UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION

HIGH DESERT CROP NOTES

LOS ANGELES AND
SAN BERNARDINO COUNTIES
335 East Avenue K-10, LANCASTER, CA 93535
(661) 974-8825, asbiscaro@ucdavis.edu

Fall 2012

In this issue:

Andre Biscaro
Farm Advisor

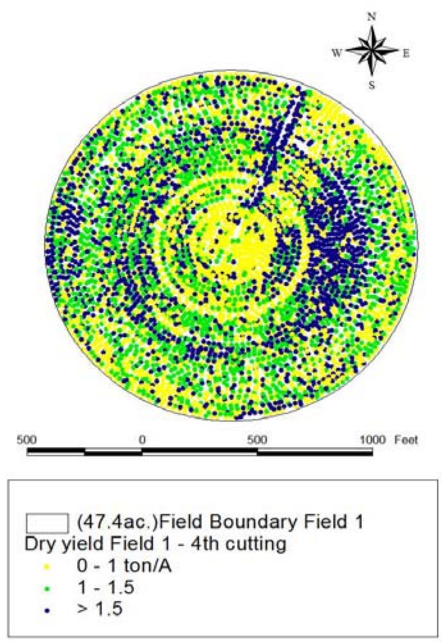
Evaluation of a Recently Developed Hay Yield Monitor

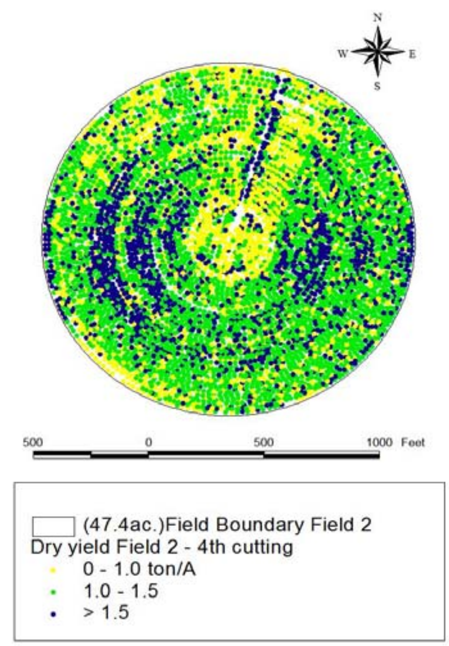
Andre Biscaro, Steve Orloff and Rob Mikkelsen

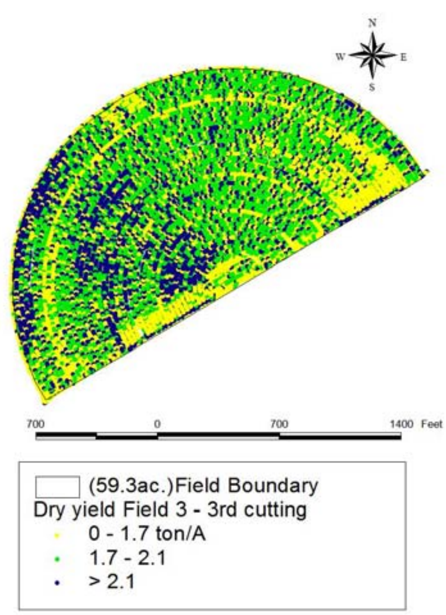
Within-field yield variability is often observed by growers while managing and harvesting their fields, however, it is difficult to determine the boundaries and magnitude of such variability. Identifying and understanding the causes of yield spatial variability can be extremely useful for improved crop and soil management and consequently maximizing production efficiency. Yield monitoring technology was developed approximately 20 years ago in Europe and in the Midwestern US with the objective of mapping yield variability of grain and soybean crops using mass-flow sensors and GPS installed on combines. In addition to grain crops, different concepts of yield monitoring technology have evolved over time for crops like sugar cane, coffee, potatoes, citrus, peanuts, tomatoes, forages and pistachios. The success of developing yield monitoring technology is related to the properties of each crop and its harvesting operation. It relies mostly on the development of reliable methods to instantaneously measure crop mass-flow. This has been a challenge for alfalfa and other hay crops, and yield monitoring technology is still under development for these crops.

