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Plant Analysis Interpretations Used in the Revised Wisconsin Program[1/]

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Interpretations of the results of plant analyses are based on the crop sampled, plant part, and stage of development. The composition of plant tissue varies from species-to-species, part of the plant sampled, and with the stage of maturity. Mobile elements such as N, P, and K tend to move from the lower to upper leaves when a plant is low or deficient in one of these nutrients. This enables the plant to continue to grow normally longer than it would otherwise. As plants mature, the carbohydrate content increases, diluting the concentrations of many nutrients. The concentration of Ca and sometimes B, however, tends to increase with plant age. Thus, it is important to sample a specific plant part at a specified stage of development.

For more detail, see Extension publications A2289 "Sampling for Plant Analysis" and AXXXX "Using Plant Analysis as a Diagnostic Tool."

Elements Analyzed and Analytical Procedures

For diagnostic purposes, plant samples are analyzed for nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), zinc (Zn), boron (B), manganese (Mn), iron (Fe), copper (Cu), aluminum (Al), and sodium (Na). The latter two elements are not essential for plants but are always present, sometimes in excess. After drying to constant weight at 60°C, plant samples are ground to pass a 1-mm screen. A subsample of the dried and ground tissue is digested in a mixture of nitric acid and hydrogen peroxide. This process makes the nutrients soluble, but N is masked by the nitric acid added. Samples are diluted with a known amount of distilled water, and the concentrations of the nutrients are determined simultaneously by inductively-coupled plasma (ICP) emission spectroscopy). Nitrogen is determined on a separate sample by the Kjeldahl method.

[1/] Presented at the Fertilizer Dealer Meetings, November 28 to December 7, 2000.

Accompanying soil sample — The results of plant analysis alone cannot be used to make fertilizer recommendations. Sometimes a plant may be found to be deficient in one or more nutrients even though there may be an adequate supply in the soil. Cold weather or insect damage can prevent the plant from taking up nutrients adequately. A low soil pH can result in excessive levels of Fe and Mn. Therefore, it is a good idea to submit a soil sample along with a plant tissue sample. (The UW-Madison Soil and Plant Analysis Lab does not charge extra for a routine analysis of a soil sample submitted with a plant sample.) Soil samples are analyzed for pH (acidity), organic matter, P, and K. For an additional fee, soil samples can be analyzed also for available Ca, Mg, S, B, Mn, or Zn.

Interpretations of Plant Analysis Results

Plant analysis results are interpreted by one or more of three methods: 1) The Sufficiency Range (SR) approach; (2) the Diagnosis and Recommendations Integrated System (DRIS); or (3) Plant Analysis with Standardized Scores (PASS).

The **SR** system is based on the relationship between nutrient concentration and yield. If the soil is deficient in a given nutrient, an increase in the supply of that nutrient will increase the yield and also the concentration of the nutrient in plant tissue. If the deficiency is severe, visible symptoms usually will be seen. As the nutrient supply increases, the deficiency symptoms disappear and yield increases. If the nutrient supply is increased further, there may be no additional increase in yield, but the concentration in the plant continues to increase. This is the zone of "luxury consumption." A further increase in that nutrient may actually be detrimental and cause a depression in yield. The sufficiency range is defined as the range in concentration that results in 95 to 100% of maximum yield.

The **DRIS** examines ratios of nutrient concentrations rather than the concentration itself. Details of the method are covered by Beaufils (1973) and reviewed by Walworth and Sumner (1987). Various combinations of nutrient ratios for a particular element are combined mathematically to give a nutrient index. An index of 0 is considered optimum. The more negative the index, the greater the likelihood that it is deficient; the more positive the index, the greater the likelihood that the nutrient is excessive. Some advantages claimed for the DRIS are (1) time of sampling and plant part are less critical than for the SR method and (2) it identifies the order of deficiency of the nutrients — that is, which is most deficient and which will likely be the next to become deficient if the deficiency of the first is corrected.

DRIS norms are not available for all crops. Crops for which DRIS indices are calculated are alfalfa, apple, corn, celery, lettuce, millet, oat, potato, sorghum (grain), soybean, tomato, and wheat.

The **PASS** system attempts to combine the strengths of the SR and DRIS methods. The SR provides easily interpreted, categorical, independent nutrient indices. The DRIS gives difficult to calculate, easily interpreted, numerical, dependent nutrient indices, and a ranking of the relative deficiencies. The strengths of the SR are the weaknesses of the DRIS and vice-versa. The PASS system combines the strengths of the SR and DRIS by including an independent nutrient section and a dependent nutrient section. Both types of indices are expressed as a standardized score and can be combined to make more effective interpretations. The PASS system has been developed only for alfalfa, corn, and soybean. For more

information, see Baldock and Schulte (1996).

The following tables present the interpretative levels (SR, DRIS norms, and PASS norms) that will be used as a part of the revised UW Plant Analysis Program, which we expect to implement in spring 2001.