Exploring the biological originalities of the oil palm fruit

Timothy J. Tranbarger

Journée Filière, July 9, 2012
Oil palm (*Elaeis guineensis* Jacq.)

- Highest yielding oil crop
- Worldwide demand for vegetable oil increases 4.4%/year
- Perennial crop with long reproductive cycle (10-15 years)
- Tropical monocotyledon

- Palm oil (mesocarp) and kernel oil
- Richest dietary source of provitamin A
- An original two phase fruit abscission process
- Recalcitrant seed germination
France
- Oil palm breeding
- Genetic analyses

UMR DIADE
France
-Maturation
-Ripening
-Abscission

CRA-PP
Benin
- Phenotypic analysis
- Genetic material

UMR AGAP
France
- Histology analyses

Walailak University
Thailand
- Hormonal regulation

Genomic Institute
Thailand
- Transcriptome
- Proteome

Kasetsart University
Thailand
- Transcriptome
- Gene candidates

University of Nottingham
UK
- Functional analyses
- Arabidopsis
Objectives

Understand molecular and cellular basis of selected original aspects of oil palm reproductive development

Biological understanding of agronomic characters in support of biotechnological applications

Develop molecular markers useful for oil palm improvement
Questions

• What is the molecular basis of the extraordinary lipid and carotenoid accumulation in the mesocarp?

• What are the mechanisms of the originalities of oil palm fruit abscission?

• Are the molecular mechanisms of ripening of the mesocarp similar to those of the model species?
454 Sequencing and Bioinformatics Analysis

RNA profiling

Global expression

Associate with Developmental, physiological biochemical data

Functional studies
> Rice, Arabidopsis (heterologous system)
> Oil palm (transient system)

Examine genetic diversity within oil palm and palm family
Scheme representing the major events that occur during the phases of mesocarp development.

Metabolites
- Biosynthesis
- Regulation
- Hormones

Fruit Shedding

Cell division & expansion
Lag period
Maturation
Ripening
Coordinated transcriptional regulation of FA biosynthesis and a WRI-like transcript

**FA synthesis**

**TAG assembly**

Between stage relative expression (%)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Expression (%)</th>
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<tbody>
<tr>
<td>0</td>
<td>1-25</td>
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<td>25-50</td>
<td>25-75</td>
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Tranbarger et al. Plant Physiol 2011;156:564-584
Unsynchronized fruit ripening and shedding

Economical losses

• Oil yield and quality
• Increase harvest cost
  ✓ Labor to identify and harvest ripe bunches before fruit drop
  ✓ Labor to collect dropped fruits
Questions

• What is the exact timing of the abscission process?

• What is the cellular basis of the functional AZ?

• Identify the polygalacturonase (PG) gene responsible for the high PG activity observed in the AZ

Peerapat Roongsattham
Oil Palm Fruit Shedding

Mesocarp

Pedicel

Abscission Zone

Adjacent Abscission Zones

Primary Abscission Zone

9 hours
Three major cellular features of a functional AZ (180 DAP)

- Vascular bundles remain undifferentiated in AZ
- Nuclear alignment (AZ organizes into cell layers)
- Intracellular pectin accumulate during development throughout AZ layers
What cellular features change during separation?

- AZ toluidine blue color change after separation suggests cation changes in cation environment (e.g. H\(^+\), Ca\(^{2+}\))
- Intracellular pectins decrease
# Oil Palm Fruit Development and Abscission Partners

**Palm Developmental Biology Group, Montpellier, France**

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Position</th>
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<tbody>
<tr>
<td>James Tregear</td>
<td>IRD</td>
<td>Group Leader</td>
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<td>Fabienne Morcillo</td>
<td>CIRAD</td>
<td>Research Scientist, Fruit projects</td>
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<tr>
<td>Myriam Collin</td>
<td>IRD</td>
<td>Technician (Histological and cytological analyses)</td>
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<tr>
<td>Peerapat Roongsattham</td>
<td>IRD</td>
<td>Doctoral Fellow (Agropolis Fondation)</td>
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<tr>
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**UMR DIADE, Montpellier, France**

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<tr>
<td>Stéphane Dussert</td>
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<td>Thierry Joët</td>
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<td>Jean-Luc Verdeil</td>
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<td>Oil palm breeder/genetics</td>
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<td>Marilyne Summo</td>
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**PalmElit Montpellier, France**

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<tr>
<td>Phillippe Amblard</td>
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**Benin, CRAPP**

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<td>Alphonse Omore</td>
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**Thailand Partners, Bilateral Franco/Thai PHC Thailande 2007-2010 Project (MAE, CHE and BIOTEC)**

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<td>Somvong Tragoonrungr</td>
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<tr>
<td>Potjamarn Suraninpong</td>
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**Europe**

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<td>Zinnia Gonzalez-Carranza</td>
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