AfricaYam II: Progress report and work plan at CIRAD

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AfricaYam II Annual Progress Review and Planning Meeting, 15 -17 September , 2022

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

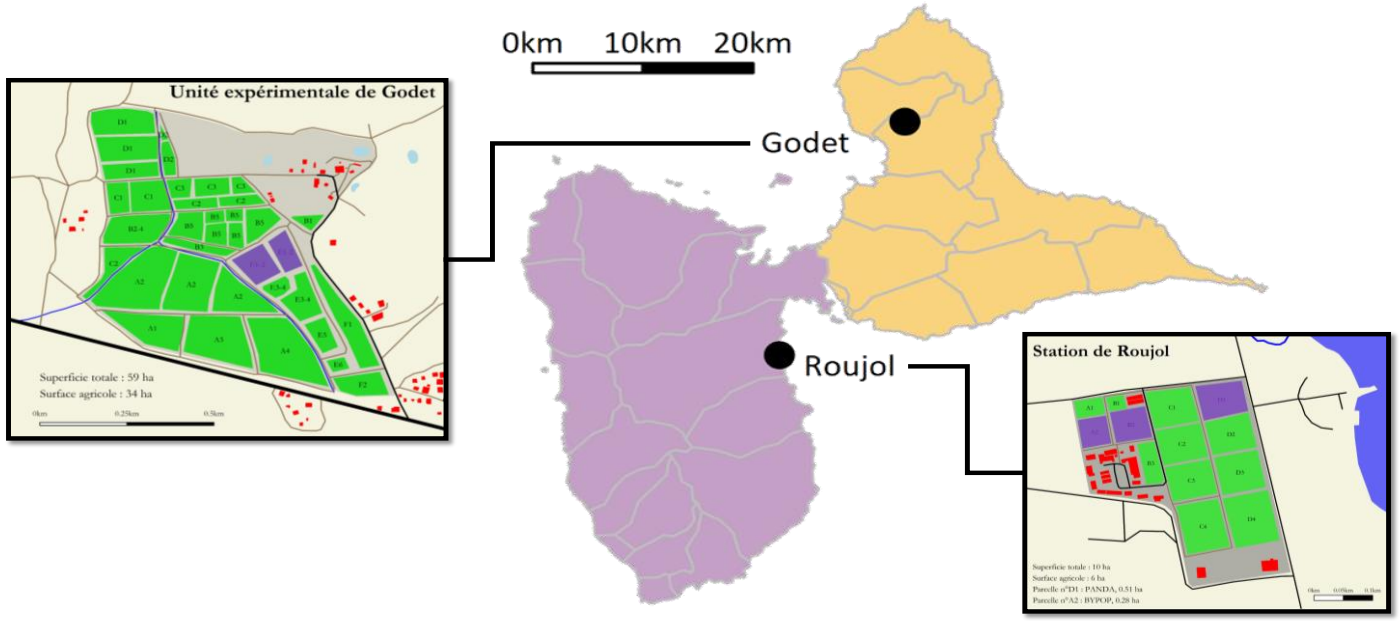
FP2

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

FP 1 PROGRESS SUMMARY

Develop M/HTPP

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



FP 1 PROGRESS SUMMARY

Develop M/HTPP

Phenotyping

FP 1 PROGRESS SUMMARY

Develop M/HTPP

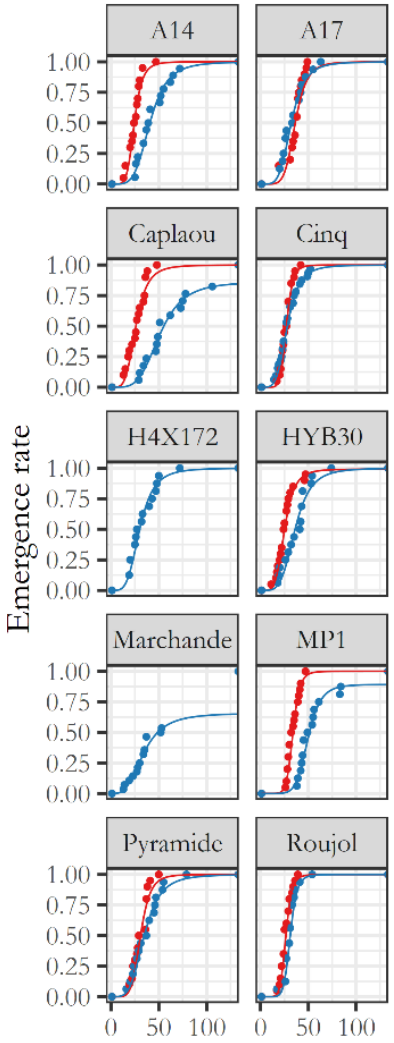
Phenotyping: Characterization of emergence dynamic

