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Tissue Analyses for Nitrogen Fertilization of Irrigated Soft White Winter Wheat

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Nitrogen is the nutrient most often responsible for limiting yield of irrigated wheat in southern Idaho. Adequate nitrogen is necessary for producing maximum wheat yields, but excess nitrogen contributes to lodging and can reduce yields or cause high grain protein levels undesirable in soft white wheat. A sound fertility program should provide enough nitrogen for maximum yield without adversely affecting wheat yield or quality.

Plant tissue analysis can be an effective means of monitoring the nutritional status of a crop. Potential deficiency can be identified before visual symptoms appear, and early enough that additional nutrients can be applied before yields are reduced.

A nitrogen tissue test procedure has been developed for use as an indicator of the nitrogen status of irrigated spring wheat cultivars in the southwestern U.S. This tissue test is based on the capacity of the wheat plant to accumulate nitrogen in the form of nitrate in the stem tissue when an abundance of nitrogen is available, particularly during early vegetative stages of growth. Field experiments have been conducted in southern Idaho to evaluate this procedure for use with irrigated soft white winter wheat.

Sampling Procedure

Sampling begins when the wheat seedlings reach the 3- or 4-leaf stage of growth. Initially the plant tissue used for the sample is the below-ground portion of the stem. Plant tissue samples are collected most conveniently by lifting the entire plant from the soil and clipping the roots below the crown at the soil surface. Later, at jointing, the first 2 inches of the stem above ground are used.

Collecting a representative sample for analysis is important if the tissue test is to be a useful indicator of the need for nitrogen. At least 25 plants should be removed at random from each field, or each area in the field differing in soil type, management or appearance of the crop.

Place plant samples in clean paper bags together with a label telling where the sample was collected. Avoid the use of plastic bags. Immediately submit the samples to a laboratory for drying and analysis.

Experiments

Field experiments were conducted (1) to establish the relationship between tissue nitrate concentration and optimum nitrogen fertilizer rate, and (2) to determine whether nitrogen deficiency could be identified early enough that additional nitrogen fertilizer could be applied to prevent reductions in yields. Plant tissue was collected at periodic intervals during the vegetative growth period.

Figs. 1, 2 and 3 show the changes in wheat stem nitrate concentrations occurring with maturity as a result of different nitrogen rates and dates. Nitrate concentrations in stem tissues increased as greater amounts of nitrogen were applied. Peak nitrate levels and maximum concentration differences coincided generally with the first or second sampling date. Stem nitrate concentrations decreased rapidly during tillering.

Optimum nitrogen fertilizer rates, the rates that gave maximum yields (80 lb./acre at Roswell and 120 lb./acre at Parma, Figs. 1 and 2), were associated with tissue nitrate concentrations between 3,000 and 4,000 parts per million (ppm) at the 3- to 4-leaf stage of samplings. This range therefore represents adequate tissue nitrate for early season samples.

At jointing, tissue nitrate concentrations associated with optimum nitrogen rates were approximately 1,000 ppm. Grain yields were reduced when nitrate levels fell below 3,500 and 1,000 ppm nitrate nitrogen at 3- to 4-leaf and jointing stages, respectively.

Nitrogen fertilizer applied in the fall at planting time is subject to leaching loss and microbiological tie-up over

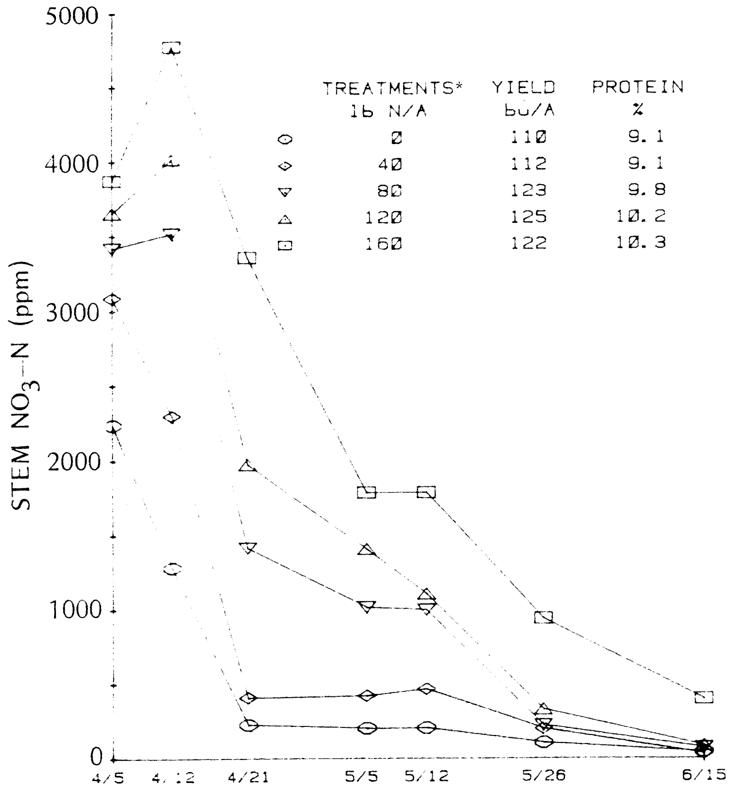

Fig. 1. Nitrate concentrations and wheat yields as affected by fertilization at Roswell, 1977.

winter. Therefore, early spring application more effectively increases yield and tissue nitrate than the same rate applied in the fall. Applications made later in the spring, after jointing, increased the nitrate content in wheat tissue but were less effective in increasing yield than early applications. Therefore, the tissue test on samples taken between 3- to 4-leaf and jointing stages identifies nitrogen shortages early enough that additional nitrogen can be applied before yields are reduced. Deficiencies identified later, from jointing to boot stage, can be corrected but yields may be lower than would be obtained from early applications.

