FERTILIZER PLACEMENT OPTIONS FOR IRRIGATED NO-TILL CORN 2005

THE DAKOTA LAKES STAFF

INTRODUCTION: Fertilizer placement and timing remains one of the most discussed factors in agriculture. Terms such as strip till, zone-till, and zone building are in common use in the Corn Belt. On the prairies, producers discuss mid-row banding, stream-bar applications, single shoot, double shoot, and triple shoot. As a consequence there has been an abundance of public and private trials focused on testing differing options for fertilizer placement and timing. This report is focused on a series of replicated strip trial experiments conducted on irrigated corn fields at the Dakota Lakes Research Farm during the 2005 growing season. These data may prove helpful for producers making decisions regarding equipment purchases.

BACKGROUND: Agricultural plants obtain nutrients from the soil and the air. In order for the plant to obtain elements from the soil there must be healthy and active plant roots in the same place in the soil where there is adequate nutrient in plant available form. This location must be at moderate temperate and contain proper amounts of air and water to facilitate plant uptake. This goal is relatively straight forward. The complex part is determining how to facilitate occurrence of these conditions in the most economical and environmentally sound manner.

No-till systems are characterized by soils that are cooler in the spring than if they were tilled. They also have a higher proportion of the soil nutrients in the organic form. This is desirable because nutrients will become available later in the season more closely synchronizing nutrient availability with plant uptake. This maximizes efficiency and minimizes the potential for loss. The drawback is that it can also lead to instances where early growth of crops is slower as compared to tilled systems. From a systems standpoint, it is desirable to optimize early growth in order to maximize the crop's ability to compete with weeds.

Methods designed to improve early growth in no-till include using residue managers to move residue from the row area to speed warming, Employing positive closing wheels like the Thompson or May Wes that are designed to cover the seed with loose soil (this warms the soil and improves air exchange in the seed zone).

Another technique is placing some available nutrients in proximity to the seed. This increases the amount of available nutrient in the zone where the initial roots are placed. Uptake per unit of root length (specific uptake) is highest at early growth stages when root length is short. Most veteran no-till farmers have equipped their seeders to place at least some fertilizer at seeding. Many apply most or all of their fertilizer at this time. There are differing options involved but they generally fall into the following categories:

1. Fertilizer placed in the seed trench. This is called a pop-up by many producers. Seed damage can be a concern depending on the fertilizer used and the rate so rates are normally low and limited to high P sources. For this reason, pop-up techniques are not well suited to use for variable rate applications. This is the easiest application technique to adopt because it takes little additional equipment. If this is the only technique used, it is called single shoot on the prairies.

2. Fertilizer placed with a separate opener placed a safe distance from the opener used for seeding. This is called a starter by most producers. The traditional placement of starter in conventional tillage was 2 inches to the side and 2 inches deeper than the seed. With no-till there will be active root growth closer to the surface (residue cover and cooler soils) so the band is normally placed at the same depth as the seed. Horizontal separation is still commonly 2 to 3 inches. Mid-row banding is a variation of this technique. It places a fertilizer band midway between two adjoining rows.

Starter fertilizer can contain significant amounts of nitrogen and other compounds that would harm germination if placed closer to the row. Higher rates can also be employed. This makes it a good technique to use in variable rate (precision ag.) situations. Some producers apply a portion or all of their nitrogen fertilizer in this manner. Almost everyone using this technique will apply all of their P needs with the starter. A nice benefit of having the separate low-disturbance opener is that it can serve the dual purpose of placing the fertilizer and cutting surface residue. Cutting the surface residue before it encounters the residue managers, significantly improves there ability to provide a cleared row area without plugging.

