

# EFFECT OF RESIDUE DENSITY, STRIP TILLAGE, AND STARTER K ON NO-TILL CORN GROWN IN WHEAT STUBBLE<sup>1</sup>

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## ABSTRACT

Field studies were conducted in 1992 to 1994 at 2 locations in southern Illinois to evaluate the influence of wheat straw residue density and strip-tillage vs no-tillage on corn growth and yield. Corn growth and resultant yield is frequently reported by producers to be depressed in the residues of a previous wheat crop. Allelopathy is thought to be at least partially involved. The objective of the research was to evaluate straw level (removed, remain non-modified, and doubled), strip tillage, and K presence (30-10-30-4S lb/ac) or absence (30-10-0-4S lb/ac) in a starter fertilizer on corn growth, nutrient composition, and yield. The experiments were conducted at the Belleville Research Center of Southern Illinois University and at a commercial farm (Louis Taylor Farm) about 20 miles from the Research Center.

The non-modified straw level resulted in corn growth and yields that were usually among the highest attained. Doubled straw contributed to greater growth and yields when rainfall was average or below, which is a reflection of the moisture-conserving characteristics of the mulch. During a season of much above normal rainfall (1993), the doubled straw level contributed to apparent higher denitrification losses and reduced yields. Strip tillage, as opposed to no-tillage, was of the greatest benefit under conditions where the straw was completely removed. Little benefit from strip tillage was observed when the straw level was doubled. Inclusion of potassium in the starter fertilizer resulted in significant yield increases in 3 of the 6 experiments conducted and averaged 3 bu/ac over all the experiments. The potassium in the starter fertilizer had less impact on K uptake by the corn than did removal vs doubling the level of straw. In general, it was concluded that allelopathy was not a factor in influencing corn growth or yield during any of the years of the studies.

## INTRODUCTION

Poor growth of no-till corn planted into the residues of a previous wheat crop has frequently been reported by consultants and producers. Usually there is little consistency to the pattern of diminished corn growth such as topography, previous tillage,

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fertility pattern, or wheat harvest direction and associated straw and chaff distribution. Plant population is sometimes reduced and in most cases the stunted corn recovers but reduced yields are usually observed.

Soil environmental factors during the early growth stages such as cool temperatures, excessive wetness, compaction, and reduced nutrient availability are thought to be contributing factors. Also likely involved is allelopathy, which is the negative effect of the residues of a preceding crop on the succeeding crop. Work by Guenzi and McCalla (1966), Guenzi, et al. (1967), Patrick (1971), and Elliott, et al. (1978) has shown that phytotoxic compounds are produced during early stages of crop residue decomposition and most frequently occur under anaerobic conditions.

The objectives of this study were as follows:

- a) to determine if straw removal, doubling its density, or a non-modified amount of straw would have an impact on corn growth, nutrient composition, and yield.
- b) to determine if strip tillage of a narrow, 10-inch band ahead of intended corn rows would have an effect on corn growth and yield.
- c) to evaluate the influence of potassium inclusion in a starter fertilizer applied at planting.

#### METHODS

Field studies were conducted on two southern Illinois sites, the Belleville Research Center (BRC) of Southern Illinois University and at the Louis Taylor Farm approximately 20 miles northeast of the BRC, in 1992, 1993, and 1994. The soils were classified as Iva and Stoy silt loams (Alfisols) and had an organic matter content ranging from 1.7 to 2.0 percent. Different areas at each location were utilized for the 3-year studies and the individual soil tests by location and years were as follows:

Belleville				Taylor Farm			
Year	pH	Bray P <sub>1</sub> -----lb/ac-----	Exch. K	Year	pH	Bray P <sub>1</sub> -----lb/ac-----	Exch. K
1992	6.6	102	385	1992	6.3	49	214
1993	6.3	96	402	1993	6.2	110	319
1994	6.0	91	236	1994	6.4	45	180

Wheat was grown the preceding year followed by double-crop soybeans on each study area. In 1992 straw was removed prior to corn planting from selected plots and added onto other plots to give 0-X and 2-X levels of straw as residue cover. Additional plots remained non-modified to give a 1-X straw level treatment. In 1993 and 1994 this redistribution of straw was done both (a) just after wheat harvest and again (b) just before corn planting such that a timing factor of redistribution, i.e. (a) after harvest

and (b) before planting, was also introduced as a treatment variable. Amounts of wheat straw redistributed to form the 2-X plots were as follows for each of the experimental years:

		<u>Belleville</u> (lb/ac)	<u>Taylor Farm</u> (lb/ac)
1992	April 1992	4,900	2,800
1993	July 1992	6,600	5,200
	April 1993	5,400	6,300
1994	July 1993	2,900	2,800
	April 1994	2,100	2,400

In all years straw levels were duplicated to allow each level to be either strip-tilled (ST) in the intended corn rows (10 inches wide to a depth of 5 inches) with a power roto-tiller or planted directly into the straw treatments as no-till (NT). The tillage in ST treatments was sufficiently minor to allow the soil surface to remain mostly as a no-till environment.

Phosphorus and potassium was broadcast-applied prior to planting in accordance with soil test recommendations. Nitrogen as a 28% UAN solution was applied as a split application: 75 lb N/Ac as a broadcast "weed and feed" at planting and 75 lb N/Ac as a side-dress application dribbled between corn rows.

Starter K (30 lb K<sub>2</sub>O/ac) was either absent or present as a treatment variable in two of each four-row corn plot as the following grade analysis: 30-10-0-4% S or 30-10-30-4% S. Placement of the starter fertilizer was approximately 2 inches below and 2 inches to the side of planted seeds. Pioneer brand 3394 seed corn at 26,000 seeds per acre was planted at both locations each year of the study.

Crop measurements taken included plant height at maturity, ear-leaf nutrient composition, and grain yield. Soil samples were also taken for available potassium determination in the 0-X, 1-X and 2-X straw level plots in the final year (1993-94) of the study. Increment samples were collected in the 0-1, 1-2, 2-4, 4-8, and 8-12 inch depth in December 1993 and April 1994 from plots that had straw redistributed in July 1993.

