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Reduced Tillage with Herbicides

Wheat: Fallow Cropping Sequence

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FERTILIZERS AND THEIR APPLICATION IN CONVENTIONAL, MINIMUM, AND NO-TILLAGE WINTER WHEAT-FALLOW SYSTEMS

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Most of the soils in the Central Great Plains have been farmed for 60 or more years. During this time very few of these soils have received applied nutrients. Therefore, they have essentially been mined during this period of cultivation. Nitrogen is probably the most severely depleted nutrient in all of our soils. This is evident when areas such as Tribune, Kansas, with a highly erratic average rainfall of approximately 16 inches can receive an average wheat yield increase of approximately 10 bu/ac 3 years out of 4. This is similar to results at Akron, Colorado where total rainfall is the same as Tribune but not quite as erratic, and the same yield increase can be expected 7 years out of 8. With such consistent need for nitrogen in the production of our major crop, winter wheat, we need to understand the factors that affect the accumulation of nitrate-nitrogen in the soil during fallow for the different management systems that are currently available for use throughout the area.

These management systems include conventional stubble mulch tillage, a reduced or minimum tillage system in which all but two, or at the most three, of the tillage operations have been eliminated through the use of herbicides, and a no-till fallow system in which all tillage has been eliminated. For conventional stubble mulch fallow, the largest amount of the nitrate accumulation occurs after most of the soil water storage has taken place during fallow which results in most of the nitrate accumulation in the upper 2 feet of soil with soil water stored to depths of 4 to 6 feet. What is needed is nitrate distributed throughout the entire profile where soil water is stored. This can be obtained in most years only when nitrogen applications are made so that the nitrate can move into the soil with the water to produce the desired distribution. However, when we change our management system from a conventional stubble mulch tillage to a no-till or minimum till system, we change the micro-climate of the surface soil where nitrate mineralization occurs. The largest change occurs in the soil water content of the surface 2 inches of soil where mineralization occurs.

With conventional tillage, in the fall following harvest, there is only a short time in which the soil water content is sufficient for nitrification, whereas, with the minimum and no-till systems (at this time there is no difference between the two), the period for mineralization is much longer. During the following spring and summer we find again a large increase in the amount of time in which the water content is favorable for mineralization in the no-till systems compared to a conventional tillage system, with a minimum or reduced system being somewhat in between the conventional and have fewer problems, but by having changed the water content we are also changing the soil temperature with the minimum and no-till system. Prior to early May, soil temperature is considerably warmer with the conventional till than with the no-till system. Therefore, we tend to get a larger increase in nitrate during the early spring with conventional tillage than with no-till. However, following the May-June

period, soil temperature is not a factor and we are limited then by the water content and with water being more favorable in both the no-till and the minimum tillage systems, we tend to get a larger increase in mineralization during this portion of the fallow period with these systems.

I want to emphasize that this is what occurs only after a minimum of three cycles of either minimum or no-till fallow when going from a conventional stubble mulch system. If you were to go from a bare fallow system results would be different, but since we do not practice bare fallow no results are available. During the first three wheat-fallow cycles, the amount of the previous crops residue that is incorporated into the surface 2 inches of soil for decomposition and mineralization is greatly reduced, thereby reducing the amount of material available for mineralization. This residue is on the soil surface and becomes available in later years, but in the initial year or two there is a tremendous difference in the amount of this residue that is present in the soil because there has been, in one case, no tillage to incorporate residue into the soil, and the other only one, maybe two operations for a minimal amount of incorporation. The amount of residue in the surface soil by the end of the fourth wheat-fallow cycle is nearly the same as is present with conventional stubble mulch tillage systems. Thereafter, a slight increase in amount of residue present in the surface soil occurs with no or minimum tillage compared with conventional tillage.

Actual amounts of available nitrogen are about one-half in the first year with minimum and no-tillage systems compared to that in the conventional system. Significantly more nitrogen would have to be applied to acquire a necessary amount to produce a respectable crop. This is especially true with a minimum or no-tillage system where we have even larger amounts of water stored into the soil where maximum water-use efficiency is desired. By the fourth wheat-fallow cycle we tend to have increased the amount of nitrate present with minimum and no-tillage over what was present with conventional tillage largely reflecting to the more favorable conditions for a longer period of time.

I mentioned earlier that distribution of nitrate in the profile is important for production of both yield and quality. When liquid fertilizer N was knifed into the soil, the yield and protein are both higher than with broadcast except when the N was applied after wheat is growing. However, the yield is still higher when applied prior to planting. With anhydrous ammonia, the more uniform application with a blade produced higher grain yield and higher protein than when applied with a chisel plow on 18-inch spacings.

From these results it appears that with a no-till system some means will have to be taken at the optimum time during the fallow period to apply nitrogen to the soil rather than broadcasting it on the surface. Also, due to the differences in rainfall patterns, time in which we expect the rain to fall, the optimum application time may have to vary from geographical location to location in order to acquire the desired nitrate distribution within the profile. However, we know that when a farming system is changed, the nitrogen mineralization pattern changes and the only way to obtain maximum production of a quality crop is to apply sufficient nitrogen to produce the crop. With the rate being adjusted according to the number of years that this system has been practiced, present indications are that after the third wheat-fallow cycle the N application can be reduced to that which was previously being used prior to the time the system was changed.