A commercial hay yield monitoring device (Harvest Tec 500®) was installed in a Freeman 370T® baler (small square bales) and evaluated in a study conducted in three alfalfa fields located in the High Desert of Southern California to assess its accuracy and acquire insight into its usability (e.g., ease of installation and data collection). Two methods were used to assess the accuracy of the yield monitor based on different sampling dimensions. Overall, the installation of the yield monitor was simple, especially if compared to grain yield monitors, and the grower did not find it difficult to use. However, a considerable amount of data was lost during the two years of data collection, and it is unclear whether the cause is related to operational mistakes or equipment malfunction. Yield maps of the three alfalfa fields monitored in this study (figures below) presented clear patterns of low and high productivity for all the cuttings evaluated.

Such patterns were recognized by the grower, who pointed out that greater clay content, gopher infestations and irrigation nozzle issues were the most probable reasons for the observed differences. Those differences were consistent among cuttings. In addition, plant height measurements were significantly higher on parts of the field where yields were higher. Although the results of this study indicate that the yield monitor underestimated alfalfa yields, this equipment can be used in hay farms to help growers and consultants identify and understand the causes of yield spatial variability and ultimately target crop and soils management to specific areas of the field. For example, a grower or PCA can target soil and plant tissue sampling on low yielding areas in order to understand what's limiting yield, or reduce input application on areas of limited profitability that cannot be improved by crop or soil management.







We would like to acknowledge grower Richard Miner and the International Plant Nutrition Institute for their support and sponsorship throughout this project.

NITROGEN MANAGEMENT IMPACTS ON WHEAT YIELD AND PROTEIN

Steve Orloff, Steve Wright and Mike Ottman[1]

There is no other nutrient as important as nitrogen (N) to attain high yields of wheat with acceptable grain protein. Proper N management requires an understanding of the seasonal N needs of the crop and a realistic estimate of the yield potential. An accurate estimation of available N in the soil, a step many producers skip, is important to determine how much fertilizer N is needed to maximize yield. Nitrogen available during early vegetative through boot growth stages affects yield potential, while N applications after the boot stage are primarily used to increase protein. A late-season N application is often needed to achieve protein standards for hard red and white wheat and durum wheat. Plant tissue testing shows promise for predicting the need for a late-season N application.

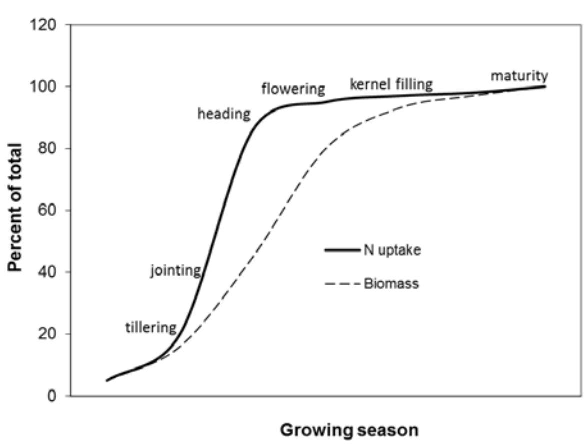


Figure 1. Percent of total biomass and N uptake during the growing season at various wheat growth stages. From: *Nitrogen Management for Hard Wheat Protein Enhancement*

NITROGEN UPTAKE

The nitrogen needs of a wheat plant change markedly over the season, and are commonly thought of as occurring in three distinct phases. Cumulative nitrogen uptake in wheat follows a sigmoid (or "S" shaped) curve giving rise to the three phases (Figure 1). Nitrogen uptake is slow during the early growth phase from emergence into tillering (Phase 1). Rapid accumulation of nitrogen occurs in Phase II, which corresponds to the stem elongation phase from jointing to heading. Maximum N uptake occurs during this period and can reach 2 – 3 pounds per day totaling approximately 100 to 150 pounds of N per acre or more depending on the yield potential. The plant accumulates most of the N by boot stage. Uptake slows during the third phase. The plant still takes up some N but the rate slows and this phase is characterized primarily by a redistribution of N within the plant. As the grain forms, N is translocated from the leaves and stems to the developing grain.

