ROOT DISTRIBUTION IN AN AGROFORESTRY ALLEY CROPPING PRACTICE

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Agroforestry farming practices provide multiple benefits including high and diversified productivity, and better maintenance of soil fertility and carbon sequestration capacity than annual cropping systems (Schroth et al., 2001). We showed that agroforestry practices reduce non-point source pollution from corn-soybean rotational watersheds at the Greenley Center (Udawatta et al., 2002).

Although several benefits of agroforestry have been claimed, in fact, there has been little research to demonstrate effects of interfacial root densities. Root density is an important determinant of crop water and nutrient acquisition (Chopart and Siband, 1999). In agroforestry, competition reduces crop yield and the advantage of intercropping depends on the extent to which the plant components are not in competition. In order to design best management practices that include agroforestry, land owners, policy makers, and farmers need information on variations in root distribution and density. The objectives of this study were to: (1) determine soybean, grass and tree root densities to a 1-m depth and (2) determine root distributional patterns along a transect extending from within a tree-grass buffer strip into a conventional soybean field.

Soybean, grass, and tree roots were sampled to a 1-m depth using a Gator-mounted soil sampler. Soybean root samples (n=27) were collected near the edge of the buffer and between buffers. Grass roots were sampled from the edge and middle positions of buffers (n=27). Tree roots were sampled from south, east, and west coordinates around trees (n=27). Roots were separated by horizons and diameter classes (dia.< 0.5, 0.5-1, 1-2 and > 2 mm) and root length was expressed in m m^{-2} surface area. The root shallowness index was determined for five trees per species by digging 75-cm deep pits around each tree. Proximal root diameter and vertical insertion angle of all roots ≥ 3 mm diameter were measured with a caliper and protractor, respectively. The shallowness index was determined as the ratio of the sum of cross-sectional areas of horizontal roots to the sum of cross-sectional areas of all roots (Salas et al., 2004). . Statistical differences in root length densities were determined by SAS software (SAS Institute, 1999).

The mean soybean, tree and grass root densities to a 1-m depth soil were 809±298, 1608±527 and 3887±1805 m m^{-2}, respectively. Grass buffers had two and five times more roots in a 1-m depth soil than trees and soybean, respectively. The mean crop and grass root densities were significantly different at $p \leq 0.05$ (Fig. 1). Distribution of soybean roots sampled from areas adjacent to buffer strips, and at sample points between buffer strips, were not significantly different (Fig. 2). The average root densities at the edge and in the crop alley were 680 and 868 m m^{-2}, respectively. Distribution of grass roots sampled at the edge and the middle of the buffer strip were 3257 and 4084 m m^{-2}, respectively (Fig. 3). The density of grass roots in the middle and at the edge of the buffer was not significantly different at $p \leq 0.05$. Among the three study tree species, pin oak (1633±561 m m^{-2}) and bur oak (1713±442 m m^{-2}) had more roots than swamp white oak (1479±600 m m^{-2}) (Fig 4). The distribution of horizontal and vertical root densities among the three species was not significantly different (Fig. 5). Pin and bur oak had almost the same amount of roots and similar distributional patterns.

Summary:

Results of the study demonstrated that grass buffers had not significantly reduced the soybean root lengths at the edge of the buffer in the soybean alley. Grass had significantly more roots at the edge of the buffer compared to the middle of the buffer. The study trees in the agroforestry watershed have similar root distributional patterns and similar root densities.

References:

Chopart, J.L. and P. Siband. 1999. Development and validation of a model to describe root length density of maize from root counts on soil profiles. Plant & Soil 214: 61-74.

SAS Institute. 1999. SAS user's guide. Statistics. SAS Inst., Cary, NC.

Schroth, G., J. Lehmann, M.R.L. Rodrigues, E. Barros, and J.L.V. Macedo. 2001. Plant-soil interactions in multistrata agroforestry in the humid tropics. Agroforestry. Systems. 53: 85-102.

Udawatta, R.P., J. J. Krstansky, G. S. Henderson, and H. E. Garrett. 2002. Agroforestry practices, runoff, and nutrient loss: a paired watershed comparison. J. Environmental. Quality. 31: 1214-1225.

Figure 1. Soybean, tree and grass root densities to a 1-m depth.