Nitrogen deficiency symptoms were evident particularly at the lowest nitrogen rates at Parma. Wheat plants first became pale and then yellow, depending on the degree of the deficiency. Deficiency symptoms appeared during tillering and were associated with tissue nitrate concentrations less than 1,000 ppm.

Grain protein was increased with addition of nitrogen fertilizer but remained at acceptable levels for soft white wheat. Grain protein increased slightly when nitrogen was applied after the jointing stage. Maximum grain yields for the two locations differed primarily due to differences in soil moisture during late fall and early spring at Parma.

Factors other than sampling date may influence tissue nitrate levels. Cold temperatures, inadequate moisture and other stresses prohibiting normal plant growth and development may increase nitrate concentrations in plants. Awareness of these conditions is necessary for the correct interpretation of wheat stem tissue analysis.

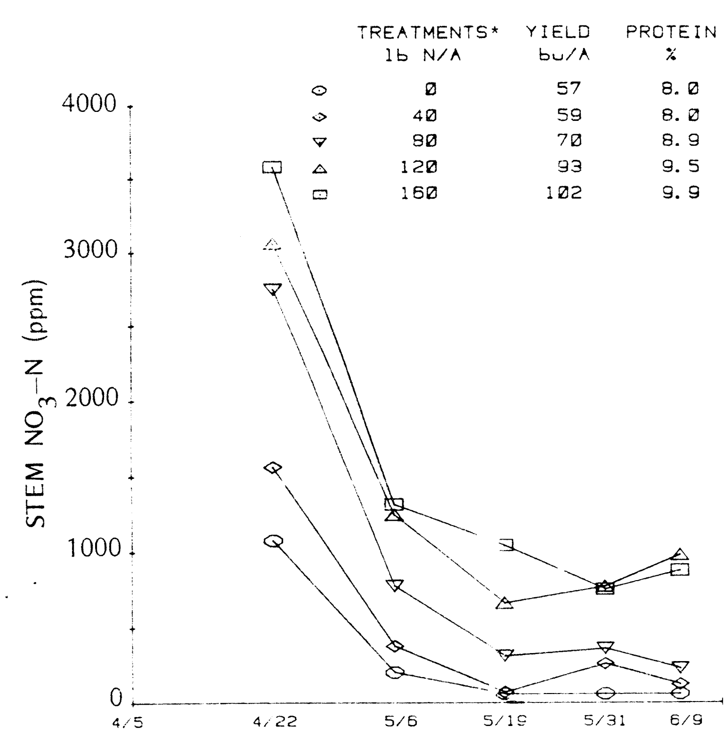

Fig. 2. Nitrate concentrations and wheat yields as affected by fertilization at Parma, 1977.

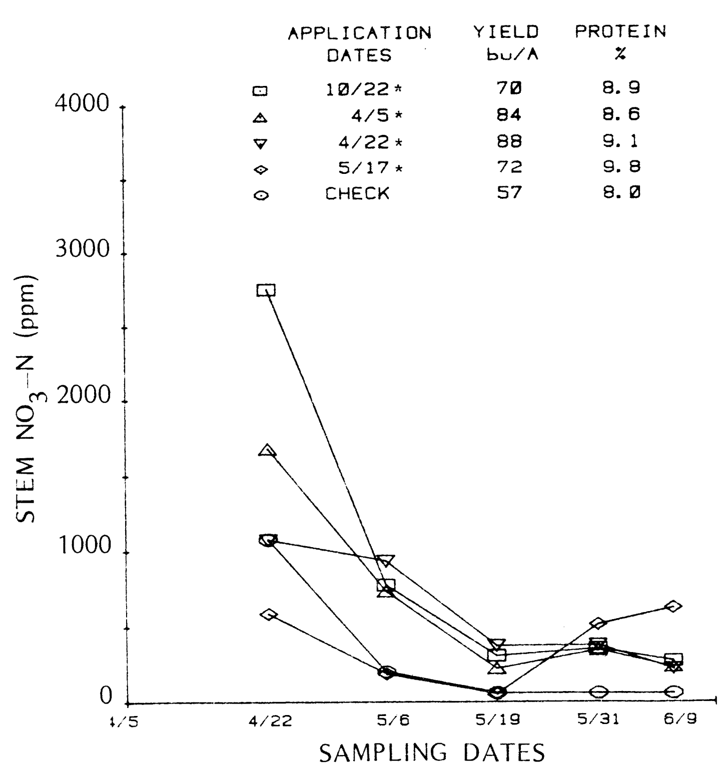

Fig. 3. Nitrate concentrations and wheat yields as affected by application date at Parma, 1977.

***Fertilizer applied at the rate of 80 pounds nitrogen per acre.**

Stem tissue nitrate concentrations can identify the need for additional nitrogen, and the actual amount of additional nitrogen fertilizer that will be needed for maximum grain yield can be determined from past experience and fertilizer experiments.

Summary

Nitrate concentrations in the wheat stem between the bottom of the crown and the soil surface are useful indicators of the need for additional nitrogen. Nitrogen shortages can be identified sufficiently early to give ample time for nitrogen to be applied before yields are reduced. Based on field studies near Parma, nitrate concentrations necessary for maximum production should be at least 3,500 ppm at the 3- to 4-leaf stage and 1,000 ppm at jointing. This procedure can be an effective means of assuring maximum yield and increasing the efficiency of fertilizer use.

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