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

IWYP SCIENCE BRIEF

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Waste Not, Want Not – Higher Yields with More Energy Efficient Wheat

Given the importance of photosynthetic energy capture to plant growth and development, it is surprising to note that as little as 10-15% of daily aquired energy is actually used for growth. More than 70% of daily captured CO_2 is released during night respiration. The energy this represents is generally used in 'futile cycles' (wasteful processes) and for high-cost processes like nutrient transport. **As little as 4.6% of a plant's energy may be used for biomass accumulation**, and a shrinkingly small amount for grain production. To investigate wheat energy use efficiency (EUE), a project "**Improving Yield by Optimising Energy Use Efficiency"**, led by Professor Barry Pogson at the Australian National University, together with other colleagues in Australia and at CIMMYT, aimed to measure genetic variation in respiration rates of wheat and identify proteomic and metabolic candidates that indicate how energy is being used after it accumulates. Linking these results to the yield and growth of wheat has produced novel relationships that are providing new targets for genetic improvement, better understanding of the nature of futile cycles and emphasized the importance of knowing how far a photosynthetic 'tank of gas' can take yield vs. not just how big the tank is.

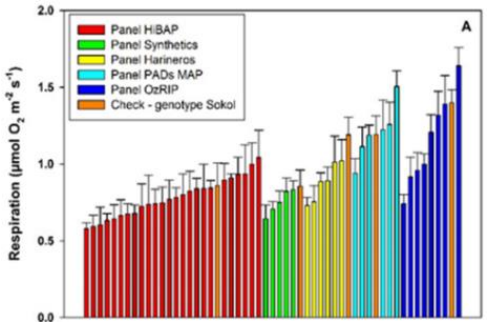
What Solutions have been Identified?

- Genetic variation in wheat lines for dark respiration, which is **correlated with yield**.
- Proteins influencing the formation or utilization of the **pyruvate pool** provide a central target for influencing EUE that have powerful novel correlations with yield and respiration.
- A focus on **phosphoenolpyruvate carboxylase, acetolactate synthase, 3-phosphoglycerate kinase, fructose-bisphosphatase** and a range of other proteins and metabolites presents opportunities for the future.

What has been Transferred to the Wheat Improvement Pipelines?

- A hyperspectral method/protocol for screening *Rd* (dark respiration rate).
- QTL locations for genetic variation found to be correlated to EUE.

Respiration per unit	2017		2016	
	r	Sig.*	*r*	Sig.*
Area (mmol O_2 m^{-2} s^{-1})	-0.205	0.192	-0.109	0.65
Dry mass (nmol O_2 gDM^{-1} s^{-1})	**-0.408**	**0.002**	**-0.382**	**0.041**
Fresh mass (nmol O_2 gFM^{-1} s^{-1})	**-0.306**	**0.032**	0.17	0.449



Left, Rate of leaf respiration per unit (area, dry and fresh mass) **confirming a significant inverse relationship between respiration and yield** in consecutive years of trials in CIMMYT. *Right*, **3-fold variation in respiration** in CIMMYT field material with a heritability of 0.67.

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