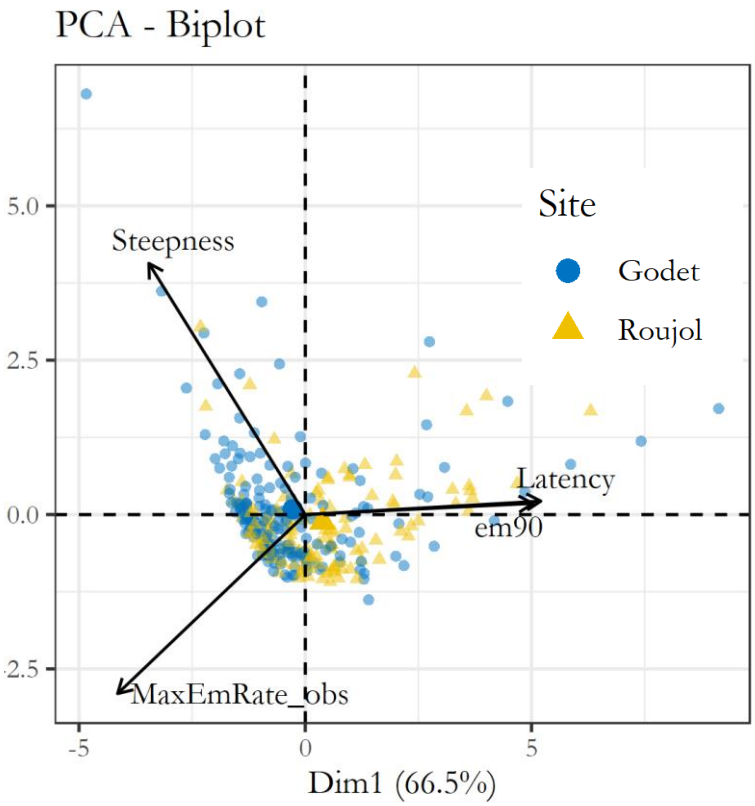
Phenotyped leaf traits:
Steepness
Emergence duration
Emergence rate

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

***Site**: Godet and Roujol*

1200 plants followed every 3 days





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

FP 1 PROGRESS SUMMARY

Develop M/HTPP

Phenotyping: Characterization of ground cover dynamic

Phenotyped leaf traits:
Maximum ground cover
Ground cover speed
Senescence duration

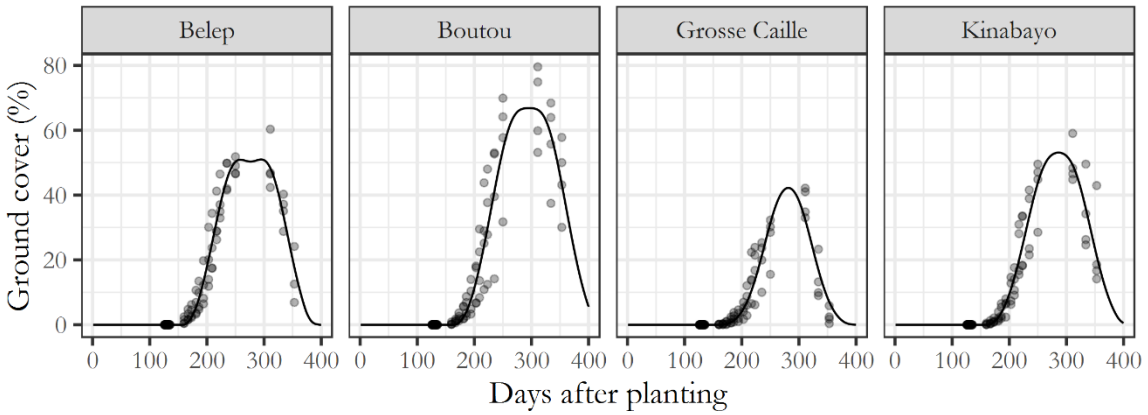
***Genotypes**:*
D. alata *diversity panel (50 acc.)*

