# FERTILIZER PLACEMENT IN FALL STRIP TILLAGE

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## Abstract

Fall strip-tillage potentially provides an opportunity to increase conservation-till corn yields while simplifying corn planters by minimizing the need for multiple coulters and application of relatively high rates of starter-band fertilizer associated with no-till. However, little is known about the relative efficiency of P and K application using fall strip-till systems compared to when starter-band applied in no-till systems. The objectives of the research reported in this study were to evaluate 1) the ability of fall strip-till systems to increase conservation-till corn yields and 2) determine if fall banded P and K fertilizer in fall strip-till systems can improve conservation-till corn yields when compared to planter applied P and K fertilizer. Corn yield response to tillage was minimal on sites with sufficient soil K levels implying that adequate availability of P and K will minimize yield differences among tillage systems. However, on sites with a requirement for K fertilizer, conventional-till yields were higher than either fall strip-till and no-till systems with the size of yield difference greater where P and K fertilizer was not applied. On sites were planter applied P and K resulted in no additional corn yield neither did deep-placed P and K in the fall within the strip tillage system. On sites with moderate requirement for K fertilizer, fall banding P and K fertilizer provided yields similar to those obtained with no-till where P and K was planter applied. However, on sites with a large requirement for K fertilizer, fall application of P and K fertilizer was not sufficient to maximize yields regardless of the placement/tillage technique.

## Introduction

Fall strip-till systems for corn production have received increasing attention in Ontario because of research reports which suggest that the yield limitations associated with no-till can be eliminated by restricting tillage to the immediate row area (i.e. strip tillage) (Vyn and Raimbault, 1992; Opoku et al., 1997; Hooker and Vyn, 2000). Furthermore, strip-tillage has been promoted as a means to band apply P and K fertilizers deeper in the soil profile where their availability, and(or) efficiency of use, may be improved compared to where they are broadcast applied in tillage systems with limited soil mixing (Rehm, 1995; Bordoli and Mallarino, 1998).

Fall strip-till systems usually produce a zone of loosened soil 4" to 8" wide into which the crop rows are to be planted. The in-row seedbed environments of strip-till systems are often described as having lower spring residue cover, warmer spring soil temperatures, drier spring moisture contents and lower mechanical impedance when compared to no-till systems (Vyn and Raimbault, 1992; Opoku et al., 1997; Hooker and Vyn, 2000). Recent Ontario research has shown that fall strip-till, systems because of faster spring soil drying rates can result in an opportunity to start planting earlier than no-till thereby increasing the likelihood of late April or early May planting (Univ. of Guelph, Unpublished data); which in northern production regions has been shown as the planting date period which maximizes yield potential (Lauer et al., 1999).

Application of some fertilizer located close to the seed as part of a starter fertilizer is generally accepted as often increasing corn yields in northern production regions; even if soil test P and(or) K levels are high (eg. Vetch and Randall, 2002). On soils with medium soil test K levels, inclusion of about 50 lbs/ac of K as part of a starter fertilizer has been shown to increase no-till corn yield (Vyn and Janovicek, 2001; Yibirin et al., 1993).

Adoption of no-till systems has been hampered, in part, because of the complexity associated with no-till planters equipped with multiple coulters and row cleaners as well as the application of relatively high volumes of dry and(or) liquid fertilizers. Fall strip-till systems offer the potential to simplify no-till corn planters by reducing the need for planter attachments as well as providing an opportunity to effectively replace planter applications of P and K with fall banding. However, little information is available which provides a comparison of fall vs. spring application of P and K banded fertilizers in conservation-till systems. The objectives of the research reported in this paper are to evaluate 1) the ability of fall strip-till systems to increase conservation-till corn yields and 2) determine if fall banded P and K fertilizer in fall strip-till systems can provide similar (or higher) conservation-till corn yields when compared to planter applied P and K rates.

## Materials and Methods

Corn yield response to timing and placement of P and K fertilizer summarized in this paper were conducted on nine field sites located in West-Central Ontario during 2001 to 2003. The growing season is rated at 85 to 95 Relative Maturity Days.

