Influence of Tillage on the Distribution of Soil Nutrients under Continuous Soybean Production

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Soybean production significantly differs from corn production in that soybeans return much less residue to the soil and no fertilizer nitrogen (N) is required for soybean production. However, most studies of fertilization and nutrient uptake under no-tillage have been conducted with corn. In this study the influence of tillage on the distribution of soil nutrients under continuous soybean production was determined.

Materials and Methods

The experiment was initiated in 1981 at the Bledsoe Research Farm in Pike County, Georgia on a Cecil sandy loam, which is a member of the clayey, kaolinitic, thermic family of Typic Hapludults. This study was part of a larger experiment evaluating tillage and residue management practices. For this study, two tillage practices were utilized: no-tillage (fluted coulter), and conventional tillage. The conventional tillage treatment was moldboard plowed to a depth of approximately 12 in, disked twice, and planted. The size of each plot was 15 x 30 ft and the experimental design was randomized complete block with four replications. A cover crop of rye (Secale cereale L.) was planted each fall without tillage using a no-till drill. The soybeans were planted in 30 in rows in May of each year. Seeding rate was 9 seed/ft of row using the cultivars 'GaSoy 17' in 1981 and 'Ransom' in 1982 and 1983. The only fertilizer applied was 100 lbs K/A as KC1 (0-0-60) in November 1981 since soil pH and extractable P levels were adequate.

Soil samples were collected after seed harvest in 1983 at depths of 0 to 3, 3 to 6, and 6 to 12 inches. Soil pH was determined in a 1:l soi1:water suspension. Extractable P, K, Ca, Mg, Mn, and Zn were determined by extracting a subsample of soil from each plot with a double-acid extract. The amount of P in the extract was determined colorimetrically, and the amount of K, Ca, Mg, Mn, and Zn was determined by flame emission or atomic absorption spectrophotometry.

Results and Discussion

The distribution of pH and extractable P, K, Ca, Mg, Mn, and Zn for conventional and no-tillage is shown in Figs. 1, 2, and 3. For no-tillage, the concentration of extractable nutrients was consistently greater in the soil surface than for conventional tillage. However, deeper in the soil profile the concentration of most nutrients was greater for conventional tillage compared to no-tillage.

The accumulation of these nutrients at the soil surface is associated with the surface application of fertilizers and lime without soil mixing and with the return of crop residues to the soil surface rather than incorporation. The impact of surface applications of lime without incorporation is illustrated by the distribution of soil pH with depth (Fig. 1). The divergence of soil pH with depth between conventional and no-tillage is indicative of greater efficiency of incorporated lime in ameliorating soil acidity. The increase in acidity and concomitant decrease in Ca in the soil surface under no-tillage corn production observed by Blevins et al, in Kentucky was not apparent in this study for soybean production where lime but no fertilizer N had been applied.

Results from analyses of whole plant samples or trifoliolate samples collected at this and other sites show that P, K, and micronutrient concentrations are ofter greater for no-tillage soybeans compared to conventional tillage (data not shown). This is easy to reconcile with the distribution of soil nutrients and the observation (made by me and many other researchers) that no-tillage results in a shallower root system.

The seed yield response to tillage is variable and generally depends on rainfall amounts and distribution (see Hargrove et al, this Proceedings) As a result of moisture conservation, no-tillage often results in greater seed yields in years with less than adequate rainfall. It would therefore seem that although continuous no-tillage results in a redistribution and concentration of soil nutrients at the soil surface this is not a disadvantage to soybean growth and seed yield. Lesser seed yields for no-tillage compared to conventional tillage on some soil types is probably related to soil physical limitations and not nutrient availability, per se.

