

Kansas

Crop Residue Removal and Fertilizer Effects on Crop Yield and Soil Sustainability

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Kansas studies emphasize the importance of crop residues and adequate soil fertility in maintaining yields and soil organic matter levels.

CROP RESIDUES are being considered as a source of raw materials for various non-agricultural uses. But crop residues also are needed for surface soil cover and to replenish soil organic matter.

Many grain producers currently harvest crop residues for livestock feed or other farm uses with little noticeable negative effects. Generally, this is not done on an every year basis from the same field. Also, some of these plant materials may be returned to the field as animal wastes. The potential for influencing crop and soil sustainability could be much greater with non-agricultural crop residue uses.

The first concern when crop residues are removed is with soil erosion protection and whether conservation compliance will be jeopardized. Residue removal can also affect soil water conservation and storage. Residue removal can deplete plant nutrients, deplete soil organic matter, and change soil physical properties. The effects of fertilizer management in offsetting plant nutrient losses when crop residues are removed is not well understood.

Kansas Study

This study was established to determine the effects of returning varying levels of crop residue on crop yields and soil properties in a soybean-wheat-grain sorghum rotation, fertilized with variable rates of nitrogen (N), phosphorus (P) and potassium (K).

The study at the East Central Kansas Experiment Field on a nearly level (0 to 1

percent slope) Woodson silt loam soil included residue treatments begun in the fall of 1980 and continued for 12 consecutive years using a soybean-wheat-grain sorghum cropping sequence. Only one crop was grown each year. Residue treatments were: 1) residue removed each year after grain harvest; 2) normal crop residue incorporated; and 3) twice normal residue incorporated. Fertilizer treatments listed in **Table 1** . . . zero, low, normal and high levels of N-P-K for the three crops . . . were superimposed on residue treatments.

Table 1. N-P-K fertilizer treatments for crops in rotation.

Fertilizer treatments	Soybean ----- N-P ₂ O ₅ -K ₂ O, lb/A -----	Wheat N-P ₂ O ₅ -K ₂ O, lb/A -----	Grain sorghum N-P ₂ O ₅ -K ₂ O, lb/A -----
Zero	0-0-0	0-0-0	0-0-0
Low	0-0-0	25-15-25	50-15-25
Normal	0-0-0	50-30-50	100-30-50
High	0-0-0	75-45-75	150-45-75

Grain yields and residue yields were measured each year. Soil samples (0 to 6-inch depth) were collected after the 11th year for chemical analysis. Soil bulk density measurements were also performed on the 0 to 4-inch depth. A disk-field cultivate tillage system was used for seedbed preparation and residue incorporation all years.

The Results

Grain yields and residue yields varied with crop and year. Soybean yields ranged from 14 to 53 bu/A, residue yields ranged from 0.34 to 0.81 tons/A; wheat

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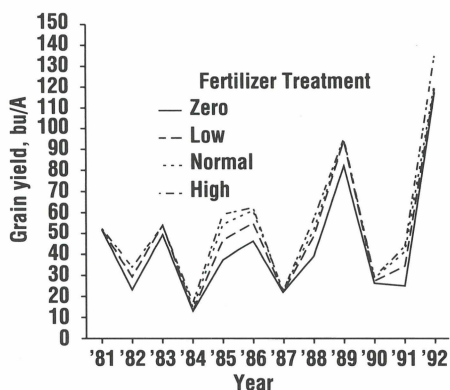


Figure 1. Effects of fertilizer applications on grain yield.

yields ranged from 29 to 50 bu/A, residue yields from 0.99 to 1.47 tons/A; and grain sorghum yields ranged from 54 to 129 bu/A, residue yields from 1.11 to 2.66 tons/A. Crop residue yields, like those of grain, vary substantially with growing season. Although direct residue production comparisons are not valid because all crops were not grown in the same year, grain sorghum produced the highest overall average amount of residue, 1.69 tons/A, wheat 1.20 tons/A, and soybean 0.57 tons/A.

The residue treatments caused no statistically significant differences in grain yield for any crop in any year. Neither the removal of crop residue nor the adding