***Site**: Godet and Roujol*

12000 pics acquired



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



FP 1 PROGRESS SUMMARY

Develop M/HTPP

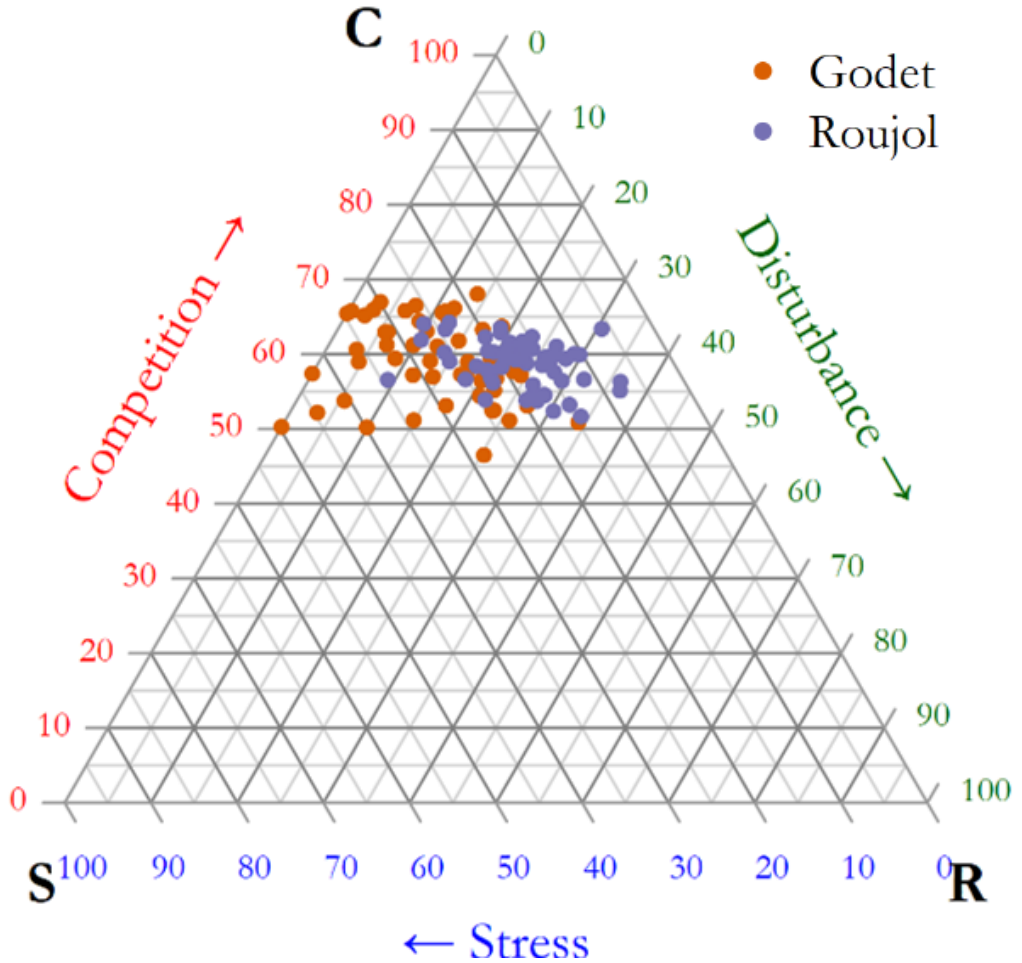
Phenotyping: Characterization of ecological strategy

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



FP 1 PROGRESS SUMMARY

Develop M/HTPP

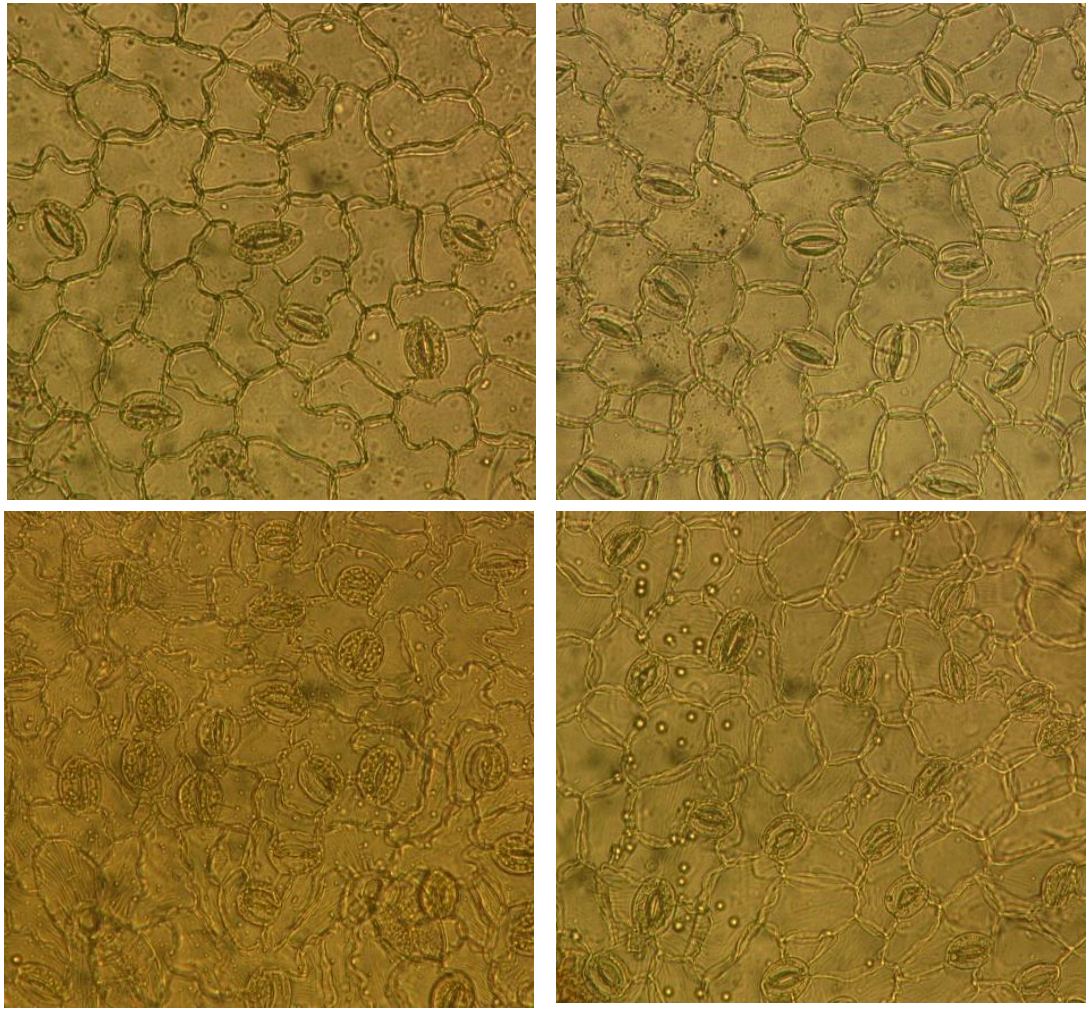
Phenotyping: Characterization of leaf stomata

