by Dr. Jay W. Johnson

Rule Number One for High Yields in Reduced Tillage: Proper Management

Selecting good hybrids, planting on time, minimizing crop pests, and properly supplying nutrient needs are among essentials outlines by Ohio researcher.

Summary: *Reduced-till systems require special evaluation of all inputs if the crop is to perform to maximum capability and produce high yields. Among the essentials to consider are: hybrid selection, plant population, pest management, adequate drainage, and proper nutrient management. Through research, strategies have been developed to overcome the problems of stratification, volatilization, and accumulated organic matter that impede yields. In addition, strategies have been developed to promote plant root growth— another key in producing higher yields.*

Crop production is the optimization of the use of sunlight, nutrients, and water by plants to make carbohydrates, oil, and protein. For reduced tillage systems, a producer should evaluate how each input can be managed to enable the crop to perform to its maximum capability and produce high yields. Achieving optimum yields in such a system involves a number of considerations.

Hybrid. In the early spring, reduced-till soils are often cooler than conventional-till soils by 2 to 4 degrees F. The cooler temperatures usually will delay planting 7 to 10 days. Under cooler conditions the seedling may be slower in emerging. Hybrid or variety selected, therefore, is critical for good emergence. Seeds with good vigor should be selected to ensure good emergence. Delay may also require selection of shorter-season varieties to ensure maturity.

If residue levels are unusually high, the use of row cleaners may be warranted to increase soil temperature in the row. This should decrease the time it takes for seedling emergence. Other criteria for uniform emergence are good seed/soil contact, proper planter setting, and, of course, waiting until soil conditions are suitable.

Plant population. Growers must not only select proper hybrids to achieve optimum yields in reduced-till systems, but also account for plant population. Work by Olsen at Rocky Ford, Colorado, has demonstrated that high plant population—along with top varieties, high levels of soil fertility, and good water management— was among the key ingredients that produced corn yields more than twice the Colorado average (Figure I). Note that as plant populations of two hybrids increased from 25,000 to 37,000 plants/A, yield responses to nitrogen actually increased. In all cases of Olsen's work, high rates of nutrients were the rule.

Pest management. Pest management is altered when there are high residues. Residues may harbor disease and insects a producer normally does not encounter with conventional-till. Lower soil temperatures resulting from high residues may slow plant growth early in the season, requiring weed control to be extended for up to an additional two weeks. Otherwise, growers risk having weeds compete with crops for water, sunlight and nutrients. High residues may also delay insect emergence, necessitating a good insect management program. Use of genetic materials is also effective in minimizing crop disease and insect problems. Crop rotations are also very effective. In addition to minimizing insect and disease problems, rotations allow use of a broader array of herbicides in combating weeds.

Drainage. Reduced-till usually results in more water availability for a crop during the growing season. Lower soil temperatures mean less evaporation early in the season. Therefore, adequate water drainage is important if the soil is to dry early enough to ensure proper planting dates. Drainage is additionally important to ensure that the soil does not stay saturated for long periods after planting, which can result in seedling loss due to decay, disease, and insect damage.

Nutrient management

Proper nutrient management is one of the most critical areas under reduced-till

Table 1. Benefits of deep fertility in producing high-yield corn crops for growers in Nebraska and Illinois.

Soil depth (inches)	Schmit, Nebraska Phosphate	Schmit, Nebraska Potassium	Warsaw, Illinois Phosphate	Warsaw, Illinois Potassium
	lbs/A		lbs/A	
0-6	200	500	107	284
6-12	108	451	31	142
12-18	21	452	6	150
Yield	**311 bu/A**		**338 bu/A**	

systems. Lower soil temperatures mean less N mineralization from soil organic matter early in the season. This is why it is essential to provide the crop with supplemental N to assure robust early growth. This can be accomplished by applying 20 to 40 lbs/A of N in starter

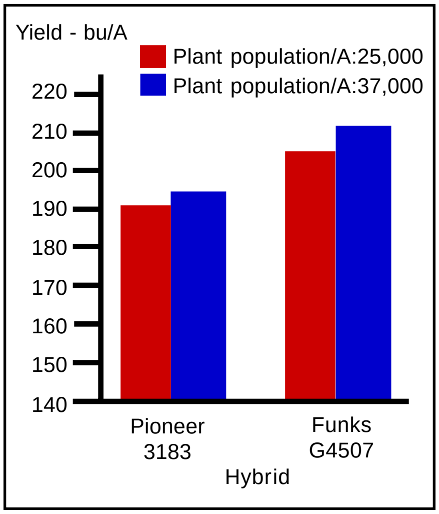

Figure 1. Effect of hybrid selection and plant population on corn yield, Olsen, Colorado State University.

fertilizer or by broadcasting 30 to 60 lbs/A of N near time of planting.

