Future vision of oil palm genetic improvement in Latin America.

Several resolutions on cooperation in Colombia for planting material improvement

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PalmElit
Planting Material Solutions for the Tropics

CIRAD

Introduction

- Colombia : 780,000 t of palm oil (2007)
- ahead of Ecuador : 295,000 t of palm oil

- In Latin America : considerable development potential :
  - In Peru, Brasil, Colombia, Equador, …
  - In Colombia alone, several million hectares could be developed on savannah or degraded pastures.

Introduction

- However, in South America and Central America, "Bud Rot" is slowing down the development of the area under oil palm.
- "Bud Rot" (BR) is a disease with a complex symptomatology.
- Several diseases ? Or existence of a primary causal agent, followed by different local cocktail of opportunistic microorganisms ?

➢ Since the solutions are similar, for simplification purposes we will consider that a single cause with variable symptoms is involved.

Introduction

- Large zones that seem to be **disease-free**.
  - Pucallpa region in Peru,
  - Quinindé region in Ecuador,
  - Southern Magdalena Medio region in Colombia, Honduras, etc.

- "spear rot" (SR) is **a not very aggressive form** (85 to 95% of affected palms recover).
  - Llanos region in Colombia
  - Quepos area of Costa Rica.
  - …

- **Aggressive or very aggressive forms** have destroyed plantations from the South to the North of the continent.
  - Rio Maniti, Peru,
  - Eastern region of Ecuador,
  - Suriname (Victoria, Phaedra and Patamacca),
  - Tefe, Dempasa Brazil,
  - Turbo, Colombia (in the 1960s)
  - Tumaco, San Lorenzo Colombia/Ecuador
  - ….. Panama (Icacal), Costa Rica and Venezuela..

Introduction

- **Hypotheses** for the cause of this disease :

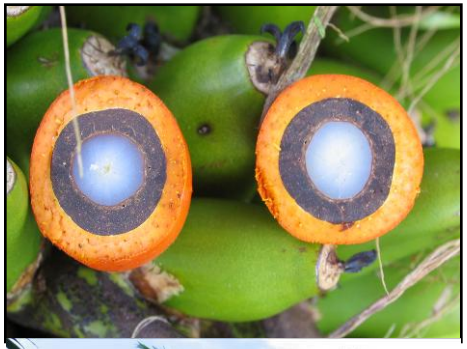
- Some says that it might not be a disease…
- Virus, Viroïde, Phytoplasma, Fungus,… Insect as vector, ...

- *Phytophthora*, G. Martinez come with some new and very interesting experimental findings. (This hypothesis is currently being validated according to Koch's postulates)

➢ Confirmation of that work would be a tremendous leap forward for the entire oil palm growing community.

Introduction

- **Chemical solution :** if *Phytophthora*, is involved, chemical treatment might be a solution, economically viable.
- **Genetic solution** :
- Resistance of *E. oleifera* to the disease is proven.
- *E. guineensis* x *E. oleifera* interspecific hybrids have displayed good resistance.
  - 1978 at Victoria, Suriname still intact by 2007
  - 1974 to 1976 at Turbo (Coldesa), a few rows were kept still remained intact by the end of 2008
  - In the Tumaco region, old hybrids from the 70's that have resisted the recent attack of the disease.
  - Re-plantings in Tumaco : only hybrid palms have an acceptable survival rate.



Introduction

- Generaly speaking *E. guineensis* is susceptible to the disease.
  - C. Chinchilla (Chinchilla, 2008) reported having found some partial resistances in *E. g.* he mentions the Deli origin as being susceptible, along with Deli x AVROS
  - But Deli source of CIRAD'S 07** materials show quite good resistance in the Eastern zone of Ecuador (Amblard, 2009) and to PF in Hacienda la Cabaña, it has yet to prove the same resistance in the San Lorenzo/Tumaco region.
  - Deli x Ghana was mentioned as being particularly susceptible (Aya, 2008).

➢ It is therefore possible to provide genetic solutions to this disease by combining the partial genetic resistances found in *E. guineensis* and *E. oleifera*.

➢ This publication explores the advantages and disadvantages of the different genetic solutions.