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

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

Site*:*
Godet and Roujol

>9000 pics acquired



FP 1 PROGRESS SUMMARY

Develop M/HTPP

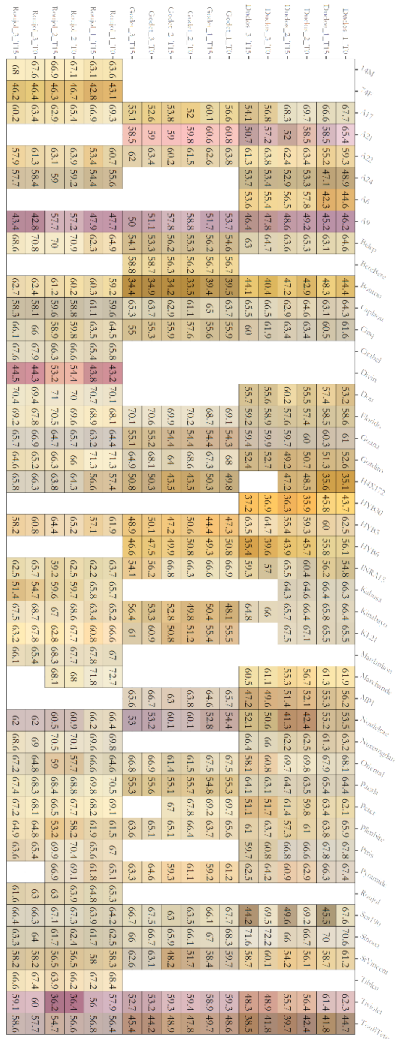
Phenotyping: Characterization tuber color and oxidation

Phenotyped traits: *color indices, color indices spatial variability, color indices temporal variability*

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

Site*:*
Godet and Roujol

>3000 pics acquired



$$Whiteness\ Index = \sqrt{(100 - L^{*2} + a^{*2} + b^{*2}} \text{ (Rhim et al. 1999)}$$

$$Yellowness\ Index = \frac{142.86\, b^*}{L^*} \text{ (Francis and Clydesdale 1975)}$$

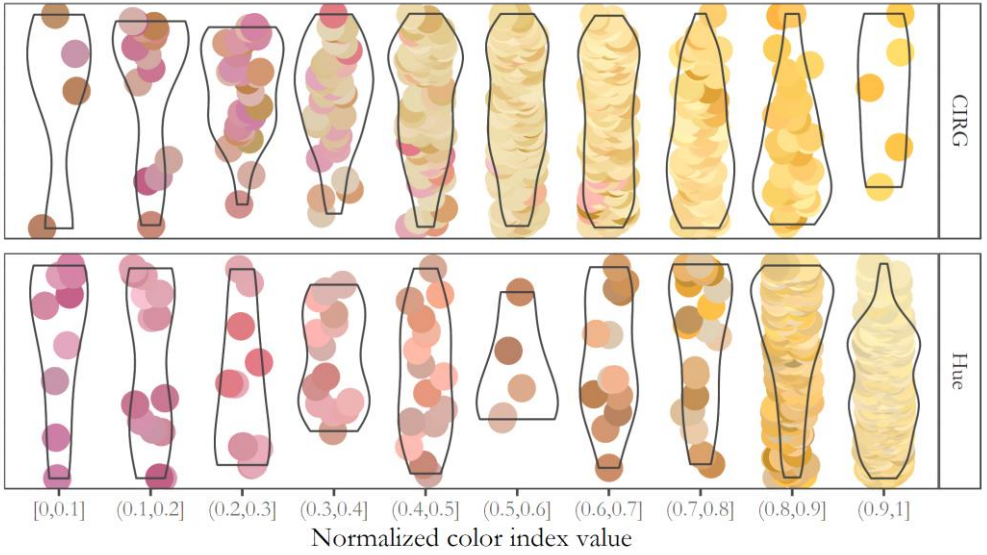
$$Browness\ Index = [100(x - 0.31)]/0.172 \text{ (Buera et al., 1986)}$$

$$Color\ Index\ for\ Red\ Grape = \frac{180 - Hue}{L^* + Chroma} \text{ (Carreño et al. 1995)}$$

