FERTILITY MANAGEMENT

Several key goals for optimizing wheat growth and yield can be addressed, at least partly, through appropriate fertility management. The success of a fertility management program can be judged by how much it contributes to meeting these goals, which include

- Good fall growth.
- An appropriate level of tiller development.
- Rapid and vigorous stem elongation and head development.

This chapter will discuss each of these goals, and how fertility management can help you achieve them.

GOOD FALL GROWTH

Development of a vigorous root system and several healthy tillers per plant in the fall is instrumental in growing high-yield winter wheat (Figure 3). If this fall growth is not achieved, yield potential is reduced and there are no spring management practices that can restore it.

The most important management factors to promote good fall growth are the planting date and seed placement. A successful, well-managed planting operation is the most important component of a profitable wheat system. Fall weather will interact with planting variables to determine the amount of fall growth. When wheat is planted too early and fall weather is warm, excessive growth can occur and the wheat will be vulnerable to winter kill. Late planting is even more undesirable, particularly when fall weather is cold; fall development will be inadequate and the wheat crop will not be primed for rapid spring growth.

Only minimal fertility management is needed to promote good fall growth. A small amount of available nitrogen (N) and an adequate level of soil phosphorus (P) are the main requirements. Nitrogen availability is crucial for good fall growth, but most fields in Missouri appear to have enough N in the soil at the time the wheat is planted to support good fall growth. Research across Missouri showed that only one in eight fields needed fall N fertilizer to achieve maximum yields. A small application of N in the fall, maybe 20 lb N/acre, is recommended to ensure that all fields have enough N to support good fall growth. Often, this N can be supplied as part of a fall P application before planting wheat.

Figure 3. Timely and accurate planting, normal fall weather and a modest level of N and P availability contribute to ideal fall growth.

Phosphorus availability in soil is limited in cold weather. Thus, phosphorus fertility is crucial for good fall and early spring growth in winter wheat. Wheat is thought to be more sensitive to P deficiency than most other crops. University of Missouri target levels for soil test P are set at a level that will easily supply enough P to support the maximum possible growth rate for wheat in the fall. All that is required is to maintain soil test P at an adequate level, which is somewhere near the target level of 45 lb soil test P/acre.

SUPPORTING AN APPROPRIATE LEVEL OF TILLER DEVELOPMENT

One of the most difficult aspects of successful wheat management is achieving an appropriate population. As with all other crops, the established stand density is less than the seeding rate. Unlike other crops, the harvested

Figure 4. A wheat plant with a main stem and three good-sized tillers.

population is not plants, but tillers. Each plant can develop side shoots, or tillers (Figure 4), that will bear heads nearly as large as the head on the main stem. Normal seeding rates are sufficient to produce an optimum harvest stand only if two to three vigorous tillers develop on each plant.

There are two main periods when tiller development occurs: (1) in the fall between planting and dormancy and (2) again for about a month in the spring when the wheat resumes growth until jointing and stem elongation begin. Ideally, the wheat crop should develop two to three strong tillers per plant during the fall, and then no additional tiller development is needed in the spring. Tillers formed in the fall are often more vigorous and yield more than tillers formed in the spring. However, if there are not enough tillers formed during fall growth, then formation of additional vigorous tillers in early spring is critical to attaining good yields.

Tiller development is strongly influenced by nitrogen availability. A small amount of N is needed to support the development of tillers during fall growth. As mentioned in the previous section, there is usually enough N in the soil to support fall tiller development, but it is safer to apply a small amount of N to all fields to make sure that N availability is adequate. On sandy soils, even when fall N fertilizer is applied, a heavy rain within a week or two of planting may wash the N below the root zone of the seedlings. If this occurs, responding quickly with a small additional N application, maybe 20 lb N/acre, could be beneficial. In this situation, if a small additional fall N application is not made, a small application at the beginning of a warm snap (high temperatures above 50 F) during January or February may be beneficial.

If there is a combination of late planting, cold fall weather and inadequate fall N availability, the wheat crop will enter the spring growth period with an inadequate number of tillers. It will be important then to fertilize the wheat as soon as spring growth resumes, a stage that is sometimes called greenup. This is typically around March 1 in central Missouri and somewhat earlier in southern Missouri.

Nitrogen applications at greenup will stimulate the formation of additional tillers and increase yield potential. Fields with an average tiller density below 60 per square foot should receive top priority for early spring applications. A single spring N application at this time is a reasonable management option, but splitting spring N applications is slowly becoming more widely practiced.

