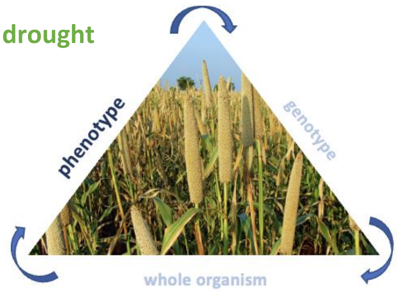
1.3 Advanced methodologies identify the basis to plant water use and drought

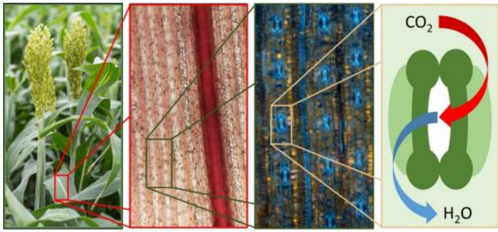
TIGR²ESS
Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies



Exploiting the physiological controls on leaf water loss in Sorghum and Millet

Photosynthetic CO_2 uptake is critical for plant growth and crop yield, but around 1000 water molecules are lost for every CO_2 assimilated. Hundreds of tiny pores, called stomata, are found in each mm^2 of leaf surface. They act as variable valves, controlling the supply of CO2 whilst sensing the evaporative cost in terms of water through transpiration. TIGR2ESS researchers are investigating how this relates to crop resilience to drought, in varieties of sorghum, millet (and wheat) which possess stomata that are more sensitive to dry environments, potentially allowing these plants to respond more rapidly to future climate change.

Evaluating crop water use efficiency is technically demanding High throughput screens are needed to evaluate genetic variations in water use traits which can relate to water-use efficiency. Variations can be quantified by measuring the ratio of water loss per unit carbon gain, defined as water use efficiency (WUE). Relative to photosynthesis, stomata are an order of magnitude slower in responding to transient changes in environmental conditions. Measurements are time- consuming and require elaborate gas exchange equipment. The latest technology uses infra-red thermography allowing leaf temperature to indicate the extent of evaporative cooling (and transpiration rate) in contrasting crop lineages.



Stomata are tiny pores on the leaf surface which allow CO_2 in and water out

Speedy stomata can enhance photosynthesis and improve water use

Measurements of stomatal sensitivity are providing a mechanistic basis to whole plant phenotypic screens.

Researchers at the University of Essex investigated traits linking photosynthesis to water use in a range of Sorghum and Millet in landraces, traditional cultivars, breeding material and elite varieties identified by TIGR2ESS partners based at ICRISAT. This has led to varieties being ranked on the basis of stomatal density and WUE.

The studies have identified the most suitable lines for international crop breeding programmes which will be resilient and adaptable to more extreme climatic conditions in the future. In addition, selected lines were measured in detail to evaluate the amplitude and speed of stomatal movements for maximising assimilation of carbon at the lowest cost of water (high WUE), as well as developing online resources and protocols to support a broader international community phenotyping during Covid lockdowns

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