

NITROGEN FERTILIZER PLACEMENT WITH ZERO TILLAGE

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In order to practice zero tillage, farmers have fewer options with respect to fertilizer placement. This has led to a review of fertilizer placement techniques in order to determine efficient alternatives.

This study was set up to determine (a) the relative yield potential of zero till compared with conventional till, (b) the most efficient fertilizer placement technique, and (c) the soil water recharge over the winter period. A number of studies were carried out over a three year period at various locations in Saskatchewan (Fig. 1).

A. FERTILIZER NITROGEN STUDIES

There are three types of situations where zero till seeded crops are compared with conventional till seeded crops: (1) zero till on stubble versus conventional till on spring-worked stubble, (2) zero till on chemical fallow versus conventional till on summerfallow, and (3) zero till on stubble versus conventional till on summerfallow.

1. Zero till on stubble (ZT-Stb) versus conventional till on spring worked stubble (CT-Stb)

During 1983 fertilizer nitrogen response of wheat directly seeded into stubble (ZT-Stb) was compared with that of wheat seeded into spring-worked stubble (CT-Stb). Tillage was per-

formed with a Howard rotovator to a depth of 3 inches. Seeding was carried out with a precision press drill (Fabro, Swift Current). Fertilizer urea (46-0-0) was sidebanded between each seed row at 3-4 inch depth during the seeding operation. Phosphate as monoammonium (11-51-0 @ 30 kg P₂O₅/ha) was seed-placed.

Crop yields for the plots located in the Brown, Dark Brown and Black soil zones are shown in Figures 2, 3 and 4. In the Brown soil zone, yields between ZT-Stb and CT-Stb were similar except at Viceroy, where CT-Stb had resulted in higher yields. In the Dark Brown soil zone yields between ZT-Stb and CT-Stb were similar except at Weyburn, where ZT-Stb resulted in higher yields possibly because of better soil water conservation. In the Black soil zone yields were again similar except at Waldheim.

In summary, spring tillage did not result in any major differences in crop yield when compared with zero tillage. Results from ten sites in the Brown, Dark Brown and Black soil zones indicate seven cases where yields between spring tillage and zero tillage were the same, two cases where yields were higher following spring tillage, and one case where yields under zero tillage were higher.

2. Zero till on chemical fallow (ZT-cf) versus conventional till on summerfallow (CT-smf)

A fertilizer nitrogen placement study was initiated in 1981 at Drinkwater. Winter wheat was grown on 5th year zero till which had been chemical fallowed (ZT-cf) and was also grown on an adjacent summerfallow field (CT-smf). Soil conditions by the spring of 1982 were quite similar between the two fields (Table

1). Soil moisture levels were approaching saturation (95% for ZT-cf and 90% for CT-smf), to the level where soil aeration is limited. Yields of winter wheat on ZT-cf were significantly lower than that seeded on CT-smf. It is possible that the high soil moisture levels in spring have restricted both soil warming and soil aeration on the ZT-cf more than on the CT-smf due to the trash cover. Fall seedplaced nitrogen fertilizer and winter broadcast N were the least effective methods of fertilizer N placement. Spring broadcast and fall deepband N were the most effective N placement methods. The high soil moisture levels in spring are likely responsible for the success of the spring broadcast method, providing a means for translocating fertilizer N to the root zone.

3. Zero till on stubble (ZT-stb) versus conventional till on summerfallow (CT-Smf)

In many areas zero till farmers are also practicing continuous cropping, while their neighbors are using rotations of crop-summerfallow or crop-crop-summerfallow. The result is that continuous crop zero till is often compared with a conventional till crop on summerfallow. Two soil conditions are most likely to be different between the ZT-Stb and the CT-smf; soil moisture and soil available nitrogen levels. During 1982 a fertilizer N placement study was initiated at Leipzig. Spring wheat was seeded on 4th year zero till stubble (ZT-Stb), and was also seeded on an adjacent summerfallow field (CT-smf). Spring soil moisture levels were similar between ZT-Stb and CT-smf, which is attributable to successful snow trapping (see part B of this

paper). There was twice as much plant available nitrogen in the CT-smf field at seeding than in the ZT-Stb field (Table 2). Consequently crop yields where no fertilizer nitrogen had been added were higher on the CT-smf. However where fertilizer N had been applied, yields of ZT-Stb were equal to the yields on CT-smf. Differences between fertilizer N placement methods were small.

