



# AfricaYam II: Progress report and work plan at CIRAD

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# TARGET OUTCOMES AND DELIVRABLES

## FP1

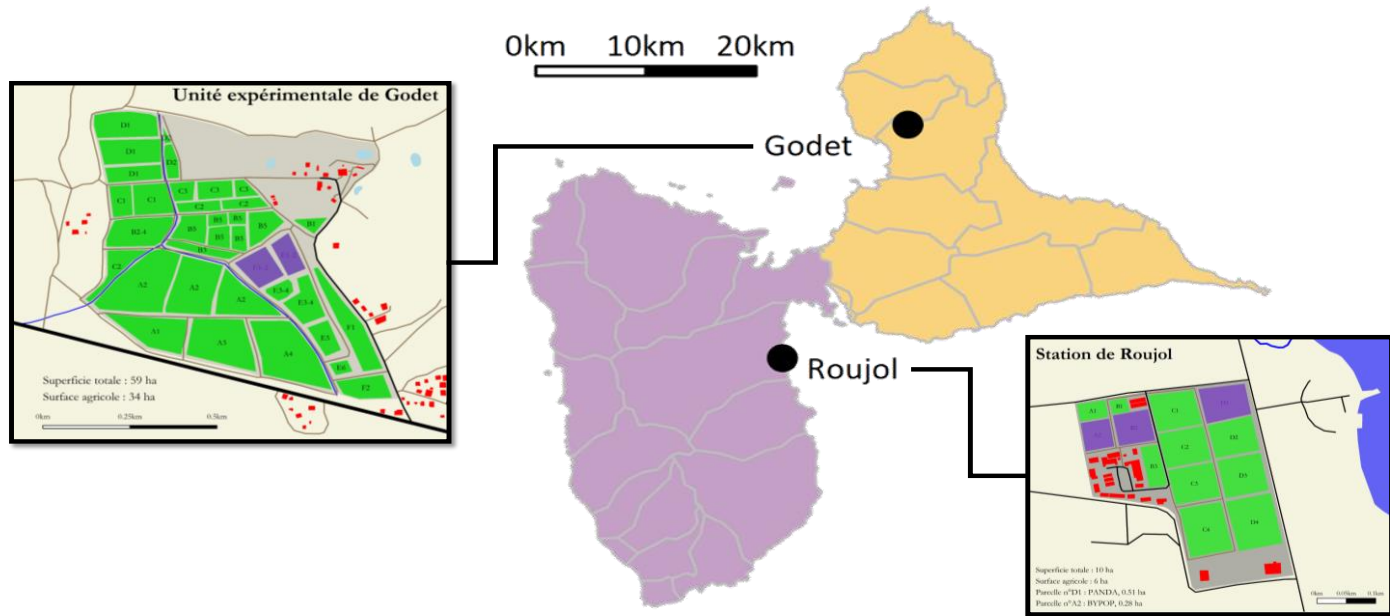
- Develop and transfer medium or high throughput method for morphological quality traits
- Organize and attend the joint training on methodologies for sensory evaluation, textural determination and food quality assessment developed by RTBfoods

## FP2

- Identify QTLs and genes controlling key traits regarding competitiveness against weeds

## Develop M/HTPP

- *Field: Diversity panel reconducted at 2 pedoclimatically contrasted sites in Guadeloupe (Roujol and Godet)*



