Selective tissue tests for defining the phosphorus status of wheat and annual pasture legumes

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In southern Australia the requirements of annual crops and pastures for phosphorus (P) fertilizer are normally estimated by analysis of soil collected before planting. Until recently, little research has been concentrated on developing and calibrating plant tests for diagnosing the P status of annual agricultural species. For some plants, analysis of whole shoot has been used, but critical P concentrations decline with advancing plant age which presents problems of interpretation.

A series of experiments aimed at developing suitable plant P tests in wheat (Triticum aestivum L.) and in annual pasture legumes (Medicago truncatula L.) have been conducted in South Australia. The initial research. undertaken in the glasshouse. examined the effect of R supply on the distribution of both P and labile P (largely extracted inorganic P) in various plant parts of known physiological age. Relationships between shoot dry matter yield and P concentration for various index tissues were established and criteria for diagnosing P deficiency were estimated. In later glasshouse experiments diagnostic criteria for P were compared in a range of cultivars of both species, and in wheat the indices were compared in plants grown at 3 levels of N supply. Field experiments were then undertaken in 1982 and 1983 at ten P deficient sites to confirm the validity of the plant tests developed under glasshouse conditions.

Phosphorus was unevenly distributed within the shoots of both wheat and medic plants. In P deficient plants. P concentration was highest in young tissue and declined in subsequently older leaves. As P supply was increased. R concentration increased in all tissues, but at luxury supply older leaves often accumulated high levels of R, particularly when plants were relatively young.

Critical P concentrations for current growth, determined by two phase linear regressions. declined with advancing plant age for all tissues and for whole shoots in both species, but the change in values for mature blades was less erratic than that for whole shoots. The youngest emerged blade (YEB) in wheat and the youngest open leaf (YOL) in medic are considered satisfactory tissues for analysis although older leaves (e.g. YEB+2) tended to be more sensitive to changes in P supply in the adequate to luxury range.

The tests established for Halberd wheat and Jemalong were applicable to other cultivars within each species. Also, nitrogen supply did not affect critical P concentrations in wheat. Analysis of % labile R does not offer any significant advantages over % total P.

Suggested critical P concentrations for wheat, sampled at Feekes Scale 5 are: 0.24% in YEB. 0.18% in YEB+1 and 0.17% in YEB+2 (each ? 0.1%) For medic. sampled at the commencement of secondary lateral development the concentrations are:0.40% in YOL, 0.35% in YOL+1 and 0.30% in YOL+2 (each 0.05%).

The experimental data indicate that plant R tests based on sampling leaf blades of known physiological age can be used as a reliable and sensitive means of diagnosing P deficiency in cultivars of both species up until the commencement of flowering. As such. these new tests and their diagnostic criteria are likely to be a useful adjunct to the traditional soil analysis technique. They will be particularly useful for solving nutritional problems in field grown crops and pasture legumes, especially since characteristic deficiency symptoms only occurred when plant growth is reduced by more than 60%.

We believe the new tests will ultimately also be useful for diagnostic laboratories undertaking multi-element plant analysis and in mapping P deficiency on a regional basis.