

1-29-2001

Soil erosion and crop productivity: topsoil thickness

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Recommended Citation

Al-Kaisi, Mahdi, "Soil erosion and crop productivity: topsoil thickness" (2001). *Integrated Crop Management News*. 1897.
<http://lib.dr.iastate.edu/cropnews/1897>

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Abstract

The effect of soil erosion can be partitioned into costs to the actual site where erosion takes place and costs off site where sediment contributes to water quality problems. The on-site costs can include loss in production potential due to deterioration in soil physical and chemical properties such as infiltration rate, water holding capacity, loss of nutrients needed for crop production, and loss of soil carbon. This article focuses on the effect of soil erosion on productivity, particularly on yield.

Keywords

Agronomy

Disciplines

Agricultural Science | Agriculture | Agronomy and Crop Sciences | Soil Science

INTEGRATED CROP MANAGEMENT

Soil erosion and crop productivity: topsoil thickness

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The effect of soil loss on production varies, depending upon the type and depth of the topsoil. Some seriously eroded soils are not useable for crop production. Many studies have been conducted on the effect of depth of topsoil on corn yields in the Corn Belt states. Figure 1 (from Stallings, J.H. 1964. Phosphorus and water pollution. *Journal of Soil Water and Conservation* 22: 228-231) summarizes the relationship between topsoil depth and crop productivity. There is a direct relationship between topsoil depth and yield. The decline in yield with the reduction in topsoil depth can be related to A horizon thickness.

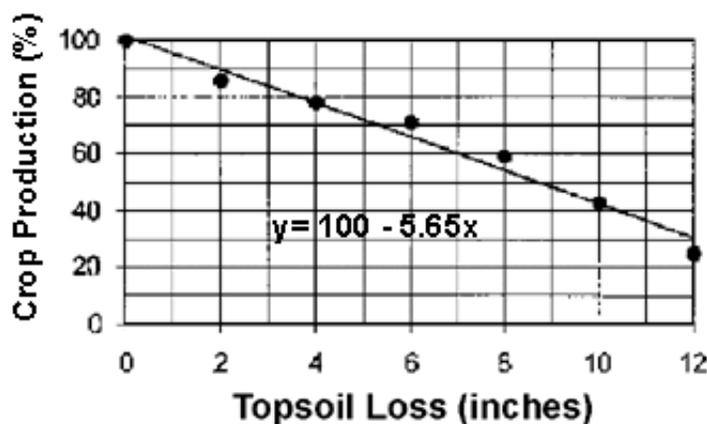


Figure 1. *Reduction in crop productivity from loss of topsoil. Data were primarily collected on soils without adequate fertilizer treatment.*

As the topsoil erodes, infiltration rate and water availability become limited. The subsoil does not absorb the rainfall as rapidly, leading to more surface water runoff and less available water for crop production. A study on erosion and slope effect on productivity, especially yield, was initiated in 10 Iowa counties in 1983 and expanded to 44 counties in 1984. The objective of the study was to determine the effects of slope and erosion and their interaction with other variables such as moisture, fertilizer rates, and slope on crop productivity. There

was a strong relationship between soil A horizon thickness and yield, especially for Till-derived soil, where yield was more negatively affected as the A horizon thickness declined compared with Loess-derived soils. Similarly, there was a strong relationship between yields and slopes for the same soils. The reason is that Till-derived soil has shallower soil depth compared with Loess-derived soil, where the water holding capacity or moisture and nutrients become a detriment to yield.

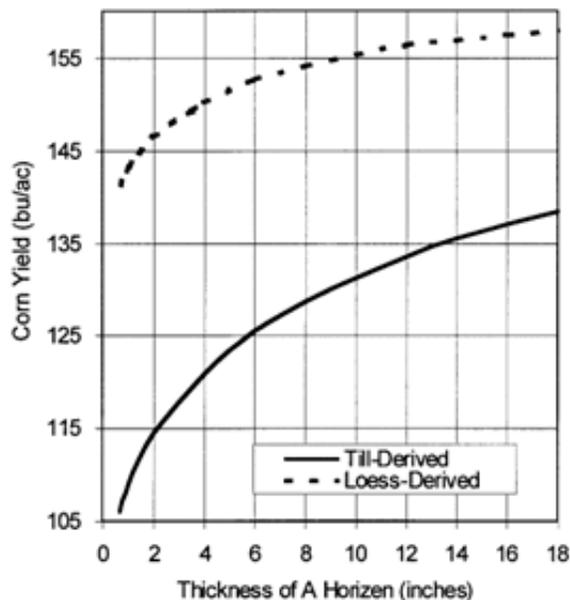


Figure 2. *Effect of A horizon thickness on corn yields for loess-derived and till-derived soils.*

The thickness of A horizon had an effect on yield up to a certain thickness (Figure 2). As the A horizon thickness increased from 1.5 inches (mid-range for the severely eroded soils) to 5 inches (mid-range for moderately eroded soils), the estimated corn yield increase was 13 bushels per acre. However, the rate of increase in yield will be much lower, especially for Loess-derived soils compared with Till-derived soils. The change in yield between soil A horizon, 5 inches thick, and soil A horizon, 12.5 inches thick (mid-range for the slightly eroded soils), was 8.9 bushels per acre. The change in soil A horizon thickness plays a significant role in changing the amount of soil moisture that will be stored for the plant use. One study showed that when the rainfall was adequate during the growing season, there was little difference in yield regardless of A horizon thickness. However, in years when rainfall was not adequate there was an extreme difference in yield. In general, the results show that corn yield is much greater for Loess-derived soils compared with Till-derived soils having the same A horizon thickness (Figure 2) (from Kazemi, M.L., L.C. Dumenil, and T.E. Fenton. 1990. Effects of accelerated erosion on corn yields of loess-derived and till-derived soils in Iowa. Unpublished technical report, pp. 1-102, Department of Agronomy, Iowa State University).

Conclusions

The effect of the A horizon thickness (an index of soil erosion) and other management factors on yield was significant. Corn yields of Loess-derived soils were greater than those of Till-derived soils of similar slopes and A horizon thicknesses. The better yield response with the Loess-derived soils can be attributed to the soil uniformity and better water- and nutrient-holding capacity compared with till-derived soils.

This article originally appeared on page 11 of the IC-486 (1) -- January 29, 2001 issue.

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