## RESULTS AND DISCUSSION

### General Comments

Large differences in seasonal rainfall during each of the 3 years resulted in varied planting dates and responses to treatments. A dry spring in 1992 followed by favorably moist conditions in July and August allowed early planting and nearly ideal crop development conditions that resulted in corn yields that exceeded 200 bu/ac at both locations. In 1993, excessive wetness

was a problem during most all of the growing season. However, good yields were still attained, but nitrogen losses cut into the yield potential. The 1994 crop season was substantially drier than normal but cool temperatures from mid to late summer decreased the effects of moisture stress. Above average yields were obtained.

### Crop Responses in 1992

Wheat residues had a significant effect on corn height, especially in no-till (NT) plots (Figure 1). In the non-tilled plots removal of residues resulted in significantly shorter corn than if residues were not removed or if the residues were doubled. At both Belleville and the Taylor Farm the tallest corn was observed where the residue level was doubled. It was apparent that wheat residues were not negatively affecting corn in NT and actually the added residues were likely contributing to enhance soil moisture and improved corn growth. Strip-tillage (ST) had a modifying effect on corn height across the levels of wheat residues. Essentially, there was no difference in corn height regardless of the residue level for ST. Soil loosening and mixing-in the residues in the strip tillage process probably nullified the beneficial effects of residue cover in reducing moisture losses. Adding potassium in the starter at both locations had a positive and significant effect on corn height, even though the average increase was only 1 inch.

Significant yield effects due to residues and tillage were observed only at the Taylor Farm (Figure 2) and not at the Belleville site. As shown, within no-till or strip-till, the lowest yields were measured in plots with residues removed. Highest yields were observed with doubled residues in NT plots and at the 1-X level of residues in ST plots. Removal of straw was not beneficial to yields regardless of tillage (NT or ST) used. Addition of K in the starter had no effect on yield at the Taylor Farm but resulted in a 5 bu/ac yield increase at Belleville (BRC).

### Crop Responses in 1993

Corn yields were negatively affected by doubled straw levels, regardless if redistribution occurred right after wheat harvest (July 1992) or just prior to planting (April 1993) (Figure 3). This effect was observed at both locations and was probably a crop response to excessive soil wetness caused by the thick residue cover. The depressing effect of the high straw level was observed both in the NT and ST plots. Overall, higher yields were noted in plots that were ST rather than NT. Addition of K in the starter resulted in significant yield increases of 6 bu/ac at both Belleville and the Taylor Farm.

The reduced yield observed in the doubled straw treatments was probably the result of high denitrification losses associated with wet soil conditions under the heavy residue blanket. As seen in Figure 4, ear leaf N composition was 0.2 to 0.3 percent lower in doubled straw treatments compared to treatments with straw removal.

Ear leaf K concentrations were reduced significantly by complete straw removal (Figure 5). This effect was most pronounced when straw was removed following harvest rather than for straw removed prior to planting. Apparently K had become leached from the straw by the later redistribution date and smaller differences in leaf K resulted.

#### Crop Responses in 1994

Corn height at Belleville was increased as a result of doubled wheat straw compared to corn grown in plots where straw was removed (Figure 6). A differential of 6 inches was measured in NT plots where straw redistribution occurred prior to planting. The extra mulch was apparently beneficial in moisture conservation as the growing season was much below normal in rainfall. Added K in the starter resulted in corn being, on average, about 1 inch greater in height.

Yields at Belleville, however, did not follow a comparable pattern in response to the straw level (Figure 7). Some of the best yields were attained in plots where straw was removed and where plants were shorter in height. This apparent contradiction was probably a physiological response of the corn to favorable moisture in doubled residue plots followed by prolonged dryness that exhausted available moisture before grain-fill was completed. Potassium in the starter had no effect on grain yield.

Ear leaf potassium was increased by doubled straw compared to concentrations observed in leaves of corn grown in plots with straw removed (Figure 8). Higher leaf K composition was observed in plots with NT compared to those receiving ST. Addition of K in the starter had no effect on leaf K concentration. Results from the Taylor Farm closely paralleled those of Belleville and are not presented.

#### Effect of Straw Redistribution on K in the Soil

Potassium levels in the soil were affected by straw removal (Figure 9). As seen, soil test K increased at both Belleville and the Taylor Farm soon after redistribution occurred, and the test levels increased the greatest in the surface few inches of the soil. After 9 months following redistribution, soil test levels in the surface inch (expressed as lb K/ac) increased by 45 lb K/ac at Belleville and 65 lb/ac at the Taylor Farm. Potassium leached from the wheat straw was the probable cause for the soil test increase. The dissimilar K distribution patterns in the soil was probably a reflection of long-term previous tillage in that moldboard plowing was practiced in recent years at Belleville whereas no-till was the dominant practice at the Taylor Farm.

#### Overall Effects of Straw, Tillage and K, 1992-1994

When averaged over the 6 site-years and across both NT and ST, corn yields were generally the highest (189 bu/ac) when the straw

level was not modified (Figure 10). For the straw level that was doubled the average yield was about 185 bu/ac and when straw was removed the corn yield averaged about 182 bu/ac. For most years the doubled level was a benefit to the corn yield but during excessively wet conditions it was a detriment. Throughout the study no apparent and observable allelopathy was manifested by the corn as a response to the wheat straw residue.

Strip tillage had a positive effect on overall yields, contributing to an average 5 bu/ac increase in yield over no-tillage (Figure 10). The benefit of ST over NT was the greatest where straw was removed, increasing yield by 8 bu/ac. Strip tillage resulted in a yield increase of 5 bu/ac for non-distributed straw and 1 bu/ac for the doubled straw level. Overall, the inclusion of K in the starter resulted in a 3 bu/ac yield increase.

Straw level affected corn ear leaf K composition more than did addition of 30 lb  $K_2O/ac$  in the starter (Figure 11). There was a 0.15% K increase in leaf K from doubling straw compared to straw removal. Apparently, the K in the straw and the organic matter combined to enhance K uptake by the corn. Inclusion of K in the starter increased ear leaf K by a negligible 0.03 percent.