## Develop M/HTPP *Phenotyping*



# FP 1 PROGRESS SUMMARY

## Develop M/HTPP

### Phenotyping: Characterization of emergence dynamic

#### Phenotyped leaf traits:

Steepness

Emergence duration

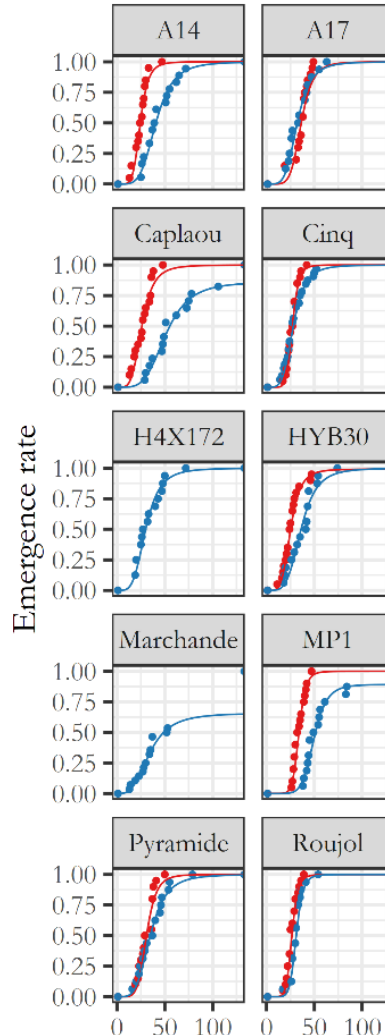
Emergence rate

#### Genotypes:

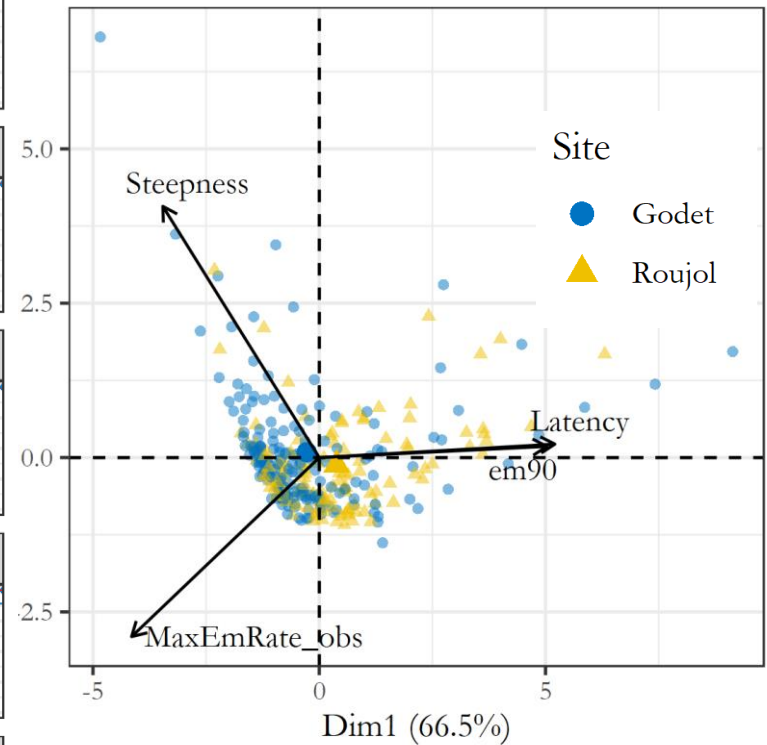
*D. alata* diversity panel (50 acc.)

Site: Godet and Roujol

1200 plants followed every 3 days



PCA - Biplot



$$f(x) = \frac{d}{1 + \exp(b(\log(x) - \log(e)))}$$

## Develop M/HTPP

*Phenotyping: Characterization of ground cover dynamic*

### **Phenotyped leaf traits:**

*Maximum ground cover*

*Ground cover speed*

*Senescence duration*



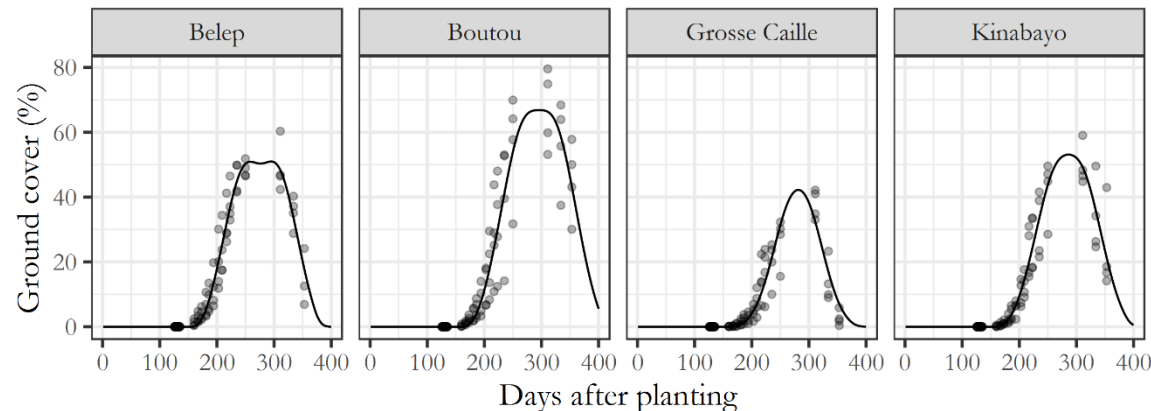
### **Genotypes:**

*D. alata diversity panel (50 acc.)*

*Site: Godet and Roujol*

*12000 pics acquired*

$$w = w_{max} \left(1 + \frac{t_e - t}{t_e - t_m}\right) \left(\frac{t}{t_e}\right)^{\frac{t_e}{t_e - t_m}} \text{ with } 0 \leq t_m < t_e$$