On the prairies, the side-band technique is known as double shoot. In other words the seed and fertilizer travel different paths to different openers. A somewhat radical variation of this approach is strip tillage. Strip tillage is a separate operation (usually in the fall) that loosens the seed zone so it dries (and consequently warms) in the spring. Fertilizer nutrients are applied to the zone. In some cases, the residue is removed as well. The operator attempts to plant on top of the fertilizer bands during the seeding operation that occurs later. There are many inefficiencies and complexities associated with the strip tillage system. It requires use of specialized equipment to make the strips and to be able to follow them accurately when seeding. It makes a second operation necessary during the season when there are already time constrains It places the nutrient into the system well before it should be there increasing the probability for loss. There is increased weed pressure and more difficulty in controlling them because of the disturbance and the non-uniformity created in the field. The list could go on. There is little or no evidence that strip till improves yields (as compared to proper no-till with fertilizer placement) sufficiently to overcome the additional costs and risks. In fact there often is no yield increase and occasionally dramatic yield decreases. Consequently, it is likely that producers will either improve the fertilizer capabilities of their no-till equipment or go back to doing tillage (not likely) rather than adopting strip tillage as a long-term strategy.

The use of cover-crop techniques along with fertilizer placement capability on the seeder appears to be a more environmentally and economically friendly way to modify the seedbed environment.

Many if not most veteran no-till farmers in central South Dakota utilize both a pop-up and a starter. They place a little high P analysis fertilizer in the seed trench as either a liquid or dry product, and place most if not all of their remaining nutrient need in a side or mid-row band. This is called a triple shoot. The N and P (along with other nutrients) placed in the side-band can easily be applied using variable rate techniques. With irrigated production, the amount of N applied at seeding represents only part of the need. The rest can be applied through the irrigation water.

Some producers prefer to limit the amount of product that they carry or do not want the expense of the second opener. Consequently, they apply N in a broadcast or stream bar operation separate from the seeding pass. Liquid N is sometimes used as a carrier for herbicides.

More detail on adopting equipment for use in no-till can be found on the No-till Seeding Concepts video created as part of a cooperative technology transfer project with NRCS and CES. These should be available from your local NRCS or CES office or it can be downloaded from the www.dakotalakes.com website version of this progress report.

PROCEDURES: A series of replicated strip trials with fertilizer placement variables were conducted with corn under irrigated conditions during the 2005 growing season. The station build Concept seeder was utilized for seeding. It has the capability to apply dry N and/or P product from separate tanks 3 inches to the side of the seed row. It can also apply a high P source dry "pop-up" from a third tank in the seed trench between the opener and before the positive closing wheel. This positions the pop-up slightly different than some other designs. It is mixed throughout a V that extends from seed depth to the

surface. This places the nutrient where the first nodal roots will be placed and where the soil will be warm.

For this series of experiments, urea (46-0-0) was used as the dry source of N. The starter and pop-up both consisted of a 11-26-15-6 blend. A 4-ton batch of this is made by blending 1 ton of ammonium sulfate (20-0-0-24), 1 ton of Potash (0-0-60), and 2 tons of MAP (11-52-0). This provides some chloride as a byproduct of the potash and also supplies sulfate sulfur. Urea Ammonium Nitrate (28-0-0) was used for surface application treatments.

Corn was seeded at 34,000 seeds/acre. All trials were seeded on April 30, 2005 with the exception of one seeded on May 2, 2005. Soil test P was between 5 and 8 ppm using the Olson procedure. Soil test potassium was high (over 300 ppm). Nitrate nitrogen was less than 100 lbs/acre to 2 ft.

All plots received nitrogen at the rate of 60 lbs of N/acre. This was either placed in the side-band as urea (46-0-0) or applied to the surface as UAN (28-0-0). All plots received a total of 70 lbs/acre of 11-26-15-5. This was applied in one of three ways. The first is the normal practice of placing 50 lbs/acre of product in the side band and 20 lbs/acre as a pop-up in the seed trench. The second method simulated using a side band but no pop-up. It places 50 lbs/acre of the product in the side band but applied the remaining 20 lbs/acre on the surface. The third method simulated using a pop-up but no side band. In that instance 20 lbs/acre were applied in the seed trench with 50 lbs/acre of product applied to the surface.

All of the studies received additional nitrogen fertilizer through the irrigation system. The amount used was based on using a yield goal of 200 bu/acre with a factor of 1.12 lbs of total N/bu of corn. Soil nitrate N and seeding time N is subtracted from the 2.24 lbs/acre total. All full length strips were harvested with a field scale combine and weighed in a weighing grain cart.

