Technology to improve and prolong production of selected tropical fruits

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IFAS Extension

Outline

Fruit crop	Practice(s)
Guava	Selective pruning, fruit thinning, and fruit bagging; defoliation
Banana	Selective and timed pruning
Carambola	Selective limb bending and pruning; crop sacrifice and drought stress
Longan	Pruning and application of potassium chlorate
Papaya	Ratooning and crop sacrifice

Guava (*Psidium guajava*)

- Growth habit
  - Small single to multi-trunked tree easily managed to <10 ft tall
  - Flowers/fruits on new shoots
  - Response to pruning is new shoot initiation where flowers arise in the leaf axils of the second to fourth node
- Potential
  - Synchronize all shoots on a tree to flower and fruit at the same time
  - Alternatively, defoliate entire tree to synchronize and induce flowering
  - Selectively prune shoots to induce flowers and fruit over an entire year
    - Normally two crops: summer and spring

Guava types

Pink types (eaten when ripe)

‘Barbie Pink’

‘Homestead’
(Ruby Supreme)

White types (eaten hard and crunchy

Thai-guava
(generic name)

Taiwan guava types

Crop cycling strategies

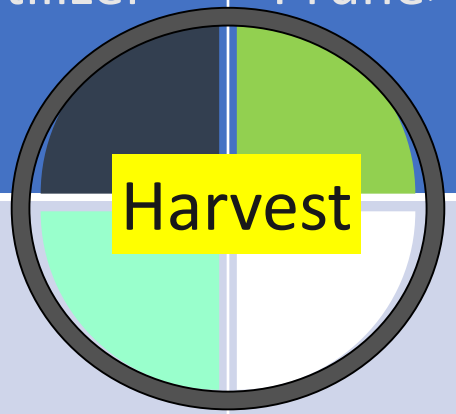
Method sequence	> = then
Pruning	Harvest>Selectively prune
Drought	Harvest >Prune and impose drought stress (3-4 wks) >fertilization (N) and irrigation
Defoliation	Harvest>Prune>apply defoliant>fertilization (N) and irrigation
	Defoliants include: 1) ethrel (900 ml/30 oz), 11 kg/24 lbs urea plus surfactant; 2) ethrel (600 ml/20 oz), 11 kg/24 lbs urea plus surfactant; 3) 25% solution of urea plus surfactant
Factors	• Ambient temperatures • Time from treatment to harvest 6-7 months • Time from flowering to harvest 4-6 months

Attempting year-round production

* four trees or four blocks of trees
* weather conditions change during the year

Month 1
Prune>drought>irrigation plus fertilizer

Month 4
Prune>defoliation>irrigation plus fertilizer



Month 6
Prune>defoliation>irrigation plus fertilizer

Month 8
Prune>drought>irrigation plus fertilizer

Hand pruned, tree size control – white guava

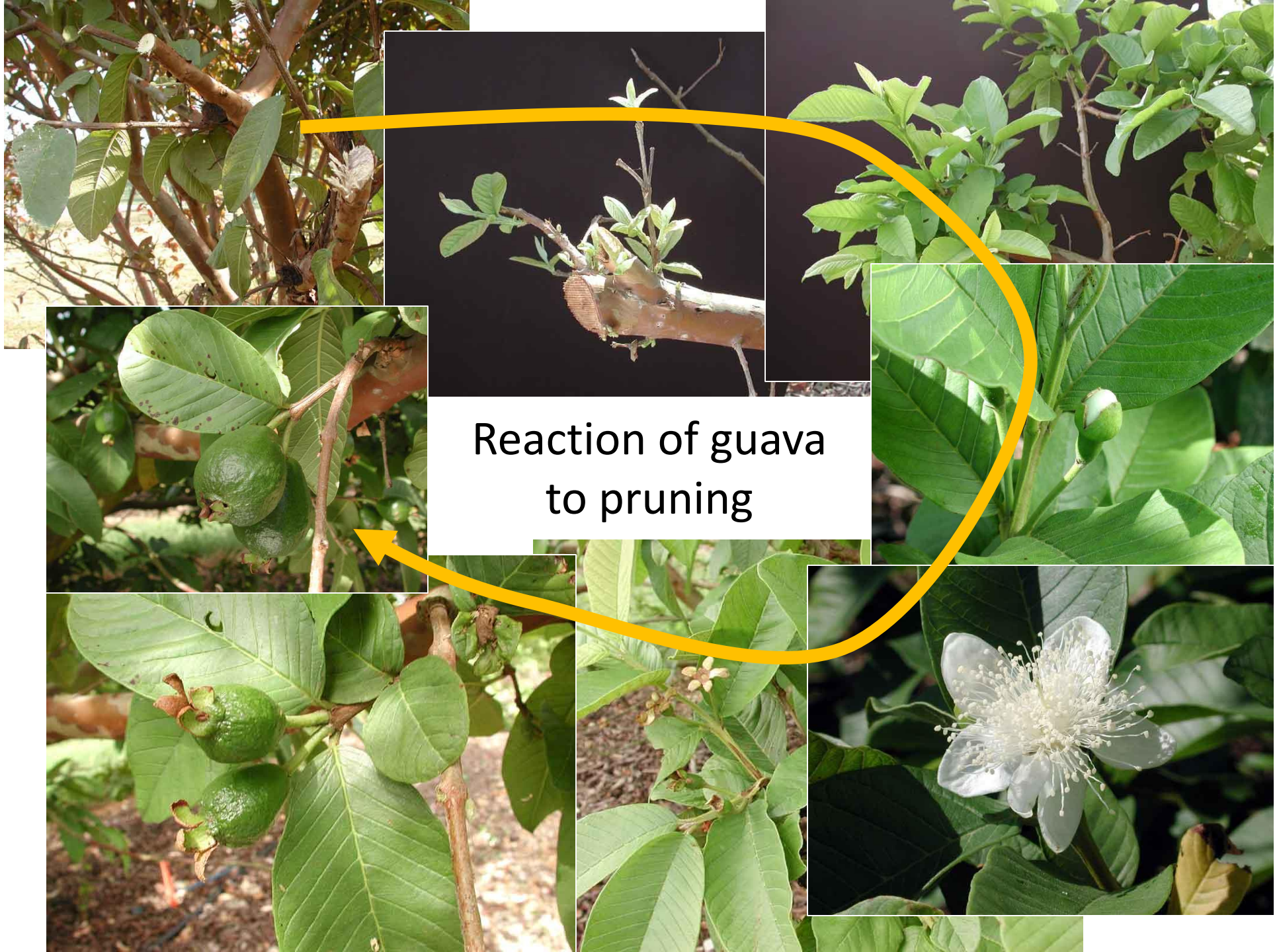
Selective pruning, fruit thinning and bagging