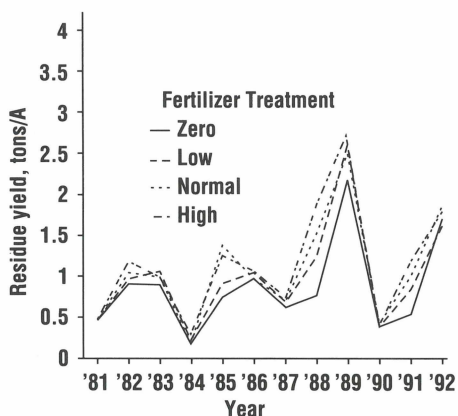
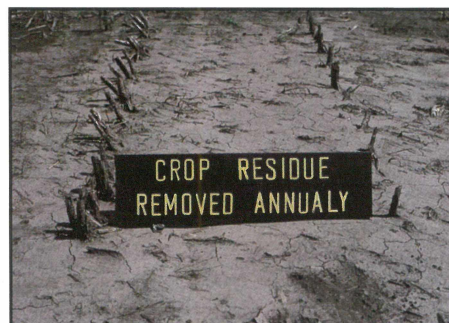
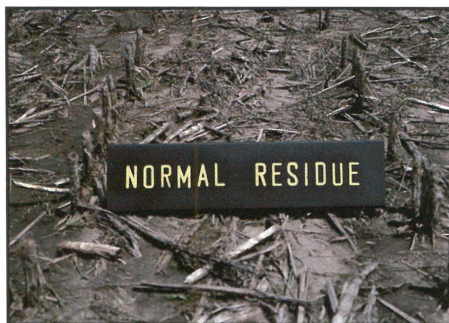


Figure 2. Effects of fertilizer applications on residue yield.



INCREASED crop residues result from better fertilization practices and higher yields. The benefits are better erosion control, increased soil organic matter and improved moisture infiltration.

of twice normal crop residue influenced crop yield.

Fertilizer increased both grain and residue yields, shown in **Figures 1 and 2**.

Generally, highest grain and residue yields were produced with the normal and high fertilizer treatments.

Soil analyses after 11 years of residue-fertilizer treatments indicated significant differences in exchangeable K, bulk

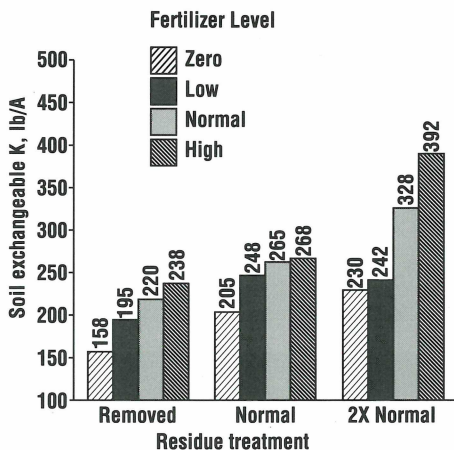


Figure 3. Soil exchangeable K after 11 years of residue and fertilizer treatments.

density (data not shown), and organic matter due to residue treatments. There was a statistically significant interaction between the residue and fertilizer treatments for exchangeable K, **Figure 3**.

Exchangeable K was affected most by the residue treatments. Exchangeable K decreased when crop residue was removed. Doubling crop residue increased exchangeable K, especially when higher levels of K fertilizer were applied. This was because the high K content of the residue plus the fertilizer K exceeded crop K removals.

Soil organic matter decreased with crop residue removal and with normal residue incorporated when no fertilizer was applied, **Figure 4**. Doubling crop residue increased soil organic matter. Doubling crop residue in combination with high fertility produced the most residue and the highest soil organic matter levels. Organic matter in the soil is a result of the balance between loss from decomposition and gain from crop residues and roots returned to the soil. Soil bulk density increased slightly with removal of crop residue and decreased slightly with doubling of crop residue. This is likely a reflection of the differences in soil organic matter levels.

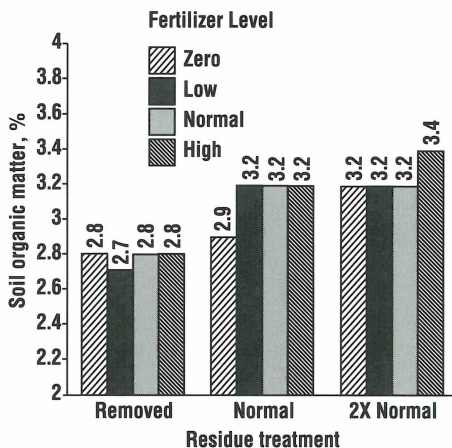


Figure 4. Soil organic matter after 11 years of residue and fertilizer treatments.

Summary

The results of this study suggest that in situations where soil erosion and soil water relations are of little concern, removal of crop residues should not affect crop yield over the short term. Removal of crop residue will, however, slightly lower soil organic matter and will increase soil bulk density compared to normal residue incorporation. These slowly occurring effects are potentially long-term serious factors. Removal of crop residue will require application of extra K in the relatively short term because of the high K content of residues.

Long-term, continuous residue removal remains questionable. That's because long-term removal could cause further decline in soil organic matter, increased soil physical problems and eventually affect crop yield.

In different environments with different soils, the effects of removing crop residue could be much different. This soil was initially high in soil organic matter for the area and had medium to high levels of soil fertility. Soils with lower organic matter and lower fertility would likely be affected more quickly by crop residue removal. ■