During 1983 another fertilizer N placement study was initiated at Kindersley. Spring wheat was seeded on 5th year zero till stubble (ZT-Stb) and on adjacent summerfallow (CT-smf). Soil moisture levels between ZT-Stb and CT-smf were similar, which was attributable to better soil water conservation (see part B of this paper). There was twice as much plant available N in the CT-smf compared with the ZT-Stb at seeding (Table 3). Crop yields were substantially higher under CT-smf in the case where no fertilizer N had been applied, which is attributable to the higher spring soil N levels. Wheat yields of ZT-Stb were equal to yields of CT-smf where fertilizer N placement had been effective. Spring broadcast N was the least effective method of fertilizer N application. The long dry spell that followed seeding probably prevented much of the broadcast N to be translocated to the root zone. Spring sidebanded N was a very effective method under both tillage systems. Deepbanding was a good alternative method, with spring deepbanding resulting in greater yield increases than fall deepbanding. Double shooting N+P in a deepband in the spring was also a good alternative. Spring sidebanding or deepbanding when resulting in substantial soil

disturbance, may result in higher losses of soil moisture due to evaporation. Consequently, deepbanding operations in the spring on dry soils may give poor results.

B. SOIL MOISTURE RECHARGE OVER THE WINTER PERIOD

During the winter of 1982-83 soil moisture contents were monitored at Leipzig and Kindersley. It involved comparing a stubble field which had been in zero till for 4 years with a summerfallow field. Soil moisture was measured throughout the fall-winter-spring period with a neutron probe. Depth of snow was recorded during the winter months (Fig. 5).

At Leipzig the stubble field gained 3.5 inches (8.8 cm) of water in the soil profile, while the summerfallow field only gained 2 inches (5.2 cm). The total snow pack was 12 inches. The difference in snow trapping meant that the difference in soil moisture content between the stubble and summerfallow had been reduced from 4 inches in the fall to 2.6 inches by seeding time.

At Kindersley the stubble and summerfallow fields each gained 3.3 inches (8.4 cm) in soil moisture by late March (total snow pack was 10 inches). By seeding time each field had lost some of its gained moisture, the stubble field lost 1.5 inches and the summerfallow field lost 3 inches of soil moisture. The period after snowmelt and before seeding at Kindersley was 1.5 months characterized by strong dry winds. The stubble field was thus more effective in conserving the soil moisture that was gained from snowmelt infiltration.

In summary, it was shown that soil moisture recharge under

zero till stubble conditions is superior to conventional till summerfallow conditions due to (a) better snow trapping and (b) better conservation of soil moisture during the period after snowmelt and before seeding.

3. CONCLUSIONS

The practice of zero till cropping was compared with conventional till cropping on a number of sites located throughout the agricultural region of Saskatchewan. The comparisons were: (a) zero till on stubble versus conventional till on spring-worked stubble; (b) zero till on chemical fallow versus conventional till on summerfallow; and (c) zero till on stubble versus conventional till on summerfallow. The major results are:

1. Crop yields of zero till fields were equal to crop yields of conventional till fields where there were no differences in soil moisture and soil nitrogen.
2. Conventional till seeded crops on summerfallow had higher yields than zero till seeded crops on stubble when soil available nitrogen levels and/or soil moisture levels were higher on summerfallow.
3. Snow trapping and soil water conservation was better under stubble than under summerfallow. This can therefore reduce differences in soil moisture levels between zero till seeded crops on stubble and conventional seeded crops on summerfallow.
4. Fertilizer N placement was critical under zero till. With banded fertilizer N placement zero till resulted in the same

yields as conventional till where soil moisture levels were similar.

5. Under wet soil conditions winter broadcast was not an effective method of fertilizer N placement, whereas spring broadcast N was quite effective.
6. Under dry soil conditions, followed by a dry spring, spring broadcast was not an effective method of N placement. Spring seedplaced, sidebanded or deepbanded N gave good results. Care must be taken to avoid excessive soil disturbance during spring deepbanding operations in order to conserve soil moisture.
7. Fall deepbanded N was less effective than spring deepbanded N. Double shooting N+P as a deepband was not as effective as seedplaced P and sidebanded N.

