TILLAGE AND NITROGEN APPLICATION METHODOLOGY AFFECTS CORN GRAIN YIELD

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Introduction

More efficient use of fertilizer nitrogen (N) is essential for improved yields and environmental stewardship. While university N recommendations for corn are based on observations typically made in conventional tillage systems, few universities have established research to evaluate if N recommendations should be different for alternative tillage systems. Generally speaking, no-till or minimum tillage systems have been identified as needing additional N to compensate for microbial immobilization of applied N. While this certainly is the case for surface broadcast applications, sub-surface placement of N should minimize the impact of residue located on the soil surface. Sidedress applications may also improve N use efficiency (NUE) due to improved competitiveness of the plant with the microbial population. Surface application of urea-based N fertilizers may also be subject to ammonia volatilization losses in reduced tillage systems due to the plant residue left on the soil surface. Increased fuel costs have caused some producers to consider a single application of N early in the growing season to eliminate a pass from their operations.

Objectives

The objective of the conducted research was to evaluate the effects of and the interaction between tillage and timing of nitrogen application on corn grain yield.

Materials and Methods

The experiment was located at the Northwest Experiment Station near Hoytville, OH. A randomized complete block design was employed with four replications. Plot size was 10 ft (4-30 inch rows) x 70 ft. Six different tillage methods were evaluated with no N applied, N applied near planting as a weed 'n' feed (urea-ammonium nitrate (UAN-28-0-0)) at 150 lb N/ac), and N split applied between starter (20 lb/ac) and sidedress at V4-6 (130 lb/ac) in a complete factorial arrangement. Triple superphosphate (0-46-0) and potash (0-0-61) were applied every fall after soybean harvest at rates of 100 and 200 lb/acre, respectively, to ensure they were not limiting crop growth. Tillage methods evaluated were no-till, early planted strip till, normal planted strip till, Aer-way tillage tool, zone-deep till, and disk-field cultivator. All tillage was conducted in the fall after soybean harvest. The treatments for tillage and nitrogen application were evaluated for four years from 2002 to 2006. Nitrogen applied prior to planting was broadcast surface applied representing a weed and feed application. Nitrogen applied at sidedress was coulter injected mid-row as UAN. Grain yield was collected by harvesting the two center rows at physiological maturity. Statistical analysis was performed using PROC GLM to determine treatment differences.

Results and Discussion

There was a significant interaction between tillage and timing of N application in 2004 and 2005, thus main effects will only be discussed for 2002 and 2003.

Corn yields in 2002 were poor due to low rainfall conditions throughout the summer months (Table 1 & Figure 1). The conventional tillage (disk/field cultivator) treatment had higher yields than the no-till, Aer-way, and zone builder treatments in 2002 (Table 1). Corn grain yield was improved with N fertilization, but yield improvements were minimal due to dry conditions and no differences could be determined between nitrogen application methodologies (Table 2).

Average monthly rainfall amounts over 4 inches between May and September resulted in excellent corn grain yields in 2003 (Table 1 and Figure 1). Corn grain yield was impacted by tillage as the no-till and zone builder treatment resulted in higher yields than the two strip-till treatments (Table 1). There was a significant response to N application in 2003, and the split application of N between planter applied starter and sidedress resulted in over 37 more bu/acre than the weed 'n' feed application (Table 2). The difference in corn grain yield may be explained by ammonia volatilization losses associated with surface applications of a urea-based N fertilizer or the timing differences between the weed 'n' feed and split application. Split application of N may not have been subject to other loss mechanisms such as denitrification or leaching like the early weed 'n' feed application of N. It may also be a combination of the two.

A significant interaction was noted in 2004, thus only simple effects will be discussed. The primary cause of the interaction was the performance of the conventional tillage treatment relative to the conservation tillage treatments (Table 3). Nitrogen application methodology (weed 'n' feed versus split) did not affect corn grain yield within the conventional tillage treatment (disk/field cultivator), but the conservation tillage treatments had lower yields due to the surface broadcast application of UAN. This could be due to low rainfall amounts after application of the weed 'n' feed treatment that resulted in greater ammonia volatilization with the presence of surface residue. Another plausible explanation was the increase in nitrogen mineralization due to tillage. This is reflected in the significantly higher yield of the zero N treatment of the disk/field cultivator treatment compared to the zero N treatments associated with conservation tillage.

In 2005, a significant interaction was also observed between tillage and nitrogen application timing hence only simple effects will be discussed. The cause of the interaction was the yield difference between the weed 'n' feed N application and the split application within the no-till treatment (Table 3). Application of N as a weed 'n' feed resulted in 9 less bu/acre compared to the split application of N. This may be due to the presence of surface residue that promoted ammonia volatilization. The lack of yield differences between the different N application methodologies may be due to the rainfall event that occurred shortly after UAN application decreasing the risk of ammonia volatilization. The strip-till early planting treatment performed significantly worse than the other tillage treatments due to wet weather after the application of N. The wet weather apparently only affected nitrogen application methodology (weed 'n' feed and split not the zero N) suggesting that the yield depression was due to N loss and not a yield loss due to the cold and wet weather experienced in early May.