Plant biomass production lags behind N uptake and accumulation (Figure 1). By boot stage, the plant has taken up most of the N but has only accumulated about half of its biomass. It is important to have adequate N available to the plant preceding the peak uptake periods so that biomass production and yield potential are not adversely affected.

Early-season (prior to the boot stage) N uptake contributes to yield primarily and has minimal effect on grain protein. <u>It is critical not to short the plant during this critical early season time period to realize full yield potential.</u> In addition, early-season nitrogen applications can be important to break down residue from the previous crop. Yield potential is determined by three factors 1) the number of head-bearing tillers per unit area, 2) the number of kernels per head, and 3) the size of individual kernels. Of these, the density of head-bearing tillers is by far the most significant.

Therefore, an adequate supply of N throughout the vegetative growth stages is critical to reach maximum potential yield. Nitrogen at tillering is important because it obviously affects tiller density, and N during jointing is important because of its influence on the number of kernels per head.

In contrast to early season N, late-season N has minimal impact on yield because tiller density and kernel number have already been established. Late-season N can improve yield slightly in deficient plants because it can increase individual kernel size and bushel weight somewhat. However, of the three factors affecting yield, kernel size is the least important. Late-season N can, however, have a significant impact on protein concentrations, as will be discussed later.

HOW MUCH NITROGEN TO APPLY

The appropriate amount of N fertilizer to apply can be a difficult question to answer without knowing how much N the soil will supply, the growth and N uptake dynamics of the crop, and the yield potential. Preplant soil testing and in-season plant analysis can provide guidelines for N fertilizer application. However, for planning purposes, yield potential is a very important consideration. This is not the yield the grower simply wishes to achieve, but rather what yield can realistically be expected. The main considerations are the availability of irrigation water, soil properties and weather conditions. Obviously, it does not make sense to apply as much N to a dryland crop in California as it does a well-irrigated wheat crop. Cool conditions during grain fill along with an absence of foliar diseases can also improve yield potential appreciably. The class of wheat is another important consideration, as high protein is important for hard wheat classes and durum wheat; whereas, lower protein is desirable for many uses of soft wheat.

Estimating Total N Requirement. The amount of N required can be calculated by multiplying the yield goal by the N requirement per unit of grain yield. The amount of N (soil + fertilizer) required in the Western US to optimize wheat yields varies from 3.3 to 5.0 pounds of N per 100 pounds of grain. Higher yields with acceptable protein typically require the upper end of this range because of decreased N-use efficiency with increasing yield.

Significantly more nitrogen is needed when high protein is required in addition to maximum yield. For example, research and observations in the Pacific Northwest indicate that for that area 2.6 to 3.3 pounds of N per 100 pounds of grain yield is required for maximum yield alone, while the requirement increases to 4.6 to 5.3 pounds N per 100 pounds of grain to produce wheat with a protein content of 14 percent.

Fertilizer N Requirement. Fertilizer N rates should be based on the expected crop yield minus credits for residual soil nitrates and N mineralized from organic matter, manure, and previous legume crops such as alfalfa. Soil N available to the wheat crop also includes current available N (nitrate-N and ammonium-N) as well as N that becomes available during the growing season from soil minerals and organic matter.

