Erosion-Productivity Relationships for Blackland Prairie Soils in Mississippi

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Introduction: The Soil and Water Conservation Act of 1977 created an interest in research quantifying erosion-induced productivity losses for soils in the U.S. Many such eroded sites with low productivity occur in the Blackland Prairie of Mississippi and Alabama. Soils in this land resource area are, in general, alkaline Vertisols high in montmorillinitic clay overlying impermeable chalk (2,3). On this land resource area, an erosion-productivity study was initiated in 1982 (2), and expanded in 1984.

The primary objective of the expanded study was to determine effects of soil depth to chalk and water stress on growth and yield of nonirrigated soybeans.

Materials and Methods: Six experimental sites were located in farmer's fields where 'Centennial' soybeans were planted on either Binnsville or Dempolis soils. These sites were located in four counties of east Mississippi so that rainfall distribution within a growing season could be included as a variable. Weed control and fertility status at all sites was good, as cooperating farmers used "best management" practices for nonirrigated monocropped soybeans. Utilizing within field variability, 25 miniplots (0.00044 acre) were established with the depth of soil ranging from 5" to greater than 60". Depth of soil to firm chalk was measured with a penetrometer-type probe. Weekly rainfall was determined at each site, as was plant height and growth stage. Soils were tested for nutrient availability, and bean and biomass yields were taken at the end of the growing season.

Results and Discussion: For comparative purposes, fields A and B are the southernmost sites (Noxubee County), fields C and D are 25 miles further north (Clay County), and fields E and F are northernmost (Chickasaw County and Lee County, respectively). Soybean yields as a function of soil depth are seen in Figures 1-6. In four cases (Figures 1,2,5, and 6), depth to chalk accounted for more than 60% of the yield variability. In Figure 4, depth to chalk accounted for less than 28% of yield variability while in Figure 3, there was no significant relationship between yield and soil depth.

Weekly rainfall distribution for all six locations is seen in Figure 7. A comparison shows that fields A and B received the highest total rainfall. Note, however, that during pod fill (August 25 - September 22) fields A and B recorded rainfall during only one week. Fields C and D were planted late (21 days later than field A). Although they received considerably less total rainfall than fields A and B, the distribution of rain was reasonably uniform throughout the season.

Field E received the least total rainfall, and rainfall distribution was poor. From planting through early vegetative growth, significant rainfall was recorded only once (0.47 inches). Note that for this field, 96% of the variability in yield can be accounted for by soil depth. Similarly at site F, soil depth accounted for 80% of the variability in yield. Here, rainfall distribution was consistent throughout the season but the bulk of the total occurred after early vegetative growth.

In four fields (A,B,E,F) rainfall was insufficient during a particular growth period (e.g. early vegetative growth, flowering, or pod fill), and yields were lower than fields C and D. A comparison of rainfall distribution was made between these four fields. Fields E and F experienced drought during the early vegetative stage but received rainfall during pod fill. Their yields were the lowest recorded, and soil depth accounted for 96% and 80% of the variation in yield. Conversely, in fields A and B, rainfall was sufficient during the vegetative period, and drought occurred during pod fill. In these cases, yields were increased and soil depth accounted for 61% of yield variability. Thus, when rainfall is adequate during the vegetative stage, yield potential is maintained. Then, if drought occurs during pod fill, soil moisture storage (a function of soil depth) influences yield. In the case where drought occurred during the vegetative stage, yield potential was low, and this deficit could not be offset by adequate rainfall during pod fill.

Fields C and D recorded the highest yields because rainfall was sufficient during both early vegetative stage and pod fill. In these two cases, within-field yield variability is not related to soil depth.

It is concluded then, that when rainfall is adequate during critical plant development periods, soil depth is not a yield determining factor. When rainfall is inadequate during critical development periods, soil moisture storage becomes a yield determining factor and erosion-productivity relationships can be identified for these soils.

Literature Cited

1. The National Soil Erosion - Soil Productivity Research Planning Committee. 1981. Soil erosion effects on soil productivity: A research perspective. Journal of Soil and Water Conservation. 36:82-90.

2. Hairston, J. E., J. O. Sanford, P. K. McConnaughey. and D. A. Horneck. 1984. Erosion and Soil Productivity in the Blackbelt. Proceedings: Seventh Annual No-tillage Systems Conference, July 10, 1984. Dothan, AL. pp. 165-168.

