Crop Sciences - Water use and Photosynthesis

Background

For every kg of dry matter accumulated, crops can lose in the region of 1 tonne of water. Water supplied to crops from rainfall, groundwater or irrigation is transpired through leaf pores, or stomata, at the leaf surface. Some crop varieties show more dynamic stomatal opening and closing responses to changing conditions (e.g. light intensity: Lawson cv), and selected genotypes could use less water overall during growth (FP2a). An alternative strategy is to enhance photosynthesis by increasing the delivery of Carbon Dioxide (CO_2) substrate, in a fundamental collaboration to characterise key components needed from model systems (FP2b).

FP2a: Improving Water Use and Yield Stability in Rice

Outline of Programme Activities:

- **Identify accessions of sorghum and millet** that lose less water without a trade-off in photosynthesis and growth.
- **Analyse hyper-variable populations of sorghum and millet** that have been bred from drought-tolerant founders, using and a novel screening-method that identifies accessions that loose water unnecessarily.
- **Maximise the heritability of improved water-use in sorghum and millet** varieties for crop breeding.

Practical Description of Research and Allocation of Responsibilities to Staff in UK and India

Analysis will be carried out by PDRA1 in Cambridge and PDRA2&3 in India. PDRA1 and PDRA2 will screen sorghum and millet accessions from drought-tolerant founders for stomatal sensitivity to light, as this trait varies between sorghum and millet accessions. PDRA3 will undertake sequencing of these accessions by genome skimming (refs: Hibberd cv) to allow causal loci to be mapped and used for accelerated breeding in the future. All three PDRA will need to exchange collaboratively and work on the same material.

Engagement with Stakeholders

ICRISAT has links to deliver sorghum and millet seed with improved water use, using national distribution services, private companies, and participatory breeding through hubs of local farmers.

Outcomes, Deliverables and Impact

The legacy of FP2a will be threefold:

Identify lines of sorghum and millet that spend less water, but not at the expense of photosynthesis and productivity – these will be available for breeding and release to farmers;

Train young scientists in physiology and crop breeding that is critical to a sustainable agriculture;

The approaches are transferable to other crops and cropping systems, and could improve water-use in other orphan crops, and in other countries on the DAC list.

FP2b Crop Sciences: Enhancing Photosynthesis

Outline of Programme Activities:

Major programmes intend to increase crop CO_2 assimilation and reduce water demand, such as the Bill and Melinda Gates Foundation (C4 Sorghum and millet, RIPE). FP2b will identify components of the algal Carbon Concentrating Mechanism (CCM), for expression in higher plants, developing existing BBSRC-supported work in this area (CAPP2 programme - refs Griffiths cv).

Practical Description of Research and Allocation of Responsibilities to Staff in UK and India

- **UK PDRA will develop bioinformatics expertise** to enhance photosynthesis in higher plants;
- **Analyse transcriptomic patterns in the model alga Chlamydomonas** to identify post-translational modifications, using data arising from CAPP2 programme in Cambridge (see refs, Yadav cv).

Engagement with Stakeholders

Interactions with fundamental molecular researchers into plants and microbes, the DBT Institutional network, and biotechnology companies are scheduled.

Outcomes, Deliverables and Impact

The UCam-DBT lectureship will allow Yadav (NIPGR, New Delhi) to develop her research group in UK and India to use her cutting edge bioinformatics analyses in this new area, enhancing her career progression. The work will also identify key components of the algal CCM via curiosity-led, fundamental research, an essential requirement for academic progression.

FP2a: Improving Water Use and Yield Stability in Rice
Cambridge Lead: J.M. Hibberd; Essex Co-I: T Lawson; RR Co-I: S. Heuer; A Whitbread ICRISAT
FP2b Crop Sciences: Enhancing Photosynthesis
Cambridge Lead: Howard Griffiths; UCam/NIPGR Delhi Co-I: G Yadav
HR career stage requirements: Employment in UK: 2 PDRA; India: 3 PDRA at key Institutions
Capacity Building India-UK and UK-India
Echanges: 3 Senior Investigator; 3 PDRA/PhD extended exchanges; techniques workshops