#### SUMMARY AND CONCLUSIONS

1. Increasing straw levels generally enhanced corn growth and yield. However, apparent immobilization of N and denitrification due to excessive soil moisture under doubled straw in the wet year of 1993 led to yield decreases.
2. Greatest yield increases from strip tillage were obtained in the straw-removed treatment (up to 6 bu/ac). Least benefit from strip tillage was observed when the straw level was doubled.
3. The time of straw redistribution (following wheat harvest vs just before planting) did not have any influence on the corn growth and yield that was obtained.
4. Addition of 30 lb  $K_2O/ac$  in the starter fertilizer resulted in a significant yield increase in 3 of the 6 experiments. The average yield increase was 3 bu/ac over all experiments.
5. In all experiments, removal of the straw resulted in a lower ear leaf K composition being observed. Doubling of straw resulted in significantly higher K levels in corn ear leaves compared to the non-modified straw level.
6. Differences in corn emergence, color, height, and population were minimal during the 3 years of the study, suggesting few if any apparent allelopathic effects of the wheat straw at either location.

#### ACKNOWLEDGEMENTS

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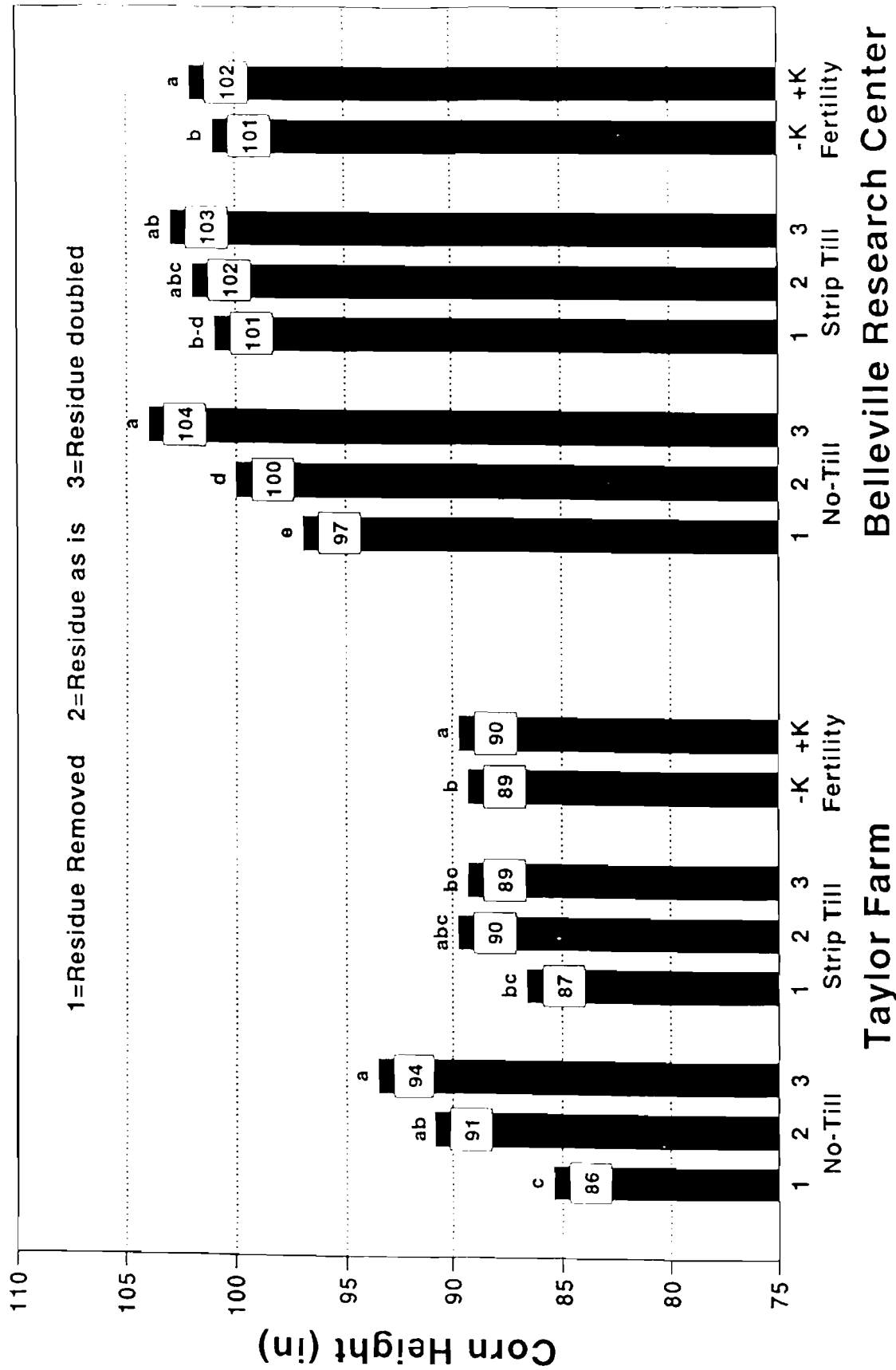


Figure 1. Effect of Straw Level, Tillage, and K in the Starter on Corn Height in 1992.