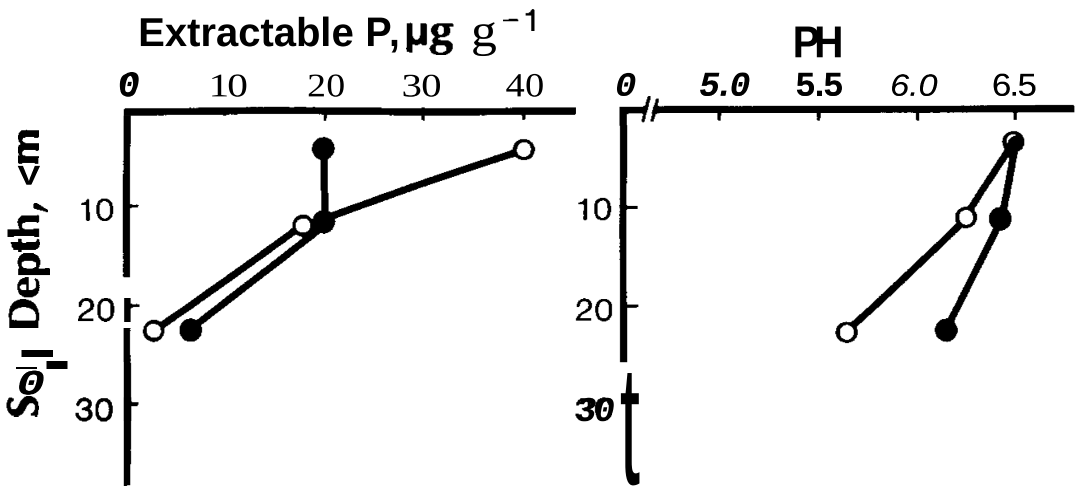

Fig. 1. Distribution of soil pH and extractable P for conventional (●●) and no-tillage (oo).

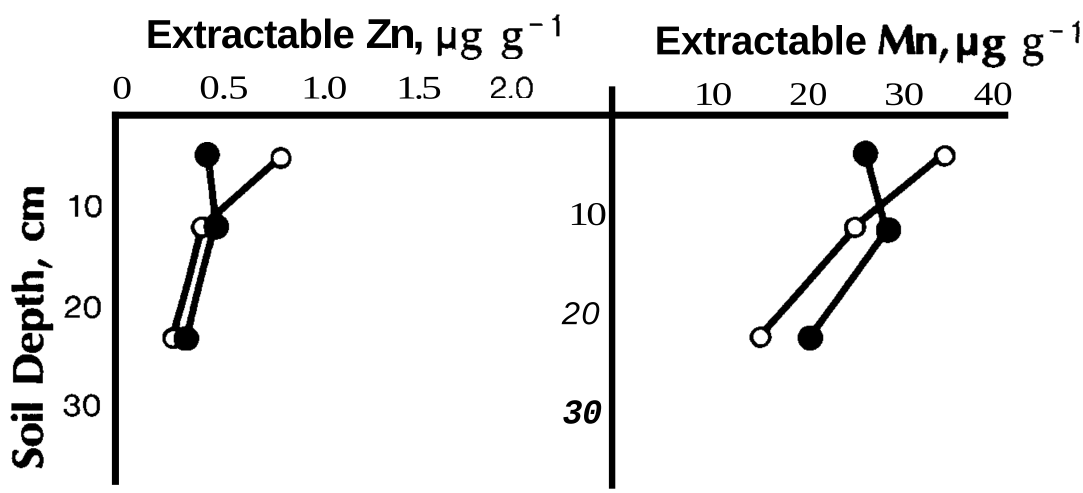

Fig. 2. Distribution of extractable Zn and Mn for conventional (●●) and no-tillage (oo).

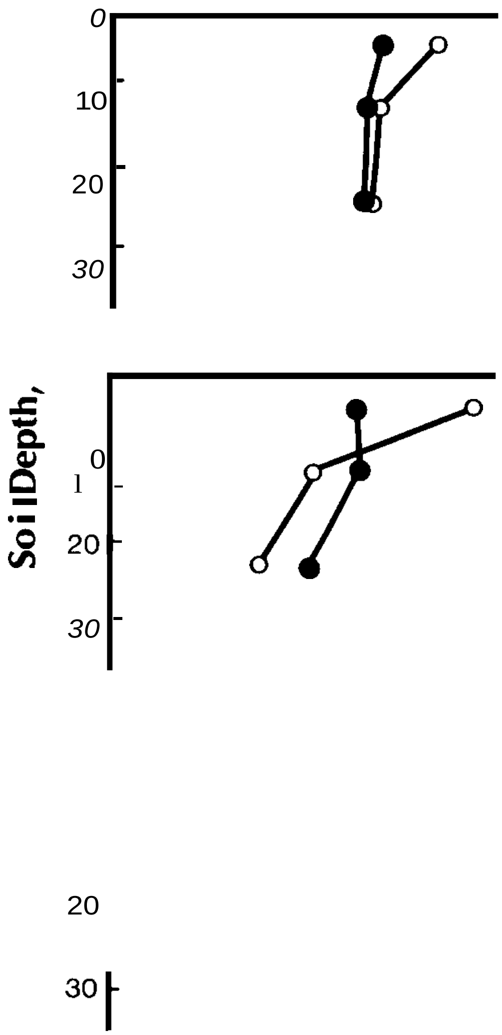

Fig. 3. Distribution of extractable K, Ca, and Mg for conventional (●●) and no-tillage (oo).