The following studies were done

Study 1: Pioneer 33N93 on May 2, 2005

Nitrogen	Starter Blend	Popup Blend	Yield	Moisture
28% Surface	Yes	Yes	197	18.0
28% Surface	Surface	Yes	181	18.4

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Study 2: Pioneer 33P67 on April 30, 2005.

Nitrogen	Starter Blend	Pop-up Blend	Yield	Moisture
Urea Side	Surface	Yes	207	23.7
Urea Side	Yes	Yes	212	24.4
Urea Side	Yes	Surface	215	23.1
28% Surface	Surface	Yes	200	23.7

Study 3: Pioneer 33W44 on April 30, 2005.

Nitrogen	Starter Blend	Pop-up Blend	Yield	Moisture
28% Surface	Yes	Yes	215	18.5
28% Surface	Surface	Yes	200	18.8
28% Surface	Yes	Surface	204	19.8

Study 4: Pioneer 33P67 on April 30, 2005.

Nitrogen	Starter Blend	Pop-up Blend	Yield	Moisture
28% Surface	Surface	Yes	194	23.2
Urea Side	Yes	Yes	207	21.7
Urea Side	Yes	Surface	202	23.3
Urea Side	Surface	Yes	197	23.6

Study 5: Pioneer 33W44 on April 30, 2005.

Nitrogen	Starter Blend	Pop-up Blend	Yield	Moisture
28% Surface	Yes	Yes	220	18.5
28% Surface	Surface	Yes	223	19.3
Urea Side	Yes	Yes	223	18.6

RESULTS These data are self-explanatory and are similar to those developed by other scientists and previous studies conducted at Dakota Lakes and the James Valley Research Centers. They can be summarized as follows:

Placement of high P fertilizer in proximity to the seed sometimes improves grain yield and reduces harvest moisture. It more frequently improves early-season growth. In this series of experiments, treatments that included **both** the pop-up and side-band starter blend placement were always in the high yield group. Using just one of the placements (side-band or pop-up) by itself was not as consistent.

Placing urea in the side-band with the starter did not produce significant response in 2005 as compared to surface stream applied 28-0-0. However, urea is much cheaper when compared on a price/lb of actual N basis. Placing the urea in the soil in proximity to the row with the seeder will same money as compared to surface applications because the product is cheaper and a trip is being eliminated. Part of the N efficiency of side-banding might be masked by the use of N through the irrigation water.

If variable rate techniques are being used, they cannot be employed with the pop-up due to the danger of seed injury.

A report covering a study conducted in 2002 at the Max Williams farm has been attached to this report. In that study two versions of strip-tillage were tested as compared to no-till. The two styles of strip tillage were utilized to counter a common source of bias in many strip tillage trials. In many trials, N and P are placed in the strips in the fall so the nutrients are in proximity to the seed row. The no-till treatments are commonly established using broadcast fertilizer treatments. It is likely that much of the early growth and yield response reported is due to fertilizer placement impacts. In this study, one strip tillage treatment had MAP placed in the strip. The other strip-till treatment had no P placed in the strip. All plots received broadcast N in the fall. When the plots were planted in the spring a liquid (10-34-0) pop-up was applied to all plots. The corn yields were 172, 166, and 169 for the Strip till with pop-up and extra P, Strip till with pop-up, and the No-till with pop-up. The three bushel yield increase between the best strip-till treatment and the no-till will not pay for the operation ($14 or more/acre) or the extra P. Applying product with the planter is much more efficient.

What should be compared is a no-till treatment where urea is applied in a side-band and the starter is split between the side-band and a pop-up as compared to strip tillage with N and P in the strip followed by using a planter with pop-up capability. That would be a fair comparison. Unfortunately for strip tillage advocates the increased potential for N loss, soil erosion, and weed problems would still exist.

The bottom line is that care needs to be taken when evaluating the results of these types of trials. Keep in mind the author may have a hidden bias. I have biases, but I try not to hide them. The attached report had at least one author that was biased toward strip tillage at the time it was written (it wasn’t me). As you read the report, you almost begin to believe that strip till won until you remember the cost of the trip and the extra P. Remember the Devil is in the Detail

SOIL/WATER RESEARCH
South Dakota State University
2002 Progress Report
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Strip Till and No-Till Influence on Corn Yield and Final plant stand in Northeast South Dakota.