Table 1. 1982 winter wheat as 5th year zero till.

Fertilizer treatment	Rate of fertilizer N applied* (lbs/acre)	Yield (bu/acre)	
		Zero till	Conv. till
Control	0	37 a,b	53 e
Broadcast	Fall	60	44 b
	Winter	60	35 a
	Spring	60	48 d
Deepband	Fall	60	48 d
Seed-placed	Fall	60	39 a,b,c
			52 e

Note - Fertilizer phosphorus was applied as 11-48-0 with the seed.

* Applied as urea (46-0-0).

a-e Similar letters in vertical columns show values that are not statistically different.

BACKGROUND INFORMATION:

Tom Mann, Drinkwater, Sask.

Soil: Regina heavy clay

Previous crop: Zero till = chemical fallow
Conventional till = summerfallow

Spring soil conditions:

Moisture to 4 ft: zero till = 21 inches
conventional till = 20 inches

NO₃⁻-N to 2 ft: zero till = 80 lbs/ac
conventional till = 80 lbs/ac

Saskatchewan Soil Testing Lab recommendations:

Zero till = 20 lbs of N, 25 lbs of P₂O₅
Conventional till = 20 lbs of N, 25 lbs of P₂O₅

Rainfall during growing season: 3.2 inches

Table 2. 1982 spring wheat as 4th year zero till.

Fertilizer treatment	Rate of fertilizer N applied* (lbs/acre)	Yield (bu/acre)	
		Zero till	Conv. till
Control	0	28 a	36 d
Broadcast	Fall	37 b,c	41 e
	Winter	40 c	40 e
	Spring	35 b	48 f
Deepband	Fall	37 b,c	44 e
	Spring	40 c	41 e
Seed-placed	Spring	40 c	43 e

Note - Fertilizer phosphorus was applied as 11-48-0 with the seed.

* Applied as urea (46-0-0).

a-f - Similar letters in vertical columns show values that are not statistically different.

BACKGROUND INFORMATION:

Ed Keller, Leipzig, Sask.

Soil: Weyburn loam

Previous crop: Zero till = wheat
Conventional till = fallow

Spring soil conditions:

Moisture to 4 ft: zero till = 11.4 inches
conventional till = 10.6 inches

NO₃⁻-N to 2 ft: zero till = 29 lbs/ac
conventional till = 68 lbs/ac

Saskatchewan Soil Testing Lab recommendations:

Zero till = 50 lbs of N, 40 lbs of P₂O₅
Conventional till = 10 lbs of N, 35 lbs of P₂O₅

Rainfall during growing season: 7.5 inches

Table 3. 1983 spring wheat as 5th year zero till.

Fertilizer treatment	Rate of fertilizer N applied* (lbs/acre)	Yield (bu/acre)	
		Zero till	Conv. till
Control	0	15 a	31 i,j
Broadcast	Fall	29 b	28 g,h
	Winter	30 b,c	29 h,i
	Spring	24 e	23 f
Deepband	Fall	29 b	32 j
	Spring	31 b	38 l
Sideband	Spring	34 d	41 m
Double shoot N + P:			
Fall deepband	60	29 b	28 g,h
Spring deepband	60	32 c,d	35 k

Note - Fertilizer phosphorus was applied as 11-48-0 with the seed (30 lbs P₂O₅).

* Applied as urea (46-0-0).

a-m Similar letters in vertical columns show values that are not statistically different.

BACKGROUND INFORMATION:

Drew McBain, Kindersley, Sask.

Soil: Kindersley clay loam

Previous crop: Zero till = wheat
Conventional till = summerfallow

Spring soil conditions:

Moisture to 4 ft: zero till = 10.7 inches
conventional till = 11.5 inches

NO₃⁻-N to 2 ft: zero till = 39 lbs/ac
conventional till = 71 lbs/ac

Saskatchewan Soil Testing Lab recommendations:

Zero till = 47-75 lbs of N, 39 lbs of P₂O₅
Conventional till = 26-41 lbs of N, 34 lbs of
P₂O₅

Rainfall during growing season: 8.5 inches