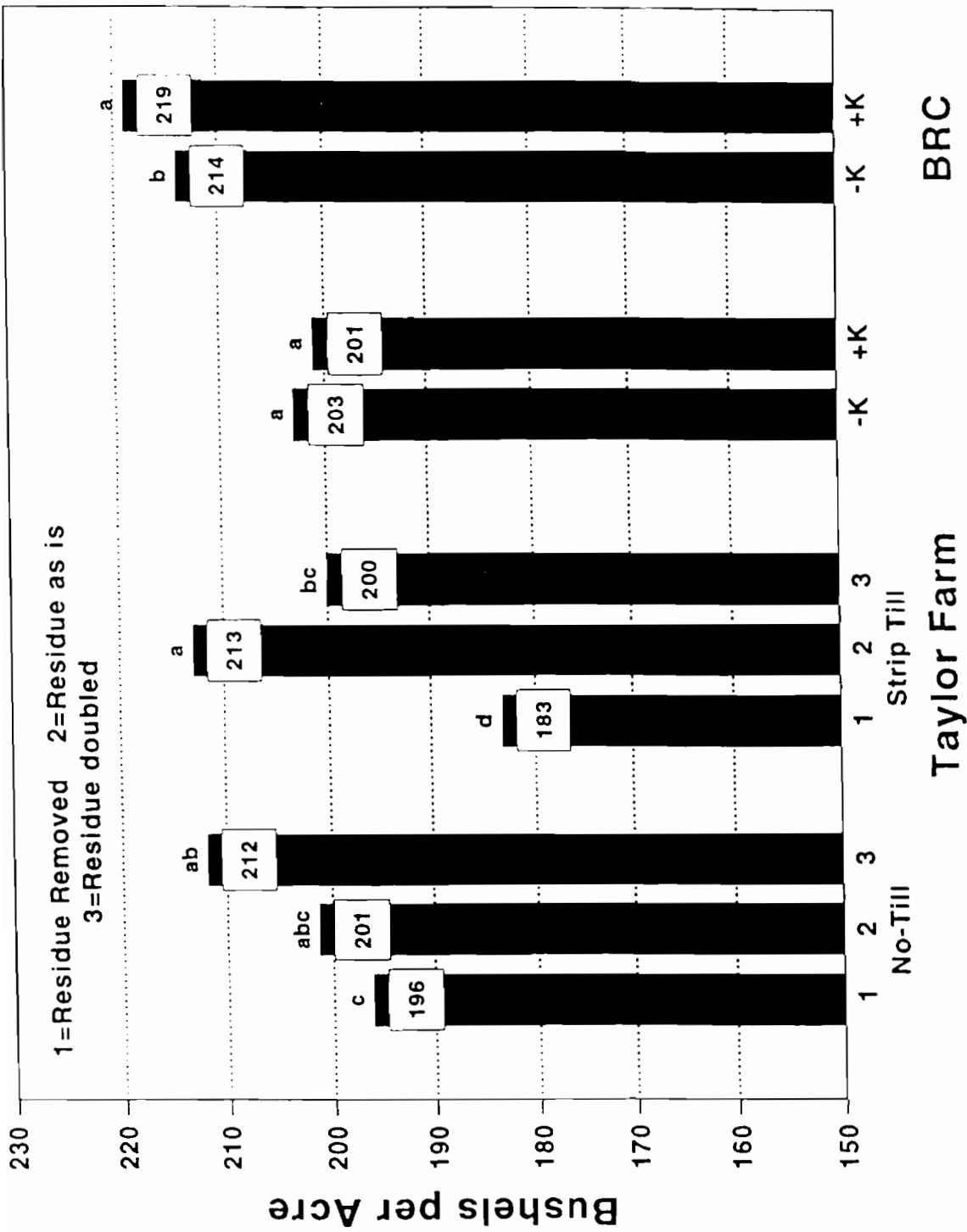
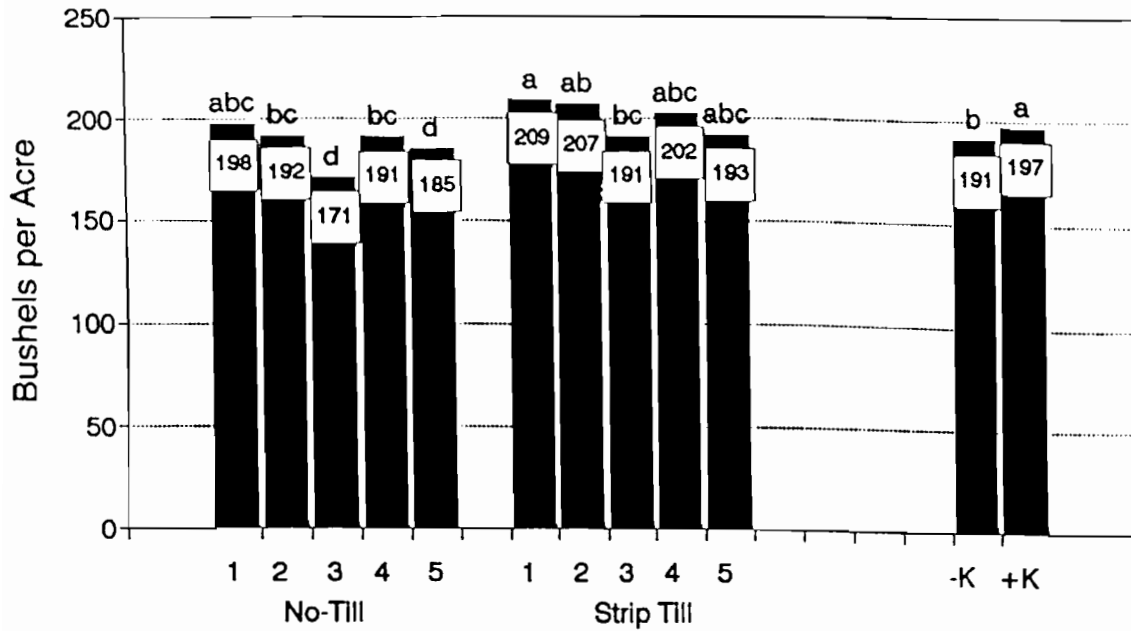
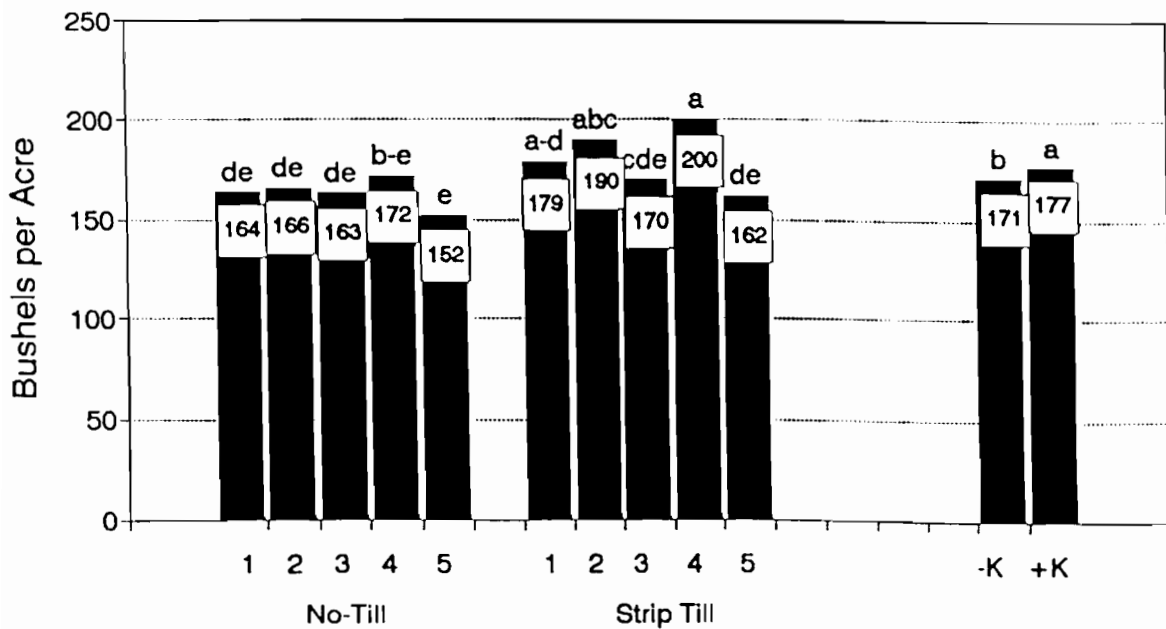