## Develop M/HTPP

*Phenotyping: Characterization of ecological strategy*

### **Phenotyped leaf traits:**

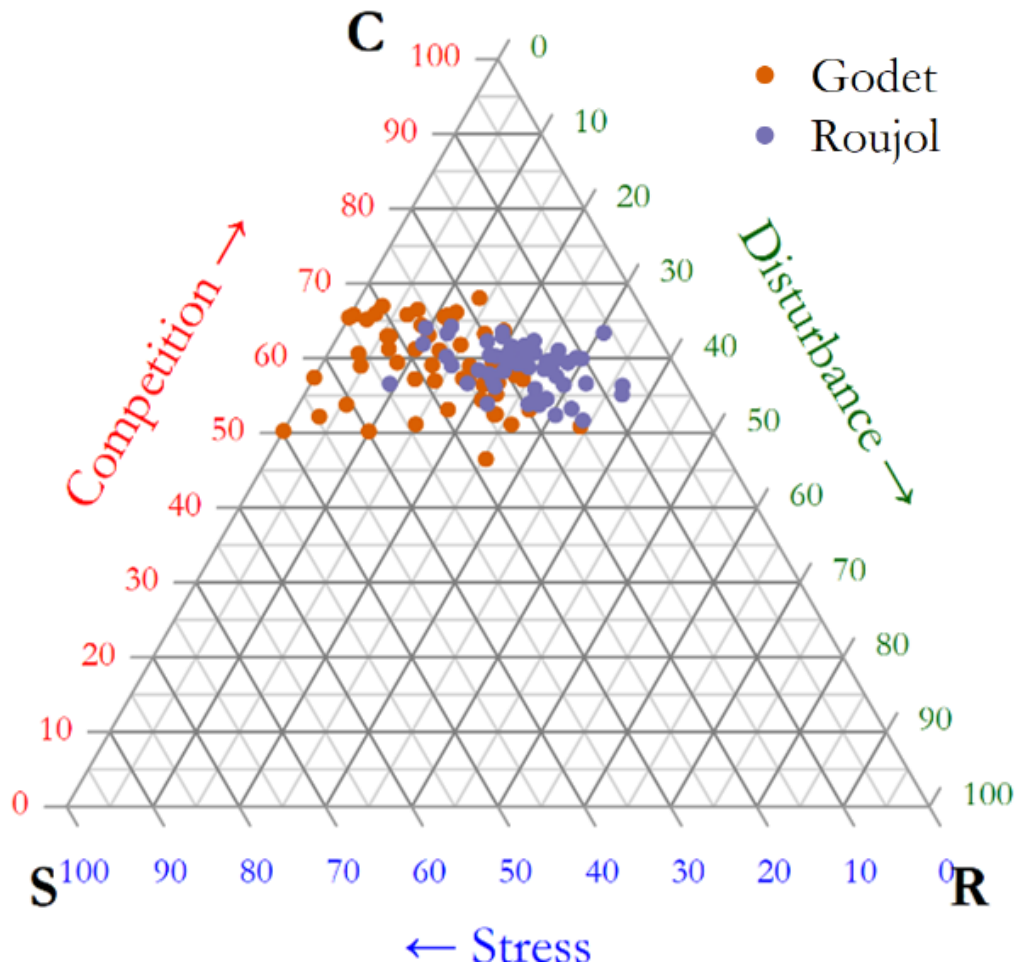
*specific leaf area,  
chlorophyll content,  
leaf thickness, leaf  
area, leaf dry matter  
content*

### **Genotypes:**

*D. alata diversity panel  
(50 acc.)*

*Site: Godet and Roujol*

*>2000 leaves  
phenotyped*



## Develop M/HTPP

### *Phenotyping: Characterization of leaf stomata*

**Phenotyped leaf traits:** Stomata index, stomata density, stomata size

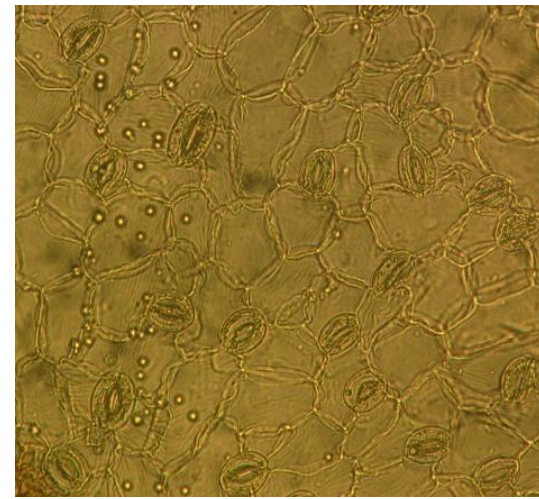
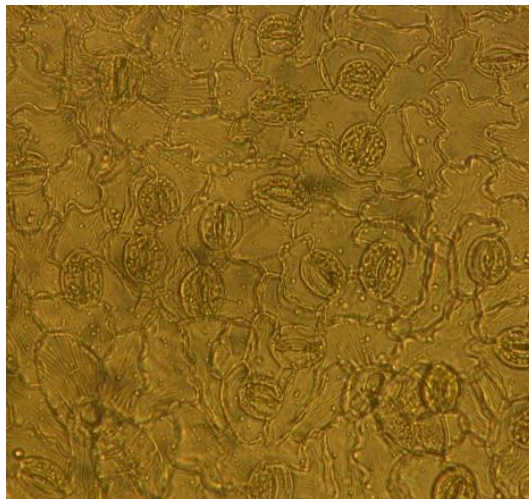
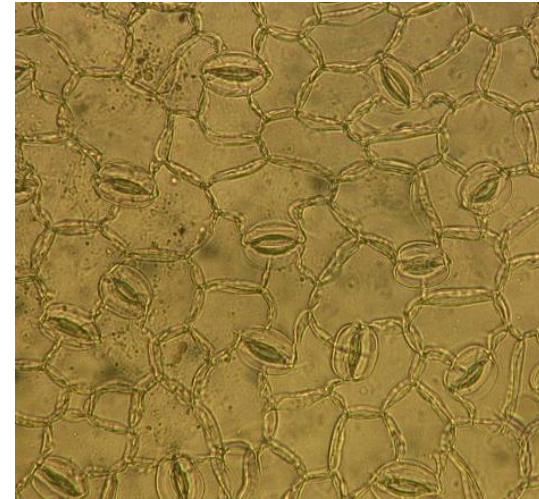
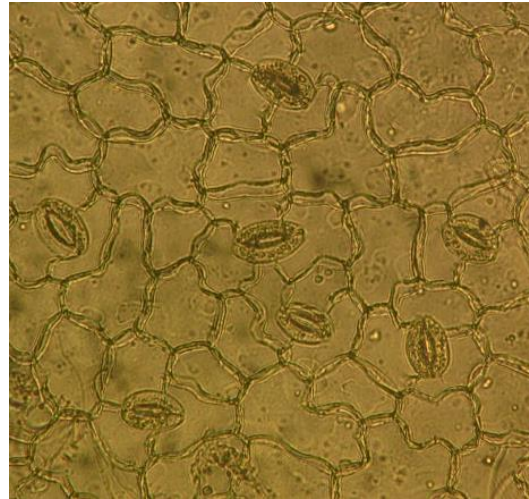
**Genotypes:**