Interspecific hybrids

➢ Bud rot resistance

- Resistance in *E. oleifera* is very strong (not total)
  ⇒ It is transmitted as a dominant trait (more or less)
- Is resistance a single factor or a sum of several factors ?
  ⇒ Specific genetic design planted in Ecuador

➢ Productivity of planting material (seeds)

- Fertility is very important : not all OxG combinations are economically viable.
- Very considerable progress will be made once the second generation of interspecific hybrids :

From 30 t/ha at 20 % OER → 35 t/ha at 21-23 % OER

➢ Clones

- Considerable variability available families and within the crosses ⇒ perfect relevance to the production of clones ⇒ Semi-commercial production in Colombia in 2010 and 2011.

OER > 24 %

Interspecific hybrids

Main advantages:

- Very resistant to bud rot &Oil yields are economically acceptable and ↗
- Partial resistances to certain pests are found, facilitating their control.
- Oil quality & FFA content.
- Spacing out harvesting rounds & fewer loose fruit (exept in Taisha x Avros).

Main Disadvantages:

- The greatest disadvantages remains the need to carry out assisted pollination even in so called "atractive" hybrids (pollinating insects)

⇒ need 1 ha of *E. gui.* per 100 ha of hybrid

- Not easily adoptable by smallholders.
- Harvesting criteria has to be redefined.
- Exuberant vegetative growth ⇒ increases competition between mature palms.

Backcrosses

⇒ The most promising and most ambitious program and it is also the most difficult program

Bud rot resistance

- For America bud rot resistance due to *E. o*. is essential to conserve.
- **If** it is a single trait, ½ palms BC1 cross will be resistant.
- **If** it is more complex, a continuum of resistance will be seen in the BC1

⇒ In both situation, is a surviving palm a resistant palm or did it escape the disease?

⇒ Do we have to wait for the next generation ?

New tools are needed:

- Development of an early test (if *Phytophthora…).*
- Molecular marker of the trait(s). (La Cabaña, Danec and CIRAD/PalmElit trials mentioned earlier …)

Backcrosses

- **Productivity**

- Mean production of BC1 does not have any real significance.
- Some individuals might have good qualities. ⇒ Clones.
- Traits linked to productivity will be selected along with BR resistance.
- Difficulty to select adtitional partial résistance of *E. guineensis*
- Difficulty to exploit the heterosis existing inside *E. guineensis* .

⇒ There is an urgent need for molecular markers.

- **Planting material: seeds and clones**

- Seeds : to produce resistant seeds, we need homozygous material for the resistance factor(s) : 1 - Self, intercrosses
  2 screening using MM.
- In the shorter term : clones:
- A BC1 clone (CIRAD/PalmElit) has proved to have good SR resistance, has to be screened for other forms of BR. (recloned and available in 2010/2011).
- Asd “Compact” clones have some E. o. blood : resistance to be checked.

Backcrosses

Advantages:

- BC will be BR-resistant. (If appropriate selection)
- It will integrate known *E. guineensis* resistances.
- BC1s, probably, and of BC2's, definitely, will not need assisted pollination
- Yields will be similar to those of *E. guineensis* + some of *E. o*. qualities.

Disadvantages:

- The major drawback of this type of material is the difficulty encountered in identifying resistant genotypes.

  $\Rightarrow$ *Again, early screening test and molecular markers tools are not available today.*
- In the short term only clones will be available in <u>small quantities</u>.

E. guineensis

Bud rot resistance

- *Elaeis guineensis* is the most productive but affected by lethal BR.
- Most of the differences between *Elaeis guineensis* material reflected in a few extra months or years of respite.
- In a few scarce cases material seems to be more resistant: as exemple Cirad cultivars C6501 and C0741. This resistance repeated almost 20 years apart.

