STRIP TILLAGE AND NO TILLAGE FERTILIZATION SYSTEMS EVALUATED FOR EASTERN KANSAS RAIN-FED CORN

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Introduction

Row-crop agriculture in East-Central and Southeast Kansas is facing increasing pressure to reduce sediment and nutrient losses via runoff. Edge-of-field measurements show that no-tillage with fertilizers placed below the surface of the soil has significantly less sediment and total P losses in runoff compared to conventional tillage (Janssen et al., 2000). However, for rain-fed corn, no-tillage in these regions can provide serious challenges some years because of frequent spring rains and an abundance of imperfectly drained soils. The increased residue and the slower soil drying conditions associated with no-tillage can keep no-till fields cooler and wet longer in the spring and that can delay planting and reduce early-season root development, nutrient uptake, and corn growth. Rain-fed corn which makes up greater than 90% of the corn acreage in East-Central and Southeast Kansas must be planted early (middle March - early April) and grow quickly to produce grain before hot and dry conditions occur in the middle to later part of July. Any delay in corn planting or slowed corn development can delay the critical tassel-silk-pollination period for corn and move it into the hottest and driest part of the corn growing season, and that can have serious negative effects on corn yield. Application of starter fertilizers or placement of fertilizers close to the seed row can offset some of the reduced early-season corn growth with no-till (Niehues et al., 2004), but delays in planting, lower plant populations, and the inconveniencies associated with the application of fertilizers at planting-time remains a deterrent to planting corn no-till. Presently, there is less than six percent of the total corn acreage in East-Central and Southeast Kansas planted using no-till practices (Conservation Technology Information Center, 2005 Survey).

Strip-tillage, on the other hand, is a compromise conservation tillage system. It is a system that includes some tillage, but only in narrow strips where the seed rows are to be planted. Row middles are left untilled. The tilled rows provide a loosened raised, seedbed, which improves planter performance and provides improved early-season seedbed drainage, warming, and drying. By planting time, the tilled zone usually settles down to 1 to 2 inches high, and after planting the field is level. Strip-tillage would seem to be beneficial for eastern Kansas corn production.

The objectives of this study were (1) to compare the performance of strip-tillage using different fertilizer timing and placement methods with no-till in which all of the fertilizers were applied 2.5" x 2.5" from the seed row at planting or all pre-plant deep-banded, and (2) to access the effects of fall strip-till with fall applied fertilizer verses fall strip-till and planting time or fall strip-till with a combination of fall and planting time applications of N-P-K-S fertilizers on the establishment, growth and grain yield of corn.

Materials and Methods

This field study was conducted at the Kansas State University, East Central Experiment Field near Ottawa, KS from 2003 to 2005 on a somewhat poorly drained Woodson silt loam soil. The field site prior to beginning this study had been managed no-till for five years. The dates in which the tillage and fertilizer treatments were established each year are shown in Table 1 (Note that the fall strip-tillage operation in 2005, because of a wet fall, was not performed until spring). The tillage/fertilization treatments were arranged in a randomized complete block experiment design with four replications. The crop preceding the 2003 corn study was corn and the crop preceding the 2004 and 2005 corn plantings was soybean. Burn-down herbicide was applied for pre-plant weed control each year and consisted of1qt/a atrazine 4L + 0.66pt/a 2,4-D LVE + 1 qt/a COC. Pioneer 35P12 corn was planted all three years on April 10, 2003, April 15, 2004, and April 13, 2005. Seed drop was 23,500 seeds per acre. Pre-emergence herbicide containing 0.33 qt/a atrazine 4L + 1.33 pt/a Dual II Magnum were applied at planting. The effect of the treatments on corn plant populations were determined by counting all plants in the center two rows of each plot, each year, after all plants emerged. Whole-above-ground corn plants (six randomly selected plants from non-harvest rows in each plot) were collected at the 6-leaf growth stage to measure tillage and fertilization treatment effects on early-season corn growth. Grain yields were measured each year by machine harvesting the center two rows of each 4-row, 10 ft wide x 40 ft long plots. Harvest was August 28, 2003; September 10, 2004; and September 8, 2005.

