Toward a functional-structural model of oil palm able to assist the evaluation of genetic differences between progenies for architecture and radiation interception efficiency

Raphael Perez, Jean Dauzat, Benoit Pallas, Hervé Rey, Gilles Le Moguedec, Sebastien Griffon, Evelyne Costes

To cite this version:

Raphael Perez, Jean Dauzat, Benoit Pallas, Hervé Rey, Gilles Le Moguedec, et al.. Toward a functional-structural model of oil palm able to assist the evaluation of genetic differences between progenies for architecture and radiation interception efficiency. 5th International Conference on Oil palm and environment (ICOPE), Mar 2016, Bali, Indonesia. hal-01837325

HAL Id: hal-01837325
https://hal.archives-ouvertes.fr/hal-01837325
Submitted on 5 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Find more sustainable and productive systems is a major challenge to fulfil increasing vegetable oil demand, including palm oil. Tackling climate changes requires bold and swift actions such as breeding of well suited plant material and implementation of innovative growing practices. But, to this end, we need sound bases of what ideotypes must be for the future and what the proper practices should consist in. For addressing these questions, functional-structural modelling approach (FSPM) enables to explore the relationships between 3D structure of plants with their physiological functioning in relation to weather conditions, with the possibility to simulate virtual management practices such as clearing and pruning.

The main assumption underlying this project is the possibility to enhance potential oil palm production optimizing plant architecture in relation to radiation use efficiency. The present study investigates two aspects of a FSPM study applied to oil palm: i) characterize architectural variability and reconstruct three-dimensional (3D) mock-ups of oil palm and ii) estimate light interception efficiency of different oil palm progenies from virtual stands.

### Material & Methods

#### Field observations

<table>
<thead>
<tr>
<th>Plant Scale</th>
<th>Leaf scale</th>
<th>Leaflet scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (H)</td>
<td>Length (L)</td>
<td>Width (W)</td>
</tr>
<tr>
<td>Stem diameter (D)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylosaxis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Allometric-based approach

- Modelling ontogenetic and morphogenetic gradients with temporal and spatial variables
- Strategy for reconstructing 3D palm mock-ups

#### Rendering inter and intra-progeny variability

**Inter-variability**

- Panel 1: Comparison of progenies in respect to light interception over seasons
- Panel 2: PAR intercepted per palm

**Intra-variability**

- Panel 3: Comparison of progeny variability

#### Validation at individual scale with terrestrial laser scans (TLS)

- Comparison of TLS acquisitions with simulations on 3D mock-ups

#### Validation at plot scale with hemispherical photographs (HPs)

- Comparison of gap fraction from camera HPs and virtual HPs

### Results

**Comparison of progenies in respect to light interception over seasons**

Simulation of photosynthetically Active Radiation (PAR) intercepted by palms and canopy (virtual plot of 20 palm mock-ups)

**Evaluation of model compliance with field observations**

Simulated vs. observed mean and variances of architectural traits

**Validation at individual scale with terrestrial laser scans (TLS)**

Comparison of TLS acquisitions with simulations on 3D mock-ups

**Validation at plot scale with hemispherical photographs (HPs)**

Comparison of gap fraction from camera HPs and virtual HPs

### Conclusions

- Studied progenies exhibit significantly different architectural traits
- Model correctly renders intra and inter progeny architectural variability
- Virtual experiments highlight contrasting light interception efficiency between the studied progenies

### Perspectives

- Identify key architectural traits affecting light interception efficiency
- Interface the calculation of light interception with photosynthesis and stomatal regulation
- Define varietal ideotype and propose new phenotypic traits for breeding trials
- Perform *in silico* experiments to test new agronomic practices

### References