One reason is that N applied in early spring can be lost before the period of rapid N uptake, particularly on sandy soils with wet weather. Another reason is that for fields with moderate tiller densities — for example, 70 tillers per square foot — early spring N is needed, but a large N application may actually lead to tiller densities that are too high. Excessively lush growth in early spring can lead to lodging and can make the crop more vulnerable to disease.

When wheat is tillered well at the beginning of the spring growth period, growers should wait until near jointing to apply spring N fertilizer. Wheat leaves will become upright at this stage

Figure 5. Wheat leaves often lie fairly flat during the winter but as jointing approaches, they become more and more upright. This is a good time to apply spring N for fields that entered spring with enough tillers.

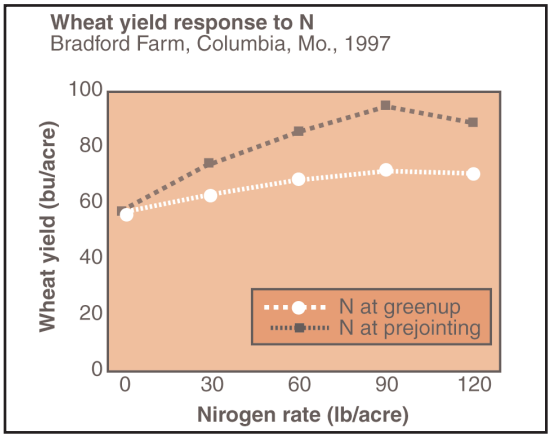

Figure 6. Delaying spring N applications until just before jointing (Figure 5) can sometimes increase yield response to N.

(Figure 5), which signals that the tillering phase has ended and jointing and stem elongation are about to begin. Early N applications can result in excessively lush growth and limit yield potential or even reduce yields. Out of six experiments with spring N timing in Missouri, yields in two experiments were higher when spring N applications were delayed until near jointing (Figure 6). In both of these experiments, fall tillering was good, and tiller density was greater than 100 tillers per square foot in early spring.

RAPID AND VIGOROUS STEM ELONGATION AND HEAD DEVELOPMENT

During the stem elongation phase of growth, nitrogen management is again the most critical element of fertility management. The highest rate of N uptake for wheat occurs between jointing and flowering (Figure 7). It is crucial that an adequate supply of N be available during this stage. This is also the time when demand for all other nutrients is highest, so a shortage of any other nutrient can also limit growth and ultimately reduce yield.

The longer the time between N application and the period of rapid N uptake, the greater the risk that N will be lost from the soil before the crop can take it up. It used to be more common for most or all nitrogen to be applied during the fall, but this practice resulted in too much yield loss from nitrogen deficiency. Potential for loss of N is greatest on sandy soils. On these soils, even N applied in early spring can be lost before the crop gets a chance to take it up. This is another reason for delaying spring N applications if tiller density is adequate at greenup.

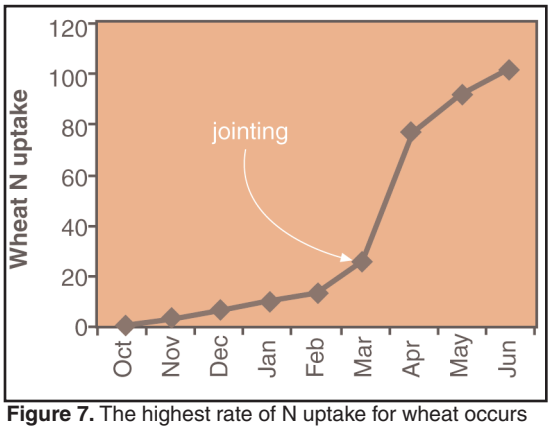

Figure 7. The highest rate of N uptake for wheat occurs between jointing and flowering

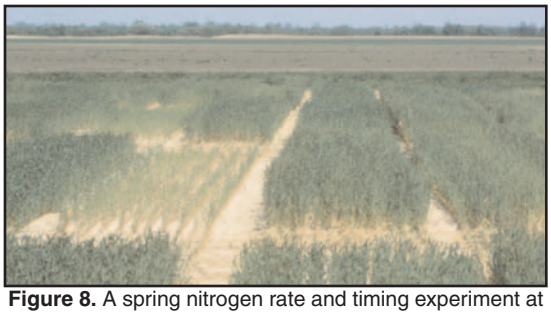

Figure 8. A spring nitrogen rate and timing experiment at the Delta Center in Portageville, Mo. Optimum N rate in this experiment was about 90 lb N/acre with no effect of spring timing (greenup vs. prejointing).

