Yield, harvest index, grain nitrogen and phosphorus

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In Australia phosphate fertilizer represents 20 - 25% of the cost of producing a cereal crop (1). The loss of any nutrient (kg/ha) increases with the grain yield, so more efficient use of fertilizer may be achieved through a reduction in the concentration of nutrients in the grain. This would be undesirable for nitrogen if the wheat is to be sold for its protein content or for its bread baking quality as demanded in Western society. However, for minerals such as phosphorus, which are consumed in luxury amounts in Western society (2), a reduction in concentration would be both economically desirable and nutritionally acceptable.

We examined some of the factors which influence the yield and final concentration of nitrogen and phosphorus in the grain of a range of cultivars of wheat.

Methods

Fifteen wheats (commercial and unnamed lines) with mean heights of 70-100cm were grown in a red earth soil at Wagga in three seasons. Phosphate fertilizer was applied at rates of 2, 6 and 18 kgP/ha to give near-optimal and sub-optimal yields in the Wagga environments. Nitrogen was applied at 30 kgN/ha (but had no effect on the crop grain yield). The results are from the 1979 plots (8 rows x 8.8 m long) which received 18kgP/ha.

Results and Discussion

At each level of applied phosphate shorter-statured cultivars produced higher yields via improved harvest index (H.I.)(dry grain : grain + straw ratio). Both yield and H.I. were negatively correlated with grain nutrient concentration. This dilution effect of yield (or one of the components of yield) on nutrient concentration indicated that the supply of nutrients to the grain was low with respect to the supply of assimilates.

Dilution of grain nitrogen by increased yield has contributed to the quality barrier facing plant breeders. But the negative linear relationship here between yield and grain %P did not plateau and we conclude that the short- stature wheats were more efficient in terms of (a) yield produced per unit of fertilizer phosphate, and (b) grain dry matter per unit of grain phosphorus (%P).

Examination of the phosphate status of wheat from several states (Batten, unpublished) showed that the highest-yielding cultivars removed more phosphate in grain than was applied as fertilizer. This suggested that breeders are unconsciously selecting high-yielding cultivars which result in the depletion of soil phosphate.

Cultivar :	Olympic	Gamenya	Teal	Egret	Kite	WW33G	Condor
Height (cm) :	103	103	98	88	88	80	78
Yield (t/ha) :	2.83	2.80	3.02	3.55	3.16	4.01	4.00
%P grain :	.239	.257	.271	.222	.258	.245	.228
Kernel wt. (mg) :	27.2	28.1	30,3	26.7	30.7	29.2	27.8
Kernel number :	14.4	13.4	12.9	18.3	14.5	16.1	17.4
Harvest Index :	.29	.31	.27	.32	.32	.36	.36
Shoot P (kg/ha) :	11.7	11.9	12.5	13.5	14.8	13.6	13.0
Harvest Index P :	-80	81	83	80	2.2	0.4	9.2

1. Batten, G.D. 1980. Riverina Outlook Conference 1980 Proc. ppl-1.27.

2. Shorland, F.B. 1978. New Zealand J.Science 21: 3-40.