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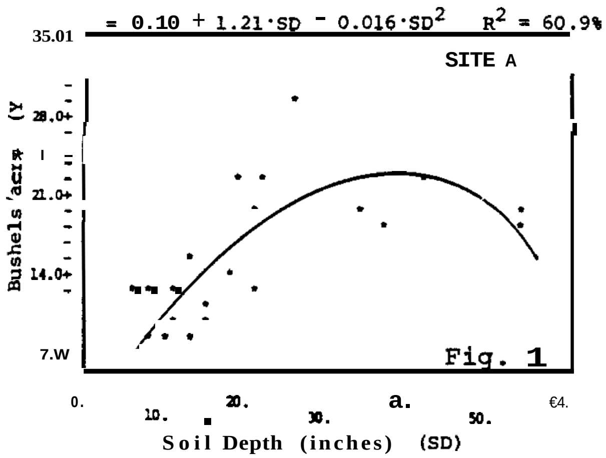

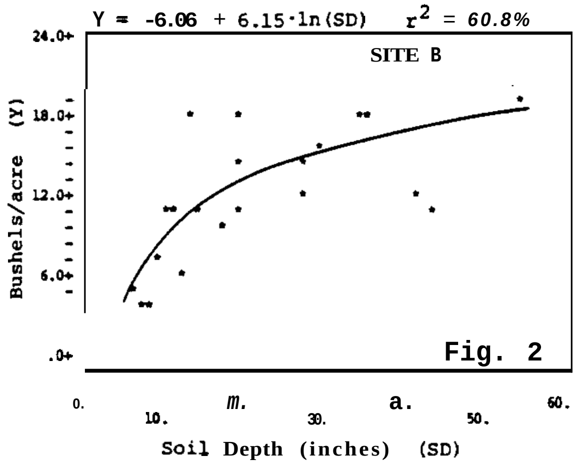

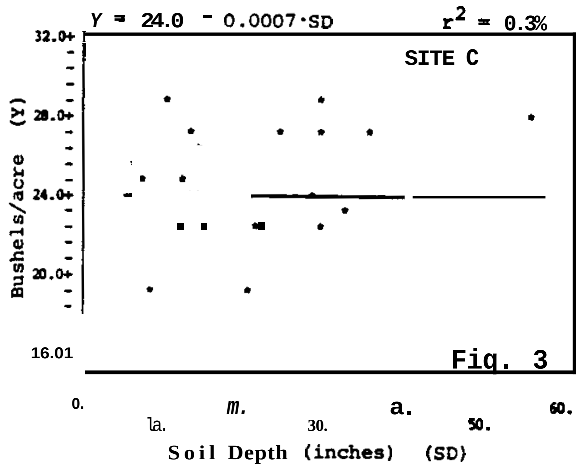

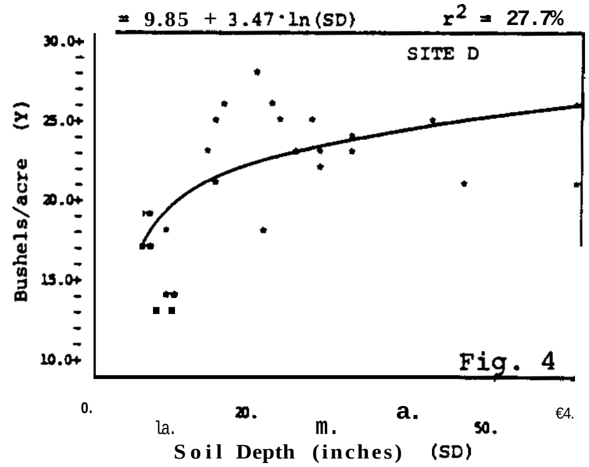

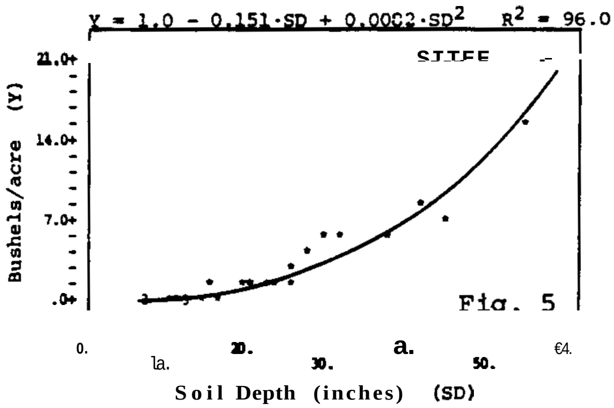

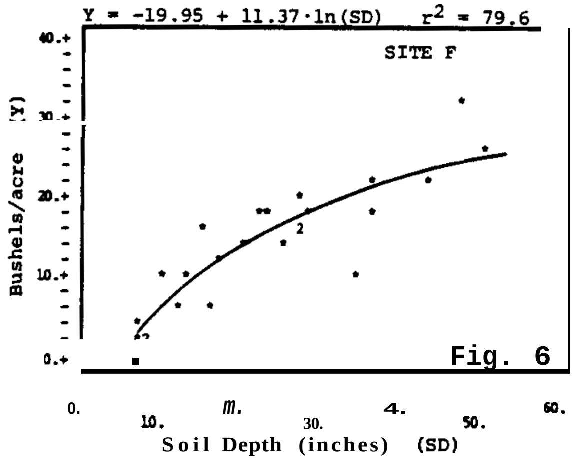

Figures 1-6: Soybean yield vs. soil depth for sites A–F in the Blackland Prairie of Mississippi, 1984 growing season.

