Smart use of fertilizers on papaya production

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Why papaya?

1 US$ / Kg * 1800 plants/ha * 15 Kg/plant/month = $27,000 US$ / month
Top secrets of papaya

Why is papaya so productive?
The canopy structure of papaya

- Genetic spiral arrangements corresponding to the 'golden angle': 137.5°
- High efficiency of light interception, thus high productivity.
- The mature leaves in the upper layer of the canopy with a LAI of 0.3-1.4 m² m⁻² (46% of the total leaf area of the canopy) were able to maintain high PPFD and photosynthesis.

LAI 0.3-1.4 m² m⁻² (11th – 29th leaf position)

LAI 2.0 m² m⁻² (37th leaf position)
Papaya has potential for high profitability.

Papaya requires large amounts of water and fertilizer

A good model plant for the development of smart use of fertilizers on tropical fruit

The income of farm production of tropical fruits in Taiwan

I like papaya!!!

'Smart use' of fertilizers on papaya production

Stupid

Smart
Overview of the papaya industry and its ecological requirements

Papaya Production in Taiwan

- Year-round production
- Total production area: 3,000 ha.
- Total yield: 90,000 tons
- Average yield: 40 tons per hectare
- Net-house planting papaya

Year-round production
Total production area: 3,000 ha.
Total yield: 90,000 tons
Average yield: 40 tons per hectare
Net-house planting papaya

Chiayi 8%
Tainan 32%
Kaohsiung 31%
Pingtung 11%
Papaya ringspot virus disease

Net-house-grown papaya
General characteristics of papaya

Papaya tree and canopy

Root system: aeration
Gender

Male

Hermaphrodite

Female

Female

Male
Hermaphrodite

Pistilloid flower

Elongated flower: standard

Carpelloid flower

http://www.agrihx.com/uploads/allimg/120814/1_120814094622_1.jpg
Main papaya varieties around the world

Tainung No.1  Red Lady  Sunrise

India and Southeast Asia: Red lady
Mexico: Maradol, Tainung No1, Intenza
Brazil: Tainung No1, Golden and Sunrise

Cultivation practices:

Field preparation and broadcast amendments
Irrigation systems for papaya

- The average planting of about 0.3 hectare in Taiwan
- Groundwater

**Micro spray tape**
- Advantages: equipment are readily available and inexpensive.
- Disadvantages: water consumption, uneven, manual fertilization
- Fertilization is less effective and more labor intensive.

Flooding irrigation

**Advantage:**
- cheap cost

**Disadvantages:**
- low homogeneous
- water waste
- soil structure damage
- flow estimation is difficult
- slow rate of recovery
- Furrow irrigation also has high water consumption
- Soil without proper drainage may cause root rot in plants

**Furrow irrigation**

**Ditch blocked**

Drip irrigation: fertigation system

http://www.netafim.com/
**Streamline 16080 (SL80)**

- **1.3 USD/10m**
- **Thickness** 0.2mm
- **Spacing** 0.2m/0.3m
- **Flow rate** 0.98L/hr
- **Crops** Short term crops

**Fertilizing**

- Provides proper fertilizer utilization for high productivity and quality papaya
- The fertilizer application rate:
  - 14 kg ha\(^{-1}\) N (NH\(_4\)NO\(_3\))
  - 22.9 kg ha\(^{-1}\) P\(_2\)O\(_5\) ((NH\(_4\))\(_3\)PO\(_4\))
  - 12.4 kg ha\(^{-1}\) K\(_2\)O (KNO\(_3\))
- Every two weeks for plants 7 months and older
- 1/3 rate for plants 1-3 months old and 1/2 rate for plants 4-6 months old.
Appropriate fertilizer utilization for papaya

- Plants were given different amounts based on their age:
  - 1-3 months: 1/3;
  - 4-6 months: 1/2;
  - 7 months and older: full amounts.