Methodology

- Selectively cut back shoots (>1.0”)
- Selectively remove some fruit (~1 fruit per foot or so)
- Place netting then breathable bag (cut slits in bottom)

Benefits

- Potential year-round cropping
- Reducing fruit load results in remaining fruit to be larger
- Bagging fruit protects fruit from fruit flies, insect probing, and wind scar (scratches)
  - Paper (biodegradable)
  - Plastic


Reaction of guava
to pruning

Fruit thinning, bagging and results

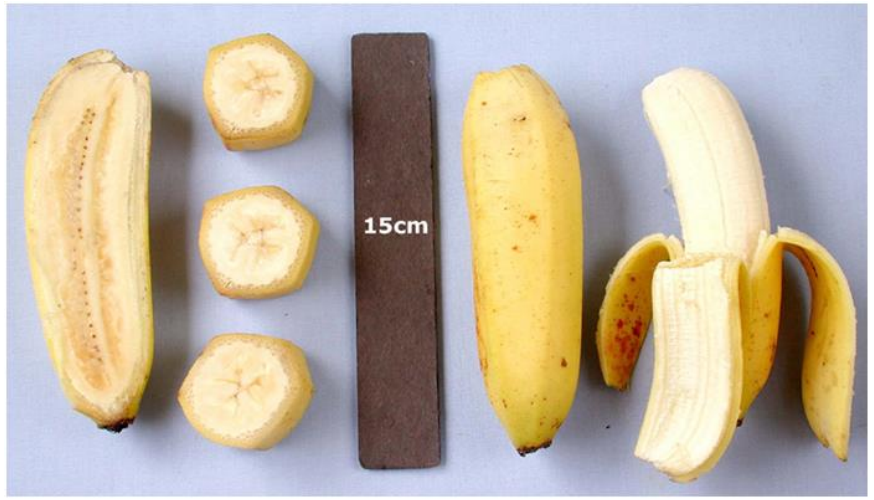
Banana (*Musa* hybrids)

- Growth habit
  - Small to large arborescent (tree-like) plants ranging in height from 3 to 26 ft tall. Single to multi-trunked
  - Each banana stalk grows vegetatively, then flowers and fruits, then dies and is replaced by a new pseudo-stem
  - Flowers after ~26 to 32 leaves or so have emerged
  - After flowering 10-15 leaves are present. By harvest usually 5-12 leaves are present
  - Time from shooting (flowering) to harvest in subtropics 110-300+ days
- Potential
  - Synchronize plants to flower and fruit at about the same time
  - Time pruning so fruit are harvested to meet specific market windows

Fruit description

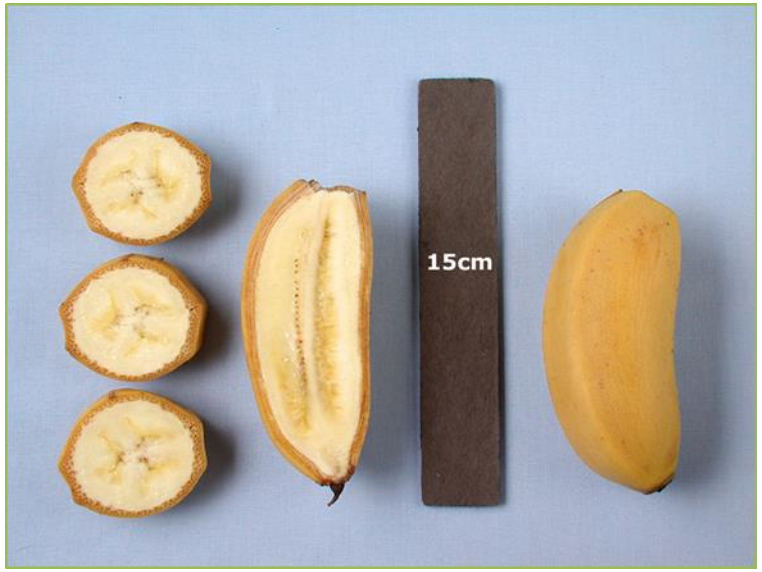
- Fruit are seedless, the pulp develops mainly from the outer edge of the locule (inner face of the skin). However, the septa and axis tissue also contribute
- The ovules shrivel and remain as minute brown flecks in the edible pulp
- The majority of fruit are sterile probably due to specific sterility genes, triploidy, and chromosome structure

Selected banana cultivars



‘Gold Finger’ (FHIA1)

‘Klunamwa’



‘Mona Lisa’ (FHIA2)

Inflorescence – flower description

- The male and female flowers are grouped in 10-20 and are separated along the inflorescence
- The first flowers to emerge are functionally female and in edible cultivars are seedless (parthenocarpic)
- Next transition flowers
- The last flowers to open are functionally male

Flowering also called shooting

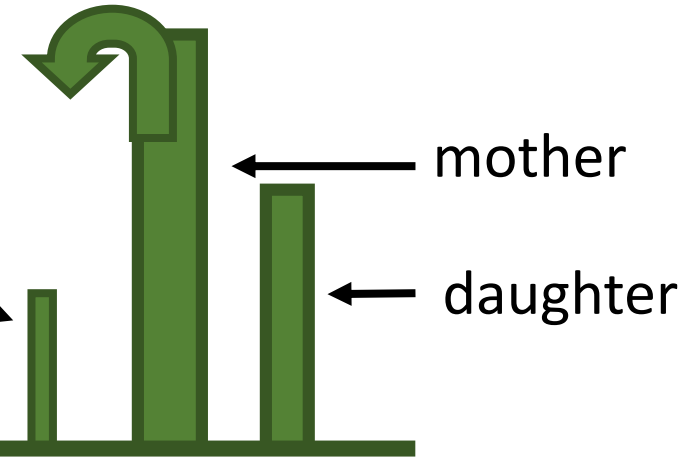
Mat management to synchronize cropping

- Overcrowded, competition for light, water, and nutrients
- Each mat is on it's own development cycle
- At any specific time harvest is low

- Minimal competition for light, water and nutrients
- Entire planting is synchronized, i.e., on the same development cycle
- Harvest is high at a specific time

Conventional mat and stem pruning

1. Remove water suckers and re-growths from damaged or previously cut psuedostems
2. Select a daughter sword sucker that is healthy and is most appropriately located to minimize competition with adjacent stems and newly emerging suckers
3. Removal all other suckers 3 ft tall or more.



