ecobreed
IMPROVING CROPS

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Increasing the efficiency and competitiveness of organic crop breeding

PRACTICE ABSTRACT No. 12

Does technology allow us to bridge the high throughput phenotyping and genotyping gap in crops?

THE PROBLEM:

For any breeding strategies there are essentially three resources needed. A large population, dense maps of the population and evaluated traits which can be linked with those genetic resources (Fig. 1). Advancements in development of genetic resources and genomics over the last couple of decades have radically altered the density of these genetic/physical maps, providing a landscape for conducting high-throughput genotyping and genomic analyses. However, developments in plant phenotyping have been slow to materialise especially for physiological traits, limiting advancements in crop improvement.

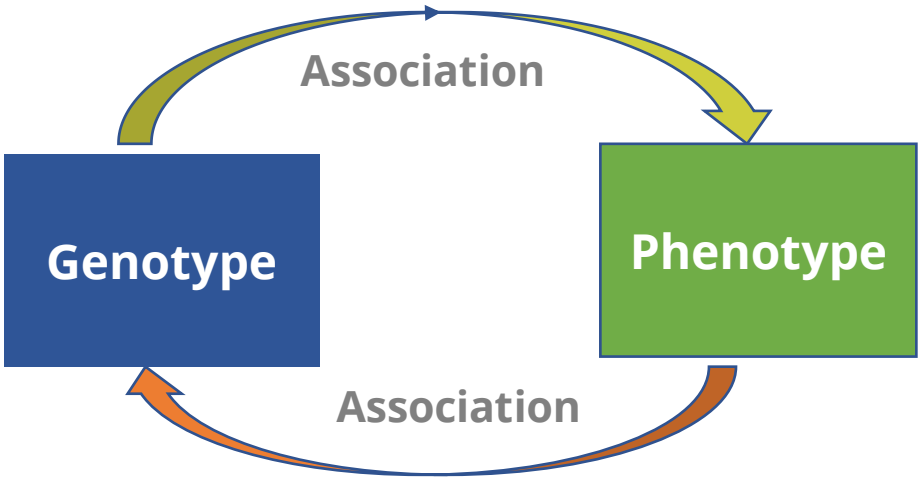

Fig. 1: The relationship between Genotype and Phenotype.

SOLUTIONS:

With the advent of climatic change and changing scenarios of both biotic and abiotic stresses and plant adaptability, physiologists and breeders are looking at alternative ways of increasing yield. The need is to understand traits which are directly or indirectly linked

to yield, e.g. physiological traits and also provide a high throughput way of stress detection and quantification in order to understand how plants adapt and tolerate stress.

The availability of different technologies involving remote sensing, information and imaging techniques have allowed real-time image analysis of physiological changes in plants. Data extraction from these resources combined with systems integration allows morpho-physiological traits to be assessed non-destructively and as a time-series approach across whole populations and throughout development. These tools and techniques also allow pre-symtomatic monitoring of plant stress and pre-detection something which is a struggle using traditional assessment approach, i.e. visual assessment.

Some of these imaging resources include:

- **RGB sensing**: Plant phenotyping and monitoring approaches using RGB digital cameras which with subsequent analysis enables determination of canopy morphological characteristics with improved speed and precision.
- **Spectral sensing**: Stress in plants, e.g. diseases, result in physiological and morphological changes that potentially affect crop quality and final yield. Spectral sensing assesses the spectral information or characteristics of the vegetation, canopy or plant by measuring reflectance at different wavelengths of the spectrum.
- **Thermal sensing**: Infra-red thermography (IRT) is a viable alternative for the indirect estimation of stomatal conductance as studies have shown that the leaf/canopy temperature is an indicator of transpiration rate. IRT is a good resource to understand the biotic and abiotic stress responses in plants through variation in canopy temperature, e.g. water stress, stress pertaining to root diseases.

The above resources cover the broad spectrum but there are other systems, e.g. fluorescence imaging, Laser imaging, Magnetic resonance imaging etc. which also add to the phenotyping tools available for crop sensing.

PRACTICAL RECOMMENDATIONS:

The question of how and why about crop genomics has been investigated in depth over the last couple of decades, and now remote sensing applications and technological advances will allow us to answer the same questions about measuring whole-plant phenotypes in the coming decades.

The Ecobreed Phenotyping team is using integrated sensing platforms covering different spatial and spectral resolutions to monitor and phenotype both wheat and potato crops in this project.

FURTHER INFORMATION:

de Jesus Colwell F, Souter J, Bryan GJ, Compton LJ, Boonham N, Prashar A. Development and Validation of Methodology for Estimating Potato Canopy Structure for Field Crop Phenotyping and Improved Breeding. *Front Plant Sci.* 2021 Feb 10; 12:612843. doi: 10.3389/fpls.2021.612843. PMID: 33643346

Susič, N., Žibrat, U., Širca, S, Strajnar, P., Razinger, J., Knapič, M., Vončina, A., Urek, G. & Gerič Stare, B. 2018. Discrimination between abiotic and biotic drought stress in tomatoes using hyperspectral imaging. *Sensors and Actuators B: Chemical,* 273**,** 842-852.

Prashar A, Colwell FJ, Hornyik C, Bryan GJ. Advances in development of potato varieties resistant to abiotic stress. *In:* Gefu Wang-Pruski, ed. *Achieving Sustainable Cultivation of Potatoes*. Burleigh Dodds Science Publishing, 2018, pp.125-142.

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ECOBREED CONSORTIUM

ABOUT ECOBREED:

ECOBREED is a 5-year (2018-2023) project funded by European Union's Horizon 2020 research and innovation programme that will improve the availability of varieties and seed suitable for organic and low-input production. Activities will focus on four crop species i.e. wheat, potato, soybean and common buckwheat, selected for their potential contribution to increasing the competitiveness of the organic sector.

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