Linking Phenotypic with Genotypic Traits to Facilitate Selection for Water-Stress Tolerance in Cocoa

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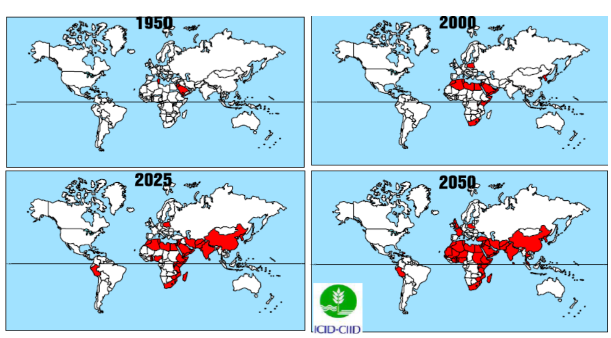
- *A very drought sensitive plant in a planet under bad future estimations about water availability.*
- *Rain fed orchards under shade (what the reasons??? Is T. cacao a light or water sensitive?).*
- *Irrigation as a solution – great results – but is not and will not be available for every one.*
- *T. cacao evolved in big humid regions but with some sites with annual dry periods (e.g. Amazon) – it can represents a high genetic sources for plant breeding regarding drought tolerance.*



Water scarcity pressure – Evolution of water shortages in 100 years

Objective

1. *To determine genotypic variation in traits associated with tolerance to water stress.*

- *International Cocoa Quarantine Centre (ICQC), Reading*
- *Mars Centre for Cocoa Science cocoa collection*

2. *To develop genetic markers for tolerance to water stress.*

- *Physiological screen for determining the variation in water stress tolerance traits within cocoa mapping population in MCCS-BAH*
- *An association analysis will then be conducted between phenotypic and genotypic traits.*

Strategy 1- Experimental approach

→ *Leaf Gas exchange*
- *photosynthesis (A)*
- *stomatal conductance (gs)*
- *transpiration rate (E)*
- *Instantaneous water-use efficiency (A/E)*
- *intrinsic water-use efficiency (A/gs)*

→ *Electrolyte leakage*
- *Leaf discs will be immersed on NaCl and (Polyethylen Glycol) PEG 6000 solutions in the osmotic potentials (- 0.25 and -0.75 MPa) in petri dishes. Followed by Electrical condutivity (EC) measurements.*
- (ECf- ECi)/(ECt-ECi) × 100

Strategy 2- Experimental approach

~ 150 d

10 contrasting progeny trees x 25 rooted cutting or somatic embryogenesis replicates

10 replicates for drought treatments

5 replicates well-watered (100% field capacity)

5 replicates under soil moisture content decrease (100, 90, 80, 70% field capacity)

-Water control using a soil moisture probe - 15 d for 90, 80 and 70% FC stages and 5 days for each transition.

5 replicates harvested for reference biomass

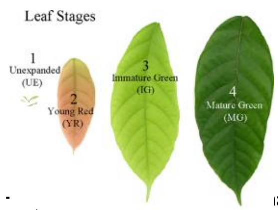
-Leaf area
-Leaf dry weight
-Stem dry weight
-Root dry weight
-Biomass partition

- *measurements of chlorophyll fluorescence*
- *stomatal conductance*
- *leaf reflectance*
- *cuticular transpiration*
- *epicuticular wax*
- *carbon isotope discrimination*
- *osmotic adjustment*
- *leaf temperature*
- *mesophyll diffusion conductance*

Strategy 2- Experimental approach

→ *(Grow measurements) From the dry biomass of the different parts of the plant and the total leaf area the following parameters will be calculated:*
-total dry matter gain
-dry matter gain of different organs
-relative growth rate
-net assimilatory rate
-specific leaf mass and leaf area ratio (Radford, 1967; Richards, 1969; Hunt, 1990)

→(Measurements of macro and micronutrients) – 5 leaf age stages

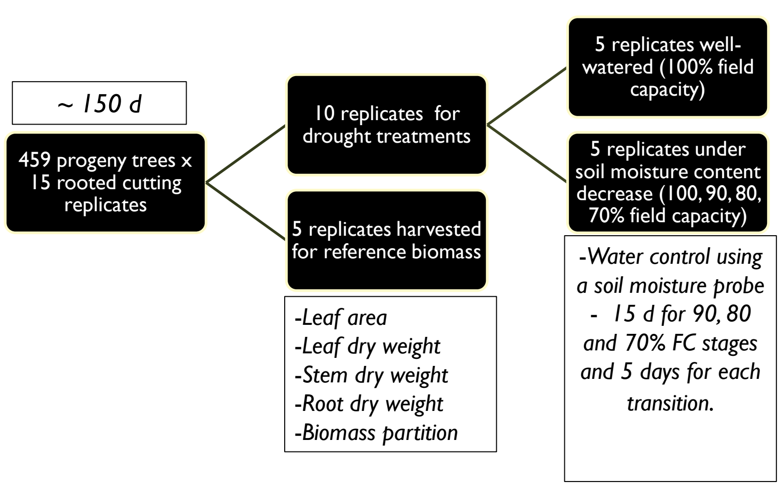


- ange) – A, gs, E, Ci, Light-response curves will also be conducted and, if time permits, CO_2 response curves.

→ Feasible and explanatory techniques (Uni of Reading Pilot Experiments)

Strategy 3- Experimental approach

Approach 01



Strategy 2- Experimental approach

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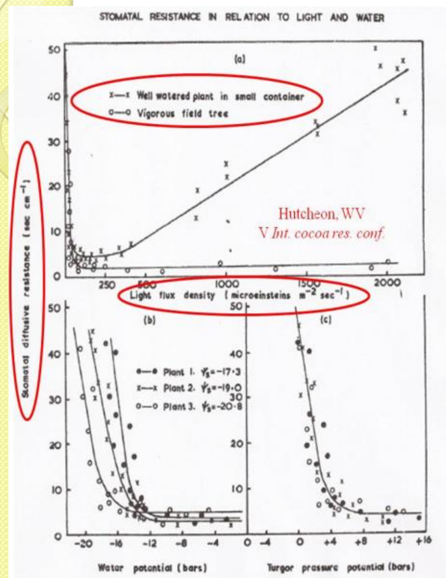
..... for each genotype
- This data will then be analyzed against the SNP map of the MP01 population to evaluate the presence of QTLs

Conclusion

→ *Good results, after following research, can provide plants selected to grow in rain fed fields (less impactant agriculture), and able to keep satisfactory production even under natural low water supply*

Thanks.


STOMATAL RESISTANCE IN RELATION TO LIGHT AND WATER
(a)
x—x Well watered plant in small container
o—o Vigorous field tree
Hutcheon, WV
V Int. cocoa res. conf.
Stomatal diffusive resistance (sec cm⁻¹)
Light flux density (microeinsteins m⁻² sec⁻¹)
(b)
(c)
●—● Plant 1. ψs=-17·3
x—x Plant 2. ψs=-19·0
o—o Plant 3. ψs=-20·8
Water potential (bars)
Turgor pressure potential (bars)

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