INCORPORATING PHYSIOLOGICAL TRAITS INTO BREEDING PROGRAMMES

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UTILISATION OF GERMPLASM IN BREEDING

• The diversity of cocoa germplasm has been utilised to an extent through the selection of seed garden parents and selection of clones
• Nevertheless, the amount of germplasm utilised for breeding is relatively small
• Characterisation of germplasm and understanding how different germplasm responds to environmental variables is important in developing varieties suited to different growing conditions (present and future)
PHYSIOLOGICAL CHARACTERISATION OF COCOA GENETIC RESOURCES: TRAITS IMPORTANT FOR YIELD

- Photosynthetic potential of leaves
- Light captured by the canopy
  - Leaf area index
  - Extinction coefficient
- Biomass partitioning
  - Ratio of assimilates partitioned between beans and vegetative growth
GENOTYPIC VARIATION IN PHYSIOLOGICAL TRAITS

Data collected from the International Cocoa Quarantine Centre, University of Reading

Lahive et al. In prep
Illustration of genotypic differences in biomass partitioning

Field data from Brazil
Daymond et al. 2002.
Hortscience, 37, 799-801

Bars represent different blocks
ENVIRONMENTAL FACTORS IMPACTING COCOA PHYSIOLOGY

• Temperature: Low temperatures, excessively high
• Water: drought or flooding
• CO₂ concentration
• Relative humidity
• Light

Influenced by
- Geographical location/ altitude
- Season
- Climate change
- Husbandry
WHY IT IS IMPORTANT TO CONSIDER GENOTYPE * ENVIRONMENT INTERACTIONS

- Adaptation to geographical locations (e.g. different temperature regimes rainfall patterns
- Adaptation to management systems (e.g. shade)
- Adaptation to future climates (climate change)
- Various studies have shown differential responses of germplasm to environmental parameters
TEMPERATURE * GENOTYPE

Fig. 1. Mean monthly temperatures of the three glasshouse compartments in which the temperature regimes of the cacao-growing regions of Brazil (●), Ghana (■) and Malaysia (▲) were simulated.
Fig. 2. Increase in the main stem cross-sectional area over the course of a year from the time of introduction into the thermal environments. Each point represents the mean of five observations. Brazil = dark grey bars; Ghana = light grey bars; Malaysia = unshaded bars.

Annals of Applied Biology, 145, 257-262
LIGHT ENVIRONMENT * GENOTYPE SHADE EXPERIMENT

- Shade net experiment (Kofi Acheampong) in Ghana (CRIG)
- Three shade regimes and four genotypes
Acheampong, Hadley and Daymond (2013)
*Exp Ag*, 49, 31-42

![Graph showing dry weight (kg/plant) for different clones and shade levels.]

- LSD clone = 0.115
- LSD shade * clone = 0.118

- 32.5% shade
- 55% shade
- 76% shade

**Clones:**
- SCA 6
- T 79/501
- P 30 [POS]
- PA 150
SCREENING FOR CLIMATE RESILIENCE

As part of the climate change programme at University of Reading we are developing screening tools for climate resilience:

- In particular for high temperature stress and water deficit stress
- Potential to apply to field situations/breeding programmes
Chlorophyll fluorescence responses to high temperature stress

Shaded = after high temperature shock
Unshaded = control
GENOTYPIC RESILIENCE TO WATER DEFICIT

Unshaded = water deficit
Shaded = control

On-going analysis is investigating associations between physiological parameters and resilience to water deficit
CONCLUSIONS

• Research at Reading and elsewhere has illustrated genotypic variability in physiological traits important for yield and that some genotypes are more resilient to abiotic stresses than others.

• Therefore potential for selection and breeding of more climate resilient materials
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