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EFFECTIVENESS OF TILE DRAINAGE ON A FRAGIPAN SOIL IN AN ORCHARD SITE

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INTRODUCTION

Orchards require a well-drained soil in order for roots to have good aeration and to function properly. The soil is unsatisfactory for orchard purposes if the water table remains within six inches to a foot of the soil surface for a week after a heavy spring rain, or within three feet of the surface for several weeks after growth starts. Poor internal water drainage is a limiting factor for many sites. In Kentucky, many orchards are on soils with a fragipan which result in perched water tables near the surface during winter and spring months. This often results in extended periods of water saturation of the top two to three feet of the soil. For good growth and optimum production, internal water drainage needs to be improved. This can be done by ridging the site or by installing tile drain lines. However, ridging changes the soil profile, makes it more difficult to operate equipment, and may be of limited value because it can lead to ponding of water and/or soil erosion. Traditional tile drainage with a crushed rock (aggregate) back fill is effective although expensive. A method of installing tile without rock aggregate by mixing the soil and staying above the fragipan is reported to be effective.

The purpose of this study was to determine the effect six years after installation of this method of installing tile on soil moisture in an orchard site that is wetter than desired through much of the dormant season.

MATERIALS AND METHODS

An orchard site on a Tilsit silt loam soil on a 0 to 2 percent slope was selected at the University of Kentucky Research and Education Center, Princeton, KY. USDA-NRCS personnel determined that the fragipan depth was at approximately 20 inches and was typical for this soil type. The Tilsit soil is classified as moderately well drained, but rainfall usually exceeds drainage during winter and early spring. As a result, the site is usually waterlogged in the rooting zone from December through April. Although the USDA-NRCS recommends setting tile lines 30 ft apart for high value crops, lines were set 40 ft apart due to existing trees planted

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on 20 ft row spacing. A 2 ft-wide backhoe bucket was used to dig trenches that followed the slope of the fragipan. Tile was installed immediately overlying the fragipan in the bottom of these trenches. After removal, the soil was thoroughly mixed and replaced.

To serve as a control, an undisturbed and untiled site with similar topography, elevation, sod cover, and management history was examined and determined to be of the same soil type and classification as the tiled site described above. This untiled site was located about 150 feet from the tiled site. Water table levels in piezometers at the two sites were compared to determine the effectiveness of the tile.

Piezometers were installed for use in monitoring ground water levels at each site. Six different tile lines were monitored and thirty-four piezometers were dug, twelve in the untiled site, twelve within 3 ft of the tile lines, and ten within 20 ft of the tile lines (Fig. 1). Thus, piezometers were nested within each of the three treatments. Each piezometer was dug with a 1 ft diameter auger to a depth of 40 inches, penetrating into but not through the fragipan. A 40 inch long, 3 inch diameter pvc pipe was placed in each hole to a depth of 26 inches below the soil surface and backfilled around the pipe. The remaining 14 inches of pvc pipe that extended above the soil surface was covered with an inverted coffee can.

The distance from the soil surface to the water level in each piezometer was measured 3 to 5 times per week from 4 January 1993 to 17 May 1993, for a total of 87 measurements. Rainfall during this period was only 0.33 inches below normal. Analysis of variance and mean separation by the least significant difference ($LSD_{.05}$) were performed on these data.

RESULTS AND DISCUSSION

Six years after installation, tile effectively reduced perched water table levels. Significantly higher water table levels were observed at the untiled site compared to the average of both 3 ft and 20 ft from the tile for 63 of the 87 days, 72.4 percent of the time. The environment in the area close to the tile line was improved significantly. Water table levels in the untiled site were significantly higher than the levels 3 ft from the tile 85% of the time (74 of the 87 measured days). The area 20 ft from the tile was also improved but not as much as the area 3 ft from the tile. The water levels in the untiled site were significantly higher than levels 20 ft from the tile 54% of the time (47 of the 87 measured days).

One of the wettest months in this study was January, with 4.75 inches of precipitation (0.95 inches above normal). During this month, the water table levels in the untiled site were significantly higher than the levels 3 feet from the tile 17 of the 18 measured days (Fig. 2). At 20 ft from the tile, the same was true for only 6 of the 18 measured days (Fig. 2).

