

# AN INTRODUCTION TO THE USE OF REFERENCE STRIPS FOR N MANAGEMENT IN DURUM WHEAT

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Although nitrogen (N) fertilizer input is high in durum wheat, growers in Arizona often find it difficult to apply an adequate amount of N at the right time to produce desirable grain yield and protein content. Many growers use fixed N fertilizer programs to manage durum wheat crops. In these programs, N fertilizer can be under- or over-applied in the field due to differential crop growth and N demand from year to year. For example, durum wheat planted following alfalfa, cotton, or grain sorghum can have very different N requirements. When crop yield is high due to favorable growing conditions, N fertilizer applications from fixed programs are often not sufficient for the crop to attain the desirable 13% protein content. When crop yield is low, N fertilizer is often over-applied in fixed programs, resulting in protein contents higher than 13%. In either case, growers' profitability is reduced.

Current recommendations for durum wheat N management from the University of Arizona are based on pre-plant soil sampling and in-season tissue testing (Ottman and Thompson, 2006). While many growers test soil before planting, few

conduct in-season tissue analysis for N management. This is due to the fact that the vast majority of N in durum wheat is split-applied, going on at with irrigations from the 3-4 leaf stage to flowering. Very often, growers are not able to receive laboratory test results before their next N application, discouraging them from using this powerful tool. Therefore, there is a need for simple and rapid methods that enable growers to make N application decisions based on quick field measurements.

Reference strips have been developed to allow visual evaluation and determination of whether an in-season N application is needed for crop (Desta, et al., 2011). This approach requires a comparison of crop plants to be fertilized with those where N is not limiting, also referred to as the sufficient-N reference. The greater the difference between plants in sufficient-N reference strips and in un-fertilized areas, the more N fertilizer is needed (Shanahan et al., 2008).

Of all these reference techniques, the most common and easiest one to use is the N-Rich Strip, first introduced by Dr. James Schempers at the University of Nebraska in 1990. With



Figure 1. N-Rich Strip (white arrow) and Ramp Calibration Strip (white rectangle) in a durum wheat field at University of Arizona's Maricopa Agricultural Center. 100 lb/acre of Pre-plant N was applied to the N-Rich Strip, but not the rest of the field. Plots from 10 to 100 lb/acre of pre-plant N with a 10 lb/acre increase in every 10 feet were included in the Ramp Calibration Strip. The plots are marked off by red flags with the first plot in the lower left corner of the field. The N-Rich Strip and Ramp Calibration Strip suggest that the field should be fertilized at a rate of 40 lb/acre of N.

the N-Rich Strip, a high rate of pre-plant N is applied to two separate strips across the length of the field, before the crop is seeded (Arnall et al., 2008). Wheat plants in the strips have excess available N, thus they are called N-Rich Strips. During the growing season, wheat plants in the rest of the field are compared to the N-Rich Strips. If wheat plants in the rest of the field grow similar to N-Rich Strips, no N application is necessary. Otherwise, N fertilizer should be applied during the next irrigation (Figure 1). In this method, the total N applied in the N-Rich Strips (including pre-plant and water-run N fertilizer) must not be less than 125 percent of the total N rate recommended for certain yield goals, which can be found in Ottman and Thompson (2006) for durum wheat in Arizona.

While the N-Rich Strip system enables growers to tell when N fertilizer is needed, the amount of N to apply is unknown and needs to be estimated based on readings from a canopy reflectance sensor such as GreenSeeker. The sensor measures normalized difference vegetative index (NDVI), which is highly correlated with plant biomass and can be used to predict yield at early to mid-season growth stages. From the potential difference in yield between N-Rich Strips and the rest of the field, one can calculate the amount of N fertilizer needed to be applied in the field based on results from Ottman and Thompson (2006). For example, a crop with 7000 and 5000 lb/acre grain yield requires 246 and 176 lb/acre of N, respectively. If yield predictions in the N-Rich Strips and the rest of the field are 7000 and 5000 lb/acre, respectively, the recommended N application rate is 70 lb N/acre (the difference between 246 and 176 lb/acre). The problem with this approach is that most growers do not have remote sensing equipment to estimate the yield differences between the N-Rich Strip and rest of the field, limiting the use of N-Rich Strip for timing N application, but not for N rate recommendations

Ramp Calibration Strip is another reference strip technique with the advantage that it does not require the use of a sensor to estimate N rate recommendations. This reference strip is based on the visual evaluation of plots with incremental rates of pre-plant N to identify the minimum N rate required for maximum yield (Edmonds et al., 2008). It includes multiple N rates and basically comprises a few small plots with low to high pre-plant N rates placed in a sequence in the field (Arnall et al., 2008). For example, the strip could consist of plots from 10 to 100 lb/acre of pre-plant N with 10 lb N/acre increases every 10 feet (Figure 1). The highest rate, including pre-plant and water-run N, is still no less than 125% of the total N recommended for the specific yield goals. During the growing season, one can walk the strip from the low rate to high rate until the crop in next plot does not appear greener. The N rate in the plot is the recommended N rate in next irrigation.

Due to variations among fields, reference strips should be included for each individual field. They should also be set up

in areas that are representative of the whole field for better recommendations. These two reference strip techniques, especially the N-Rich Strip, have been widely used by growers worldwide and across the US, thus are highly recommended (Desta et al., 2011). They are easy to set up and can be used to other grain crops to optimize N application in the field. These techniques have also been proven to help growers manage N effectively and provide economic benefits in many other states (Desta et al., 2011; Edmonds et al., 2008).

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Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Jeffrey C. Silvertooth, Associate Dean & Director, Economic Development & Extension, College of Agriculture and Life Sciences, The University of Arizona.

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