Figure 2. Effect of Straw Level, Tillage, and K in the Starter on Corn Yield in 1992.

## Belleville Research Center



## Louis Taylor Farm



- |                                     |                                     |
|-------------------------------------|-------------------------------------|
| 1. Residue as is                    | 4. Residue Removed at Corn Planting |
| 2. Residue Removed at Wheat Harvest | 5. Residue Doubled at Corn Planting |
| 3. Residue Doubled at Wheat Harvest |                                     |

Figure 3. Effect of Straw Level, Tillage, and K in the Starter on Corn Yield in 1993.

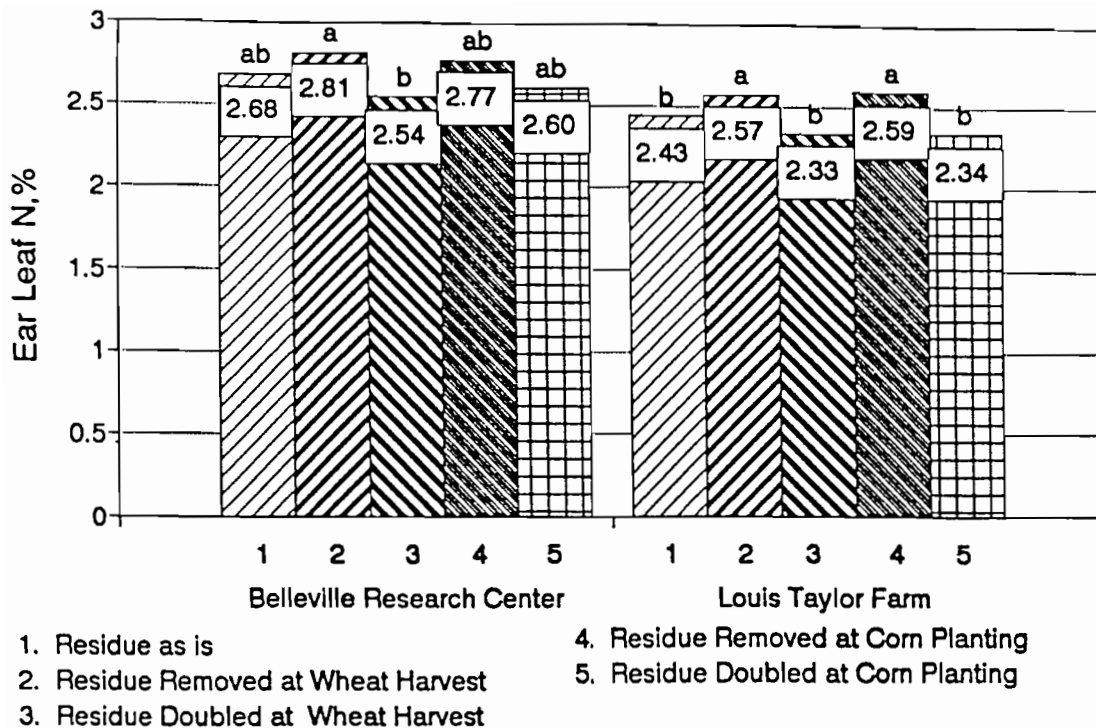


Figure 4. Effect of Straw Level on Ear Leaf N Composition in 1993.