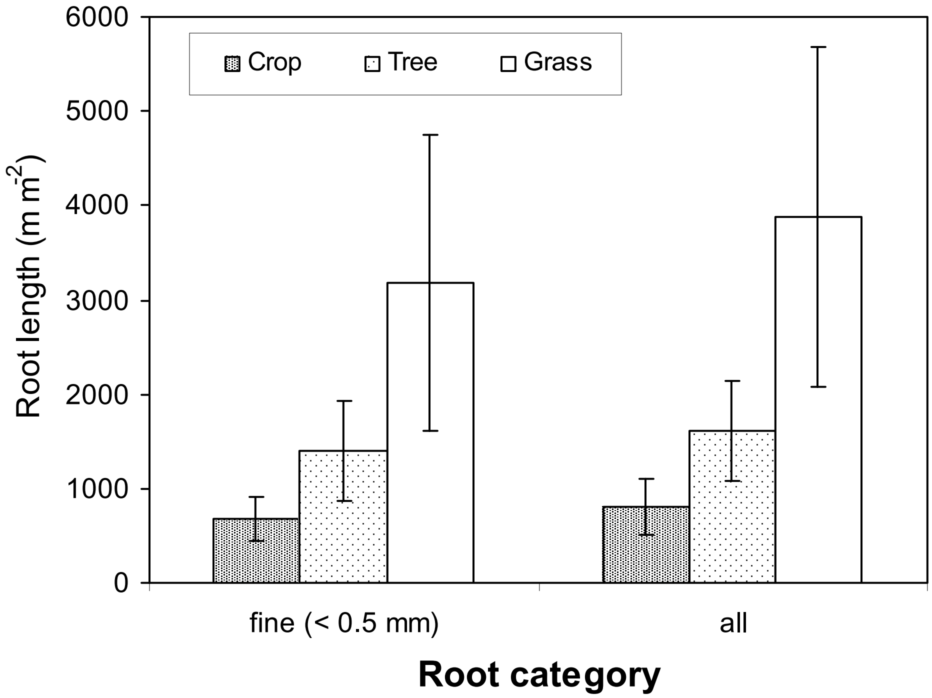

Figure 2. Distribution of soybean roots between two buffers. SE, CUS, CDS and NE denote south edge, center up slope, center down slope and north edge, respectively.

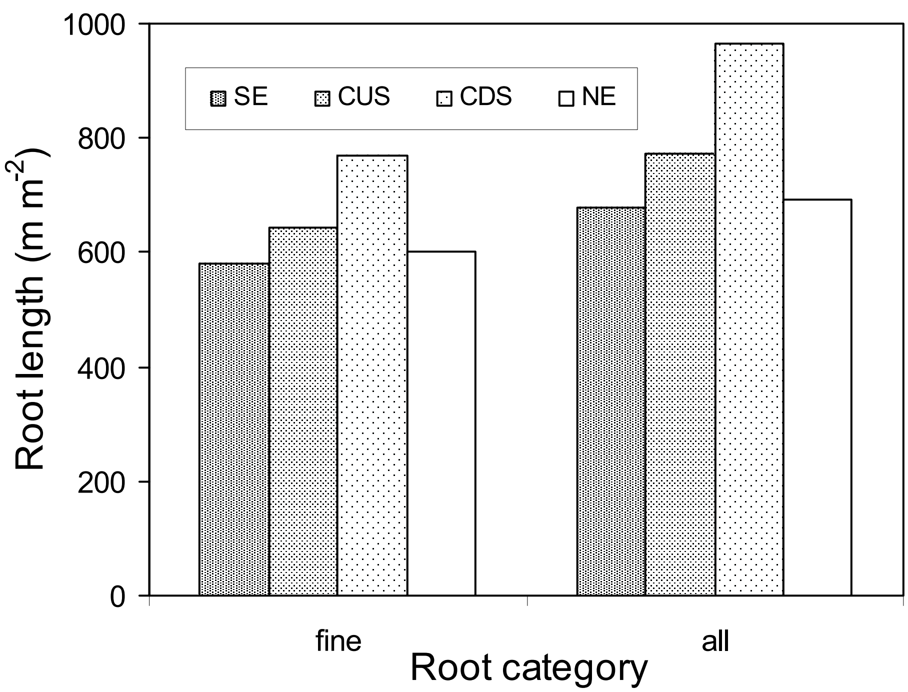

Figure 3. Distribution of grass roots within a buffer.