There were 21 days in this experiment during which the recorded water table levels averaged higher than their previous measurements. Such rising water levels are indicative of water infiltration exceeding internal drainage and evapotranspiration. The tile seemed to be most effective in this situation. Significantly higher water table levels were observed at the untiled site compared to the tiled site (average of both 3 ft from the tile and 20 ft from the tile) for 19 of the 21 days (or 90 % of the time) that water table levels were rising. However, areas close to the tile were most affected as indicated by the fact that water levels at the untiled site and 20 ft from the tile were significantly higher than those 3 ft from the tile for 18 of the 21 days water table levels were rising.

These results are summarized in terms of the percent of the days that the water table level was within 6, 12, and 18 inches of the soil surface (Table 1). Free water within 6 inches of the soil surface was observed at 3 ft from the tile less often than at the untiled site or for 20 ft

from the tile (Table 1). The percent of days that water table levels were within 12 or 18 inches of the soil surface were not significantly different between the 20 ft from the tile and the other two sites (untiled site and 3 ft from the tile), but were significantly different between the untiled site and 3 ft from the tile (Table 1). Thus, 20 ft away from the tile, water table levels do not differ significantly from those of the untiled site at either the 15, 30, or 45 cm depth.

SUMMARY

The results of this experiment suggest that tile installed without an aggregate backfill significantly lowers the water table levels near the tile on a Tilsit loam soil with a fragipan at 20 inches. Six years after installation, there was less free water at 3 ft from the tile than either 20 ft from the tile or at the untiled site, the primary benefit being within 6 inches of the soil surface. To improve a site for orchard use similar to the one in this study and utilizing the tile installation method that was used, it is suggested that tile be installed no more than 10 feet from the trees.

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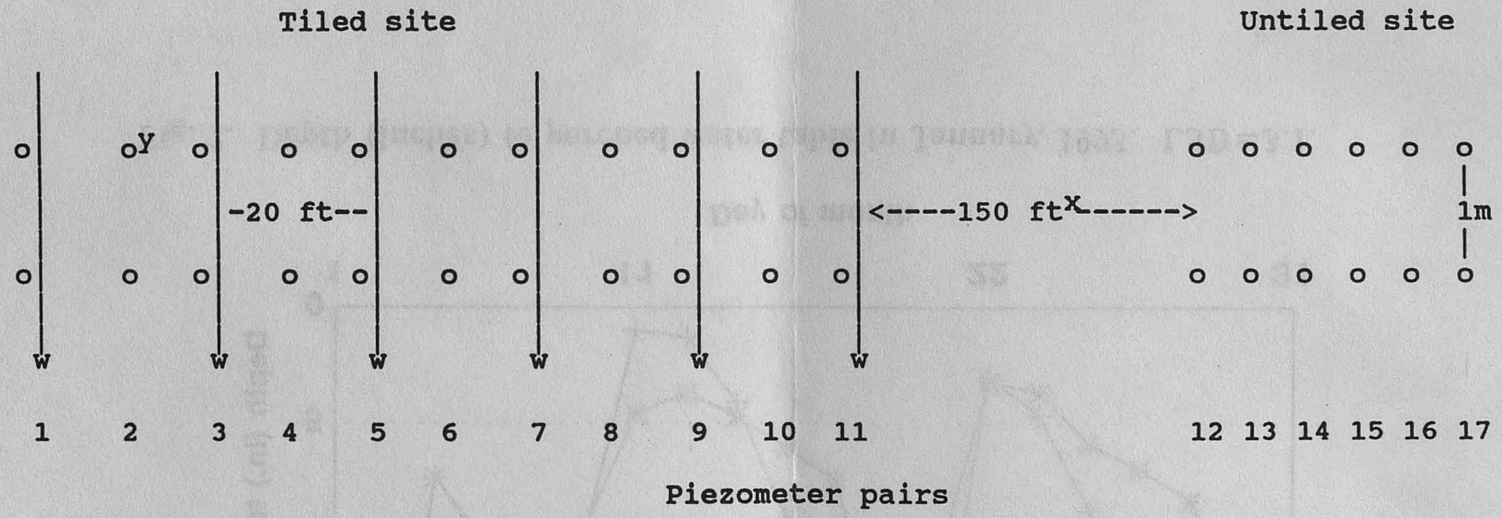
Table 1. *Percent of days the water table was within 6, 12, and 18 inches of the soil surface.*