Maintain just 3 psuedostems until the mother plant flowers or fruits, then select and allow a granddaughter to grow

One-stem method: an alternative mat management

- Constantly remove all but the fruiting psuedostem
- Focus on optimizing cultural practices to enhance plant and fruit growth
- Allow 1 new psuedostem once main stem flowers

- Faster plant growth
- Reduced time to flowering and fruiting
- Faster fruit bunch and fruit finger development
- More intensive mat management

One psuedostem mat management

Mat pruning in Florida to optimize banana production

Objectives - speed fruit development (maturation) and produce fruit at specific times of the year.

1. Plant or replant at a certain time so that the plant crop and follower (next) crops bear at different times of the year.
2. In already established plants, mature psuedostems can be
   - cut down to stimulate the growth of the younger (daughter and granddaughter) plants
   - or remove the fruit from mature (mother) plant but leave the mother plant until the daughter plants become near full size and then remove the mother plant (mother plant provides food sources to entire plant)
   - Removing the mother plant (or removing its fruit) will stimulate the growth of the daughter and granddaughter plants and they will flower sooner

One psuedostem mat management example - Florida

Under south Florida conditions (marine, subtropical) 'Burro' usually takes about 538 days and 'Klunamwa' takes 514 days (Ploetz, et al., 2000. HortSci. 35:120-124)

By removing all psuedostems but <u>one</u> on each mat and maintaining this one psuedostem, the remaining psuedostem grows more vigorously and flower and fruits sooner than the 3 psuedostem mat management system

Month	J	F	M	A	M	J	J	A	S	O	N	D
'Burro' (ABB)								**P**				
						H						
'Klunamwa' (ABB)								**P**				
							H					
Plant (P) = day 0; H (H) = harvest. **'Burro' = 301 days: 'Klunamwa' = 341 days**												

Saved 237 ('Burro') and 173 ('Klunamwa') days

Other practices to enhance fruit development

- Propping (common in Asia) and tying (common in western tropics). To reduce plant losses to toppling, the fruiting stalk/psuedostem may be propped up with poles or stakes or tied to adjacent plants or guy wires for support.
- Deleafing. Removal of leaves that touch or may touch the fruit bunch and cause scaring.
- Debudding. Removal of the male flower bud and breaking off false hands and 1-2 of the smallest apical hands speeds maturation and finger length of the remaining fruit.
- Mulching – enhance nutrient and water management
- Wind protection – enhance water management and reduce mechanical wind damage to leaves and plants

Carambola (*Averrhoa carambola*)

Growth habit

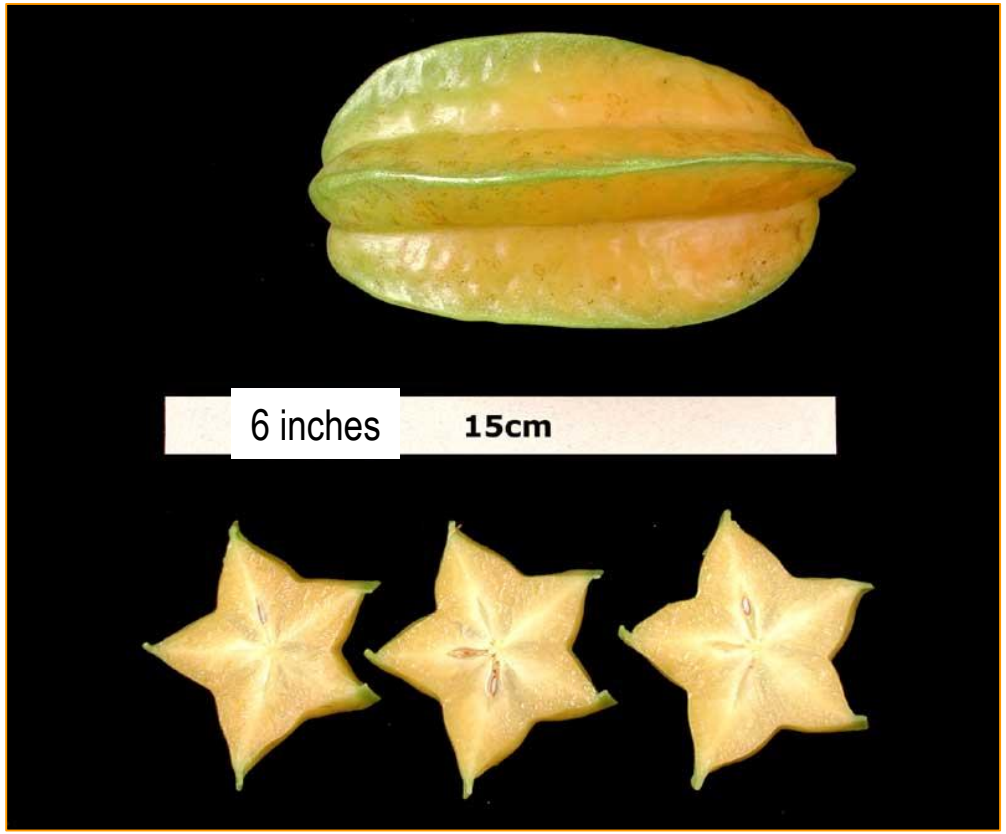
- Small single-trunked tree easily managed to <11 ft tall
- Flowers/fruits on long whip shoots, short feather shoots, at the collar base of intermediate sized shoots, and large wood
- Flowering response to bending long shoots (clipping terminals) and pruning to collar base of intermediate sized shoots

Potential

- Synchronize many shoots on a tree to flower and fruit at the same time
- Alternatively, mild drought stress entire tree, then irrigate to synchronize and induce flowering (caution)
- To extend the fruiting season (earlier and later); normal cropping behavior in south Florida is July-Sept and Dec-Feb