Variability between families and within a cultivar open the gate for selection

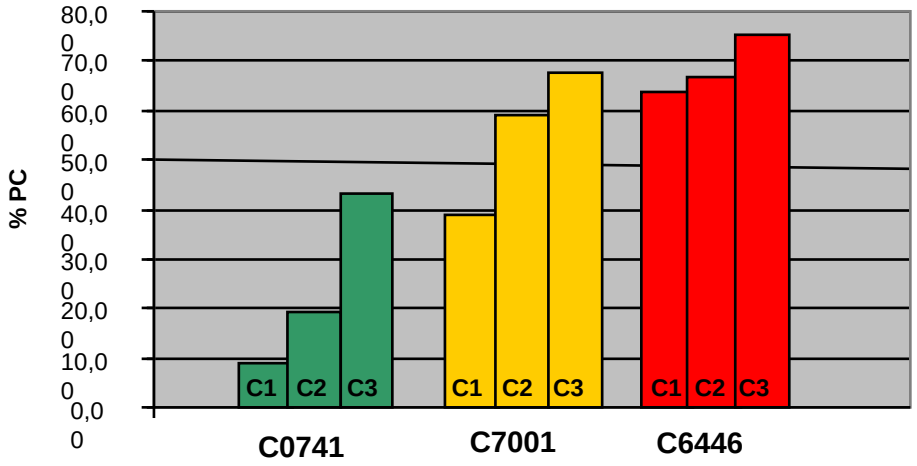


Figure 1: % BR at 9 years in three families of three different materials

E. guineensis

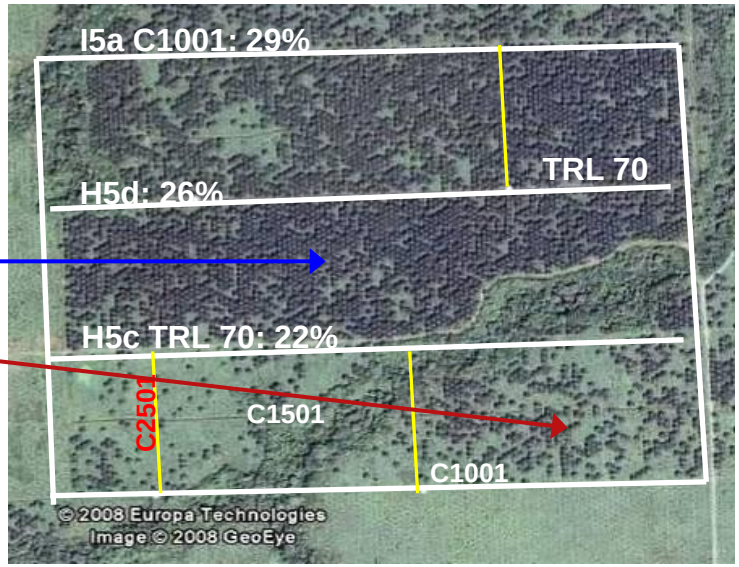
Two additional important perspectives :

1 - it is likely that strong variability subsists between palms in the same cross.

Example : TRL 70

(ex C1001)

In the Tumaco region there are a few surviving palms. Some of these palms should be cloned to test their résistance to the disease.



2 - It is clear to us, that apart from Deli (C07**, C65**), other sources of resistance should exist: we will have to identify them.

$\Rightarrow$ Colaborative initiative ?

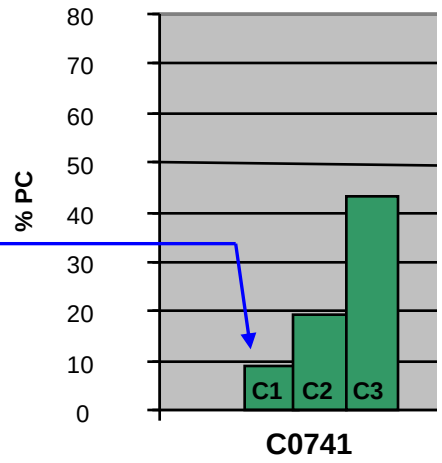
E. guineensis

Productivity

- A pleonasm : productivity of *E. guineensis* material is going to approach that of *Elaeis guineensis*…
- But the first selected trait will be for resistance sources identified in *E. guineensis* not only for yield . By chance, C07** material is good quality material.

Planting material: seeds and ramets

- Small quantities of seeds from partially resistant material are produced today, more will be produced in the coming years.
- Within ten years, one will benefit from seed gardens set up from the most resistant parents.
- Partially resistant *E. guineensis* also provide pollen for the assisted pollination of interspecific hybrids.
- Resistant E guineensis Clones will be available after selection for both their BR resistance and their productivity.