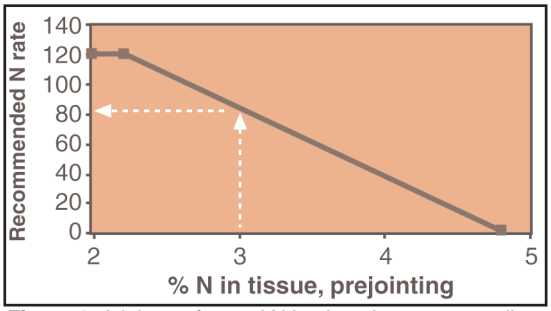

Figure 9. A lab test for total N in plant tissue can predict how much N fertilizer is needed. The dotted arrow shows how to use the line on the graph: a tissue N level of 3 percent translates to an N rate of 80 lb N/acre.

For six nitrogen rate and timing experiments conducted by the University of Missouri, optimum spring N rate was about 90 lb N/acre in four of the experiments, 120 lb N/acre in one of the experiments and 40 lb N/acre in the other experiment. One of these experiments is shown in Figure 8, and the dramatic effect of N on wheat growth is apparent. Average yield over these six experiments was 72 bu/acre. A rate of 90-100 lb N/acre in the spring is probably a good average. Most of these experiments were in wheat following soybean harvest. The amount of N needed is more variable for wheat following corn than for wheat following soybean. For wheat following corn, a tissue test can be used to diagnose whether a high rate or low rate of N is needed (Figure 9).

This tissue test measures the total N concentration in wheat tissue shortly before jointing. It is important not to take the samples too early because results will come back high and too little

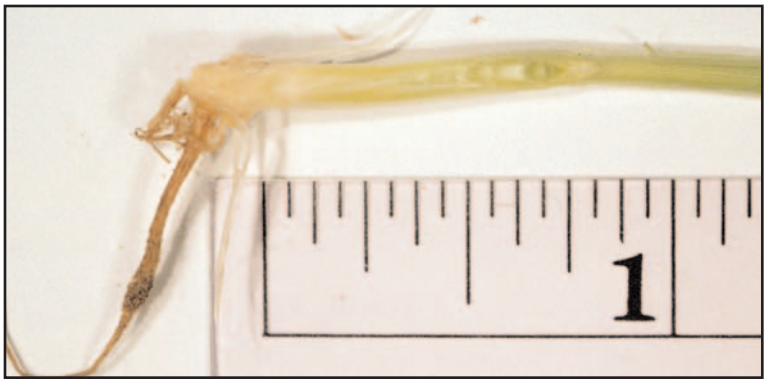

Figure 10. Just before jointing, a small hollow space will begin to form at the bottom of the wheat stem. This can be seen by splitting stems with a knife. When this stage is reached, a tissue test can be used to diagnose the amount of N needed by the crop (Figure 9).

N will be recommended. A small hollow space at the bottom of a stem split with a knife (Figure 10) indicates the wheat is at the right stage. Small handfuls of tissue should be cut at ground level from a variety of locations around the field that look typical for that field.

Arrangements should be made with a lab ahead of time to ensure a rapid turnaround time for the sample. Even so, there is some risk with this method of weather turning wet while the sample is being analyzed, which makes N applications difficult. Some producers have managed this risk by building small sprayers that can be pulled by a four-wheeler so that they can top-dress their wheat even when soils are wet.

The other nutrients that are most likely to limit winter wheat yields are phosphorus, potassium and sulfur. In eight Missouri experiments with good soil test P levels, no yield response to P was seen. Current University of Missouri soil test interpretations, if followed, should provide adequate P availability to maximize yield.

In these same experiments, wheat yield was increased 3-4 bu/acre by potassium (K) applications at the three locations with the lowest soil test K (below 230 lb K/acre). No response was seen in experiments with higher soil test K. Full yield would have been achieved in all experiments by following current University of Missouri K recommendations.

Four of the eight experiments were in southern Missouri, and wheat yield responded to sulfur (S) applications in two of those four experiments — one in southeast Missouri, and one in southwest Missouri. Including earlier experiments with S in southeast Missouri, wheat yield response to S is probably more likely in that part of the state than anywhere else, particularly on sandy soils. However, yield responses are still not common. Soil test sulfur tends to be higher in southwest Missouri than in other areas of the state, so responses there are also not likely to be common.

SUMMARY

Fertility management for winter wheat in Missouri has three main purposes:

- Provide a small amount of N and adequate P to support good fall growth.
- Provide N in early spring to stimulate tiller formation when tiller numbers are low, but avoid N applications in early spring when tiller numbers are adequate or high.
- Provide enough N, typically 90 lb N/acre in the spring, to support vigorous stem elongation and head development. The amount of N needed is more variable for wheat following corn than for wheat following soybean, and a tissue test to predict the amount of N needed may be helpful for wheat following corn.