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N: the Vital Nutrient in the Great Plains

Cropping intensification brings greater need for N fertilizers in Great Plains.

Summary: *Cropping system alternatives to wheat-fallow have become possible in the Great Plains as a result of improved water conservation techniques. Cropping intensification, compared to wheat-fallow, leads to a greater demand on soil N supply, and thus a greater need for N fertilizers. This article reviews N fertilization practices for intensified cropping systems, and provides an update on current farmer Nfertilization practices for each crop grown in the intensified systems.*

Plant production in the Great Plains always has had two limitations: 1) water supply, and 2) available N supply. These limitations were present even before cultivated agriculture was established in the plains. Prairie plant production was basically in balance with water and N supplies. The prairie plants used most of the water and nitrate supply as soon as it was available.

Plowing the prairies changed both the water and N budgets. With respect to water, it encouraged accumulations in the soil profile far beyond those possible with a prairie system. With respect to N, it stimulated a flush of N mineralization as the resident organic matter mineralized after plowing. Dryland cultivated systems in the Great Plains, mostly crop-fallow, were able to exist without addition of N fertilizer and/or legume N inputs for 30 to 50 years after sod breaking.

Beginning in the 1970s, it became apparent that wheat produced on many of our soils was responding to N application and that N mineralization no longer met plant demand. Higher wheat yields associated with improved soil water conservation and superior yielding varieties accentuated the N deficiency.

In efforts to minimize erosion and maximize water storage efficiency, reduced tillage and no-till systems were developed. Scientists soon recognized that the economics of no-till in crop-fallow systems usually were not favorable. Often the cost of saving additional water was higher than the value of the additional crop produced.

Scientists from Canada to Texas have subsequently identified cropping systems that efficiently and profitably use water. The new more intensified systems use rotations involving canola, corn, forages, millets, peas, safflower, sorghum, sunflower, and wheat produced with a mixture of no-till and reduced-till practices. Our data show a 28 percent increase in crop production per unit of water by switching from crop fallow to more intense systems.

As anyone would expect, increased productivity with intensified cropping systems leads to even greater N demands on the soil system. We'll briefly review how farmers and scientists are addressing N fertilization problems in intensified cropping systems across the Great Plains.

N management issues

N quantity. Intensified cropping systems would be expected to consume more N than crop-fallow if they produce more grain forage. On an eroded Weld loam soil with a low wheat production potential, Kolberg and Kitchen reported an average yield increase response of 5.5 bu/A to N applied at the rate of 90 lbs/A (Figure 1). However, on a more productive Keith clay loam, N at 90 lbs/A resulted in an average increase of 6.4 bu/A under wheat-fallow and

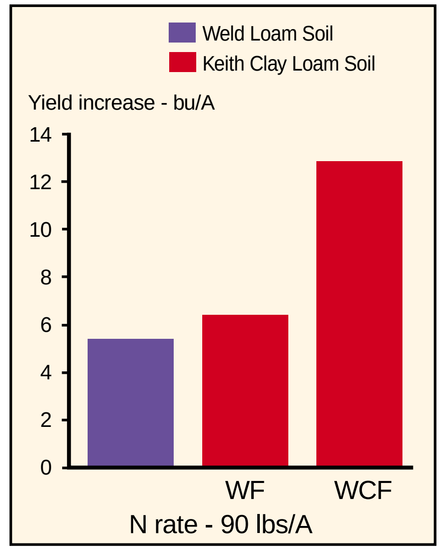

Figure 1. Comparison of average wheat yield increase response to N applid on different soils at rate of 90 lbs/A. WF=wheat fallow, WCF=wheat-corn-fallow.

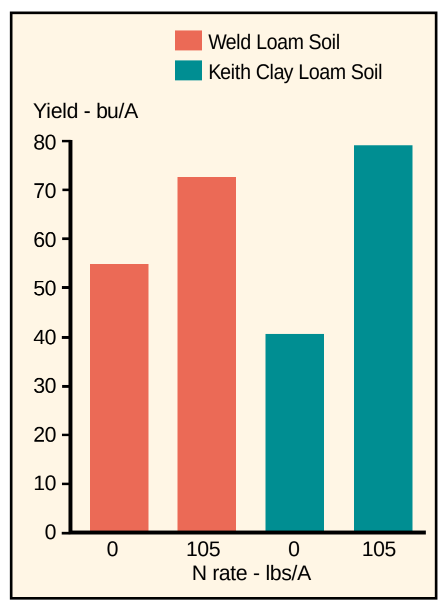

Figure 1. Comparison of corn yield response to N applied on different soils at rates ranging from 0 to 105 lbs/A.

12.8 bu/A under wheat-corn-fallow (Figure 1). The greater yield response in wheat-corn-fallow occurred because greater residual soil NO_3 depletion in the check treatments (0 N rate) of the more intensive cropping system.

Dryland corn yields in these systems were increased with N fertilizer rates up to 105 lbs/A. Yields were increased from 55 to 73 bu/A on the Weld soil and from 41 to 80 bu/A on the Keith soil as N fertilizer rate increased from 0 to 105 lbs/A (Figure 2). Yield increased linearly up to the 105 lb/A rate, but this rate was the point of diminishing return. The wheat-corn-fallow cropping system required 73 to 90 percent more N fertilizer compared to the wheat-fallow system.

In western Kansas, wheat-sorghum-fallow cropping systems required 40 to 80 lbs/A of N for maximum economic winter wheat yields. Higher fertilizer N rates were needed in higher rainfall years or wetter locations.

Havlin has reported that fertilizer N rates between 75 to 125 lbs/A were needed to optimize dryland corn yields in wheat-corn-fallow rotations. Similarly, 80 to 100 lbs/A were required to maximize sorghum yields in no-till wheat-sorghum-fallow rotations.

The key means of determining N quantity remains soil testing.

Placement/timing. The two placements that usually ranked highest for the wheat crop were 100 percent urea preplant broadcast and 30 percent UAN banded below the seed plus 70 percent surface banded at planting.

In a higher rainfall environment, Carlson et al. showed 15 and 10 bu/A no-till corn yield increases for preplant banded N as compared to broadcast at 75 and 150 lbs/A rates, respectively. In the same environment, Lamond et al. reported 28 and 13 bu/A sorghum yield increases for preplant banded N as compared to broadcast at rates of 50 and 100 lbs/A, respectively.

Although we appear to have flexibility in N placement recommendations, additional research is needed to develop precise fertilizer N placement recommendations.

Farmer practice

Wheat-fallow, with mulch tillage, is still the most common cropping system in the plains. The more intensive cropping systems are being used on less than 20 percent of the cultivated areas.

Alternative cropping systems, which include various legume crops, seem to be most diverse in the northern plains. In the central Great Plains, corn and sorghum are most common. In the southern plains grain sorghum is the most common crop grown in rotation with wheat.

UAN is applied in a variety of ways ranging from injection to use as a herbicide carrier. Using UAN as a herbicide carrier for preplant applications is reported to be effective and cost conserving. Why sidedressing has not been widely used is not clear. It may be farmers lack suitable injection equipment that won't handle surface residue. It may also be that sidedressed N gets stranded in dry soil, which is of natural concern to farmers who are always looking for the cheapest, most efficient way possible to apply nitrogen. More research is obviously needed to improve uptake efficiencies of N.

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