Site	6 in	12 in	18 in
3 ft from tile[y]	2 b[x]	12 b	26 b
20 ft from tile	25 a	37 ab	53 ab
untiled	31 a	51 a	64 a

[z]Data recorded on 87 of the 137 days from 4 January through 17 May 1993, at UK, REC, Princeton, KY.
[y]Installed Fall 1987.
[x]Mean separation by $LSD_{0.05}$. Means with the same letter are not significantly different.

Fig. 1. Schematic of the location of piezometers at the two sites[z].



[z]Not to scale.
[y]Piezometers.
[x]The untiled site is about 53° N.E. of the tiled site.
[w]Tiled lines.

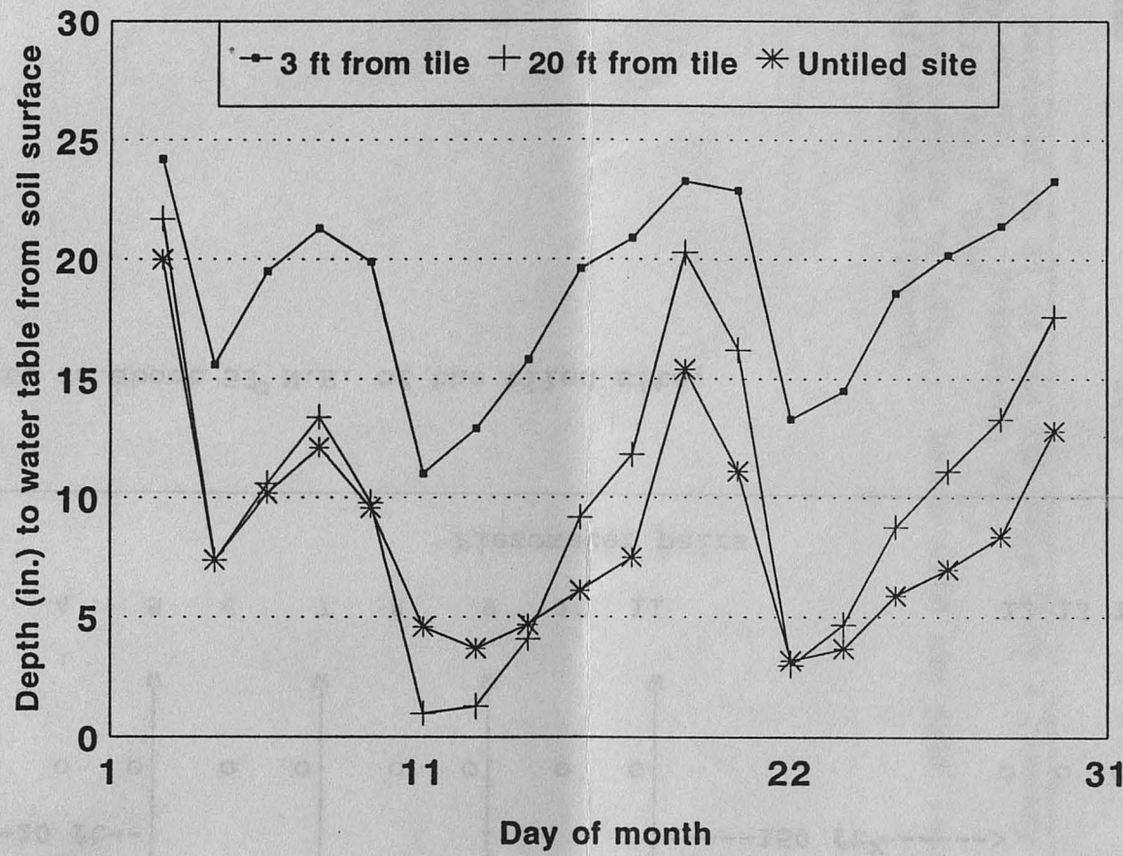


Fig. 2. Depth (inches) to perched water table in January, 1993. LSD=3.1.

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