Prior to application of fall fertilizer and tillage, soil-test P and K levels in the surface 6" were determined using Ontario Ministry of Agriculture and Food (OMAF) accredited procedures (OMAF Staff, 2002). Ontario accredited soil test for plant available P is based on extraction using Sodium Bicarbonate and soil-test K is based on extraction using Sodium Acetate.

At each site, corn yield response to placement and timing of P and K fertilizer was evaluated for three tillage systems with the placement of fall applied fertilizer differing among tillage systems. The tillage systems, and associated placement of fall fertilizer, are described as follows:

1) Conventional tillage (Fall Plow): Fall moldboard plowing to a depth of 6 - inches with two passes of spring secondary tillage. Fall fertilizer was broadcast on the soil surface shortly before plowing.
2) Fall Strip-tillage (Fall Strip): Fall tillage was confined to strips approximately 8 inches wide on 30 inch centres. A modified Trans-till (Row-tech, Snover MI) was operated at a depth of 6-8 inches. The Trans-till applied fall fertilizer at a depth of 6 inches in the centre of the tilled strip.
3) No tillage (No-till): No tillage occurred. Fall fertilizer was broadcast on the soil surface.

Tillage system plots were split in order to evaluate two fall fertilizer treatments, which were 1) fall fertilizer not applied and 2) fall fertilizer applied. The same rates of fall P and K were applied to all tillage systems within a site. However, actual rates did vary across sites and are described in greater detail in Table 1.

The fall fertilizer plots were also split in order to evaluate two planter-banded treatments which were 1) N only applied as U.A.N and 2) a combination of N applied as U.A.N plus a band of dry fertilizer containing P and K. The rate of starter N was 30 lbs/ac for both starter treatments at all sites. The rate of starter P and K was the same for all tillage and fall fertility treatments within a site, but actual rates of P and K did vary across sites and are described in Table 1.

Corn at all sites was planted in 30" rows at a seeding rate of 30,000 seeds/ac. The planter was equipped with unit-mounted tine row cleaners and a single disk fertilizer opener positioned to deliver starter dry fertilizer 2 inches below and 2 inches beside the seed. This same opener was also designed to apply the U.A.N. in the same band as the dry fertilizer.

Appropriate weed control measures were used at each site which ensured that yields were not affected by the presence of weeds. Supplemental N was sidedressed applied as U.A.N., when corn was at the 7 to 9 leaf stage, to ensure that the total rate of applied N at each site was at least 150 lbs/ac. Grain corn yields were calculated to 15.5% moisture.

Table 1. Experimental site details.

| Field Group | Number of site/years | Fall Fertilizer | Planter Fertilizer | P Soil Test (ppm) | K Soil Test (ppm) | Soil texture |
|---|---|---|---|---|---|---|
| | | P @ lbs/ac ($P_2O_5$)<br>K @ lbs/ac ($K_20$) | | | | |
| Wellington | 3 | P: 42 | P: 30 | 15 - 21 | 127 – 145 | Loam |
| | | K:100 | K: 30 | | | |
| | | | | | | |
| Ancaster | 3 | P: 43 | P: 30 | 15 - 18 | 75 – 111 | Silt loam |
| | | K: 100 | K: 30 | | | |
| | | | | | | |
| Alma A | 2 | P: 43 | P: 31 | 20 - 25 | 75 – 86 | Silt loam |
| | | K: 100 | K: 31 | | | |
| | | | | | | |
| Alma B | 1 | P:62 | P: 31 | 16 | 58 | Silt loam |
| | | K:62 | K: 31 | | | |

## Results

Yield response to tillage and P and K fertilizer at the various experimental sites fall into three groups which are related to their soil test values. The groupings and their associated soil test values for P and K are presented in Table 1.