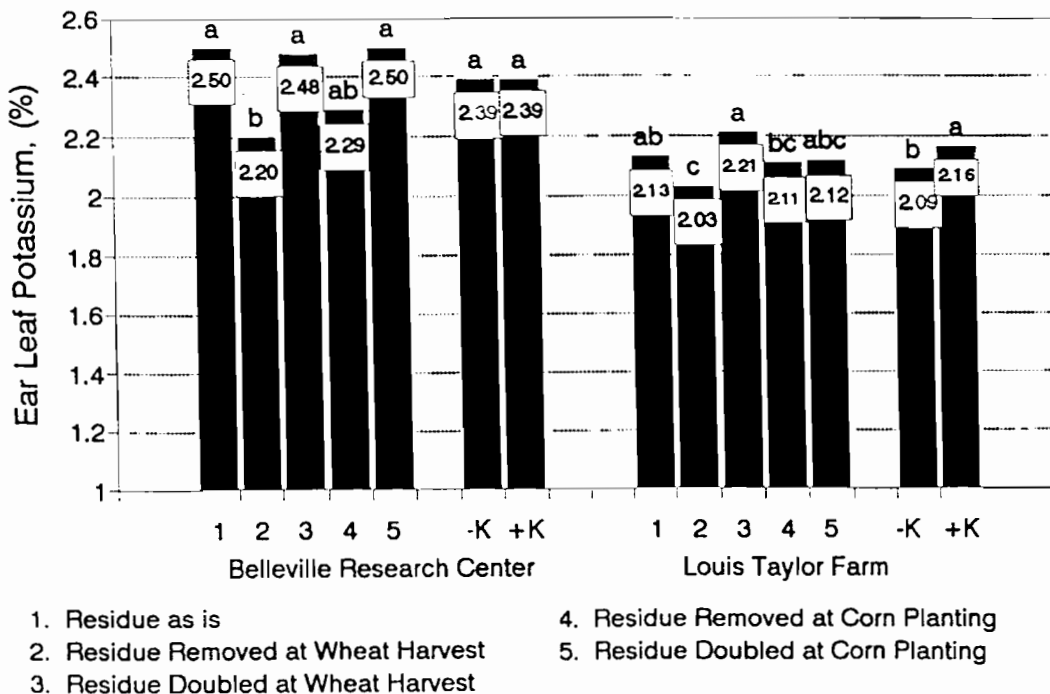
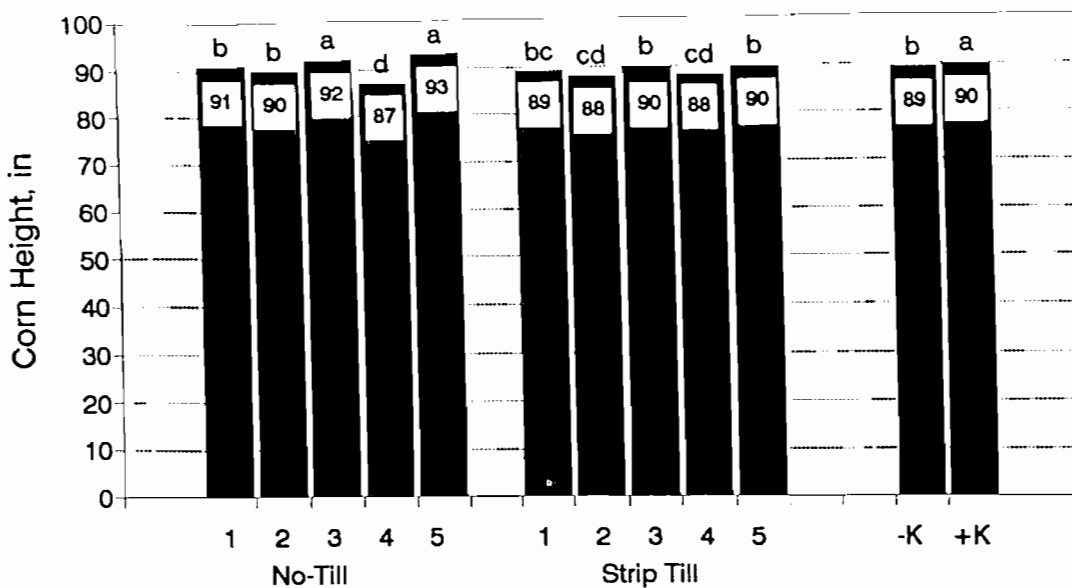
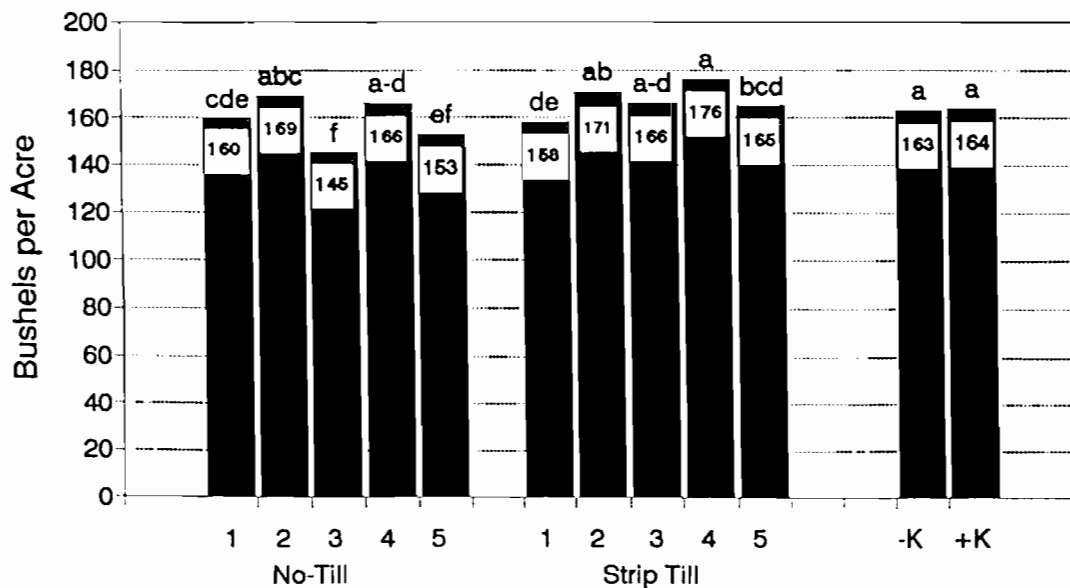


Figure 5. Effect of Straw Level and K in the Starter on Ear Leaf K Composition in 1993.



1. Residue as is
2. Residue Removed at Wheat Harvest
3. Residue Doubled at Wheat Harvest
4. Residue Removed at Corn Planting
5. Residue Doubled at Corn Planting