*D. alata diversity panel (50 acc.)*

**Site:**

*Godet and Roujol*

*>9000 pics acquired*

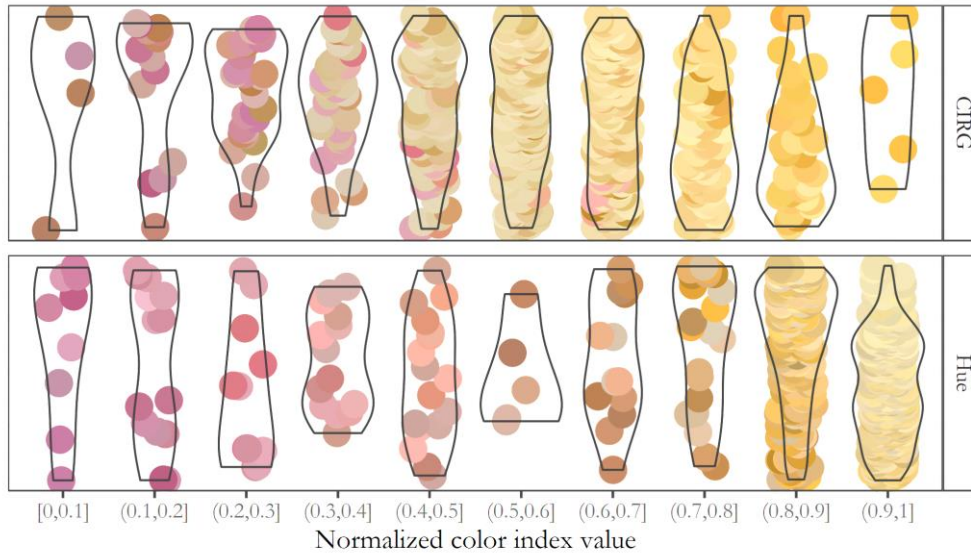




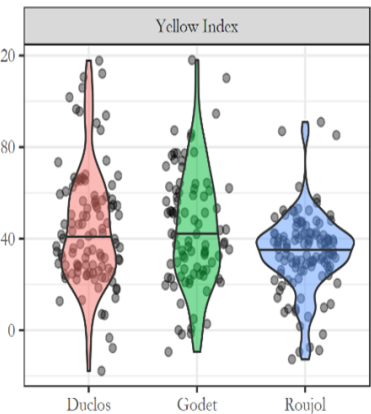
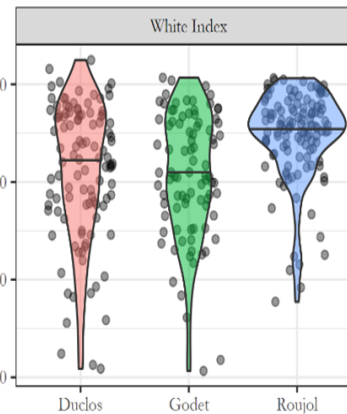
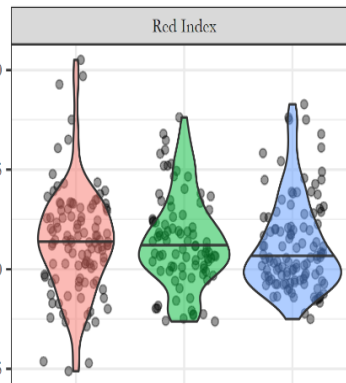
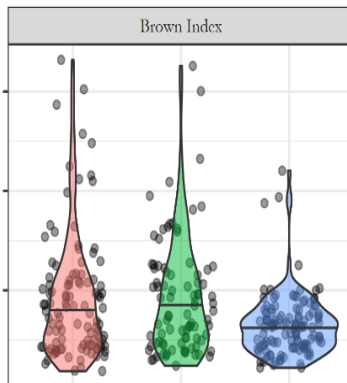


## Develop M/HTPP

### Phenotyping: Characterization tuber color and oxidation

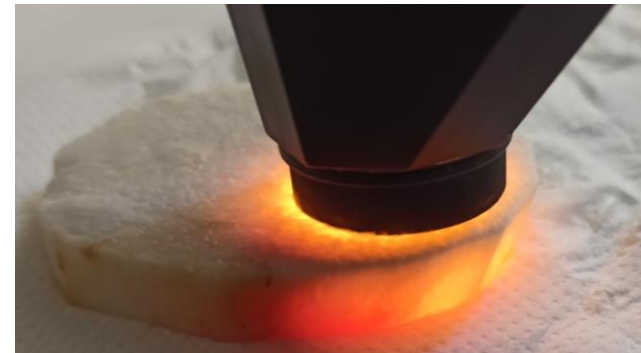


Purpleness index  
CIRG -> Hue



## Develop M/HTPP

*Phenotyping: Characterization of pounded yam mouldability, cooking time, peeling yield*