Conclusions

Producers applying their entire N budget as a broadcast surface application of UAN are taking considerable risk of yield loss if environmental conditions are less than ideal. In two of the four years of this study, application of broadcast UAN resulted in yield losses compared to split applications. One year did not show a difference due to dry conditions throughout the growing season and the other year had a rainfall event shortly after the broadcast application decreasing the chances of ammonia volatilization. Conventional tillage systems may reflect a lower risk of yield loss because of less surface residue, but the effect cannot be completely isolated within this study because of the higher apparent mineralization associated with the disk/field cultivator treatment. Split applications of nitrogen are a lower risk than surface broadcast applications of UAN.

Acknowledgements

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Table 1. Main effect of tillage on corn grain yield in 2002 and 2003.

Tillage	Grain yield, bu/acre	
	2002	2003
Aerway	56	164
Disk/field cultivator	73	169
No-till	53	175
Strip-till (early planting)	62	156
Strip-till (normal planting)	61	150
Zone builder	54	170
$LSD_{(0.10)}$	13	14

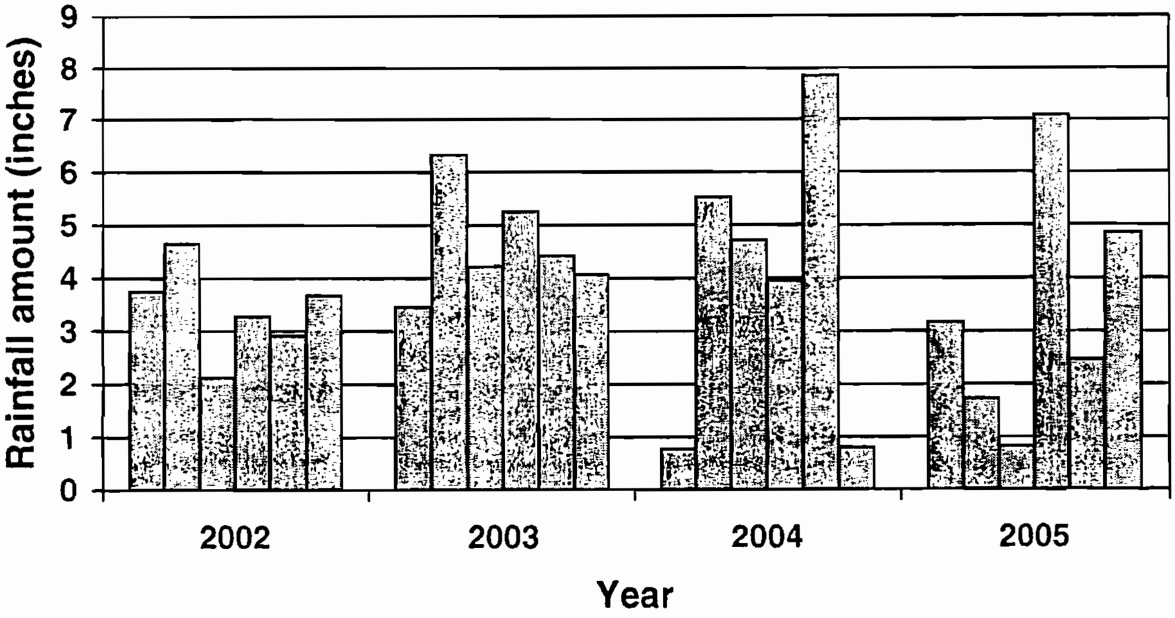
Table 2. Main effect of nitrogen application timing on corn grain yield in 2002 and 2003.

Nitrogen application timing	Grain yield, bu/acre	
	2002	2003
No N applied	43	76
Weed 'n' feed	69	185
Split	66	222
$LSD_{(0.10)}$	5	6

Table 3. Simple effects of tillage and nitrogen application timing on corn grain yield in 2004 and 2005.

Tillage	N application timing	Grain yield, bu/acre 2004	2005
Aerway	No N applied	97	105
	Weed 'n' feed	154	168
	Split	174	168
Disk/field cultivator	No N applied	119	106
	Weed 'n' feed	169	172
	Split	176	172
No-till	No N applied	90	105
	Weed 'n' feed	150	166
	Split	173	175
Strip-till (early planting)	No N applied	98	95
	Weed 'n' feed	153	132
	Split	186	134
Strip-till (normal planting)	No N applied	91	96
	Weed 'n' feed	160	162
	Split	180	164
Zone builder	No N applied	91	88
	Weed 'n' feed	150	159
	Split	164	167
$LSD_{(0.10)}$ – different subplots within main plots		11	9
$LSD_{(0.10)}$ – different subplots across main plots		15	11

Figure 1. Monthly (April-September) rainfall for the growing seasons 2002-2005.



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