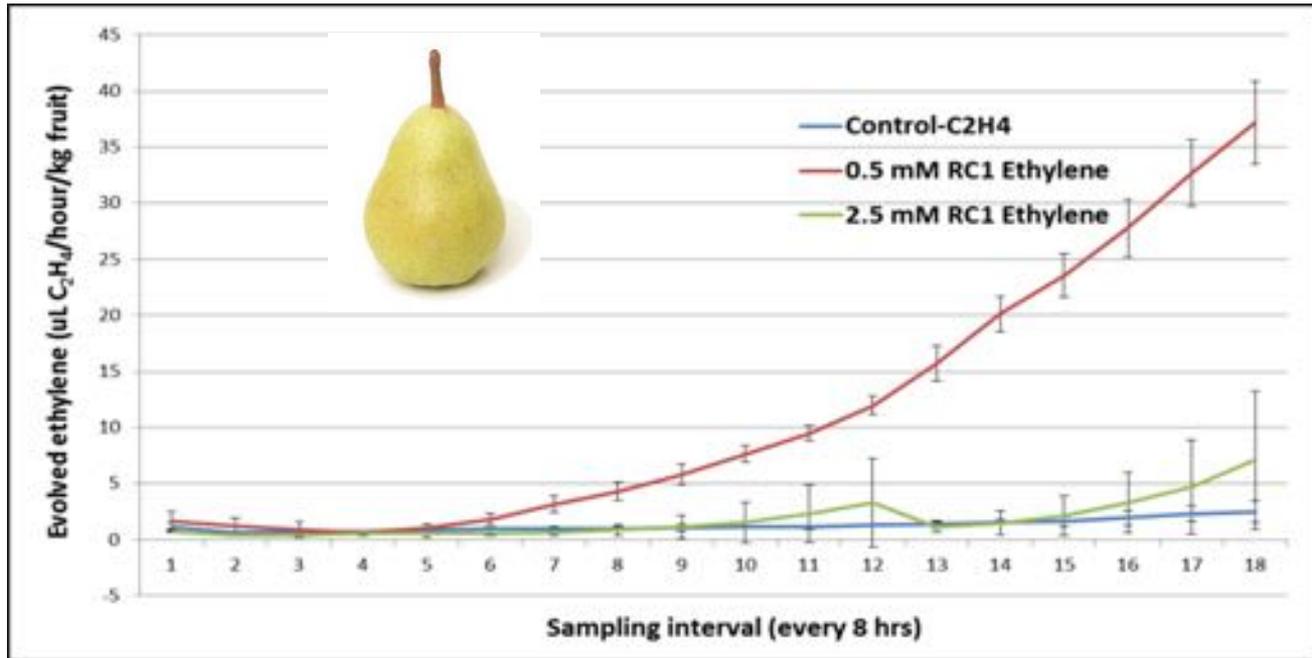
2.5 mM RC-1



Control

0.5 mM RC-1

# Results - Ethylene

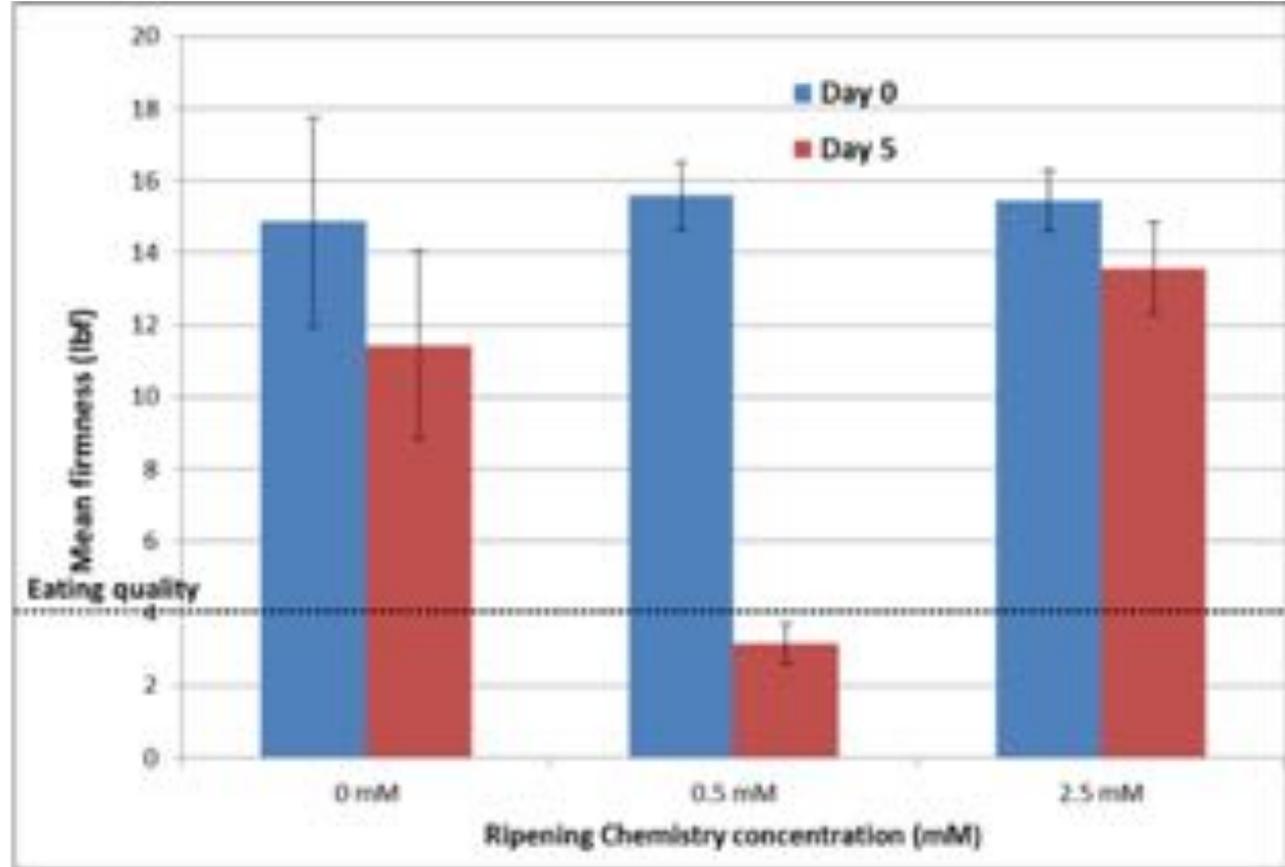


Evolution of ethylene measured in microliter per hour per kilogram fruit. Note the positive trend of ethylene release in fruit treated with 0.5 mM RC-1 as an indicator of progress towards ripening in 1-MCP treated fruit. (Dhingra and Hendrickson - US20140121110 A1)

# Results - Firmness



Mean fruit firmness as calculated on day 0 and day 5. Note the drop in fruit firmness in fruit treated with 0.5 mM of RC-1. The firmness of 4 lbf and below represents eating quality in pear fruit. (Dhingra and Hendrickson - US20140121110 A1)



# Consumer Survey



# Preliminary taste panel analysis

Ranking 2015 - Anjou				