Soil N. All too often growers fertilize based on past practices alone and fail to consider the residual N in the soil. Residual soil N levels can vary considerably and are strongly influenced by the preceding crop and the N fertilization practices associated with that cropping system. Residual soil N can be assessed by sampling the soil for nitrate-N. While not all the N in the soil is in the nitrate form, most of the readily available N is. Mineralization of N, or the conversion of N from an organic form to an inorganic state as a result of microbial decomposition, can make a significant contribution (5 to 40% of the total N needed) to the N needs of the wheat crop. However, since most California soils are typically very low in organic matter, mineralizable N is often ignored. A nitrogen mineralization soil test including nitrate and ammonium-N has been developed to predict the spring fertilizer needs of soft white winter wheat in Oregon. While this approach is more accurate than using soil nitrate-N alone, it has not been evaluated for California and for other wheat classes.

Soil sampling should occur close to planting, as nitrate-N levels vary depending on biological activity and fluctuate with changes in temperature and moisture. In addition, nitrate-N can be easily leached. Although under ideal conditions the roots of a wheat plant can reach 4 to 5 feet, soil sampling to a depth of 2 feet is often adequate to assess residual nitrate-N because approximately 70 percent of the wheat roots are found in that zone.

Failure to account for nitrate-N in the soil can result in over-application of nitrogen fertilizers. Sample the first and second foot depth increments separately. Pounds of nitrate-N potentially available per acre in each foot of soil can be estimated by multiplying parts per million of nitrate-N by 4 (assuming an acre furrow slice of soil is approximately 2,000,000 pounds). Then sum the pounds of nitrate-N in the two one-foot increments. Keep in mind that some of this potentially available soil N may become unavailable for crop uptake due to leaching, denitrification (loss as a gas), or immobilization (uptake by microbes).

Legume crops fix atmospheric N, which in turn affects the amount of nitrogen in the soil available to subsequent grain crops. The amount of residual N following a legume crop is not easily quantified. Alfalfa is the predominant legume grown in rotation with grain in California. An N credit of around 40 to 60 pounds of N per acre is usually given to an alfalfa crop that precedes small grains. However, the N credit should be reduced if the alfalfa stand in the last year of production is sparse and weedy.

Irrigation water can be another source of N for the crop but it is oftentimes small enough that it is not considered. Exceptions include when the water source is well water that contains high levels of nitrates or lagoon water from a dairy operation. Pounds of nitrogen per acre in the irrigation water can be calculated by multiplying the parts per million of nitrate-N in the water by 0.226 and by the number of acre-inches per acre of water to be applied.

LATE-SEASON NITROGEN FERTILIZATION

The total amount of N applied is important, but the timing of the application is critical as well, especially when it comes to the protein content of the wheat kernel. An adequate supply of N during vegetative growth stages is essential to maximize yield, but does not ensure an acceptable protein concentration. A late-season N application may be required to reach protein goals because only after most of the N required for yield is supplied will additional N applications increase grain protein content. Nitrogen applications made from the boot stage up to 2 weeks after flowering have proven effective for increasing grain protein. Applications close to flowering usually have the greatest impact. If the total amount of N required to reach both yield and protein goals is all applied preplant, there may be insufficient N available at heading to achieve the desired protein level because there is a risk of excessive vegetative growth and lodging and higher potential for leaching. The amount of N needed is a function of the desired protein concentration, the yield level and the wheat cultivar (varieties differ in their ability to accumulate N). The amount of N typically applied with a late-season application intended for protein enhancement is in the neighborhood of 30 to 50 pounds of N per acre. The higher the yield, the more N required to increase the protein content.