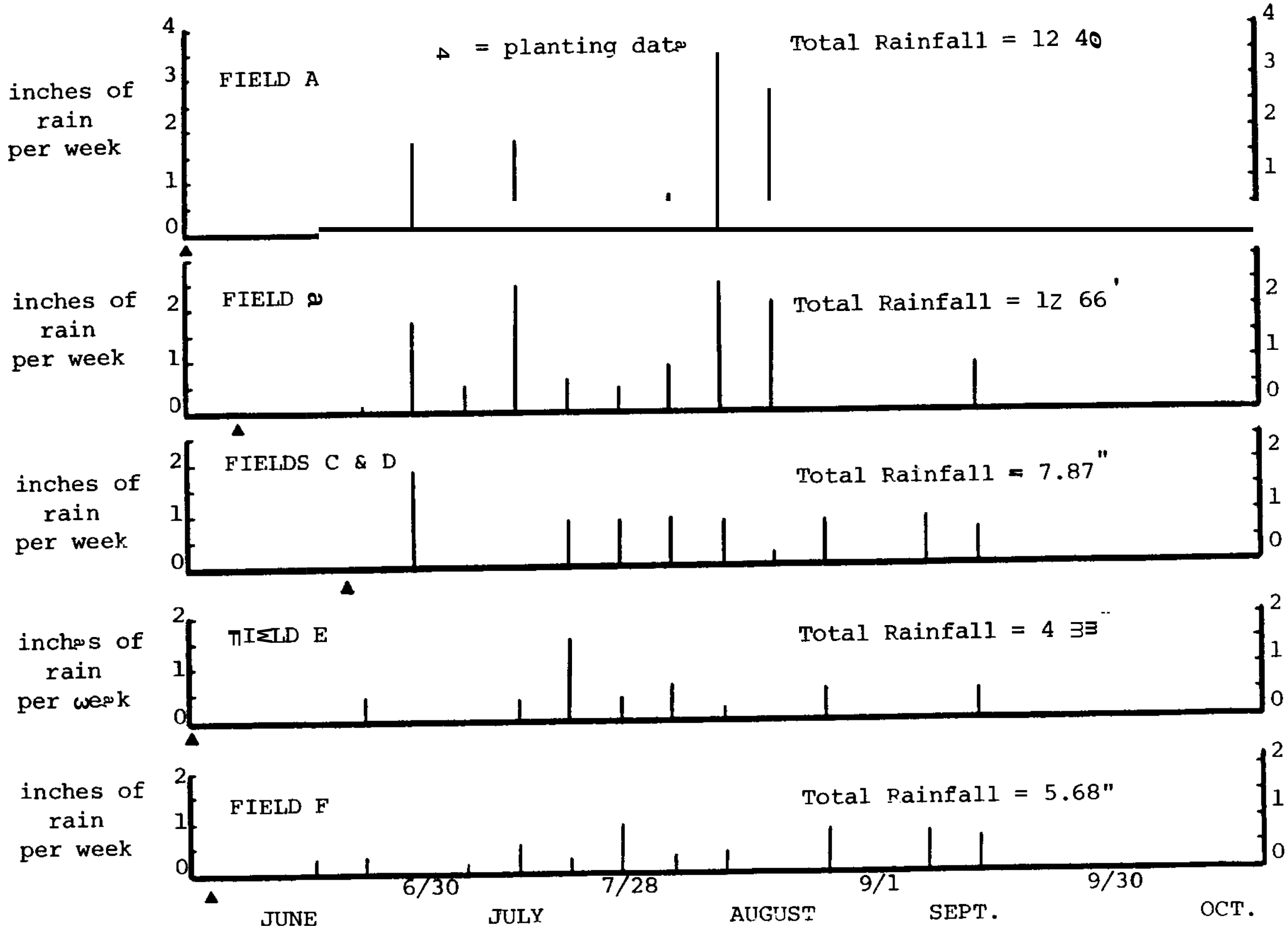

Figure 7: Weekly rainfall for Blackblet Prairie Sites A-F from 6-6-84 to 10-6-84.