Stratification. Non-inversion tillage systems result in stratification of nutrients within the soil profile. For soils with depleted nutrients due to stratification, the need for starter fertilizer is increased. Also, cooler, wetter conditions, which usually result in slower release of nutrients from the soil, may suggest a need for starter fertilizer. Immobile nutrients such

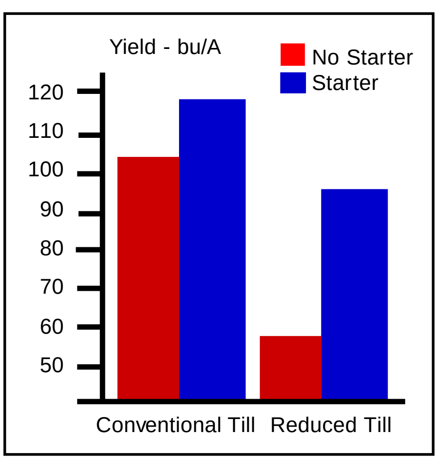

Figure 2. Effect of starter fertilizer on corn yield in reduced-till vs conventional-till system, Wisconsin.

as phosphorus and potassium usually decrease with soil depth. Available P and K will usually be concentrated in the upper 2 to 4 inches of the soil. In a Wisconsin corn study, a starter application of 80 lbs/A of phosphate and 80 lbs/A of potassium produced more than double the yield increase (35 bu/A vs. 14 bu/A) in a reduced-till field versus conventional-till (Figure 2), again demonstrating how starters benefit crops in reduced-till situations where soil temperatures are lowered and nutrients are tied up by residue.

Root growth. The direction of root growth for a young seedling is usually downward. Under heavy residue systems, roots may concentrate near the soil surface due to the cool temperate and higher moisture conditions. This permits good nutrient uptake from the surface soil later in the season, but does not supply the seedling with needed nutrients. If residue levels are low, the need to incorporate nutrients deeper in the soil profile will be magnified. Plants will not concentrate roots at the soil surface if the soil dries out and temperatures are high, as would be anticipated when soil surfaces have little or no mulch. Table 1 shows the payoff of deep fertility, one of the common denominators in producing high yields. Note the extremely high levels of phosphate and potassium in the top 12 inches, which create an environment of greater soil volume for proliferation of roots as they search for nutrients and water.

Volatilization. One consequence of applying urea-based fertilizers to reduced-till soils is an increased probability of surface volatilization. The urease enzyme in the soil and plant residue breaks down urea to form ammonia. At the surface of the soil or on the residue there often is not enough moisture to trap this ammonia, resulting in significant N losses. Conditions that control the rate of conversion are temperature, pH and the presence of the urease enzyme. There are several ways to minimize conversion:

1. Apply N when soil temperatures are lower
2. Lime soil when pH rises, applying it as far ahead of planting time as possible
3. Reduce contact of fertilizer with the urease enzyme by concentrating N in bands (i.e., dribbling 28% UAN)
4. Apply N where there is adequate moisture to absorb the ammonia
5. Place the N below the soil's surface.

Figure 3 shows how knifing (versus broadcast) produces superior wheat yields.

Organic matter. Reduced-till results in the accumulation of organic matter near the surface of the soil, producing higher available carbon for microbial growth. The higher residues also reduce surface evaporation of water. These two

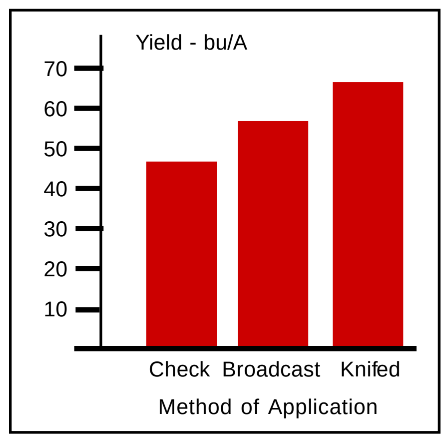

Figure 3. Comparative effectiveness of banding vs. knifing, (75-40-0 treatments), Kansas.

conditions may result in higher potential for denitrification losses. Injection of N below this layer should reduce denitrification of N. Nitrification inhibitors can also help. A third alternative is to split apply N, applying most of the N at side-dress time when surface soil is seldom wet for a long period and plant uptake rapid.

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