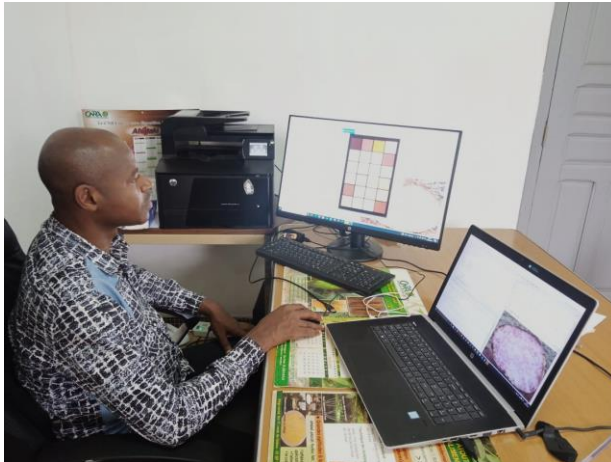
## Develop M/HTPP

*Phenotyping: External validation for NIRS model predicting starch, soluble sugar and protein content (RTBfoods)*

			Calibration						
Constituent	N <sub>total</sub>	SEL	N <sub>calib</sub>	Outlier	Noise	Mean	SD	SEC	R <sup>2</sup>
Protein	1032	0,069	784	0	5	5,244	0,997	0,093	0,991
Sugar	1032	0,077	784	0	3	3,335	2,23	0,135	0,997
Starch	1032	0,541	784	0	3	78,903	3,809	0,505	0,982
			External Validation						
Constituent	N <sub>total</sub>	SEL	N <sub>valid</sub>	Outlier	Mean	SD	SEP	R <sup>2</sup>	RPD
Protein	1032	0,069	248	0	6,77	1,205	0,753	0,61	1,324
Sugar	1032	0,077	248	0	3,798	2,659	0,984	0,862	2,2663
Starch	1032	0,541	248	0	77,156	3,854	1,858	0,767	2,0501

## Transfer M/HTPP

- *Capacity building with CNRA*
  - *Hosting of Dr Dibi (Oct. – Nov. 2021 in Montpellier)*
  - *Training session in Cotonou*
  - *Support mission in CI*



6 RGB 0526290 XYZ 002104292 Lab 14,3,57	12 RGB 0112274 XYZ 03122001 Lab 80,82	18 RGB 0810149 XYZ 02021096 Lab 75,24,9	24 RGB 22125220 XYZ 9551,49 Lab 30069
5 RGB 0813610 XYZ 04278035 Lab 88,17,43	11 RGB 09506195 XYZ 05201008 Lab 79,110	17 RGB 22220192 XYZ 04000499 Lab 34,210	23 RGB 0906570 XYZ 0061104 Lab 39,36,46
4 RGB 20163130 XYZ 01204010 Lab 170,10	10 RGB 20430208 XYZ 01720008 Lab 82,3	16 RGB 070174127 XYZ 01503325 Lab 76,16,37	22 RGB 19436705 XYZ 01504002 Lab 82,6,61
3 RGB 08097107 XYZ 052046055 Lab 79,520	9 RGB 0558100 XYZ 022017825 Lab 89,20,12	15 RGB 21221209 XYZ 052011044 Lab 37,213	21 RGB 1012071 XYZ 020220009 Lab 58,1230
2 RGB 0273001 XYZ 000001001 Lab 131,6,11	8 RGB 20436179 XYZ 013006033 Lab 81,210	14 RGB 211154219 XYZ 04100009 Lab 88,16,33	20 RGB 13336201 XYZ 017030014 Lab 38,3,30
1 RGB 20020115 XYZ 01504010 Lab 86,543	7 RGB 08090190 XYZ 01021050 Lab 77,00	13 RGB 204190180 XYZ 015010150 Lab 80,223	19 RGB 1112670 XYZ 011200006 Lab 35,220



- *Publications:*

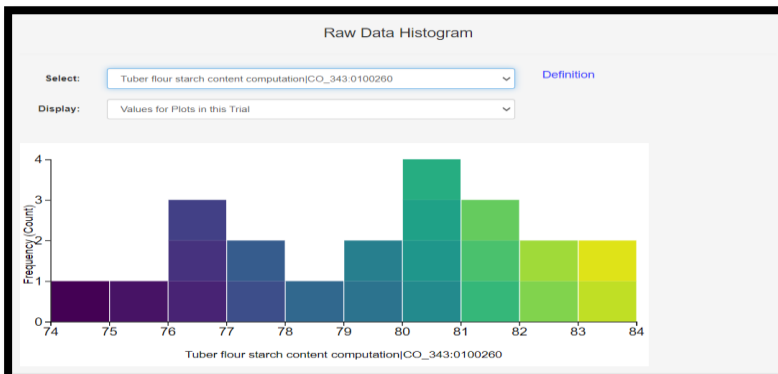


- Accepted Paper – Acta Horticulturae. Identification and validation of QTLs for tuber quality related traits in yam *Dioscorea alata* L. G. Arnau, A. E. Ehounou, E. Maledon, E Nudol, H. Vignes, M. C. Gravillon, A. S. P. N’guetta, P. Mournet , A. M. Kouakou, H. Chair, F. Cormier
- 4 paper to be submitted to JSFA



## Transfer M/HTPP

- *Yam ontology traits*
  - *Validated: color indices, emergence dynamic related traits*
  - *Ongoing: textural trait using NIRS (springiness, moldability...)*
- *Yambase:*
  - *Trials from 2016 up to 2018 were added*
  - *Tuber composition*
  - *NIRS bug*