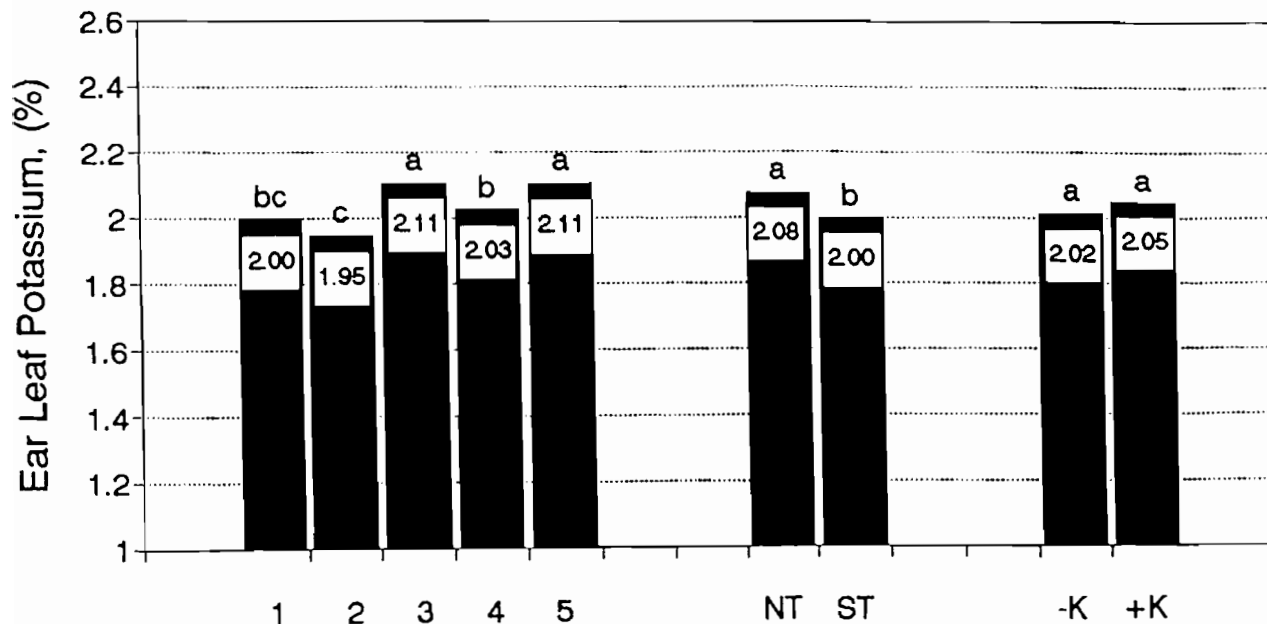
Figure 6. Effect of Straw Level, Tillage, and K in the Starter on Corn Height in 1994 at the Belleville Research Center.



1. Residue as is
2. Residue Removed at Wheat Harvest
3. Residue doubled at Wheat Harvest
4. Residue Removed at Corn Planting
5. Residue Doubled at Corn Planting

Figure 7. Effect of Straw Level, Tillage, and K in the Starter on Corn Yield in 1994 at the Belleville Research Center.

## Belleville Research Center



- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>1. Residue as is</li> <li>2. Residue Removed at Wheat Harvest</li> <li>3. Residue Doubled at Wheat Harvest</li> </ul> | <ul style="list-style-type: none"> <li>4. Residue Removed at Corn Planting</li> <li>5. Residue Doubled at Corn Planting</li> </ul> |
|--|--|

NT = No-Till  
ST = Strip-Till

Figure 8. Effect of Straw Level, Tillage, and K in the Starter on Ear Leaf K Composition in 1994.

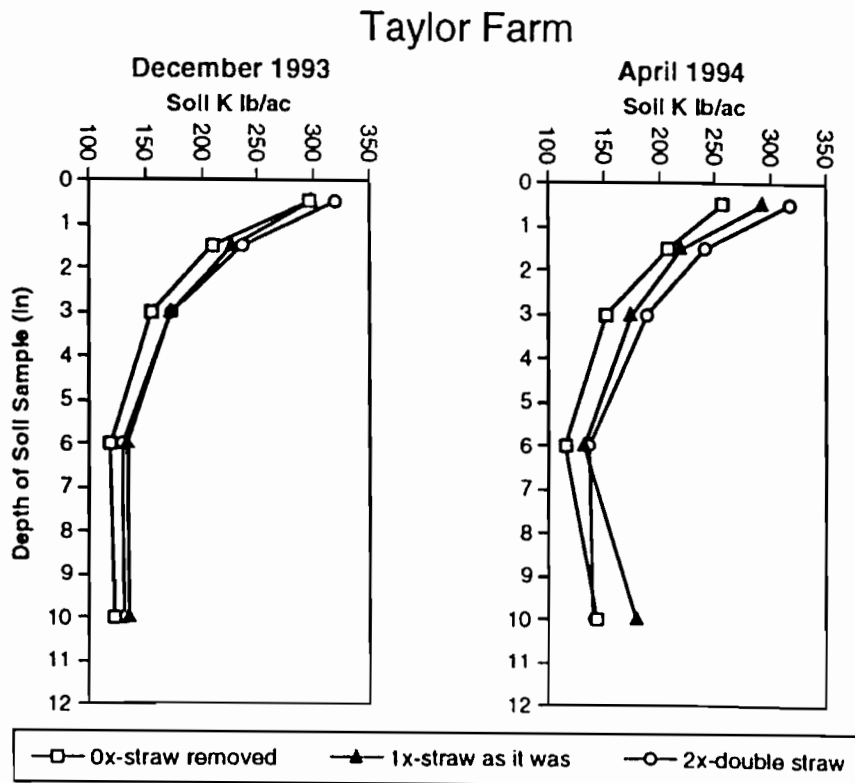
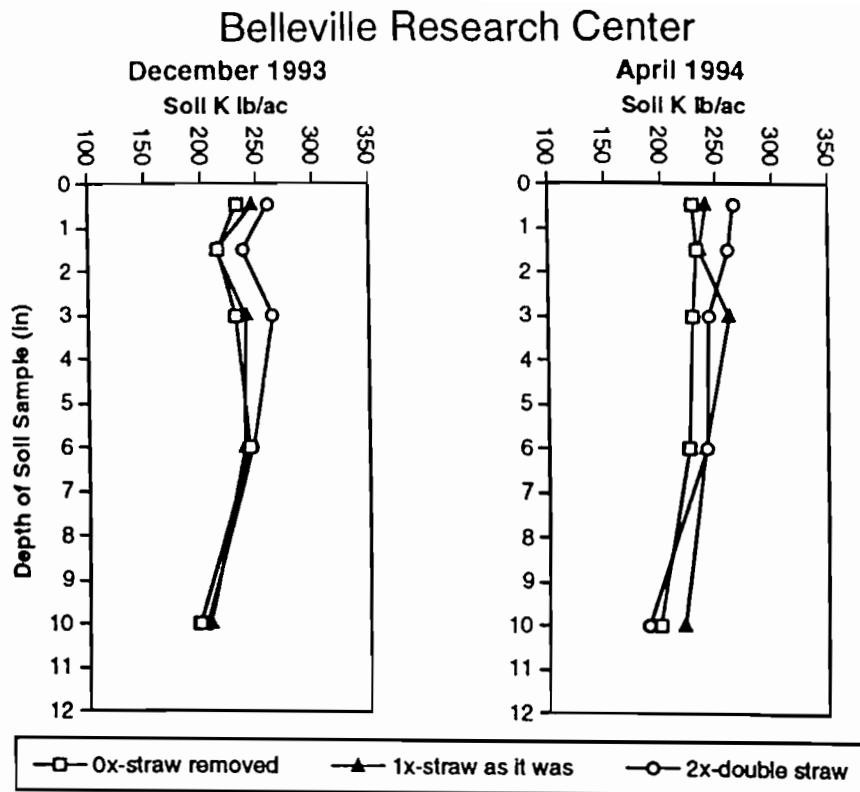


