Efficient utilization of phosphorus by wheat

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Hexaploid (bread) wheats evolved about 10,000 years ago in the Mediterranean regions of Asia Minor and the Middle East. Intensive selection for yield over the last 100 years has led to substantial increases in the potential yield (now estimated to be 12-14 t/ha) associated with more efficient partitioning of dry matter into the grain (1). There has also been selection for protein concentration, flour yield and baking value. There has been no conscious selection for lower (or higher) mineral levels in cereal grains.

In Australia phosphorus is the most widely used fertilizer in cereal growing and small reductions in the concentration of phosphorus in the grain would reduce the rate of export of phosphorus from our soils. Grain phosphorus is increased when fertilizer phosphorus is applied (2), is higher in more favourable growing seasons (3), but is lower in high yielding cultivars (4). Much of the phosphorus in the grain is stored in the aleurone layer as phytate (5). This represents phosphorus which is not required by the grain and so should be reduced (6).

Methods

Twenty genotypes from the three genomes of wheat were grown in sand in a glasshouse with two levels of phosphorus in Hoagland's Solution; namely 1.0 m MP daily (High P) or 0.25 m MP for only the first 20 days, then no P daily (Low P).

Results and Discussions

Grain phosphorus (%P) was lower in the bread wheats than in the diploid or tetraploid wheats, but there was a negative relationship with harvest index at both levels of phosphorus. Within the bread wheats there were significant differences in grain %P for cultivars with a similar harvest (within each phosphorus regime). All grains contained phytate phosphorus.

This work suggests that despite the intensive selection for other characters under monoculture conditions the modern genotypes are still behaving as wild types in that they accumulate nutrients as part of a survival of the fittest strategy. Lower grain %P could be achieved indirectly by increasing plant harvest index, or directly by selection.

Table 1: Ratio of grain : tiller dry weight (H.I.) and grain phosphorus in wheats grown at two levels of phosphorus.

Cultivar	H.I.		Grain %P (s.e.)	
	Low P	High P	Low P	High P
Diploid: T. monococcum	.14	.21	.290 (.030)	.592 (.013)
Tetraploid: T. turgidum	.16	.35	.198 (.007)	.524 (.016)
Hexaploid: T. aestivum				
Gigue	.38	.58	.115 (.003)	.407 (.010)
Oligoculm	.38	.52	.144 (.007)	.458 (.020)
Gabo	.44	.59	.118 (.005)	.387 (.002)
Kite	.42	.58	.139 (.010)	.420 (.010)

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