Applying fertilizers through irrigation water, a simple fertigation system for papaya

- **Fertigation** is the application of fertilizers, soil amendments, or other water-soluble products through an irrigation system.
- Labor saving and produces high yield.
Fertigation system

Advantages

* Nutrient requirements according to crop stages (teaspoon feeding).
* More uniformed distribution and closer to the root system.
* Better availability of nutrients to plants.
* Increased nutrient uptake.
* Reduced application losses of nutrients by leaching.
* Prevents damage to roots.
* Less costly application labor.
* Less soil compaction.
* Reduced weed population.
* Flexible application (time, weather, soil).

A fertilizer injecting device: connected to the existing irrigation tube where concentrated liquid fertilizer is injected into the tube with the help of a pump, thus increasing fertilization frequency.
Application of modern technology in fertilization in papaya: drip line and tensiometer
Place a set of tensiometer at 30 cm and 60 cm depth in the field using the soil tensional readings as a guideline for irrigation.

Equipment for fertigation

**Venturi tube**  
**Fertilizer injector**
Disc filters
Estimation of soil moisture and plant growth

(1) Soil moisture
   Tensiometers for 30, 60, and 90 cm depth in soil

(2) Plant growth
   Stem diameter, petiole, leaf area, stem growth rate, and yield

Wireless radio tensiometers and flow meters for immediate monitor
(from: http://www.netafim.com/)
Using tensionmeter and flow meter to monitor irrigation requirement

Fig. Tensiometers installed at three different soil depths – 30, 60, 90 cm. (from: http://www.netafim.com/)

Use of tensiometer provides a convenient way to measure soil water content (soil water tension).

- After irrigation, red line drops sharply, green line declines slightly, and blue line remains almost unchanged,
- irrigation depth is near the 0-30 cm region.

Red, green, blue lines represent water content in soil at 30, 60, 90 cm soil depth
During the 1-3 months after planting, tensiometer reading of 20 cbar.
Fertilized every 3 to 6 days and water on the top 30 cm of soil.

Leaf area: 10-16 m²
Depth of root: 0.7 - 0.9 m
Fig. Leaf area is wider and the plant is more efficient in transpiration close to harvest. Irrigation depth should reach 90 cm and soil water tension should temporarily reach 50-60 cbar at 30-60 cm soil depth.
contiguous precipitation
Fertilizer injector
US$150

1.5 inch flow meter
US$140

Disc filter
US$200

Dripline and accessories
US$345

Total
US$835
Fertigation system

Table. Total irrigation volume and cost analysis of drip irrigation and micro spray tape irrigation for papaya (planting area: 0.3 hectare per zone)

<table>
<thead>
<tr>
<th>Item</th>
<th>Drip irrigation</th>
<th>Micro spray tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water consumption (10 months)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total irrigation volume m³</td>
<td>1,667</td>
<td>2,770</td>
</tr>
<tr>
<td>Equipment cost ($ USD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC tube and accessories</td>
<td>92</td>
<td>132</td>
</tr>
<tr>
<td>Dripline / micro spray tape</td>
<td>293</td>
<td>123</td>
</tr>
<tr>
<td>Filter and fertigation system</td>
<td>450</td>
<td>10</td>
</tr>
<tr>
<td>Total cost ($ USD)</td>
<td><strong>835</strong></td>
<td><strong>265</strong></td>
</tr>
<tr>
<td>Filter and fertigation system not included</td>
<td>385</td>
<td>255</td>
</tr>
</tbody>
</table>
Drip irrigation promotes better overall plant growth compared to micro spray tape irrigation.

Yield for drip irrigation: 114 t·ha⁻¹, micro spray tape: 89 t·ha⁻¹ (Table 1)
Uniform wetting points along the row

Conclusion

- Using drip irrigation device for fertigation can enhance water use effectiveness, achieve savings on fertilizer and labor and further increase yields.

- The concept of fertigation:
  
  Water = fertilizer = money

- Save labor and money = smart
Thanks for your attention

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