E. guineensis

Advantages and disadvantages

E. guineensis is familiar, advantages and drawbacks are well known…we will focus on E. g. and resistance to BR.

Advantages:

- Productivity : some of the partially resistant material is produced from a genetic base of a very good yield potential.
- The resistances identified are partial but, being complex, they should give rise to durable resistances.

Disadvantages:

- The quantities of seeds available for growers is too small.
- The partial resistances identified may not be sufficiently strong.
- The genetic base of the known resistances is very weak (only a few Deli).

⇒ *A strong and coordinated effort should be made by the Oil Palm community*

Discussion and prospects

1 - Solutions for growers

Type of material	Form	Availability (from)	Quantities	Resistance quality and security
Interspecific hybrids E.oleifera x E. guineensis	Seeds	2010	Several million	**The best known**
	Clones	•Now •2010-2011 •2014/5	• Very limited. • 50 to 100,000 • 500,000?	**The best known**
Backcross BC**n** (*E.o* x *E. g*) x (*E.g.*)$^{\mathbf{n}}$	Seeds	2025-2030	Several million	The best known (if selected)
	Clones	•2010/2011 •2015-18	• 25,000 (1 clone) • 100,000?	• Probably very good • Good?
		•2025-2030	• 0.5 or X millions?	• Very good
Elaeis guineensis	Seeds	•2010 •2012/13	• < 200,000 • > 2 million	•Partial •Partial
		•2018/2020	• xx million	•Partial improved
	Clones	2013	100,000?	Partial improved

Discussion and prospects

1 - Solutions for growers

Special care by cooperatives ?

Short term (immediately)

⇒ Interspecific hybrid seeds for the most part. *Difficulties for smallholders*.

Medium term (2012-2018)

⇒ Interspecific hybrid seeds will continu. *Difficulties for smallholders*
co-planted with:

- Partially resistant E. guineensis.
- Possibility of having clonal material.

Long term (2025-2030) *Simple solutions for smallholders*

⇒ Seeds from backcross programs + Interspecific hybrid seeds.
Sufficiently resistant E. guineensis.
Clonal material…

Discussion and prospects

2 - Main research required

• E. oleifera breeding

- *E. oleifera* exhibits great genetic diversity of traits ; No population combines all the best characteristics.
- Improving the inherent value of *E. oleifera* will doubtlessly lead to great improvement of Hybrids.

• Improving BR-resistance in *E. guineensis*

- *Elaeis guineensis* breeding is being already conducted.
- Field resistance screening : to planted E. guineensis in infested zones. (Cost problem)
- Specific mating design should be implemented (such as diallele).

  ⇒ Only public-sector research, or a grower association, could offer such a set-up.
- The selection of partial resistances in E. g. should provide good resistance and durability
- If the role of *Phytophthora* is validated : an early resistance screening test will be developed.

• Development of molecular markers

- 1 – to trace *E. oleifera* resistance to BR whether it is a single factor or a more complex trait. (Special design exist)
- 2 – to trace *E. guineensis* resistance to BR, it calls for experimental designs to be set up.

⇒ An international initiative could be targeted with tighter partnerships to work on bud rot.

CONCLUSIONS

Solutions exist but have some drawbacks :

- Different virulence of the pathogen can be link to various climatic conditions. But an exceptional wet year may caused a severe explosion of the disease.
- In areas like the Llanos of Colombia, the growers will probably need to cultivate partial resistant E. guineensis.
- In areas where the disease is very aggressive, the planting of interspecific hybrids is the only solution. *But this come with Difficulties for smallholders*
- When the disease is not as aggressive, planting of highly resistant E. guineensis will be enough (within a few years)

A large effort and collaborative work are needed between the most affected countries in the area, to help solve the problem. These should include the same countries that E. oleifera is native to, and oil palm cultivation is important or has great development potential.

FLIPA (The Latin American Fund for Innovation in Oil Palm) could be a tool in coordinating efforts.

⇒ The genome project for E. guineensis and E. oleifera currently in progress and being led by CIRAD, can provide some needed knowledge in understanding sources of resistance.

Gracias.

Merci

Thank You

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