Pitahaya (Dragon Fruit) Research & Production in California

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Overview

• Background information
• Pitahaya production worldwide
• The need for pitahaya research
• Current research efforts at UC
• Field observations & results to date
• What next?
The Pitahaya

• Also known as Strawberry Pear, Dragon Fruit in South East Asia, and Pitaya in Central America

• Native to tropical America, range from Southern Mexico to Northern South America

• Taken by the french to South East Asia at the turn of the 19th century
Pitahaya Types

• Over 25 species of Hylocereus identified
• Differentiated by stem & fruit characteristics (fruit skin and flesh color)
• Uncertainty about proper ID
• Two commonly available in CA:
  – Hylocereus undatus (red skin, white flesh)
  – Hylocereus sp. (primarily red skin & red flesh)
  – Many Hylocereus hybrids (several skin and flesh colors combinations, from yellow to deep magenta or dark red)

• Selenecereus megalanthus
  – Yellow or Colombian - yellow, thorny skin and white, translucent flesh
Why Pitahayas?

• Great potential as a new crop for growers in California
• Increasing demand for new, exotic fruits
• Current demand exceeds supply, current prices are high (retail @ $10/pound)
• Relatively high antioxidant activity when compared to other subtropical fruits
Pitahayases in California

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Commercial Production

- US production is limited to small scale producers of Hylocereus sp. in California and Florida, few large plantings
- Mostly white fleshed varieties used for fresh consumption or for décor/garnish
- Red fleshed varieties becoming more popular for fresh consumption and for processing
Commercial Production

- Nicaragua is main producer of Hylocereus sp. (red flesh) in Central America
  - 800-1000 Hectares planted under various production systems
- Fruit consumed fresh or processed for use in ice cream and refreshments
- Pitahaya pulp exported to US and as fresh fruit to Canada and Europe (APRONOT)
Commercial Production

• Colombia top producer of yellow pitahaya (Selenecereus megalanthus) in South America
• Ecuador also producing both Hylocereus sp. and Selenecereus megalanthus
• Vietnam main producer of Hylocereus undatus in South East Asia
• Israel also a significant producer/shipper to the European Union
Varieties??

- Twenty five species and up to 70 different clones available in Southern California
- No data or information available on the performance of various clones
- Lack of reliable, consistent information about varieties a major challenge to growth of industry
- 18 varieties under experimentation at SCREC
Commercial Varieties?

• Five clones grown commercially in Nicaragua
  – Orejona, Rosa, Cebra, Lisa, San Ignacio
  – Many other clones available
  – All produce fruit without hand/cross pollination

• Several clones promoted as “superior” but no replicated research data available

• Huge challenge for commercial production
Current Research Efforts

• Evaluate varieties for commercial production in California
  – Concentrate on self-fertile varieties with good yield, fruit & flavor characteristics
• Use molecular markers to narrow gene pool for breeding program
• Determine irrigation requirements
• Evaluate promising varieties in controlled environments
Varieties Under Study

- Cebra (Nic)
- Rosa (Nic)
- Orejona (Nic)
- Lisa (Nic)
- Sin Espinas (Nic)
- San Ignacio (Nic)
- Mexiana (Mex)
- Colombiana (SD/Col)
- Valdivia Roja (Mex)
- Bien Hoa Red (SD)
- Bien Hoa White (SD)
- Delight (SD)
- American Beauty (FL)
- Haley’s Comet (FL)
- Physical Graffity (FL)
- Vietnamese Jaina (FL)
- Yellow Dragon (FL/Col)
- Seoul Kitchen (FL)
Propagation

• Cuttings is most preferred method for commercial plantings
  – use one year old wood, at least 12 inches long
  – May fruit after one year
• Seed germinates readily, great potential for breeding program
  – Slow grower, may take up to 6 years to fruit
• Grafting is also possible, but benefits not quite clear yet
Planting & Planting density

- Rooted cuttings are most common method, but direct planting of cuttings is possible
- 12 to 18 inch long cutting is ideal
- Plant spacing depends on production system
  - 6 by 10 feet spacing used in Nicaragua (600 pl/ac)
  - 4 by 6 observed in California and reported in Spain
- Spacing depends on trellis system and plant structure desired
Pruning

• There is no best way to prune
• Pruning system will depend on trellis/support system, variety, location, goals and desired plant structure
• Three basic Strategies or goals for pruning:
  – Training – usually prune to encourage upright growth during first year
  – Sanitation – removal of dead or diseased stems
  – Thinning – to improve air circulation and exposure to sunlight
Trellising

• Impacted by variety, location and desired plant structure

• Many different types used in producing areas
  – Anything that can support a plant can be used
  – Live tutors used in Central America by small scale producers but not an option for SD because of water cost
  – Concrete posts used in Southeast Asia
  – Combination of metal pipes and treated posts used in San Diego

• Wire support system used in trials
Single post support system

- Up to about 5-6 feet, depending on height of operator
- Promotes an umbrella or mushroom-like structure
- Planting managed more like an orchard
T Support System

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Ladder type support system

- Similar growth as T-type
- Used with multiple cuttings per planting
Wire support system

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Pollination

• Night blooming cactus, large flowers
• Some are self-pollinating and some require hand/cross pollination
• Pollinized by moths and bats in Central America
• Hand and cross pollination has improved fruit set in Israel (up to 100% set)
• For commercial production we should concentrate on self pollinating clones
Pest Problems