FP 1 PROGRESS SUMMARY

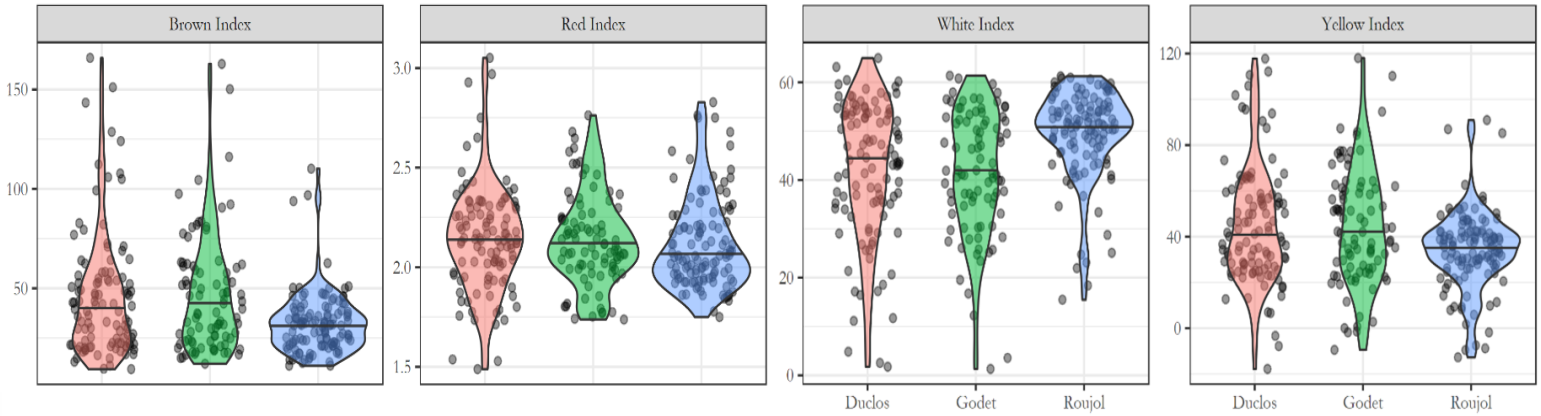
Develop M/HTPP

Phenotyping: Characterization tuber color and oxidation



Purpleness index

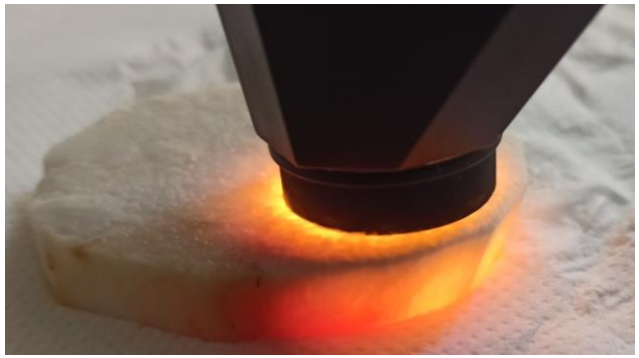
~~CIRG~~ -> Hue



FP 1 PROGRESS SUMMARY

Develop M/HTPP

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



NIRS applied to fresh and flour samples

FP 1 PROGRESS SUMMARY

Develop M/HTPP

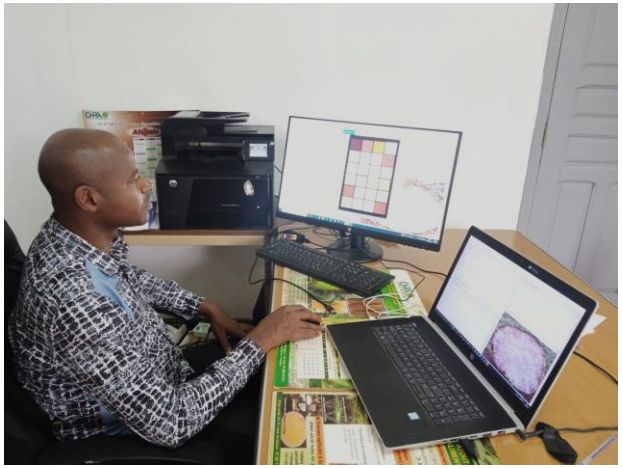
Phenotyping: External validation for NIRS model predicting starch, soluble sugar and protein content (RTBfoods)