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Introduction

Applying fertilizer nutrients for efficient use and uptake has been problematic with no-till. Extra equipment on no-till seeders such as coulters is required and can cause problems especially when the seeding operation needs to be timely. Strip-till is a modification of a no-till system and is primarily used in preparation for corn planting. In the fall, a strip for each row is tilled with a coulter/knife and covering discs are used to form a small mound. Fertilizer can be applied with the knife as liquid, dry, or anhydrous ammonia depending on the manufacturer of the equipment. This adds another field operation or replaces the broadcast application of fertilizer. Little is known about strip-till performance in South Dakota. Therefore a study was initiated on corn to determine the influence of P fertilizer management in the strip-till system, and compare strip-till to no-till.

Materials and Methods

A site for this study was located north of Brentford, SD. A composite soil sample of the site was analyzed and nutrient recommendations made for a 200 bu/a yield goal. Two strip-till and a no-till treatment were established. One of the strip-till treatments had 50 lbs P_2O_5/a applied along with the fall strip-till operation as mono-ammonium phosphate MAP (11-52-0). The other strip-till treatment had no fertilizer applied in the fall. Treatments were randomized in a complete block design with 4 replications. The strip-till operation was completed on November 1, 2001. All plots received 136 lbs. N/a during the late fall as broadcast surface applied urea (46-0-0). All plots were planted on May 1, 2002 and had 25 lbs. P_2O_5/a applied with the seed as 10-34-0. The hybrid was DK 44-46 and planted at a rate of 30,000 seeds/a. Plot size was 60 x 2640 ft or 3.6 acres. Final stand counts were taken from each plot. Whole plots were harvested with a combine and grain weights obtained from a weigh wagon.

Results and Discussion

Composite soil samples showed there was 115 lbs NO_3-N/a (0-2') and the Olsen phosphorus soil test was 4 ppm in the top six inches. The phosphorus soil test is considered to be "Low" and response to applied P is expected (EC-750). The starter fertilizer applied at planting was not shut off for the strip-till treatment that had received MAP during the fall and resulted in this treatment getting more P than the others (Table 1.) Treatment mean final plant stand and yields (Table 2) were very similar although there was a significant difference probably due to a very low coefficient of variation (CV=1.0 for yield and 2.9 for final plant stand). The CV is a measure of experimental error and is usually reduced by large plots. Errors during harvesting and weighing are not magnified as with small plots. Final plant stand was significantly different at the 0.10 level (Table 2). No-till final plant stand was significantly lower when compared to either strip-till treatment. This may reflect better seed bed conditions in the strip till plots. The grain yield of the no-till treatment was about 4 bu/a higher than that of the strip-till (ST2) when P rates were the same. More than 50 lbs of phosphorus may have been needed as the added P applied to ST1 produced a greater yield than the ST2 treatment (Table 2). It is difficult to determine tillage differences if nutrients were limiting in this study.

References

Gerwing, J. and R. Gelderman. June 2002. Fertilizer Recommendations Guide. EC-750. South Dakota Cooperative Extension Service

Acknowledgements

A special word of thanks to Max Williams for providing the equipment and land resources and to Monsanto for financial assistance.

Table 1. Nutrient rate and application timing for the strip-till and no-till study at Brentford SD, during 2002.

Treatment	Strip Till Timing	Nutrient Rate			Nutrient Timing	
		N	P_2O_5	K_20	N	P_2O_5
		------- lbs/a -------			---------- lbs/a, timing ----------	
ST1	Fall	154	77	0	146 Fall, 8 Spring	50 Fall, 27 Spring
ST2	Fall	144	27	0	136 Fall, 8 Spring	27 Spring
NT		144	27	0	136 Fall, 8 Spring	27 Spring

Table 2. Strip Till and No-till influence on corn final plant stand and yield at Brentford SD, during 2002.

Treatment	Final Plant Stand	Grain Yield
	no. / a	bu / a
ST1	29667	171.6 a
ST2	29125	165.6 b
NT	27917	169.4 a
LSD(.05)	--	3.0
LSD(.10)	1148	--
Pr > F	0.06	0.01