Tillage is Necessary in Re-establishing Peach Orchards

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Summary. Three soil management treatments (cultivation, herbicide, and killed sod) were established in the drive middle of a 10-year-old apple orchard removed the year prior to planting peaches. The cultivation and herbicide treatments used preplant tillage, leaving a bare soil surface, whereas the killed-sod system was untilled. Peach trees *(Prunus persica* L. Batsch) were planted, and growth, yield, and soil bulk density were measured after 3 years. There were no differences in tree growth or yield for the three treatments These results were contrary to published reports that the killed-sod system increased early tree growth. The lack of growth response in the killed-sod system was attributed to the high soil bulk density remaining from the previous orchard. We concluded that truck and tractor traffic in the drive middle causes severe soil compaction, which may limit root development. The soil compaction can only be moderated by tillage.

The killed-sod system of orchard establishment and soil management has increased early peach tree yield and tree growth, improved soil structure and soil bulk density (Welker and Glenn, 1988), and reduced rainfall runoff (Glenn and Welker, 1989a) and N requirements (Glenn and Welker, 1989b). The killed-sod system also may reduce nematode populations when suppressive sod species such as bahiagrass *(Paspalum notatum* Flugge cv. Paraguayan-22), bermudagrass *[Cyodon dactylon* (L.) Pers.], and tall fescue *(Festuca arundinaceae* Schreb. cv. Kentucky 31) are grown (Biggs et al., 1994; Evert et al., 1992). In the killed-sod system, required nutrients and amendments are applied and incorporated into the soil based on soil testing, and then a vigorous and dense sod is established and maintained for 1 or 2 years. Prior to tree planting, the sod in the tree rows is killed with an herbicide and the trees are planted directly into the killed sod with minimal soil disturbance. In the mid-Atlantic region, the killed sod provides cover for two-and-a-half growing seasons, thus reducing the potential for runoff and evaporation losses and protecting the soil surface from the compacting forces of rainfall impact (Glenn and Welker, 1989a, 1989b; Welker and Glenn, 1988).

Rotations are recommended by West Virginia Univ. between orchard plantings. However, commercial growers are under economic pressure to maintain orchard productivity. A 1- or 2-year fallow period to develop a sod cover or a field-crops rotation can cause an economic loss. It is not uncommon for an orchardist to establish a new orchard in the drive middles between the previous tree rows. In this practice, the orchard soil is tilled, grass is planted in the former tree row, and the trees are planted in the former drive middles. This study compared the early productivity of three soil management systems (herbicide, cultivation, and killed sod) when peach trees were planted in the drive middle of a previous apple orchard.

Materials and methods

In Fall 1989, 10-year-old apple trees planted in 5.5-m (18-ft) row spacings were removed. The tree-row soil was tilled to a 15-cm (6-inch) depth and planted to 'Kentucky-31' tall fescue The former drive middles were assigned to one of three soil management systems: 1) cultivation, 2) herbicide, and 3) killed sod. In the cultivation treatment the soil was rototilled to a 20- to 25-cm (8- to 10-inch) depth before planting and maintained weed-free through monthly rototilling to a 5-cm (2-inch) depth. The herbicide treatment had similar soil preparation to the cultivation treatment, except weeds were controlled with monthly applications of paraquat. In the killed-sod treatment, the existing sod was killed with glyphosate and weed control was accomplished with monthly applications of paraquat.

In Apr. 1990, 'Redhaven' scion on 'Lovell' rootstock peach trees were planted 4.9 m (16 ft) apart in the tree row and rows were 5.5 m (18 ft) apart. There were six trees/treatment plot. The trees were headed at 1 m (39 inches) and left unpruned for the duration of the study. Disease and insect control followed standard practices (Virginia and West Virginia Cooperative Extension, 1993). In 1992, the fruit on the trees were not thinned so that total yield potential could be evaluated. Fruit were harvested in three pickings in late July 1992. Tree diameter at 30 cm (12 inches) was measured in Sept. 1992. Trunk cross-sectional area was calculated from the diameter, assuming a cylindrical trunk.