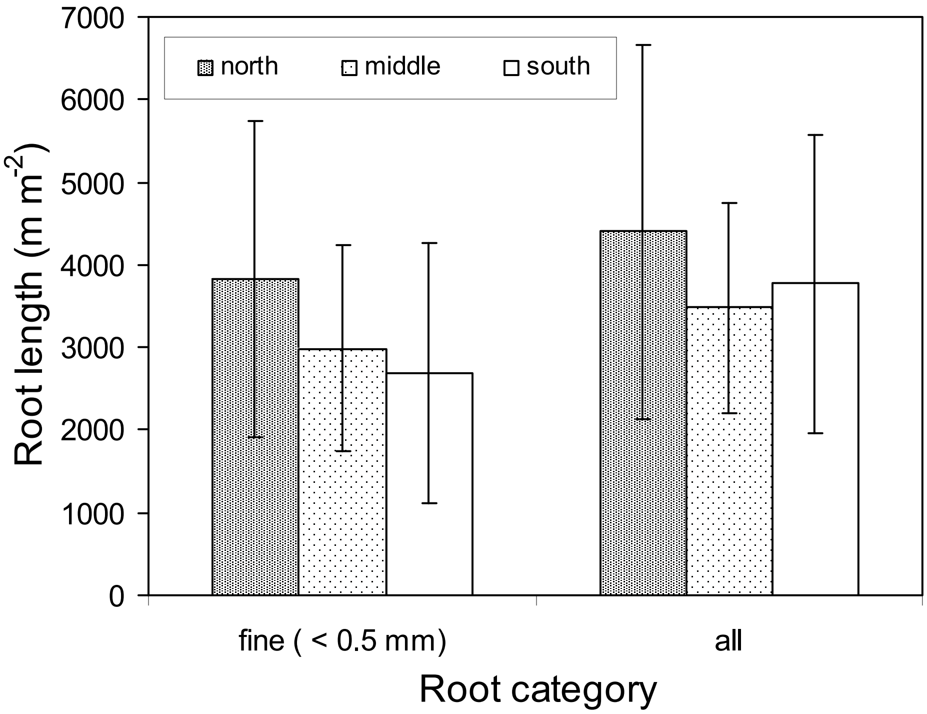

Figure 4. Pin, swamp white and bur oak root densities.

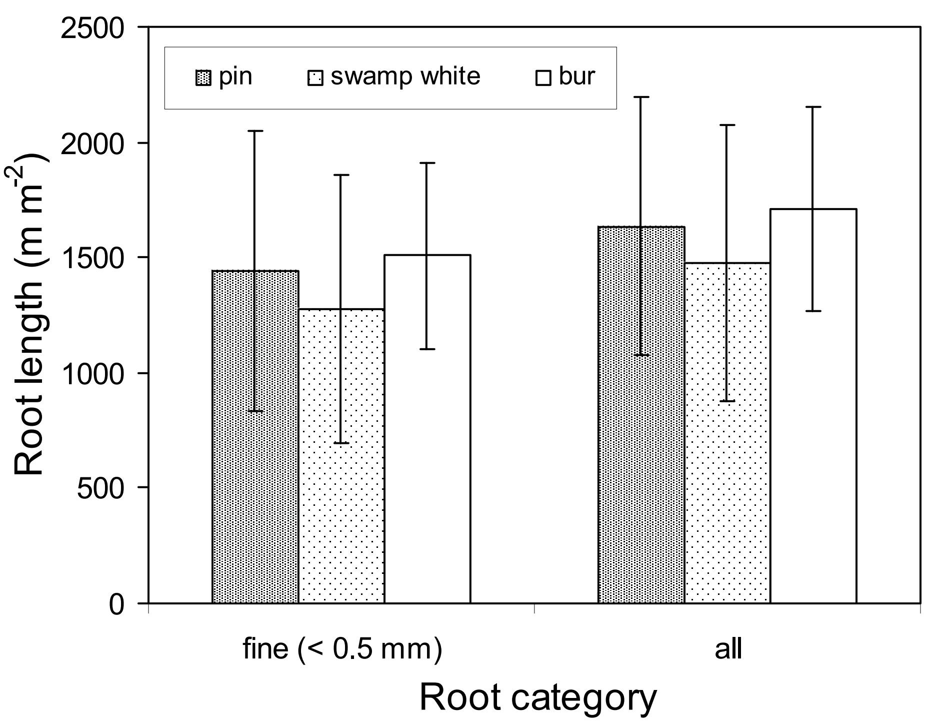

Figure 5. Mean cross-sectional areas of horizontal and vertical proximal roots in pin, swamp white and bur oak. The numbers above root bar are the shallowness index