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

IWYP SCIENCE BRIEF

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Supported by

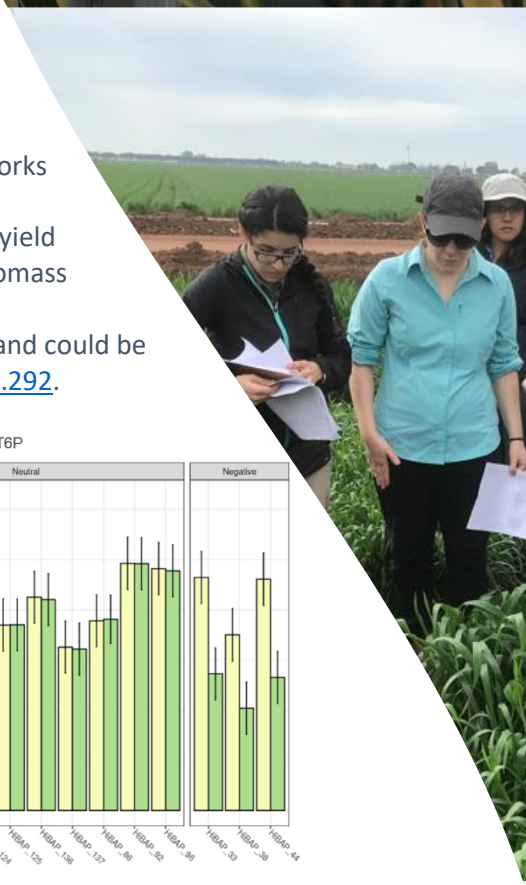
Unleashing Photosynthetic Potential to Increase Yield

The largest improvements in crop yields are likely to come from optimization of source-sink interactions. Trehalose-6-phosphate (T6P) plays a key regulatory role in coordinating source and sink connections in crops. Spraying T6P precursors on wheat during early grain filling stimulates starch synthesis in grain thus increasing grain size and overall yield by up to 20%. Significantly, this is accompanied by an increase in photosynthetic source in flag leaves due to the enhanced demand signals from the grain sink. A project "**Transforming Yield through Source-Sink Synchronization**" led by Matthew Paul at Rothamsted Research, UK, with other colleagues in the UK and CIMMYT is analyzing the responses of genetically diverse high-yielding germplasm to the T6P precursor as a smart screen to determine the effects of harmonizing source and sink activity on photosynthetic potential, grain number and size potential, increased total biomass and harvest index.

Gene editing targeting of all 9 TPS7 homeologues (left, gene edited, right, wild type) confirms a role for TPS7 genes in regulation of spike architecture and grain numbers in wheat

What Solutions have been Identified?

- The T6P pathway (synthesis and degradation of T6P) is under positive selection and the enzymes involved are associated with harvest index, final biomass, plant height, flowering time, grain number and size.
- SNP variation in TPS and TPP genes is linked to 12 agronomic traits.
- A novel methodology using the DMNB-T6P foliar spray uncovers genes and networks responsible for regulating grain number and size.
- A large variation in responsiveness to T6P was found in diverse germplasm, with yield increases of more than 50% being recorded in some lines of the CIMMYT high biomass (HiBAP) population (**Figure 1**).
- Some TPP alleles from exotic germplasm are associated with grain related traits and could be useful sources of increased yield potential. See Lyra et al. 2021 doi: 10.1002/fes3.292.



Anticipated Impact of this Research?

- DMNB-T6P sprays can be used to increase wheat yields in field conditions.
- Alleles of genes controlling T6P levels can be used in breeding selection assays.
- DMNB-T6P spray treatment can be used to identify downstream gene activities responsible for grain number and grain size.

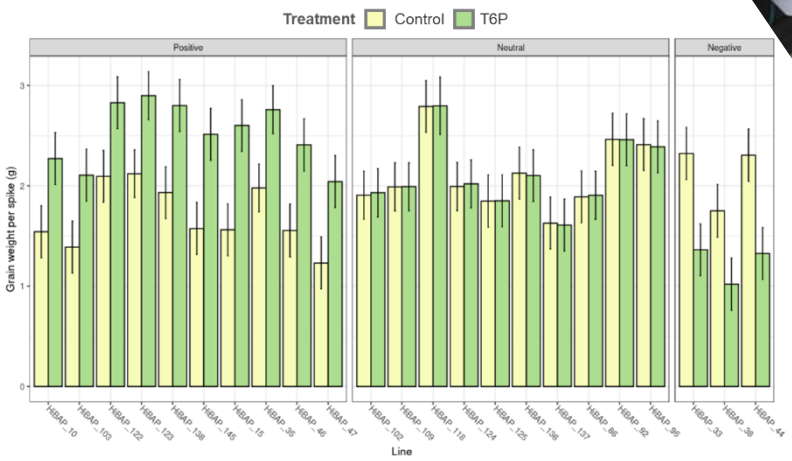


Figure 1. Grain weight per spike (calculated from total grain weight per plant /spike number) of T6P- or control- treated lines selected from the HiBAP population. Selection was based on a significant positive response to T6P, no significant response to T6P or a significant negative response to T6P. Significance considered p-value ≤ 0.05. Error bars are standard error of the mean. Note: some lines exhibit ~50% increase in grain weight per spike (significant positive response to T6P).

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