Soil bulk density samples were collected in the dormant season following harvest. Soil sample collection was from: a) the center of the tree-row treatments; b) the center of the drive middles; and c) the apparent wheel tracks in the drive-middles. Soil cores 54 mm (2.1 inches) in diameter were collected from the 0- to 10-cm (0- to 4-inch), 10- to 20-cm (4- to 8-inch), and 20- to 30-cm (8- to 12-inch) depths. Duplicate samples were collected from each plot. The study was established in a randomized block design with four replications. Treatment blocks were arranged perpendicular to the slope of the land. Yield and soil bulk density data were analyzed in analysis of variance using the Ryan–Einot–Gabriel–Welsh mean separation test ($P \leq 0.05$).

Results and discussion

The killed-sod system of peach production generally is recognized as a more-productive soil management system than cultivation or herbicide systems of soil management in the mid-Atlantic states, and is part of the extension recommendations for Virginia (Marini, 1991). In contrast to previous reports (Glenn and Welker, 1989a; Welker and Glenn, 1988), trees grown in the killed-sod treatment had no significant increase in diameter, yield potential, or yield/trunk cross-sectional area compared to cultivation or

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herbicide treatments (Table 1) . The lack of crop response by the killed-sod treatment is due in large part to the compacted soil of the tree row area in the 20- to 30-cm depth and perhaps deeper (Table 2).

In our previous study (Welker and Glenn, 1988), the killed-sod areas had significantly lower bulk density in the 0- to 10-cm depth compared to cultivation or herbicide soil management systems. Bulk densities at depths >10 cm were not affected significantly by the soil management systems in these earlier studies (Welkerand Glenn, 1988). However, all treatments were plowed to a 30-cm (12-inch) depth prior to treatment development. In this study, the tree-row soil bulk density in the 0- to 10-cm and 10- to 20-cm depths of all the treatments was lower than soil bulk densities in the drive middle areas due in part to the freeze-thaw effect in the winter over the 3-year period acting on the undisturbed tree row area (Miller, 1980), while the drive middle had regular truck and tractor traffic throughout three growing seasons (15 tractor and nine truck trips in the 3-year period). In this area of the mid-Atlantic region, soils rarely freeze to a 30-cm depth, which accounts for the high soil bulk density values in the killed-sod at 20 to 30 cm.

Table 1. ***The effect of thee soil management systems on peach tree growth and yield.***

Soil management system	Trunk diam (cm)	Fruit yield/tree (kg)	Fruit yield/ trunk cross-sectional area ($kg\cdot cm^{-2}$)
Killed sod	7.28	95.5	2.30
Cultivation	7.20	91.5	2.40
Herbicide	7.17	107.5	2.66
	NS	NS	NS

NS No significant difference at $P \le 0.05$.

Table 2. ***Soil bulk density levels in three soil management systems and in the drive middles of a 3-year-old orchard.***

Location	Depth (cm) 0–10	10–20	20–30
	Bulk density ($g\cdot cm^{-3}$)		
Killed sod	1.35 c[z]	1.42 c	1.60 a
Cultivation	1.31 c	1.36 c	1.42 b
Herbicide	1.20 d	1.42 c	1.36 b
Center of drive middles	1.48 b	1.55 b	1.63 a
Wheel tracks	1.58 a	1.67 a	1.68 a

[z] *Mean separation within columns based on the Ryan-Einot-Gabriel– Welsh proceduve (P £* 0.05),

The cultivation and herbicide treatments were tilled preplant; however, trees in the killed-sod treatment were planted directly into the previous drive middles. No action was taken to eliminate the soil compaction created by 10 years of orchard traffic. After only 3 years of orchard traffic, the soil compaction levels in the drive middles and wheel tracks of the present study are already very high (Table 2). Soil bulk-density values of 1.10 to 1.30 are considered optimal, and soil bulk-density values >1.55 $g\cdot cm^{-3}$ will limit severely the root growth and plant productivity for this soil type (Bowen, 1981).

Conclusion

We concluded that there is no advantage in developing a killed-sod system in the drive middles of the previous orchard without deep tillage at this site. The soil compaction developed by traffic in this silt loam soil during the previous orchard is severe, and probably limiting to the growth and development of the tree root system. On this soil type, the drive middle areas must be tilled to mitigate the soil compaction for any soil management system. Soil compaction can develop on any soil type, and the drive middle areas should be evaluated for soil compaction when re-establishing an orchard to prevent soil conditions from limiting tree root growth and orchard productivity.

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