1991

The Relationship Between Soil Properties and No-Tillage Agriculture

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Soil Science News & Views

Vol. 12, No. 2, 1991

The Relationship Between Soil Properties and No-Tillage Agriculture[1]

by Robert L. Blevins

I am highly honored to be invited to present the 3rd annual S.H. Phillips Distinguished Lecture on No-Tillage Agriculture. My interest and subsequent research efforts in the area of no-tillage agriculture began in 1969. Shirley Phillips encouraged my efforts through his interest and enthusiasm for this rather radical and new approach to farming without the use of tillage equipment. At that time, Harry Young, a western Kentucky farmer and pioneer of no-tillage agriculture along with Shirley, Jim Herron, Charlie Slack and other co-workers were excited about the potential of this new, innovative farming system and what it could do for the farmers of Kentucky.

During the summer of 1969 a study was initiated to measure corn yields and collect data about the soil/site conditions. With the assistance of 4 to 5 outstanding county agents, data was collected from 40 different sites over 5 physiographic regions and 25 soil series. Information included soil series, percent slope, soil drainage, pH of surface, and type of sod planted into (usually fescue).

Average corn yield of 16 sites studied in Eastern Pennyroyal (largely Pulaski-Wayne Counties) was 129 bu/ac. This convinced me that no-tillage was for real and that medium textured soils on sloping land, a common setting for Kentucky soils, were especially well-suited for no-tillage agriculture.

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[1] This paper was presented as the "S.H. Phillips Distinguished Lecture in No-till Agriculture", University of Kentucky, Dept. of Agronomy, November 29, 1990.

A long-term tillage x nitrogen rate study was initiated in 1970 at UK's Spindletop Agricultural Experimental farm. During the first 3 years soil water relations under the contrasting no-tillage (NT) and conventional tilled (CT) systems were studied. Over the growing season, approximately 20 percent more water was retained and available for corn plants use in the NT system than conventional. The conservation of soil water could carry the no-till crop through short drought periods without severe moisture stresses developing in the plants.

Physical Properties

Soil compaction has not been a problem in our long-term study on the Maury soil. No differences in bulk density between conventional tillage and no-tillage on the Maury soil were observed after 10 years of corn production. Saturated hydraulic conductivity measurements suggest better water movement in no-tillage. During the first 10 years, no deterioration of soil physical properties were observed. After 18 years of continuous corn production micromorphological examination showed the beginning of plate-like structure formation in the 1 to 5 cm soil depth.

Chemical properties

The most obvious chemical change observed in our long-term study was the rapid acidification of soil surface when high nitrogen rates were used. Associated with the reduced soil pH were increased levels of exchangeable aluminum and manganese. The acidic condition resulted in lower corn yields due to a nutrient imbalance and additional weed competition. Acidic soils ($pH < 5.5$) results in rapid deactivation of the triazine herbicides commonly used in no-till corn production. Lime studies on these soils showed the surface soil acidity could be easily corrected through timely surface application of lime. Potassium and phosphorus tended to concentrate in the 0-5 cm soil layer under no-till. This is due to a lack of physical mixing in NT as compared to the annual mixing of plow layer for conventional tillage. Recycling by plants grown on the soil also contributed to surface accumulation of nutrients in NT system.

Organic matter was twice as high in 0 to 5 cm soil depth as compared to conventional tillage systems. Changes in total soil N followed patterns similar to other nutrients, with an increase occurring near the soil surface under no-till. The accumulation of organic matter at the surface of no-till soils and higher moisture affects the distribution and activity of soil microbes. The potential for immobilization of surface applied N fertilizer is increased in NT system. Method and timing of N fertilizer application often needs refinement in NT system to get the best efficiency. For example, studies where N fertilizer is placed

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below the surface (organic matter accumulation zone) may improve the N efficiency by 10-20%.

Conclusions

There is strong evidence that no-till farming does modify soil properties and the soil environment. Positive changes include improved soil structure, increased levels of organic matter and organic N, redistribution of less mobile elements such as P to soil surface, thus increasing its availability to the plants. In our long-term study area, the soil environment is likened to a forest soil or a permanent pasture because of nutrient recycling and organic matter accumulation at surface. No-tillage is definitely a sustainable system of agriculture and has been hailed as the best erosion control practice developed during the twentieth century.

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