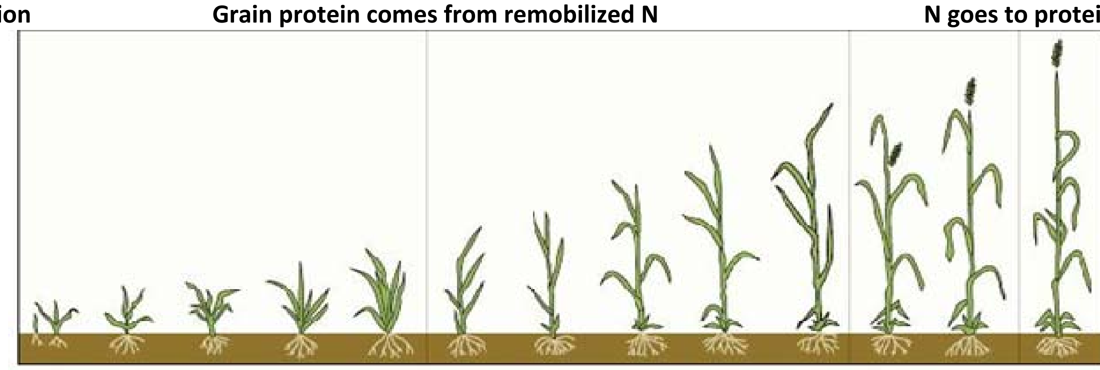


Figure 2. Appropriate cereal growth stages and N application timing effects on yield and protein. From: *Practices to Increase Wheat Grain Protein*

CONCLUSION

An adequate supply of N is essential to attain high wheat yield at desired protein levels. While some of the N needs of the plant are captured from soil residual N (nitrate and ammonium) and mineralizable N from organic matter, commercial N fertilizer is almost always needed to reach yield and protein goals. Precisely how much N to apply and when should be based on the expected yield level and the amount of soil residual N available. Effective N management throughout the season is essential for assuring both high production and grain protein. Nitrogen applications made during vegetative growth stages increase yield, while applications after heading typically have little impact on yield but increase grain protein. Oftentimes a late-season N fertilizer application is necessary to reach protein requirements. Proper N fertilizer application timing is important so that nutrients are available when required by wheat plants and to reduce potential adverse environmental effects such as excessive nitrate leaching.

EVENT ANNOUNCEMENT // UC Soil Fertility Short Course Feb. 2013

Mark your calendar!

If you missed… the February 2012 AND November 2012 courses, be sure to sign up for this one. The **UC Soil Fertility Short Course** will be repeated on **Tuesday, February 19, 2013** at the Buehler Alumni & Visitor Center, UC Davis. Register early before the course sells out—enrollment is limited to 70 participants.

~ ~

Event: **UC Soil Fertility Short Course 2013**

Date: Tuesday, February 19, 2013

Location: Buehler Alumni & Visitor Center, UC Davis

~ ~

The UC Vegetable Research & Information Center (VRIC) will sponsor the **UC Soil Fertility Short Course** on **Tuesday, February 19, 2013** at the Buehler Alumni & Visitor Center, UC Davis. The short course will focus on the practical aspects of soil fertility management in an era of escalating fertilizer costs and increasing government regulation of nutrient inputs for environmental water quality protection. The topics covered will include getting the maximum value from soil testing, interpretation of laboratory soil test results, comparing fertilizer sources, developing crop nutrient management plans, and fertilizer management and environmental protection. Although the focus will be on nutrient management in annual cropping systems, much of the material presented will be relevant to perennial crops as well. The course will not directly address organic fertility management issues, but organic growers may still benefit from attending; the majority of day will be spent covering basic soil fertility concepts, which are equally applicable to organic and conventional production. The content will be geared toward commercial scale production, and will assume a general knowledge of soil science; this course is not appropriate for home gardeners.

The program is intended for growers, certified crop advisers (CCA), pest control advisers, government agency personnel, and others involved in fertility management planning. Take advantage of the early-bird registration fee ($150.) The fee goes up on Jan. 31 to $175. The registration fee includes lunch, refreshments and study materials. UC Farm Advisors can attend at the special rate of $90.

Cooperative Extension specialists **Tim Hartz** (vegetable crops) and **Stu Pettygrove** (soils) are the instructors.

The course is approved for California CCA continuing education credits.

More information, visit the VRIC website (http://vric.ucdavis.edu).