			Calibration						
Constituent	**N_{total}**	**SEL**	**N_{calib}**	**Outlier**	**Noise**	**Mean**	**SD**	**SEC**	**R^2**
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_{total}**	**SEL**	**N_{valid}**	**Outlier**	**Mean**	**SD**	**SEP**	**R^2**	**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

FP 1 PROGRESS SUMMARY

Transfer M/HTPP

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

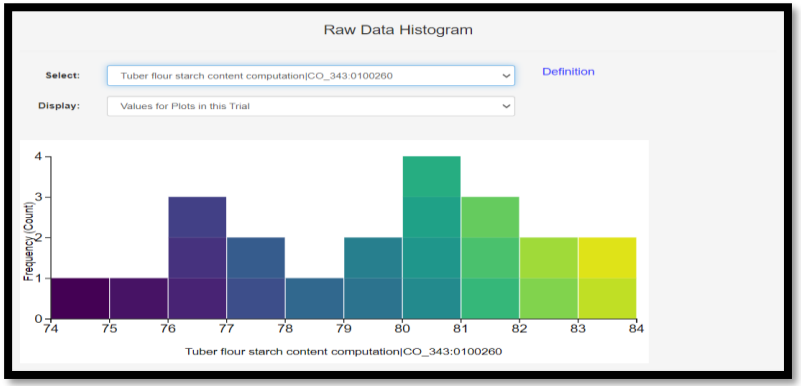


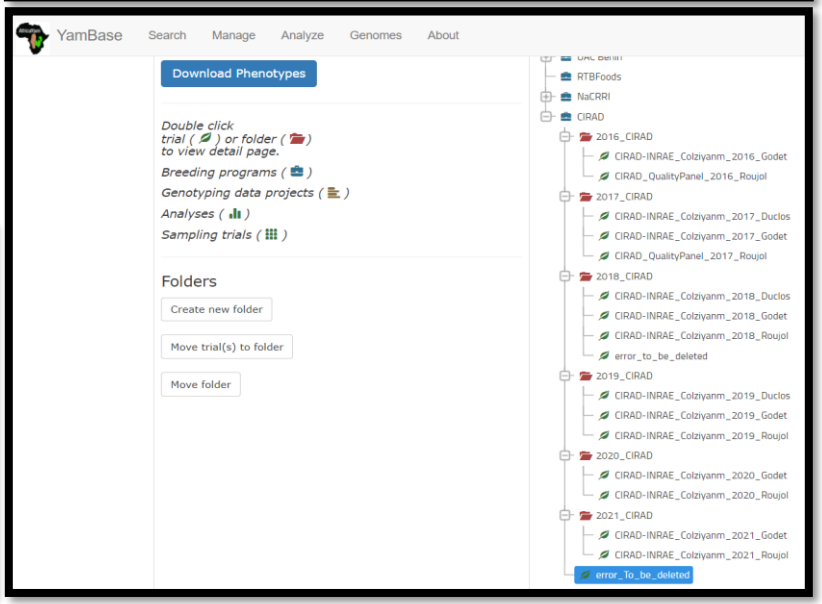
- *Publications:*
  - Accepted Paper – Acta Horticulturae. Identification and validation of QTLs for tuber quality related traits in yam *Dioscorea alata* L. G. Arnau, A. E. Ehounou, E. Maledon, E Nudol, H. Vignes, M. C. Gravillon, A. S. P. N'guetta, P. Mournet , A. M. Kouakou, H. Chaïr, F. Cormier
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

FP 1 PROGRESS SUMMARY

Transfer M/HTPP

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





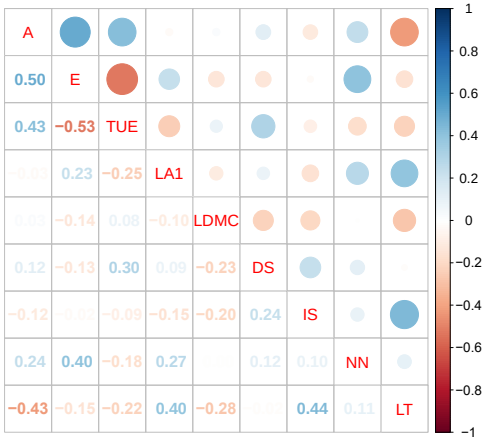
FP 2 PROGRESS SUMMARY

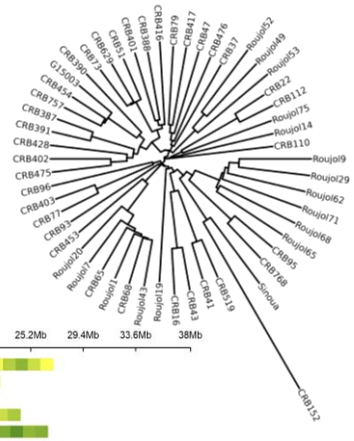
GWAS for nine leaf traits in *D. alata*

Phenotyping at two locations:

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

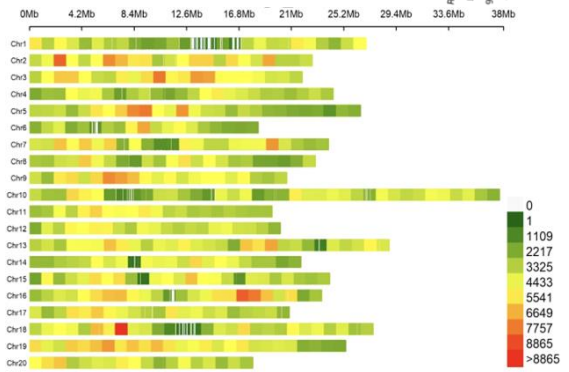
Traits		Min	Max	Mean	V	CV	H^2
LDMC	Leaf dry mater content	0.1	0.27	0.18	0.00136	20.43	0.58
LA1	Leaf area	7.32	85.67	32.37	288.21	52.44	0.92
A	Net photosynthetic rate	0.95	23.33	12.65	19.63	35.04	0.81
E	Transpiration	0.48	4.45	2.66	0.6	29	0.94
TUE	Transpiration use efficiency	0.38	9.15	4.83	1.81	27.82	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

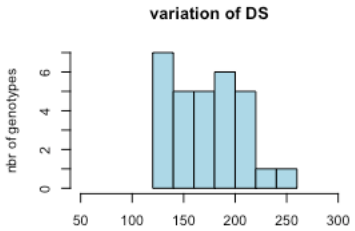


FP 2 PROGRESS SUMMARY

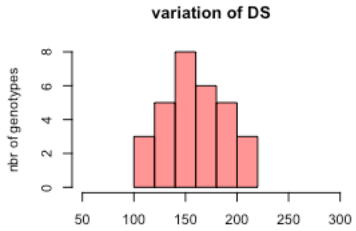
GWAS for nine leaf traits

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

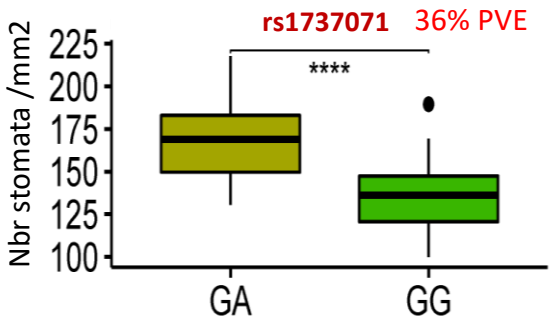
Example of GWAS for stomatal density (DS)



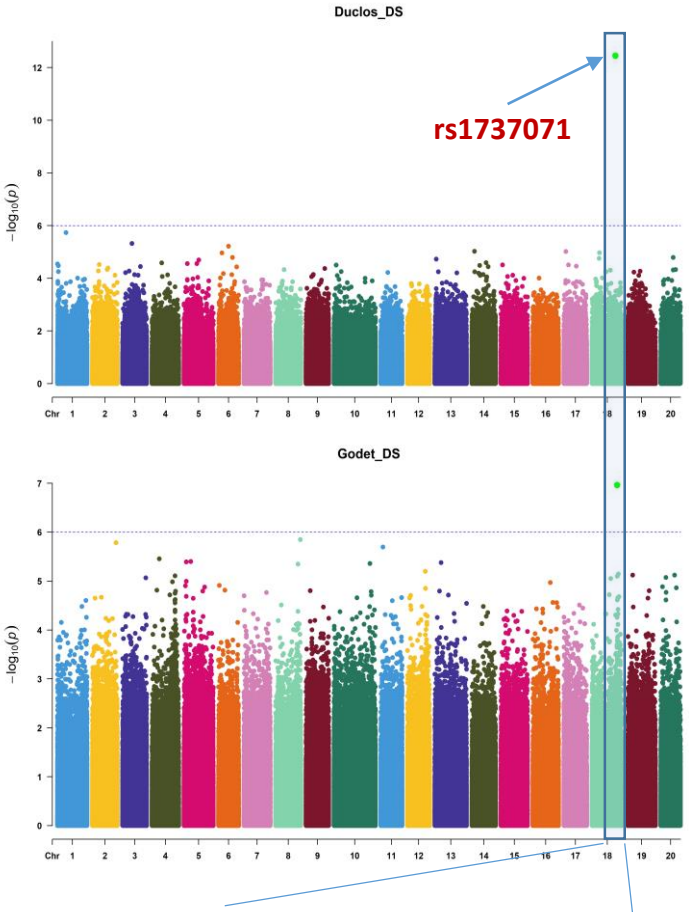
Godet

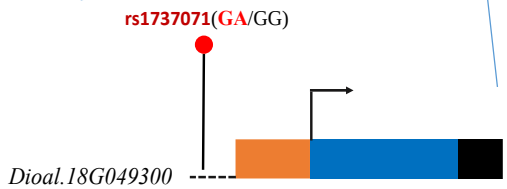


Duclos



Allelic effect on DS





Very-long-chain 3-ketoacyl-CoA synthase (KCS)