### Sites with Minimal Yield Response

Yields at the Wellington sites were not affected by tillage or by the addition of P and K fertilizers (Table 2). Deep placing P and K within the zone tillage system did not result in higher corn yields than more traditional timing or placement methods. At each of the Wellington sites corn was planted following winter wheat and soil test values (Table 1) recommend application rates of 20 lbs-$P_2O_5$/ac and 0 lbs-$K_2O$/ac (OMAF Staff, 2002). The results of this study were consistent with the results of an earlier Ontario study where tillage and K fertilization did not affect yield of corn planted following winter wheat when soil-test K levels were high (Vyn and Janovicek, 2001).

Table 2. Impact of placement and timing of P and K fertilizer on grain corn yields for 3 tillage systems on loam soils following winter wheat. Average of three experiments. Wellington, 2001-2002.

| Tillage | | Fall Fertilizer | | Planter Fertilizer | |
|---|---|---|---|---|---|
| Treatment | Yield | Treatment | Yield | Treatment | Yield |
| Fall Strip | 134 | None | 132 | N only | 131 |
| | | | | N.P,K | 133 |
| | | P and K | 135 | N only | 137 |
| | | | | N,P,K | 133 |
| Fall Plow | 144 | None | 146 | N only | 147 |
| | | | | N.P.K | 145 |
| | | P and K | 142 | N only | 139 |
| | | | | N,P.K | 145 |
| No-till | 143 | None | 141 | N only | 139 |
| | | | | N,P,K | 142 |
| | | P and K | 145 | N only | 143 |
| | | | | N,P.K | 147 |
| LSD (.10) | Ns | | Ns | | Ns |
| Averages | 140 | None | 140 | None | 139 |
| | | P and K | 141 | N.P.K | 141 |
| LSD (.10) | - | | Ns | | Ns |

Note: Standard Error of Tillage by Fall Fertilizer by Spring Fertilizer yields is 3.4.

**Sites with Moderate Yield Response**

Yields at the Ancaster and Alma A sites were affected by tillage and application of P and K fertilizer (Table 3 and 4). At each of these sites corn was planted following soybeans and soil test values (Table 1) recommended application rates, on average, which were 20 lbs-$P_2O_5$/ac and 50 lbs-$K_2O$/ac.

The Ancaster sites took a "systems" approach and compared only two of the possible four fertilizer options which were 1) P and K applied only in the fall (no starter P and K) and 2) P and K applied only in the starter band (no fall applied P and K) (Table 3). Yields were generally higher in the Fall Plow system, regardless of the timing of P and K fertilizer application. In the Fall Strip system, fall applied P and K fertilizer produced yields similar to those obtained when P and K were applied in the starter-band. Also, No-till corn yields were lower where P and K was fall broadcast applied compared to where P and K fertilizer was starter-banded.

The Alma A sites also demonstrated that fall application of P and K fertilizer could provide yield increases similar to those obtained with P and K applied through the planter (Table 4). In general, P and K applied through the planter increased yields in all three tillage systems, but the size of yield response was significant only within Fall Strip and No-till systems. Fall application of P and K fertilizer in the Fall Strip system (no starter P and K) produced yields similar to those obtained in the No-till system with P and K applied as part of the starter fertilizer (no fall applied P and K).

Table 3. Impact of placement and timing of P and K fertilizer on grain corn yields for 3 tillage systems on a silt loam soil following soybeans. Average of three experiments. Ancaster, 2001-2003.

| Tillage | Fertilizer Strategy | Yield |
|---|---|---|
| Fall Strip | Fall - P and K; Planter – N only | 120 |
| | Fall – none; Planter – N,P,K | 120 |
| Fall Plow | Fall - P and K; Planter – N only | 126 |
| | Fall – none; Planter – N,P,K | 133 |
| No-till | Fall - P and K; Planter – N only | 109 |
| | Fall – none; Planter – N,P,K | 117 |
| LSD (.10) | | 7.1 |

Table 4. Impact of placement and timing of P and K fertilizer on grain corn yields for 3 tillage systems on a silt loam soil following soybeans. Average of two experiments. Alma A, 2001-2002.

