IWYP International Wheat Yield Partnership
Research to Deliver Wheat for the Future

IWYP SCIENCE BRIEF

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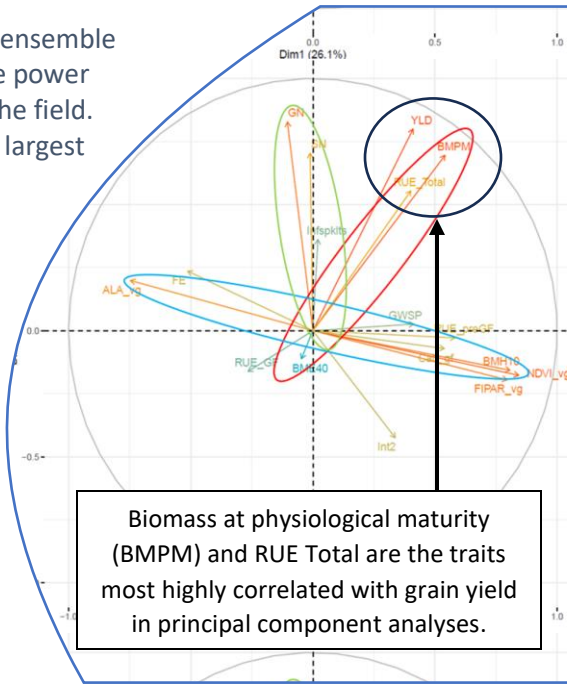
A Connected Scientific Community Dedicated to Yield Enhancement

IWYP held its Annual Program Conference in September 2023. Once again, IWYP-associated scientists illustrated the breadth and depth of their quests to provide new genetic resources and tools to aid breeders in achieving higher yields in a changing climate. Below are some highlights of a few of the research projects presented and debated.



Biomass at physiological maturity (BMPM) and RUE Total are the traits most highly correlated with grain yield in principal component analyses.

- An international team (IWYP115 - Martre et. al.) has enhanced and tested its ensemble modelling algorithms under different environments, assessing their predictive power against ground truth measurements in yields and yield subtraits achieved in the field. They demonstrated that Radiation Use Efficiency (RUE) was the trait with the largest influence on yield and that further increases in this and other traits could enhance global average production by up to 16% without additional fertilizer. Average grain yields were predicted to rise by up to 0.11tons/hectare per every 1% increase in RUE. These results strongly support RUE being one of IWYP's most important trait enhancements.
- Solar radiation captured by a crop activates different biochemical pathways depending on the time of day, due to the genetically controlled circadian clock system. Key genes in these pathways and their control have been discovered (A-IWYP02 - Laurie et. al.). Two prominent genes have now been knocked out using gene editing to enable greater dissection of the effects of radiation impinging on crops at different times of day.
- The conversion of sugars to starch/biomass/grain yield is highly regulated and Trehalose-6-Phosphate (T6P) is a critical regulatory molecule in these conversions (IWYP149 - Paul et. al.). Some of the variants of the many genes regulating the synthesis and breakdown of T6P in different tissues correlate with yield and are therefore useful targets for further selection. T6P applied to spikes 10 days after anthesis led to enhanced electron flow and increases in yields of 9-22% in the field at the IWYP Hub at CIMMYT.
- CO_2 for photosynthesis passes through stomata on leaves but open stomata can lead to water loss, so optimal regulation of stomata opening and closing is important for crop yield. Hypotheses that reducing blue light effects could sustain photosynthesis, with reduced water loss, are being tested by knockouts of the key *BLUS* genes in the blue light activated pathways (IWYP123 - Lawson et. al.). Triple knockouts of the *BLUS* genes still show some blue light effects, so other genes need to be sought to eliminate blue light effects. Another team (A-IWYP03 - Faroud et.al.) is studying genes that regulate opening and closing, size and number of stomata, and response to transpiration. They showed that knockout of *OST-1* genes leads to greater stomatal opening, increased transpiration and lower grain weight as predicted.
- Breeders rarely select root structures and their chemical activities directly due to the difficulty of phenotyping them. In a large IWYP project (IWYP122 - Ober et.al), genes and QTLs affecting root angles and biomass at different soil depths were defined. However, amongst high yielding cultivars there are only low correlations between root traits and grain yield. The cv. Avalon has a larger rhizosheath than cv. Cadenza and the amounts of heteroxylan correlate with rhizosheath mass. Interestingly, lines with different levels of xyloglucan root exudate have different fungal microbiome composition. There is some evidence that specific root traits are enhancing yields in spring wheats in field experiments at the IWYP Hub at CIMMYT.

IWYP's many projects around the world (https://iwyp.org/research-program/) continue to feed its translational pipelines and help IWYP to realize its ambitious goals and objectives for the wheat breeders and farmers of the world.