Homolog of *hic* in Arabidopsis (Gary et al. 2000) DOI:10.1038/35047071

FP 2 PROGRESS SUMMARY

QTL linkage mapping for leaf traits

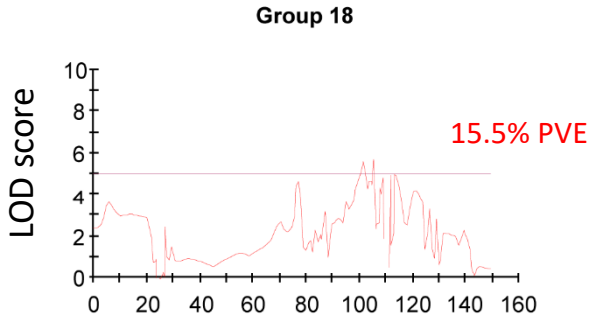
Phenotyping of a bi-parental population of *D. alata* at Roujol (2 years)

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

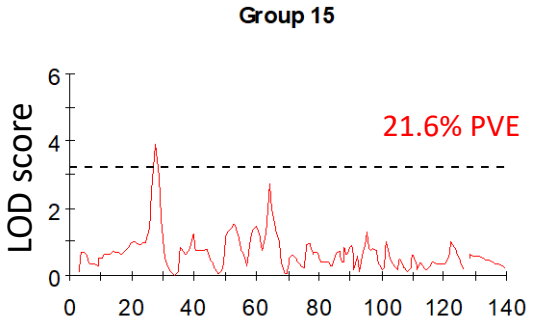
74F X Kabusa

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)



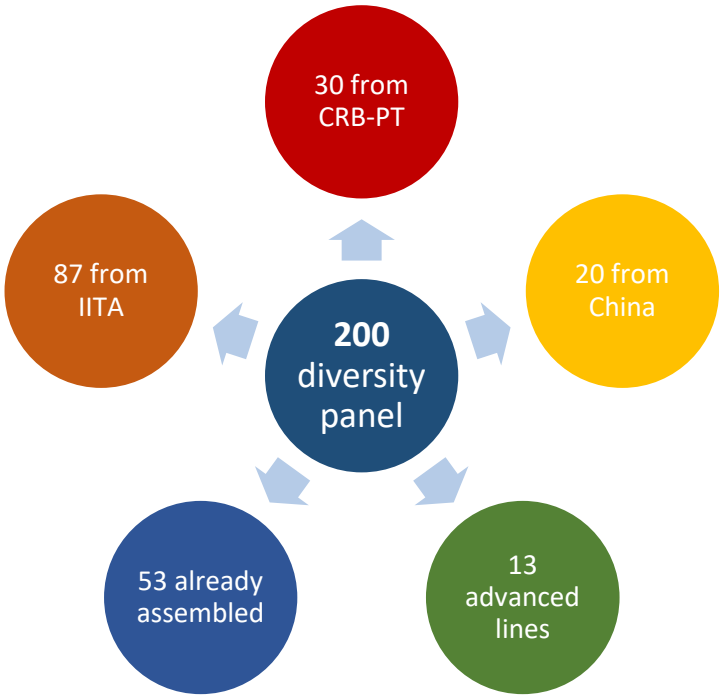
Novel QTL for leaf size

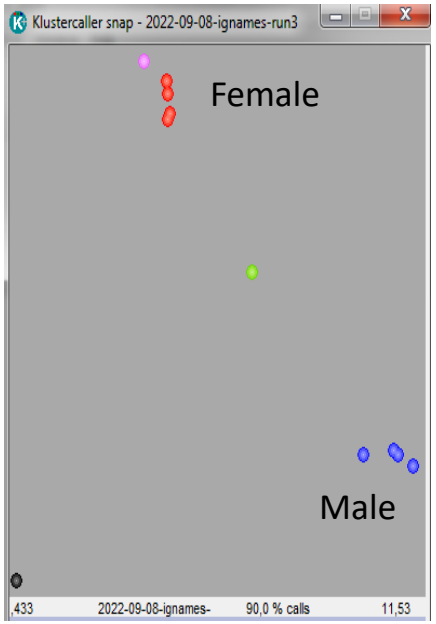
FP 2 PROGRESS SUMMARY

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 competitivity 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

WORKPLAN FOR PERIOD 2

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