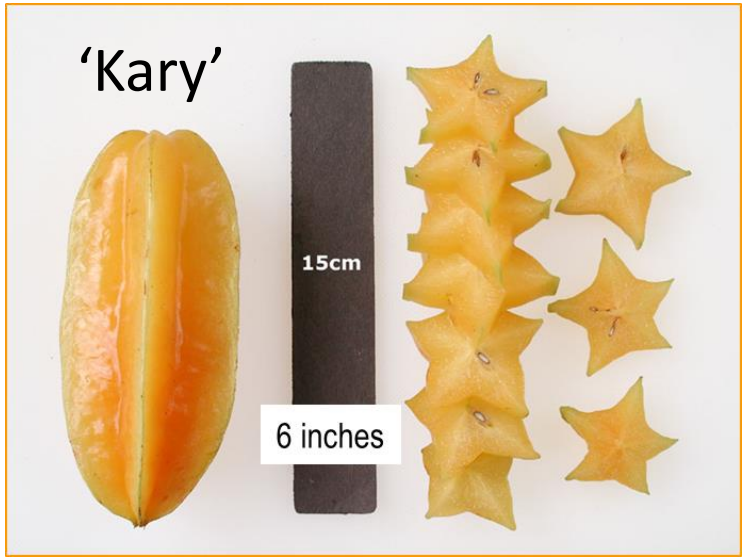
Fruit description

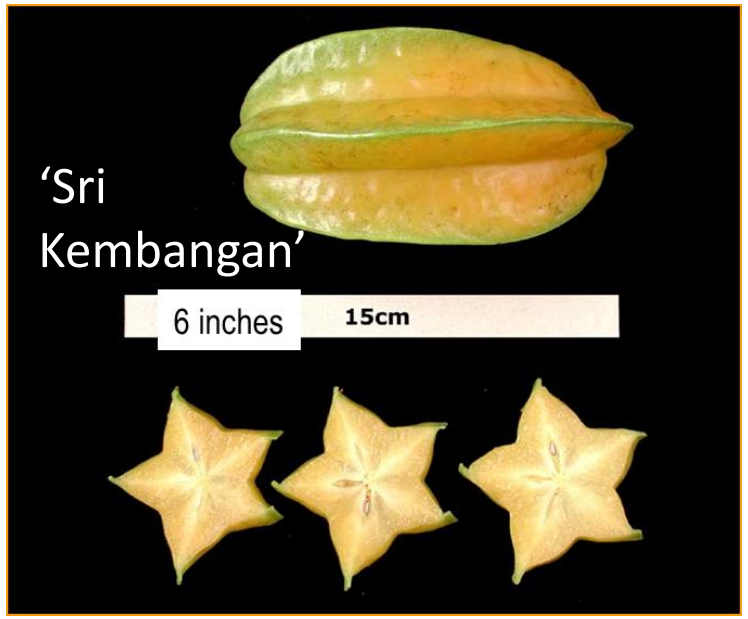
- ☆The fruit is a 4 to 5-celled berry with 0 to 12 edible seeds.
- ☆Fruit range in size from 2 to 6 inches with 4 to 8 ribs; cut in cross section the fruit has a star shape.
- ☆The fruit skin is edible, smooth, and waxy.
- ☆The fruit flesh is juicy, light to dark yellow in color, crisp, and without fiber. Desirable cultivars have an agreeable sub-acid to sweet flavor.

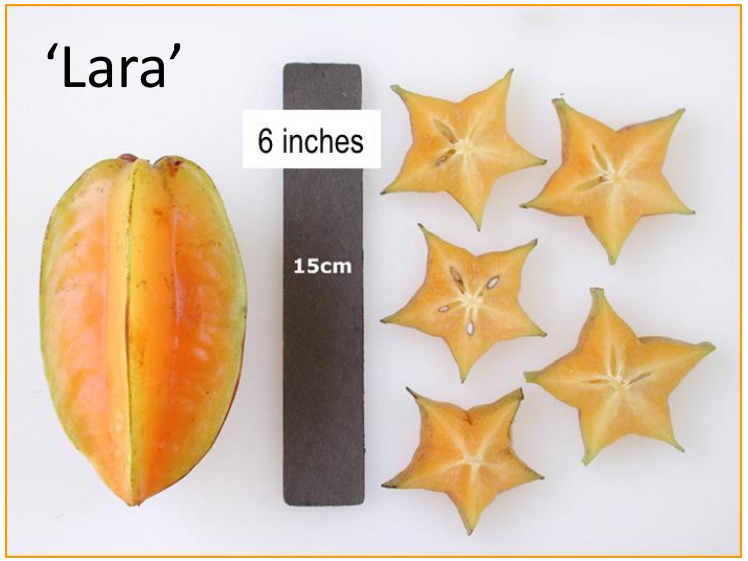


‘Sri Kembangan’

Carambola cultivars







Fruit development – normal fruit set to harvest

- The fruit development period (anthesis to fruit maturity) is cultivar and temperature dependent ranging from 8-12 weeks during the spring/summer and 10-16 weeks during fall/winter.

Season	Days - fruit set to harvest
Spring/summer	56 – 84
Fall/winter	70 – 112

Pruning for off-season fruit production

- Three methods
  - Bending long shoots and clipping the terminals back 8-12 inches
  - Pruning shoots back to just outside the collar of a major secondary limb
  - Crop sacrifice (removing young fruit)

Photo credit and copyright: Roberto Nuñez

Selective pruning of ‘Arkin’ carambola to the base collar of small to mid-sized stems may induce flowering

Photo credit and copyright: Roberto Nuñez

Selective small-medium-sized limbs cut back to basal collar

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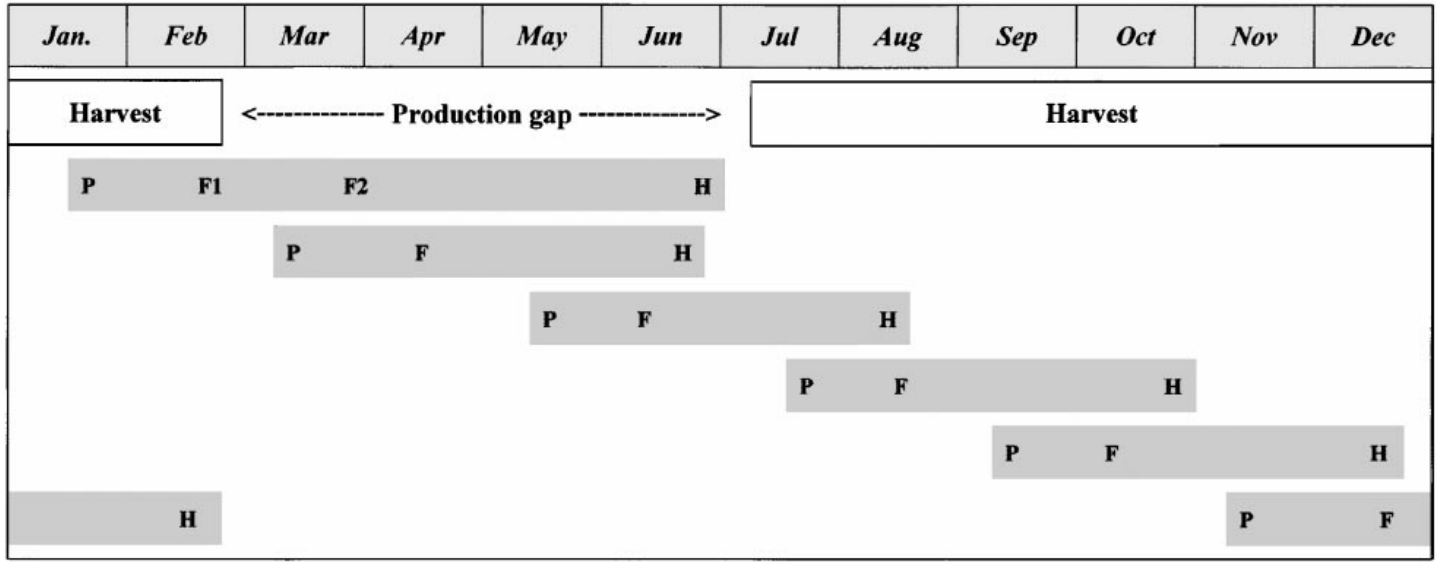