- No major pest problems observed yet
- Cactus scale a problem in the greenhouse but not in the field
- Rodents (gophers and squirrels) can be a significant problem
- Ants & aphids a problem, damage young shoots, and flower buds
- Weeds
Cactus Scale

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Gophers & Rodents

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Ants & Aphids
Weeds

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Fruit Uses

• Used in refreshments in Central America
• Red flesh used as colorant in the processed food industry (Snapples, Sobe)
• Consumed fresh, as a desert item in the US, Canada, and Europe
  • Sliced in salads or cut in half and served chilled, with flesh eaten with spoon
• Used for decoration – Southeast Asia, US
Results to Date

• Varieties in trial adapted well to growing conditions at SCREC
• Most selections set fruit WITHOUT hand pollination
  – Pollination done by bees & other insects
• Plants in trial produce well WITHOUT shade
• Fruit size & quality good, good marketable yields but results NOT FINAL yet
### Results to Date

<table>
<thead>
<tr>
<th>Variety</th>
<th>Color Skin/Flesh</th>
<th>Avg. Wt. (gms)</th>
<th>Brix Score</th>
<th>Days to Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cebra</td>
<td>Red/Red</td>
<td>468</td>
<td>17.05</td>
<td>46</td>
</tr>
<tr>
<td>2. Rosa</td>
<td>Red/Red</td>
<td>384</td>
<td>17.01</td>
<td>45</td>
</tr>
<tr>
<td>3. Orejona</td>
<td>Red/Red</td>
<td>438</td>
<td>17.3</td>
<td>45</td>
</tr>
<tr>
<td>4. Lisa</td>
<td>Red/Red</td>
<td>465</td>
<td>17.02</td>
<td>44</td>
</tr>
<tr>
<td>5. Sin Espinas</td>
<td>Pink/Red</td>
<td>393</td>
<td>16.5</td>
<td>43</td>
</tr>
<tr>
<td>6. San Ignacio</td>
<td>Red/Red</td>
<td>552</td>
<td>15.6</td>
<td>48</td>
</tr>
<tr>
<td>7. Mexicana</td>
<td>Pink/White</td>
<td>495</td>
<td>14.04</td>
<td>40</td>
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<tr>
<td>9. Valdivia Roja</td>
<td>Red/Red</td>
<td>250</td>
<td>17.9</td>
<td>40</td>
</tr>
<tr>
<td>10. Bien Hoa Red</td>
<td>Greenish Red/Fuccia</td>
<td>360</td>
<td>18.9</td>
<td>41</td>
</tr>
<tr>
<td>11. Bien Hoa White</td>
<td>Pink/White</td>
<td>388</td>
<td>11.85</td>
<td>37</td>
</tr>
<tr>
<td>12. Delight</td>
<td>Red/Pinkish White</td>
<td>371</td>
<td>18.08</td>
<td>41</td>
</tr>
<tr>
<td>13. American Beauty</td>
<td>Greenish Red/Fuccia</td>
<td>380</td>
<td>18.51</td>
<td>43</td>
</tr>
<tr>
<td>14. Haley’s Comet</td>
<td>Red/Fuccia</td>
<td>482</td>
<td>16.7</td>
<td>38</td>
</tr>
<tr>
<td>15. Physical Graffity</td>
<td>Red/Pink</td>
<td>374</td>
<td>17.93</td>
<td>40</td>
</tr>
</tbody>
</table>
Results for Pitahaya Field Day

- External Appearance
- Flavor
  - When you can see fruit color
  - When you can’t see fruit color (under red light)
American Beauty
261 = 469

Bien Hoa Red
203 = 562

Delight
283 = 512

Lisa “Smooth”
728 = 871

Physical Graffiti
863 = 706

Sin Espinas
268 = 102
External Appearance

![Bar graph showing the hedonic score of different varieties of a fruit. The varieties are: Sin Espinas, Lisa "Smooth", Physical Graffiti, Delight, American Beauty, and Bien Hoa Red. The hedonic score ranges from 1 to 9. Sin Espinas has the highest score, followed by Lisa "Smooth" and Physical Graffiti. Delight, American Beauty, and Bien Hoa Red have similar scores.](image-url)
Flavor
When you CAN see fruit color

Variety
American Beauty  Bien Hoa Red  Physical Graffiti  Delight  Sin Espinas  Lisa "Smooth"

Hedonic Score
1 2 3 4 5 6 7 8 9

Flavor Outside
Masking the color with different lighting... will it make a difference in flavor ratings?
Flavor
When you CAN’T see fruit color

Variety

<table>
<thead>
<tr>
<th>Variety</th>
<th>Hedonic Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bien Hoa Red</td>
<td>8</td>
</tr>
<tr>
<td>American Beauty</td>
<td>7</td>
</tr>
<tr>
<td>Physical Graffiti</td>
<td>6</td>
</tr>
<tr>
<td>Sin Espinas</td>
<td>4</td>
</tr>
<tr>
<td>Lisa “Smooth”</td>
<td>3</td>
</tr>
</tbody>
</table>

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Flavor
Comparing the difference between 2 flavor tests
Future Research Efforts

• Continue evaluation of varieties for commercial production in California
• Initiate breeding program based on field observation and results of molecular marker work
• Determine irrigation requirements
• Evaluate superior varieties in controlled environments
Questions??

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