Create: Springiness of pounded yam #28

Closed dcornet opened this issue on 2 Mar - 3 comments

dcornet commented on 2 Mar

**Submitter**

Name	CORNET
Program	Cirad

**Creation Request**

Trait Name	Springiness of pounded yam
Definition	Measurement of springiness based on Texture Profile Analysis using double compression test on pounded yam sample.
Trait Class	Quality
Measurement Method	Texture Profile Analysis using double compression test allow to define springiness as the ratio between distances from the onset to peak force of the second to the first compression cycle.
Measurement Type	Unit
Measurement Unit	proportion

YamBase Search Manage Analyze Genomes About

Download Phenotypes

Double click trial (👉) or folder (📁) to view detail page.

Breeding programs (👤)

Genotyping data projects (📊)

Analyses (📈)

Sampling trials (📍)

**Folders**

Create new folder

Move trial(s) to folder

Move folder

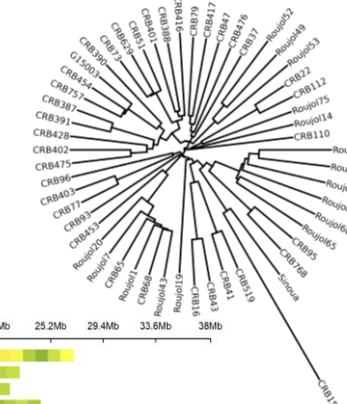
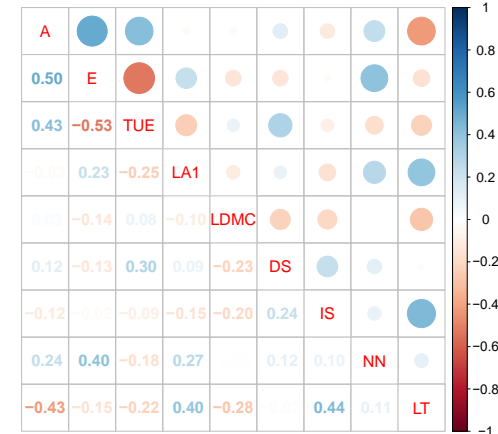
- ↳ LPHL\_Ost181
- ↳ RTBFoods
- ↳ NaCRRI
- ↳ CIRAD
  - ↳ 2016\_CIRAD
    - ↳ CIRAD-INRAE\_Cotziyanm\_2016\_Godet
    - ↳ CIRAD\_QualityPanel\_2016\_Roujol
  - ↳ 2017\_CIRAD
    - ↳ CIRAD-INRAE\_Cotziyanm\_2017\_Duclos
    - ↳ CIRAD-INRAE\_Cotziyanm\_2017\_Godet
    - ↳ CIRAD\_QualityPanel\_2017\_Roujol
  - ↳ 2018\_CIRAD
    - ↳ CIRAD-INRAE\_Cotziyanm\_2018\_Duclos
    - ↳ CIRAD-INRAE\_Cotziyanm\_2018\_Godet
    - ↳ CIRAD-INRAE\_Cotziyanm\_2018\_Roujol
    - ↳ error\_to\_be\_deleted
  - ↳ 2019\_CIRAD
    - ↳ CIRAD-INRAE\_Cotziyanm\_2019\_Duclos
    - ↳ CIRAD-INRAE\_Cotziyanm\_2019\_Godet
    - ↳ CIRAD-INRAE\_Cotziyanm\_2019\_Roujol
  - ↳ 2020\_CIRAD
    - ↳ CIRAD-INRAE\_Cotziyanm\_2020\_Godet
    - ↳ CIRAD-INRAE\_Cotziyanm\_2020\_Roujol
  - ↳ 2021\_CIRAD
    - ↳ CIRAD-INRAE\_Cotziyanm\_2021\_Godet
    - ↳ CIRAD-INRAE\_Cotziyanm\_2021\_Roujol
  - ↳ error\_to\_be\_deleted

## GWAS for nine leaf traits in *D. alata*

### Phenotyping at two locations:

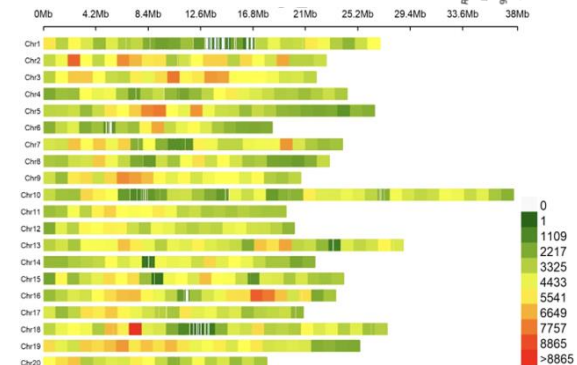
- High variability for leaf traits
- Moderate to high heritability for leaf traits
- Correlations between leaf traits highlighted