P-pruning
F-start flowering
H-harvest
F1-too cold

- Pruning in Jan. or March resulted in early-season fruit by end of June
- Pruning in July resulted in fruit in October

Effect of selective pruning on time to harvest and fruit yield in 'Arkin' carambola in Homestead, FL, 1994–1995

Pruning date	Harvest date[a]	Weeks from pruning to harvest	Fruit yield	
			g per bud[b,c]	kg per branch[b]
March 7	June 25	14	223 b	18.1 b
May 12	August 18	13	259 b	18.7 b
July 17	October 29	13	381 a	23.6 a
September 7	December 22	14	255 b	21.3 a
November 9	February 26	14	325 a	19.2 ab
January 12	June 30[d]	22	185 c	14.5 c

[a] Harvest of non-pruned trees began July 30, 1995.
[b] Means with different letter within columns are significantly different according to Duncan's multiple range test, $P \leq 0.05$.
[c] Includes fruit from panicles formed at branch collars from removed lateral branches.
[d] No fruit set occurred on these branches until March 15.

Núnez-Elisea – Crane. 1998. Proc. Fla. State Hort. Soc. 111:310-312.

Off-season bloom induction and fruit production via crop removal (crop sacrifice)

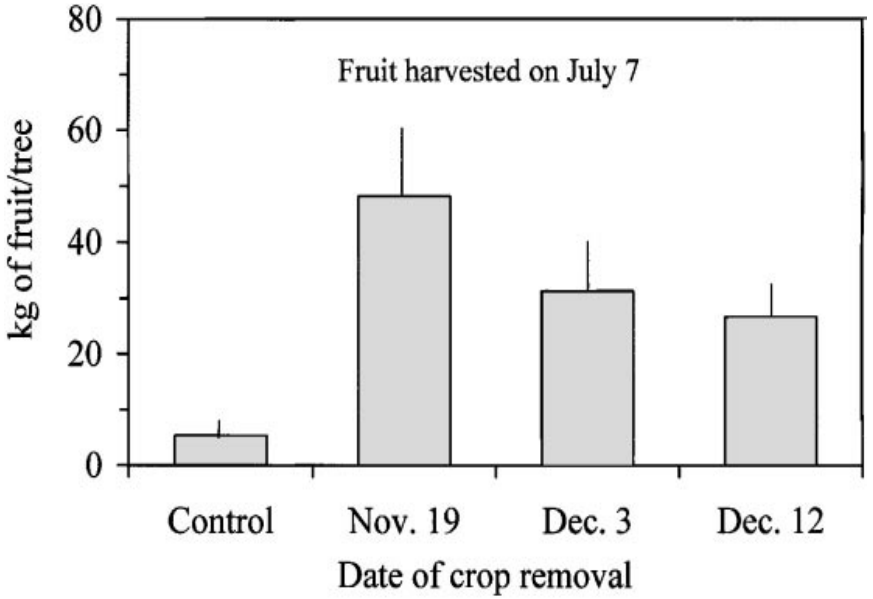
- ☆ Removing young fruit from trees during Nov.-Dec. results in a more vigorous tree during winter (leaf retention) and early spring canopy recovery and potentially earlier flowering; resulting in June-July fruit.
- ☆ Removing the fruit from the tree may result in off season flowering and fruit production.
  - ☆Fruit were 50% or more full size (shake branches)
  - ☆May be more effective if removed at smaller size but more difficult to remove (stripped)

Effect of time of crop removal on the intensity and earliness of flowering in 'Arkin' carambola in Homestead, FL, 1994

Crop removal date[a]	% of flowering shoots[b]		
	March 26	April 12	April 29
Control	12.7 b	20.1 b	65.0 c
November 19	40.2 a	63.3 a	77.2 b
December 3	35.7 a	58.4 a	90.1 a
December 12	37.4 a	62.6 a	82.4 b

[a] Fruits were removed manually from treated trees; control trees were left intact. Flowering rates were monitored on 10 one-year-old shoots per tree, selected from the canopy periphery.

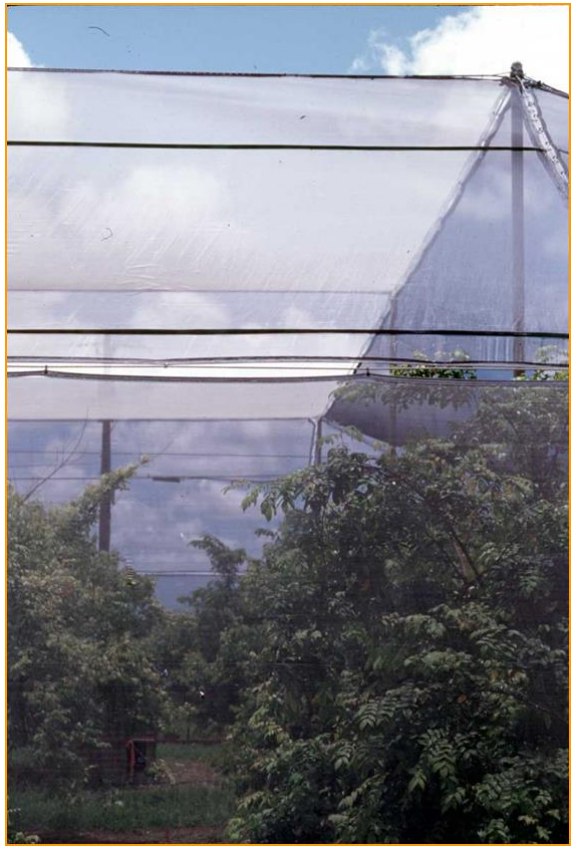
[b] Means with different letter within columns are significantly different according to Duncan's multiple range test, $P \leq 0.05$.