Figure 9. Effect of Straw Redistribution on Available-K in the Surface 12-Inches of Soil, 5 Months and 9 Months, Following Straw Transfer.

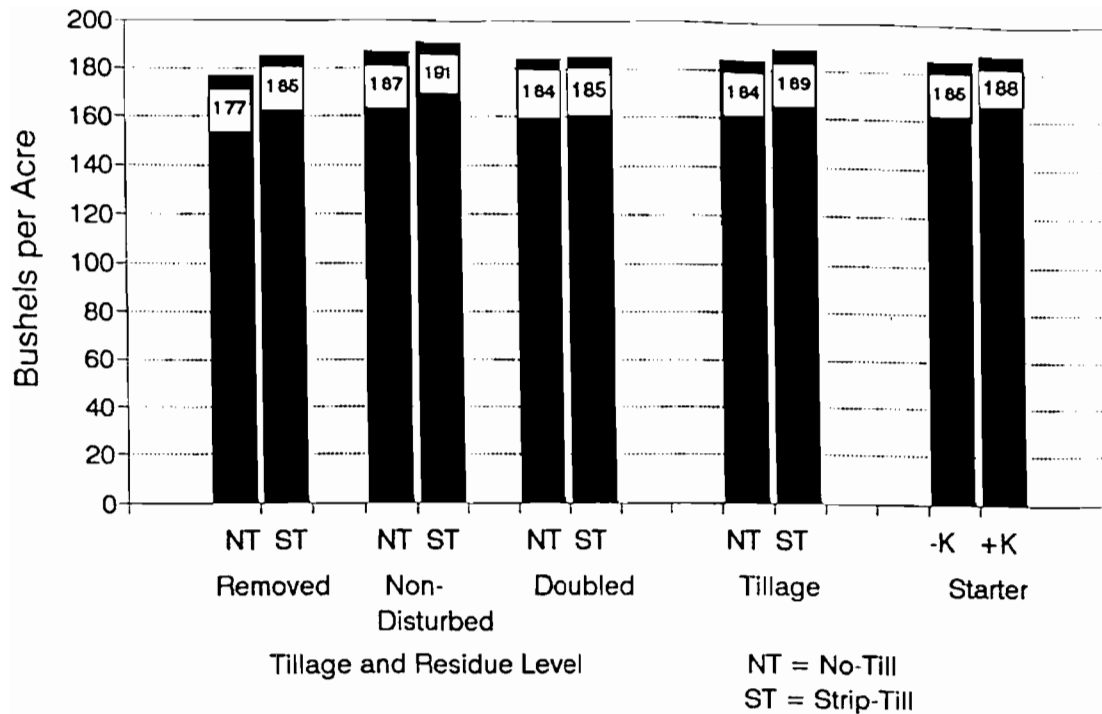


Figure 10. Effect of Straw Level, Tillage, and K in the Starter on Corn Yield, (Ave. of 6 Experiments, 1992-1994, Belleville Research Center and the Taylor Farm).

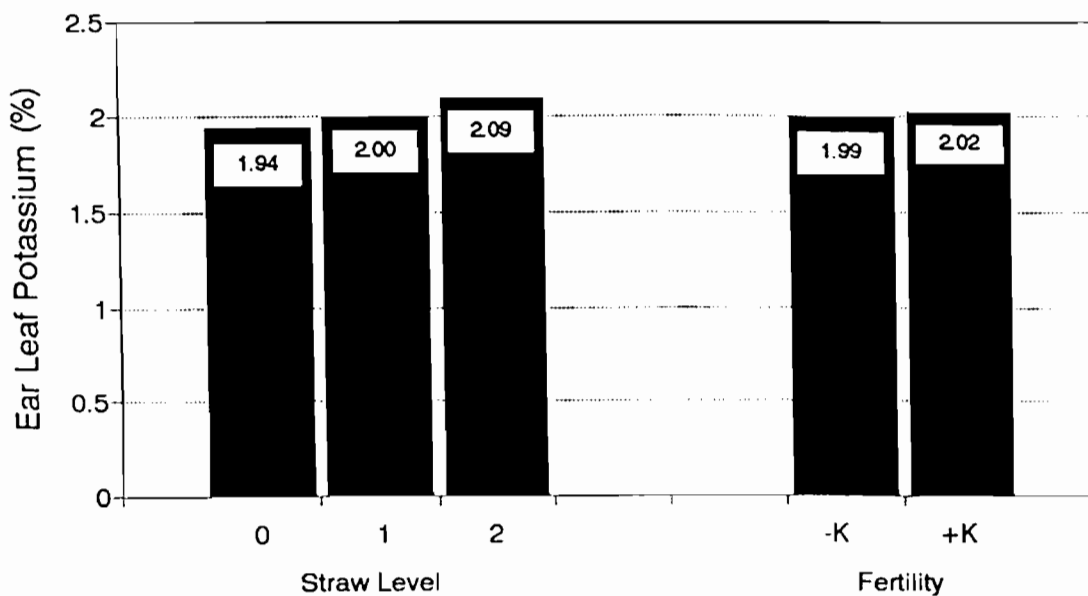


Figure 11. Effect of Straw Level and K in the Starter on Ear Leaf K Composition, (Ave. of 6 Experiments, 1992-1994, Belleville Research Center and the Taylor Farm).

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