| Tillage | | Fall Fertilizer | | Planter Fertilizer | |
|---|---|---|---|---|---|
| Treatment | Yield | Treatment | Yield | Treatment | Yield |
| Fall Strip | 143 | None | 138 | N only | 133 |
| | | | | N,P.K | 142 |
| | | P and K | 147 | N only | 143 |
| | | | | N,P,K | 150 |
| Fall Plow | 145 | None | 146 | N only | 144 |
| | | | | N,P.K | 147 |
| | | P and K | 143 | N only | 140 |
| | | | | N,P,K | 145 |
| No-till | 141 | None | 142 | N only | 136 |
| | | | | N,P,K | 147 |
| | | P and K | 141 | N only | 137 |
| | | | | N,P,K | 144 |
| LSD (.10) | Ns | | 5.7 | | 6.5 |
| Averages | 142 | None | 142 | N only | 138 |
| | | P and K | 144 | N,P,K | 145 |
| LSD (.10) | - | | Ns | | 3.8 |

**Sites with Large Yield Response**

The Alma B site had dramatic yield responses to tillage and application of P and K fertilizer (Table 5). Corn on this site was planted following soybeans and the soil test P and K levels recommend application rates of 20 lbs-$P_2O_5$/ac and 100 lbs-$K_2O$/ac (OMAF Staff, 2002). In general, yields in the Fall Plow were higher than in either the Fall Strip or No-till systems. Yield differences among tillage systems were particularly large when P and K was not applied. Both fall and starter application of P and K fertilizer significantly increased yields in all tillage systems. Yields in the Fall Strip system where P and K was applied only in the fall did not produce yields as high as those obtained in the No-till system where P and K was applied only in the starter-band.

Table 5. Impact of placement and timing of P and K fertilizer on grain corn yields for 3 tillage systems on a silt loam soil following soybeans. Alma B, 2003.

| **Tillage** | | **Fall Fertilizer** | | **Planter Fertilizer** | |
|---|---|---|---|---|---|
| Treatment | Yield | Treatment | Yield | Treatment | Yield |
| Fall Strip | 87 | None | 66 | N only | 16 |
| | | | | N,P,K | 116 |
| | | P and K | 108 | N only | 91 |
| | | | | N,P,K | 125 |
| Fall Plow | 121 | None | 106 | N only | 80 |
| | | | | N,P,K | 132 |
| | | P and K | 135 | N only | 125 |
| | | | | N,P,K | 144 |
| No-till | 88 | None | 73 | N only | 33 |
| | | | | N,P,K | 113 |
| | | P and K | 102 | N only | 72 |
| | | | | N,P,K | 131 |
| LSD (.10) | 19.8 | | 15.9 | | 16.8 |
| Averages | 99 | None | 82 | N only | 43 |
| | | | | N,P,K | 120 |
| | | P and K | 115 | N only | 96 |
| | | | | N,P,K | 133 |
| LSD (.10) | - | | 9.2 | | 9.7 |

## Summary

The major observations and associated conclusions of this study are summarized as follows:

1. Corn yields were not affected by tillage or by application of P and K fertilizer on sites with soil test K levels sufficiently high such that application of K fertilizer is not recommended. This implies that on soils were planter applied P and K result in no additional corn yield that deep placement of P and K within a strip tillage also may not increase corn yield.
2. On sites where soil test recommended about 50 lbs/ac of K, fall application of P and K fertilizers produced yields similar to those obtained with no-till where P and K was starter-banded. This implies that on sites with a moderate requirement for P and K application that P and K requirements of conservation-till corn may be effectively met by fall banding P and K fertilizers in a fall strip-till system.
3. When the requirement for K fertilizer was high, applying P and K fertilizers only in the fall did not maximize corn yields. The requirement for P and K applications through the planter was not removed by placing the fall P and K in a band within the strip tillage system. On soils with a relatively large requirement for K (or P) fertilizer optimizing corn

yields may require the application of P and K fertilizers in the fall as well as in the planter band, particularly in reduced tillage systems.


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