Effect of fruit removal on subsequent flowering and fruit production

Other practices to prolong/enhance production

Natural wind breaks (e.g., avocado)



Man-made wind breaks

Mulch

Longan (*Nephelium longana* var. longan)

Growth habit

- Medium to large tree to 60 ft, vigorous and spreading canopy
- Flowers are held on panicles (thyrses) which are produced from the terminal and subterminal buds on matured stems (shoots)

Potential

- Synchronize entire tree through pruning, nutrient and water management
- Off-season production to almost anytime of year with $KClO_3$
  - Normal season, July

Fruit description

- Longan fruit is a drupe with a thin, leathery, smooth exocarp (peel) surrounding a translucent white, sub-acid flavored flesh (aril)
- The pulp surrounds a single seed
- Fruit may be round, oval, or oblong shaped
- The peel is tan to light brown.
- Fruit may weigh up to 22 g (usually 10-20 g); total soluble solids, 15-25%

‘Hong Kong’

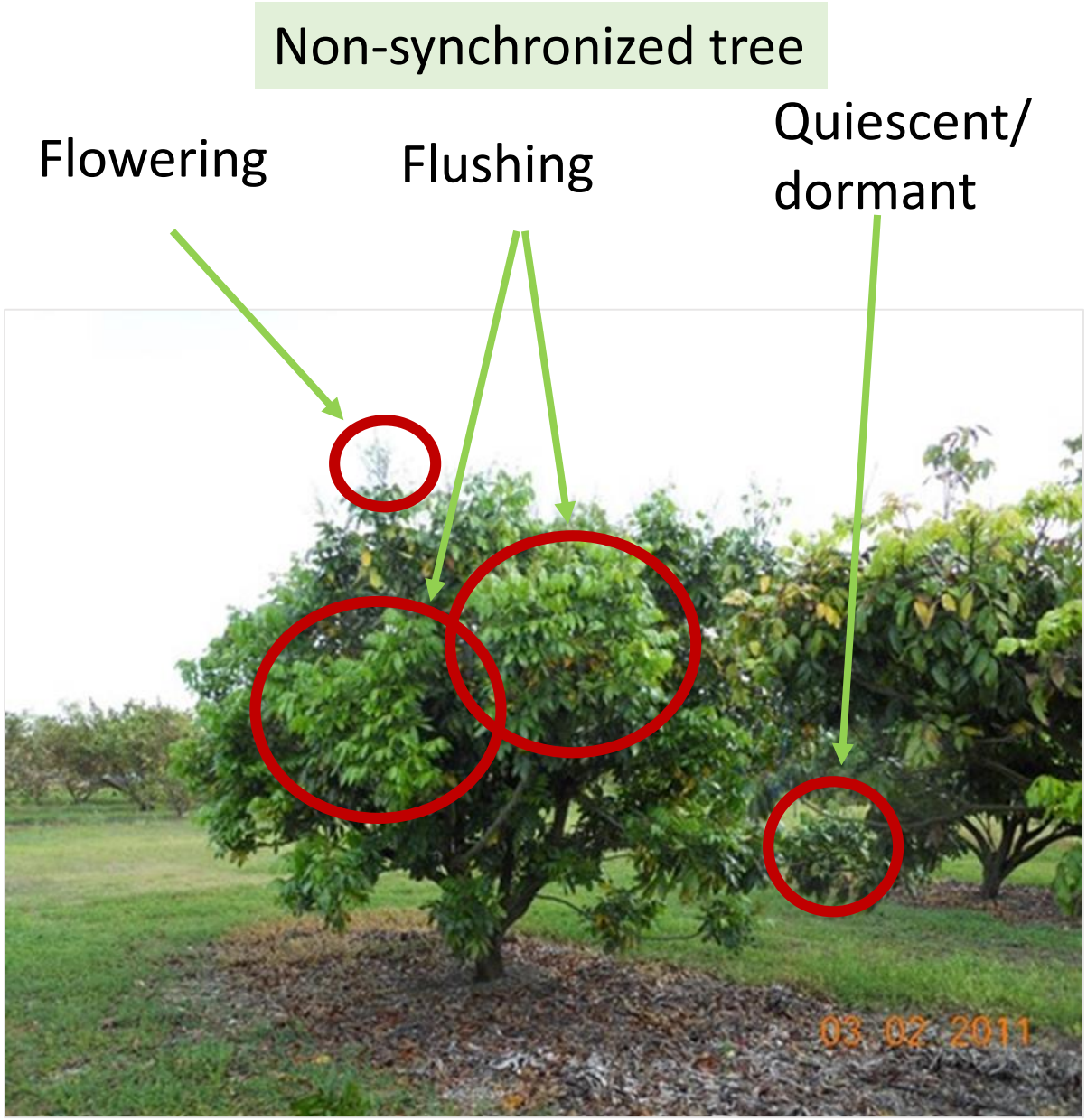
Longan cultivars in Florida

Numerous cultivars

- Top Florida cultivars
  - 'Kohala'
  - 'Chomphoo'
  - 'Edau'
  - 'Biew Keiw'

Crop production strategy – setting up trees to be induced to flower

- Maintain light exposure to entire canopy and <u>synchronize all shoots through pruning</u>
- Control (amounts and timing) nutrient and water applications to control vegetative flushes and induce dormancy (quiescence)
  - Leaf N content ~1.4% to 1.1%
  - Eliminate irrigation after harvest



Pruning to synchronize the tree (all the shoots)

Off season longan fruit production
Potassium chlorate background

Characteristics

- odorless, solid, fine crystalline, white colored material
- is a powerful oxidizing agent and used in making explosives, matches, and pyrotechnics.
- This material can explode if handled improperly

- When heated it emits toxic fumes of chloride and potassium oxide. It is categorized as a compound that requires precaution in handling and storage
- Read and follow all precautions for the Safety Data Sheet (formally Material SDS)

How to use potassium chlorate: recommended steps for applying potassium chlorate as a soil drench to induce longan bloom

- Tree phenology. Trees should not be flushing, about to flush or have just completed a flush
  - Stems need to be mature and dormant
  - You may need to wait or set trees up for the future
- Tree health. Trees should not be nutrient deficient; they need to be healthy

Tree size/age	Rate of $KClO_3$ per tree	Comments
4 to 8 years old*	4 to 7 oz	Usually 1 application only
8 to 15 years old	7 to 13 oz	Usually 1 application only
15 plus years old	13 oz to 22 oz	Some people apply twice to very large trees.
The first application may be 16 oz/tree and the second application 30 days later at 8-10 oz per tree.		