Results and Discussion

The 2003 corn-growing season was hot and dry. Rainfall during April, May, and June was normal, but July and most of August were very hot and dry. There were 48 days during the summer of 2003 in which air temperatures exceeded 90 degrees F. In 2004, rainfall distribution was good and there was no visual indication of moisture stress. Also, there were only 13 days in 2004 in which temperatures exceeded 90 degrees F. In 2005, a series of 29 to 30 degree freezes occurred from April 30 through May 3, during the 2-leaf corn growth stage. Evidence of freeze damage was greater in the no-till plots then in strip-till. Most of the freeze-damaged plants survived, as the growing point was still below the surface of the soil. However, plants that were frozen were likely set back some by the freeze. The remainder of the 2005-growing season was near normal with temperatures periodically exceeding 90 degrees F and moisture declining through late June, July and early August.

Corn Plant Populations and V6 Growth

The tillage and fertilization treatments produced statistically significant differences in plant populations and V6 plant dry weights. Plant populations overall tended to be better and emergence was more uniform for corn planted using strip-tillage than with no-till. Tillage had a much greater effect on plant populations than N rate or timing and placement of the N-P-K-S fertilizers (Table 1, Figure 1). When averaged across all fertilizer treatments in 2003, plant populations were 15% better with strip-till than with no-till. In 2004, strip-till plant populations were 7% better compared to no-till and in 2005 plant populations for strip-till were 10% better compared to no-till. Hendrix et al.(2004) also found that tillage influenced corn plant populations, with strip-till and conventional tillage having greater plant populations than no-till. The fertilizer N rates and the N-P-K-S timing and placements of fertilizers had essentially no effect on plant populations. There was no convincing evidence that suggested that the higher N rates caused any reductions in plant populations (Figure 1).

The positive effects of a loosened, strip-tilled seedbed on plant populations also, generally, improved early season plant growth. In 2003, V6 plant-dry-weights, when averaged across all N rates (0,40,80,and 120 lb/a N) were 25% greater with strip-till and fall applied fertilizer and 39% greater with strip-till with all fertilizer applied at planting, compared to no-till (Table 1). Overall, the strip-tillage system with all fertilizer banded 2.5"x 2.5" from the seed row at planting increased V6 plant dry weights more than strip-till with all fertilizer banded 5" below the row. In 2004, both strip-till and no-till treatments with all fertilizer applied at planting produced higher V6 plant dry weights than strip-till with all fertilizer banded below the row. In 2005, the effects of the strip-till and no-till fertilizer treatments on V6 plant growth were generally similar to those in 2003. Averaged across all growing seasons, highest V6 plant dry weighs occurred in the strip-till system with the 40 lb/a N rate plus P, K and S applied at planting. As the planter placed fertilizer N rates were further increased, V6 plant dry weights declined, suggesting a possibility of sensitivity in V6-growth at the higher N rates (Figure 2).

Yield

Corn grain yields were affected all years by both tillage and fertilizer treatments. Strip tillage, produced generally higher grain yields, overall, then no-till, except in 2003 when strip-till at the 80 and 120 lb/a N rates in which the fertilizers were banded 2.5"x2.5" at planting yielded less than comparable no-till treatments (Table 1). In 2003, strip-tillage alone increased corn grain yields 12 bushels/a compared to no-till. In 2004 and 2005 these same comparisons resulted in yield increases of 9 and 10 bushel/a, respectively. There was no evidence that strip-till fertilizers applied in the fall performed inferior to that at planting. The combination treatment of fall strip-till and planter banded fertilizer produced the highest, overall, 3-yr average corn yield, which was mainly the effect of one years better yield performance (2005). There was no evidence that strip-till with all of the fertilizer applied at planting performed better than strip-till with all of the fertilizer applied during the strip-till operation, which is generally the traditional strip-till method for fertilizer application.

Overall, the standard strip-till system with all of the fertilizer applied simultaneously either in the fall or pre-plant in the spring, proved to be the most effective conservation tillage system. Strip-till produced higher grain yields all years compared to no-till and would seem to be a viable option for corn producers needing to implement conservation tillage practices in East-Central and Southeast Kansas. Strip-tillage should afford many of the environmental benefits of no-till and solve some of the concerns associated with no-till, thus making conservation tillage more acceptable to eastern Kansas corn producers.

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Table 1. Treatment mean effects for corn plant population, v6 dry matter, and grain yield.