	Overall acceptance	Appearance	Taste/ Flavor	Texture
Most acceptable	3% RC	1%	3% RC	3% RC
	2%	Control	2% RC	2% RC
Least acceptable	Control	2%	1%	1%
	1% RC	3% RC	Control	Control

Knowledge –  
network of experts

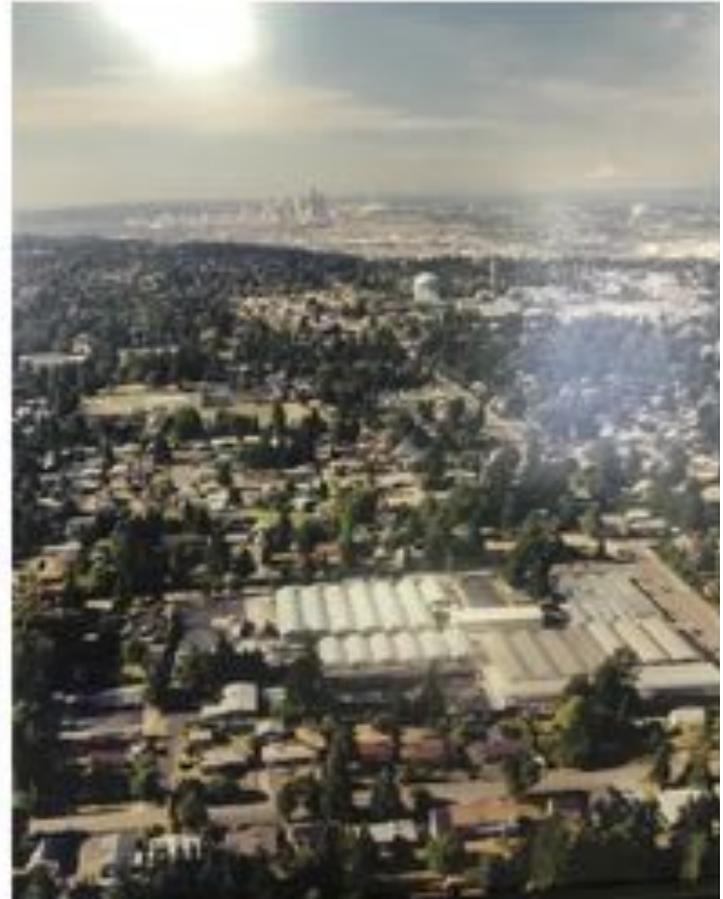
Services – DNA  
testing , virus  
screening and .....

Product – True to Type  
Plant Material



One Stop Shop

# Capacity



# 3 pillars of business success

*Time - And you run and you run to catch up with the sun but it's sinking*

*Racing around to come up behind you again*

*The sun is the same in a relative way, but you're older*

*Shorter of breath and one day closer to death....*



# Phytelligence – Jersey Boys



**Phytelligence Open House  
4:30 pm – 6:00 pm**



Thank you!

