Overview of advances in cacao and climate change research and future perspectives

International Symposium on Cocoa Research
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A Changing Climate

- Increased atmospheric levels of CO$_2$ and other greenhouse gases are contributing to changes in climate
- CO$_2$ currently around 400ppm
- Changes in
  - Surface temperatures
  - Ocean temperatures
  - Precipitation patterns
  - Seasonal patterns

(IPCC Report 2014)
A Changing Climate

‘Human influence on the climate system is clear’

‘Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.’

Intergovernmental Panel on Climate Change
5th Assessment Report, SPM 2014
‘Human Activities Are the Primary Driver of Recent Global Temperature Rise’

Impacts of Climate Change

- enhanced growth at elevated CO₂
- longer potential growing season
- increase in crop water use efficiency
- shortened growing season for current varieties
- new threats from pests and diseases
- more frequent exposure to extreme conditions
Forecasts of crop productivity for 2050

Map 1: Climate change will depress agricultural yields in most countries in 2050, given current agricultural practices and crop varieties.

World Bank Development Review 2010
Confectionary Industry

“Climate change is spooking the world’s chocolate makers”

October 24 2017 – IBM Industries
Cocoa Farmers

- Cocoa farms are mainly low input, rain-fed systems
- The crop is produced by approximately 5-6 million small-scale, low income farmers
- This group is the least able to adapt to the negative influences of climate change
Studies on Climate Change in Cocoa

Open top chambers
Changes in net photosynthetic rate ($P_N$), instantaneous water use efficiency ($P_N/E$) and transpiration rate ($E$).
Studies on Climate Change in Cocoa

Greenhouse studies
Temperature response curve of cocoa seedlings

- Sub-optimal
- Optimal temperature
- Supra-optimal

PHOTOSYNTHESIS (µmol m$^{-2}$ s$^{-1}$) vs. Leaf temperature (°C)
Effects of elevated CO$_2$ and water stress on:
A. light-saturated photosynthesis
B. Intrinsic water use efficiency

Lahive (2016)
Adaptation to climate change

- Utilisation of plant genetic resources
- Adaptation of crop husbandry practices
- Breeding
- Shade
- Irrigation
- Fertigation
- Ground level mulches
Adaptation to climate change

Utilisation of plant genetic resources

Breeding

Adaptation of crop husbandry practices

Shade

Irrigation

Fertigation

Ground level mulches
International Cocoa Quarantine Centre

- Currently holds around 400 accessions
- High level of genetic diversity represented with the collection

ICQC,R funded by the Cocoa Research Association and USDA Physiology study funded by Cocoa Research UK
Light saturated photosynthetic rate

\[ A_{\text{max}} \text{ (\mu mol m}^{-2}\text{ s}^{-1}) \]

LSD = 1.43
P < 0.001
Stomatal conductance

LSD = 0.023
P < 0.001

F.M. Lahive, P. Hadley and A.J. Daymond In Press.
Adaptation to climate change

- Utilisation of plant genetic resources
- Adaptation of crop husbandry practices
- Breeding
- Shade
- Irrigation
  - Fertigation
  - Moisture conservation
Simple establishment treatments to reduce moisture loss
Field survival of young P 30 [POS] cocoa trees under different mulch and shade treatments.

Each bar represents % plants surviving out of 48 (= 100%).

Acheampong (2012)
Agronomic Practice - Shade

Climate change: moving forward

- Large five-year project started in 2017, funded by Cocoa Research UK
- Modules on the following areas
  - Screening for water deficit tolerance
  - Screening for high temperature tolerance
  - Examining the interaction between temperature and CO₂
  - Development of a physiological model
- We are exploring ways of collaborating with institutes in the origins to conduct field-based research that will complement the greenhouse/CE work at Reading
- An International Doctoral Training Fund to support PhD projects on climate change in cocoa
Workshop held at Reading in June 2017
A review of research on the effects of drought and temperature stress and increased CO₂ on *Theobroma cacao* L., and the role of genetic diversity to address climate change

V. Medina and B. Laliberte