Check 0-0-0-0	2003	2004	2005	2003	2004	2205	2003	2004	2005
Treatments	**Plant Population**			**V6 Dry Matter**			**Grain Yield**		
Tillage x (N-P-K-S, lb/a)	x 1000			Grams/ plant			Bu/a		
Strip-Till + Banded Fertilizer (5" below row)									
Check 0-0-0-0	21.1	22.1	22.8	2.6	10.0	9.2	78	53	62
40-30-5-5	21.1	22.2	20.3	6.6	12.2	18.1	86	123	91
80-30-5-5	21.2	21.9	22.0	7.1	13.9	15.6	96	160	112
120-30-5-5	21.8	21.7	22.5	7.2	12.7	15.1	91	161	122
80-15-2.5-2.5 fall + 40-15-2.5-2.5 at planting	21.1	21.9	22.2	7.8	17.8	15.2	89	167	133
Strip-Till + Planter Banded Fertilizer (2.5x2.5 from seed row)									
40-30-5-5	21.0	22.4	21.3	9.1	17.6	18.0	90	116	91
80-30-5-5	21.3	22.1	20.6	7.6	18.1	16.2	88	144	108
120-30-5-5	22.2	22.1	20.9	6.7	16.7	12.4	78	160	118
No-Tillage + Planter Banded Fertilizer (2.5x2.5 from seed row)									
Check 0-0-0-0	18.4	20.2	19.3	2.4	8.5	8.5	66	44	52
40-30-5-5	18.8	21.1	18.4	6.2	16.9	15.7	80	101	82
80-30-5-5	18.8	20.3	18.9	5.4	15.8	14.6	90	133	99
120-30-5-5	18.1	21.1	18.9	4.8	16.5	12.8	86	149	117
No-Tillage + Preplant Deep-banded Fertilizer (15" centers x 4" depth)									
120-30-5-5	18.9	20.1	22.4	4.8	15.0	16.1	87	163	109
LSD 0.05	2.4	1.9	2.4	3.0	1.7	2.3	9	17	10

2003
Fall strip-till and fall banded fertilizer: 11/2/02
Pre-plant deep banded fertilizer, no-till: 3/26/03
Planter- banded fertilizer and planting date: 4/10/03

2004
Fall strip-till and fall banded fertilizer: 12/2/03
Pre-plant deep banded fertilizer, no-till: 4/14/04
Planter-banded fertilizer and planting date: 4/15/04

2005
Fall (*Spring*) strip-till and spring banded fertilizer 4/01/05
Pre-plant deep-banded fertilizer, no-till: 4/01/05
Planter-banded fertilizer and planting date: 4/13/05

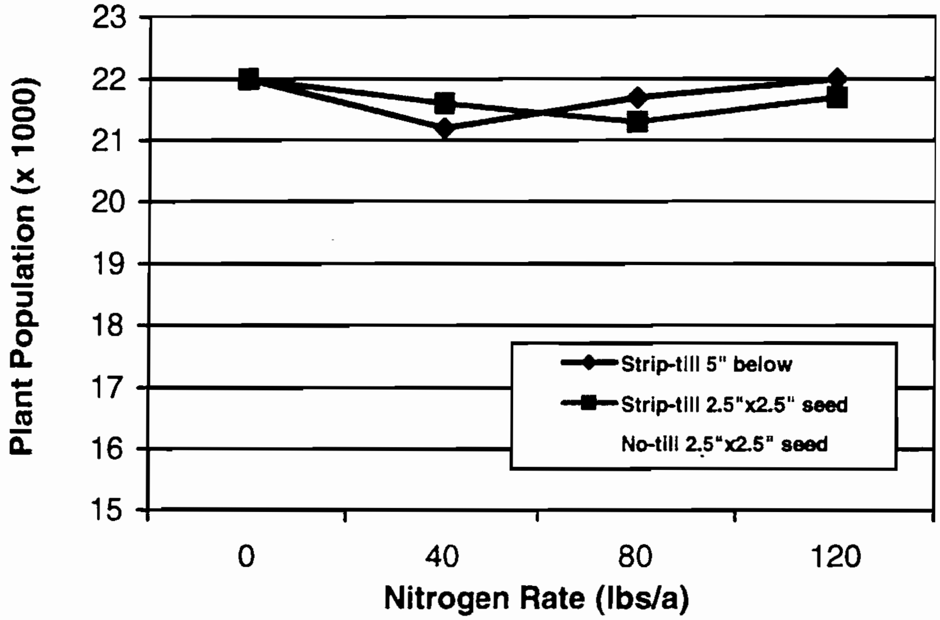

Figure 1. Three-year-average corn plant populations as affected by tillage, N rate, timing and placement of fertilizer.

