Nitrogen (N) is considered the most common nutrient limiting yield of spring wheat and other cereal crops in Montana. On the other hand, it is regarded as the most effective of all inputs for increasing profits in cereal crop production. Late-season N fertilizer application has been found to boost spring wheat protein levels by 0.5 to 2.0%. When wheat yield potential is higher than average, early-season N application may not be adequate for sufficient protein accumulation. There is great demand among Montana crop producers for up-to-date information on crop- and site-specific fertilizer use. In general, N fertilizer rates for cereal crops in Montana are determined as following: NR = YP x 2.5 – 3.0, where NR is N fertilizer rate (lb/ac) and YP is yield potential (bu/ac).

Precision agriculture tools such as sensor-based technologies make it possible to accurately assess the crop’s nutrient status and account for spatial and temporal variability. This enables adjusting fertilizer application rates according to site-specific conditions, which results in more efficient, profitable, and sustainable crop production. Remote sensing is a precision agriculture technique that quantitatively measures vegetation indices such as the Normalized Difference Vegetation Index (NDVI). Using spectral measurements, crop’s yield potential can be precisely estimated midseason in a non-destructive way. From these measurements, an algorithm is developed for midseason topdress N fertilization. The precision sensing approach helps to address the limitations of diagnostic N tools in terms of accuracy, labor requirements, and cost. The diagnostic tools utilizing soil tests, tissue N concentration, and chlorophyll concentration to determine a crop’s need for N are time consuming, expensive, and require multiple samplings. Also, yield estimates determined using the multiple-year yield average are often inaccurate because the yield goal approach assumes that spatial and temporal homogeneity exist in the field.

Crop sensor-based systems with developed algorithms for making midseason fertilizer N recommendations are commercially available to producers in some parts of the world. The growing interest in sensor-based technologies among Montana producers is offset by the lack of Montana-based research and limited knowledge of how well these systems would perform in the state’s semiarid conditions. In addition, one of the frequent questions asked by growers is whether N recommendations derived from sensors should be adjusted based on the source of topdress fertilizer N used. Two most commonly used sources of N in Montana are urea (granular, broadcasted, or applied with the seed) and urea ammonium nitrate (UAN) (liquid, often sprayed to boost protein content). Research has shown that liquid N sources might be more appropriate when coupled with precision sensor-based technologies because application of N in a liquid form allows for more accurate fertilizer delivery. The main controversy involves the discussion as to whether application of N in a liquid form provides higher N use efficiency because N is fed directly to the plant via crop canopy.

Montana study

A field study was carried out at two locations in 2011 and three locations in 2012 in northwestern Montana: two dryland sites at the Western Triangle Agricultural Research Center (WTARC) and Martin farm (Martin) near Conrad, MT, and one irrigated site at the Western Agricultural Research Center (WARC) near Corvallis, MT, using the spring wheat variety Choteau. The objectives of this research were (1) to evaluate two optical sensors, GreenSeeker (model 505) and Pocket Sensor (a prototype GreenSeeker...