Traits		Min	Max	Mean	V	CV	H <sup>2</sup>
LDMC	Leaf dry mater content	0.1	0.27	0.18	0.00136	20.43	0.58
LA1	Leaf area	7.32	85.67	32.37	288.21	52.44	0.92
A	Net photosynthetic rate	0.95	23.33	12.65	19.63	35.04	0.81
E	Transpiration	0.48	4.45	2.66	0.6	29	0.94
TUE	Transpiration use efficiency	0.38	9.15	4.83	1.81	27.82	0.76
IS	Stomatal index	8.89	37.14	22.74	23.22	21.19	0.77
DS	Stomatal density	50.44	353.1	170.69	3366.38	33.99	0.87
NN	Node number	3	15	9.42	6.07	26.16	0.74
LT	Leaf thickness	0.2	0.6	0.36	0.00576	20.8	0.72



### Whole genome sequencing of the panel:

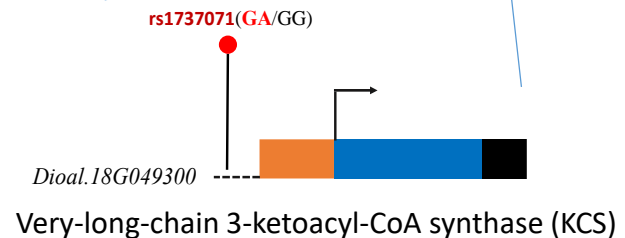
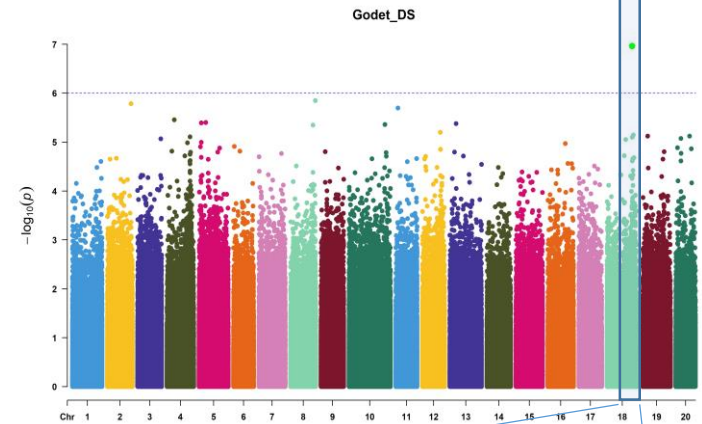
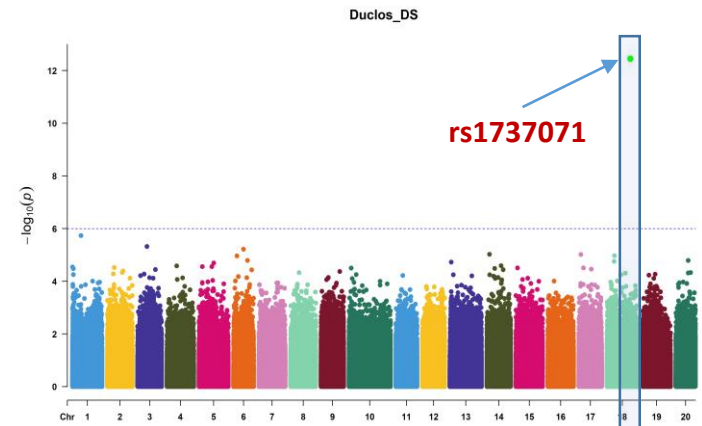
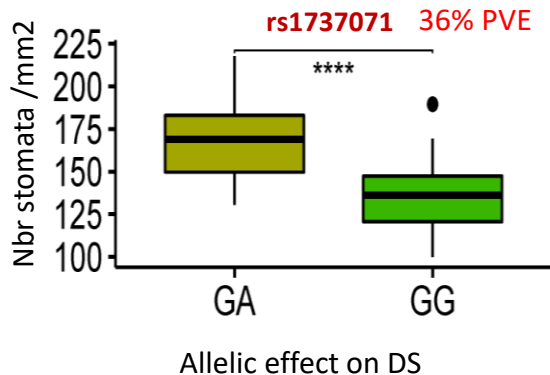
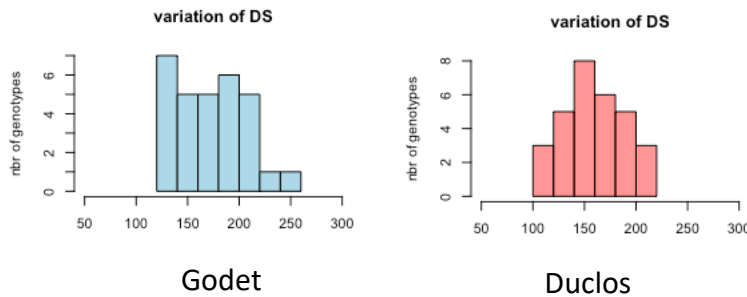
- 1.9 M SNPs
- High SNP density
- Weak population structure



## GWAS for nine leaf traits

- 18 associations detected
- Stable QTNs identified for 2 traits
- Favorable alleles at peak SNPs identified
- 33 candidate genes identified

Example of GWAS for stomatal density (DS)



Homolog of *hic* in Arabidopsis (Gary et al. 2000) doi:[10.1038/35047071](https://doi.org/10.1038/35047071)



# FP 2 PROGRESS SUMMARY

## QTL linkage mapping for leaf traits

Phenotyping of a bi-parental population of *D. alata* at Roujol (2 years)