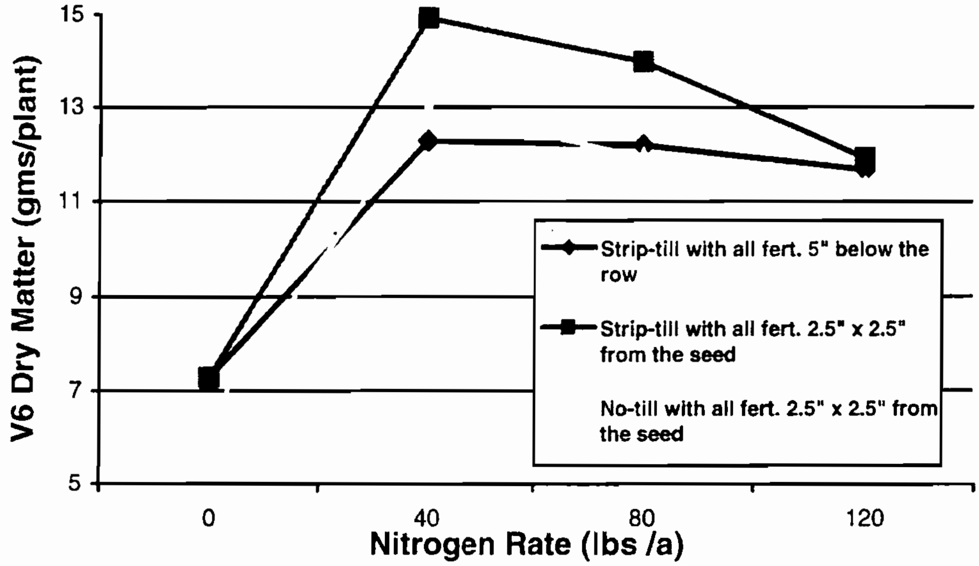

Figure 2. Three-year-average corn V6 dry matter weights as affected by tillage, N rate, timing and placement of fertilizer.

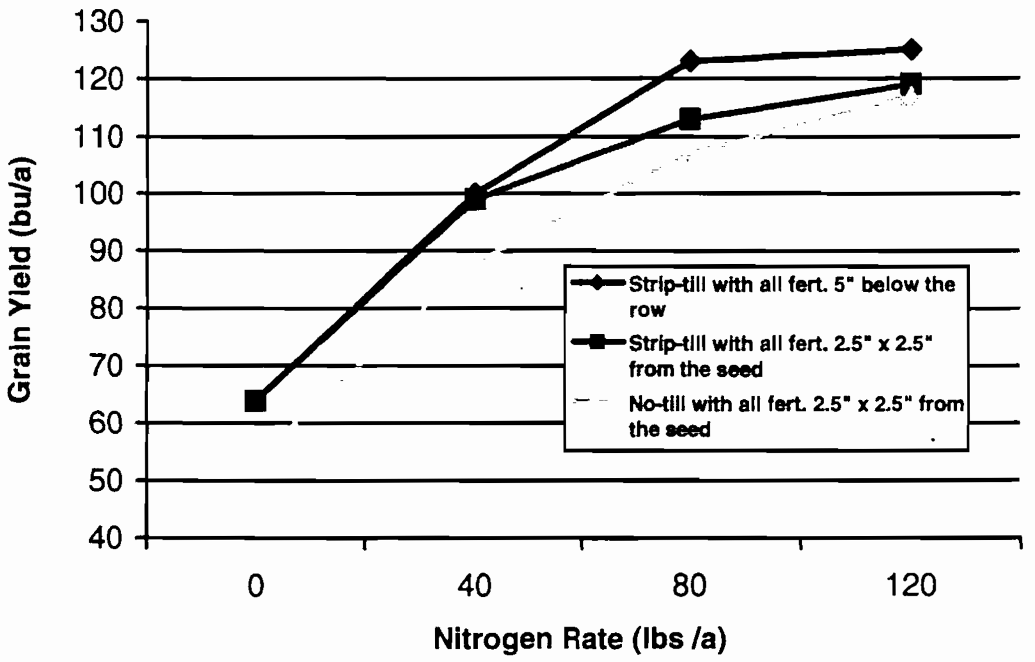

Figure 3. Three-year-average corn grain yields as affected by tillage, N rate, timing and placement of fertilizer.

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