How to use potassium chlorate ($KClO_3$) - the application

- Pull back leaf litter and/or the organic mulch layer from under the canopy
- Irrigate the grove a day or so before application
- Either apply dry by sprinkling or carefully mix with sufficient water to cover under the canopy
- Apply the material to the soil surface under the canopy
- Irrigate trees immediately to move the material into the root zone
- Irrigate for several hours every 3 to 4 days for the next several weeks
- Bloom should initiate in 3 to 6 weeks and harvest 4-6 months later

The rate of $KClO_3$ for older trees (>10 years old) increases up to
About 0.5 kg/tree or slightly more

Time from $KClO_3$ treatment and flowering and harvest

- Influenced by temperature and cultivar
- Flowering ranges from 30 to 60 days after treatment
- Harvest ranges from ~6 to 10 months after treatment
- No residues of $KClO_3$ in fruit
- If application rates are too high $KClO_3$ may be toxic
  - Marginal leaf necrosis – oldest leaves
  - Leaf drop, oldest leaves first

Papaya (*Carica papaya*)

Growth habit

- Gian arborescent herbaceous tree, usually single-trunked, and short lived
- Three plant types: males, females, and bisexuals
- Male flowers held on long branched cyme whereas female and bisexual cymes arise from leaf axils
- Flowers in response to tree size and ambient conditions

Potential

- Year-round production BUT as plants grow the fruiting column moves upward making harvest more difficult and in-efficient
- Potential to maintain fruit production through planting plants on a angle or ratoon to induce lateral branches and fruit production from these branches

Fruit description

- Papaya fruit is a berry with a thin, smooth exocarp (peel) and thick fleshy mesocarp surrounding an open cavity containing many small seeds
- Fruit may be globose, ovoid, obovoid, and pyriform, 2.5 - 14 inches long and 0.3 – 22 lbs in weight

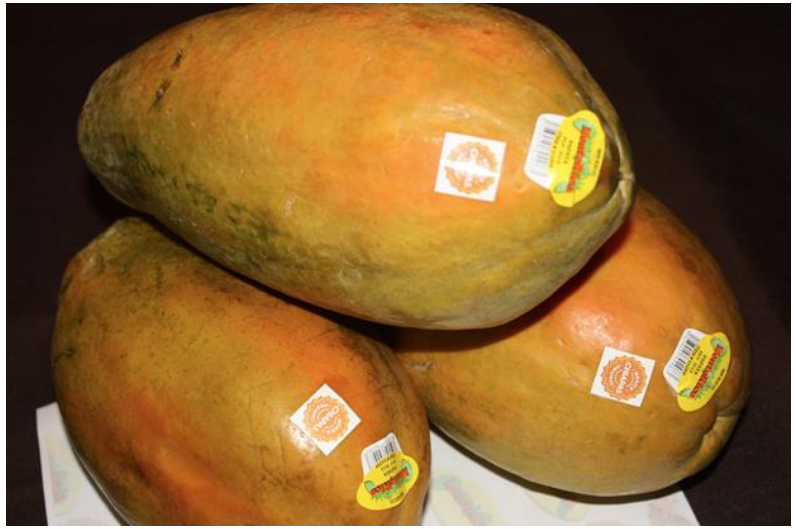
‘Red Lady’

- The peel changes from green to yellow to orange. The pulp may be yellow, orange or red, soft, and sweet to sour.

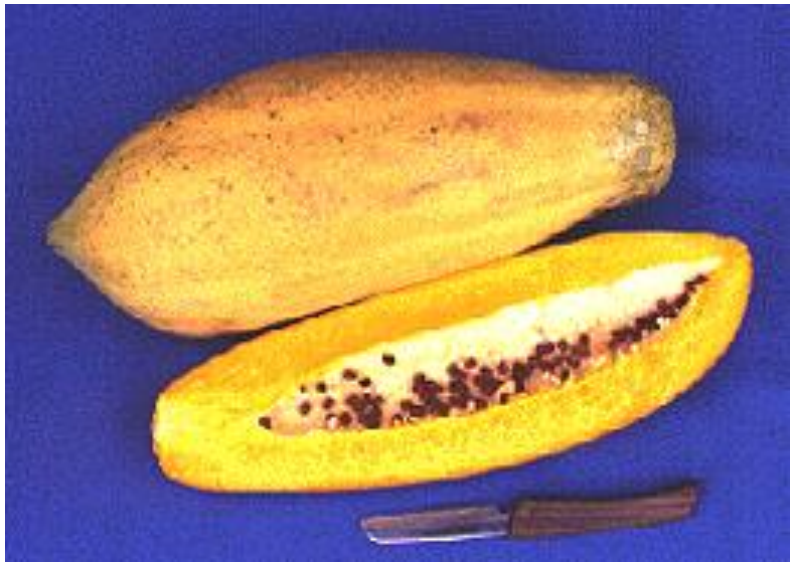
‘Red Lady’

‘Maradol’
Cuba

‘Red Maradol’
Mexico

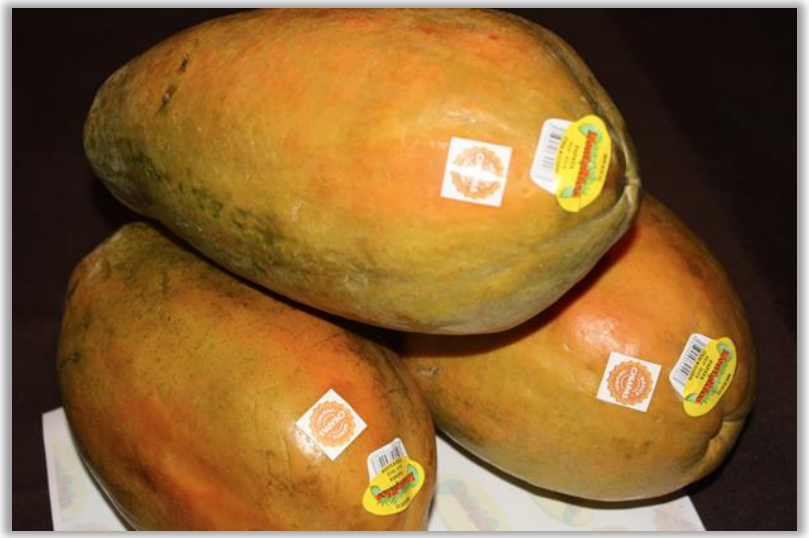


‘Known You-1’