- Leaf chlorophyll
- Leaf size
- Stomata traits
- Petiole length



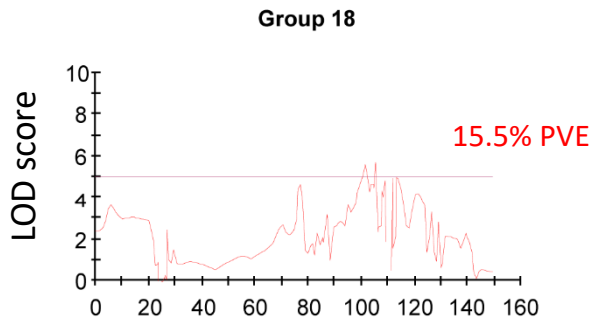
74F

X

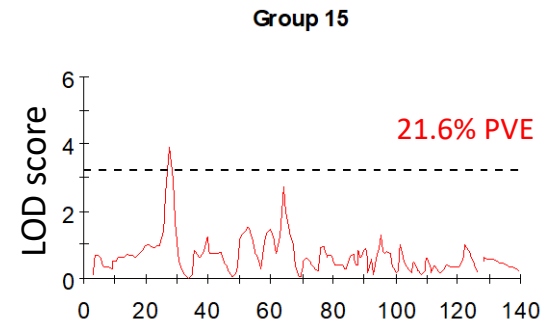
Kabusa

### 16 QTLs identified for leaf traits in the bi-parental population (GBS)

- GWAS and linkage map based QTLs coincide for some traits
- Novel QTLs detected



QTL for stomatal density (same region as in GWAS)



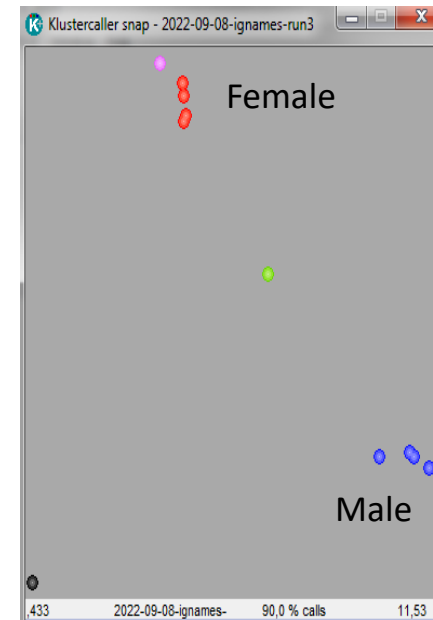
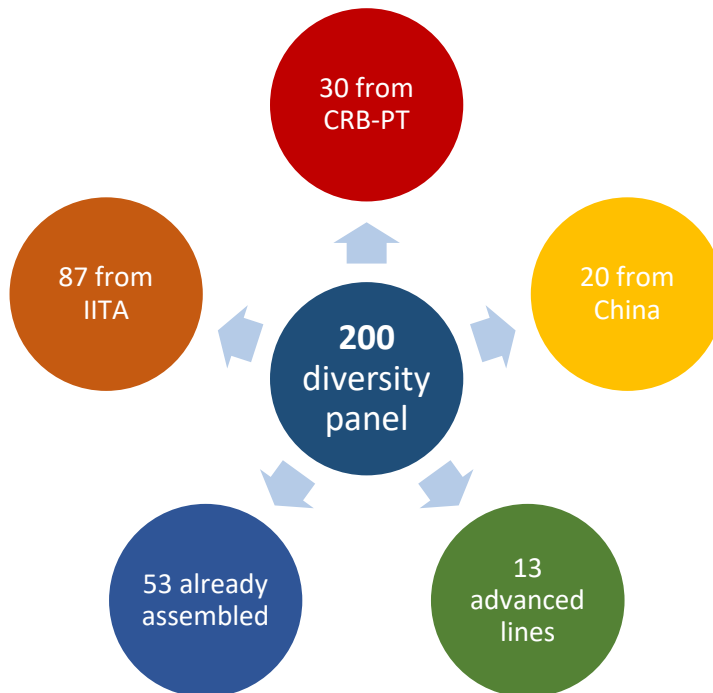
Novel QTL for leaf size

# FP 2 PROGRESS SUMMARY

## Introduction of new varieties to extend the diversity panel

### From 50 to 200 *D. alata* accessions in the diversity panel

- Improve GWAS power and GS prediction
- Re-analyze traits that failed in the initial panel
- Confirm previous results and develop diagnostic markers



Validation of SNP: 06.1.19660282 for sex determination in *D. alata*

# WORKPLAN FOR NEXT PERIODS

## Continue HTTP phenotyping development

- Validation of 3 SOPs on phenotyping methods for competitiveness against weeds
- Scientific follow-up of phenotyping activities at CNRA:
  - color and oxidative browning: assistance in data analysis and image processing
  - emergence dynamics: assistance in defining protocols and data analysis
  - Ground cover dynamics: assistance in defining protocols and data analysis
  - **drought tolerance**: assistance in defining protocols, training in the use of a UAV and image processing

## Continue GWAS/QTL analysis

- Emergence dynamic traits
- Ground cover traits
- Phenology, yield, ...
- Develop diagnostic markers

## Reproductive biology (in collaboration with CNRA)

- Develop methods for inducing flowering in *D. alata*
- Genomic and biochemical studies of flowering in *D. alata*

## Online platform (Yamhub) for managing yam genomic resources

- Genome browser
- Gene expression atlas: eFP browser
- Molecular markers mining and *in silico* analyses