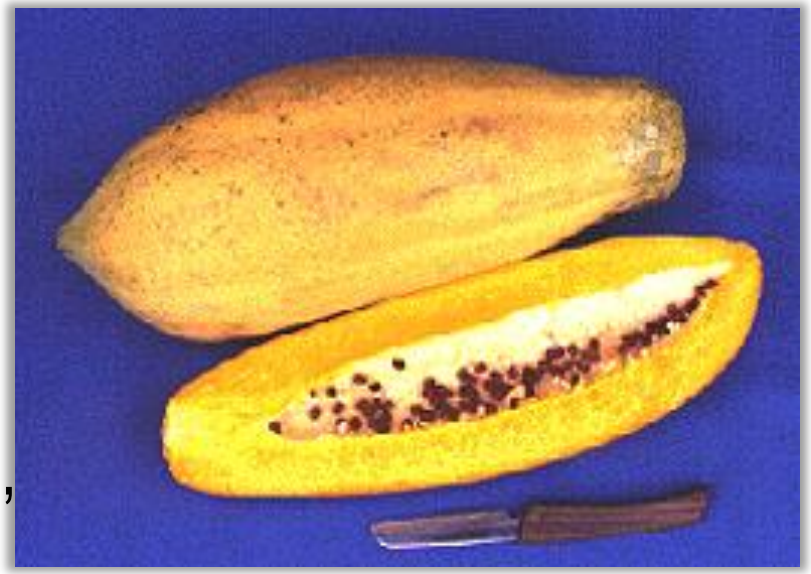
‘Red Lady’

‘Maradol’
Cuba



‘Red Maradol’
Mexico

‘Known You-1’



Papaya branching and ratooning

Trees pruned to 48” in Trial 1 and 12”, 24”, 36” and 48” in Trial 2

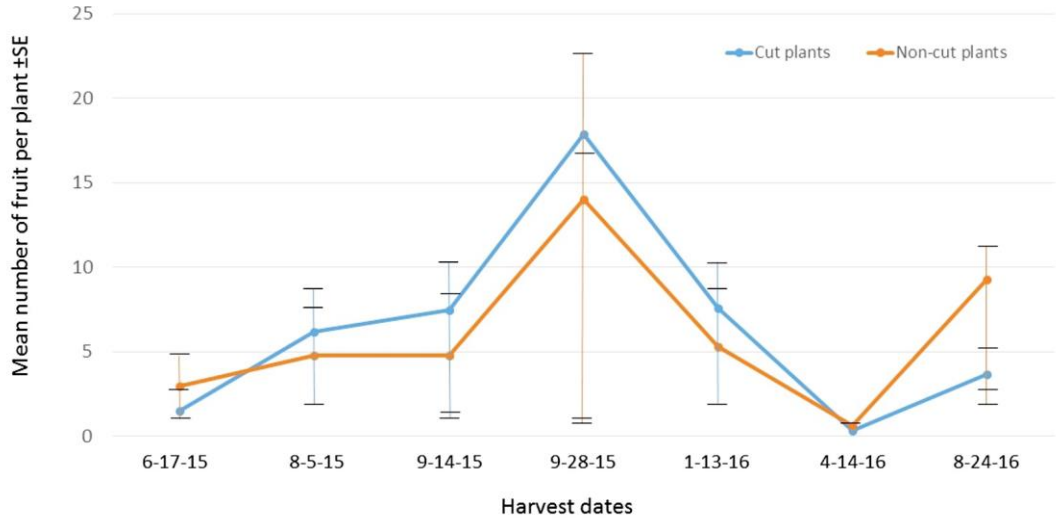
Fruit production began about 3.5-4.0 months after pruning

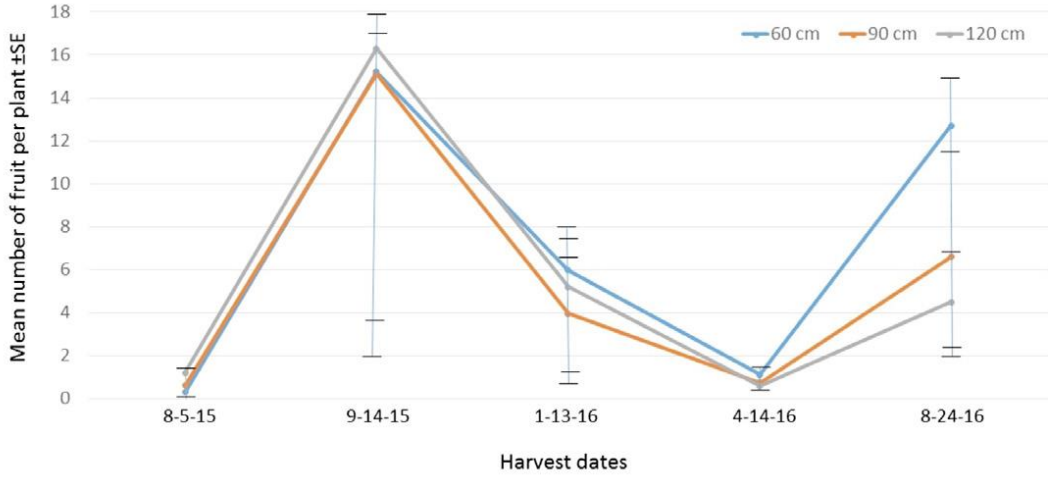
Trial 2. Effect of pruning at 12, 24, 36 and 48 inches on plant mortality

Treatment (pruning height, inches)	Percentage of plant mortality 5 ½ months after pruning
12	100
24	19
36	31
48	34

Ratooning papaya plants to facilitate culture and harvest

- Comparing the yields ~three months after selectively pruning plants to 24-48 inches and non-pruned control
- No significant difference in yield over the next 12 months





Montas et al., 2017. Proc. Fla. State Hort. Soc. 130:32-34.

Hainan, China: Angle planting to lengthen the period of harvest efficiency

Thanks
Q&A