

Orchard Floor Preparation Did Not Affect Early Peach Tree Performance on Aura Sandy Loam Soil

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SUMMARY. Peach (*Prunus persica*) trees were established and grown from 1996 to 1999 at the Rutgers Agricultural Research and Extension Center, Bridgeton, N.J., to compare performance under four methods of orchard floor preparation: flat no-till, flat cultivated, mound unmulched, and mound mulched orchard floors. The experimental site was flat and the soil was a well-drained Aura gravelly sandy loam (61% sand, 31% silt, 8% clay) with a pH of 6.5, cation exchange capacity 5.7, and organic matter content of 2.0%. Soil moisture holding and gas exchange capacity determine the efficacy of mounding in peach orchards. Under these conditions, the method of orchard floor preparation had no effect on peach tree trunk cross sectional area (TCSA), fruit number per tree, fruit size, and yield. Thus, without irrigation, there was no advantage to the early performance of peach trees

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associated with orchard floor mounding on Aura gravelly sandy loam when situated on a flat terrain.

Orchard floor modification can have a direct effect on tree survival rate, growth, vigor, and fruit yield in the early years of orchard establishment (Glenn and Welker, 1989). Funt et al. (1997) reported that the optimal soil water holding capacity and space within the soil for gas exchange have a direct impact on tree performance. The finer the soil texture, the more attention is needed to ensure adequate drainage for optimum aeration in the rooting zone. For coarse textured soils, more attention is required to ensure optimum water retention to minimize moisture stress and enhance nutrient use efficiency. Growers have attempted to solve the problem of adequate moisture and nutrient retention, as well as aeration of orchard soils, by adopting various land preparation options as may be dictated by the soil type and land terrain. On finer textured soils, several horticultural crops are commonly grown on raised beds to minimize root zone flooding and the subsequent anaerobiosis that inhibits root development and can lead to tree death from phytophthora infection (Funt et al., 1997) or weaken the tree so that death from winter injury occurs. On coarse textured soils, mulching has been shown to conserve soil water and minimize nutrient losses associated with leaching (Ji and Unger, 2001; Tanaka and Anderson, 1997; Yohannes, 1999).

The use of raised beds or mulch as an alternative to conventional flat culture adds to production costs and may or may not improve peach performance on all soils and may reduce the growers' net profit or increase the net loss. However, Funt et al. (1997) showed that raised beds increased peach TCSA and yield efficiency over 5 years on a silt loam, noncalcareous soil in Ohio. Peaches require less moisture than apples (*Malus ×domestica*) or pears (*Pyrus communis*), but require better aeration. For this reason peaches generally perform better on sandy soils and sandy loam than on soils with poor internal drainage (Westwood, 1993). Also, the ground water table should be no closer than 1 m (3.3 ft) during the

growing season because it limits root growth (Westwood, 1993).

There is limited information on the field conditions under which a grower should consider adopting raised beds or mulching for peach production in the mid-Atlantic region. At present, nearly all peach orchards in New Jersey are established on flat land with unmulched orchard floors, regardless of the soil type and terrain. While a few orchards in New Jersey use permanent drip irrigation and some use movable pipes, about half of the orchards in New Jersey do not use irrigation but depend on rainfall for soil moisture. The soils in the peach growing areas of the mid-Atlantic region vary substantially from coarse to fine particles, and the terrain varies from flat to steep slope. Aura sandy loam represents 75% of the total land area used for peach production in New Jersey (N.J. Agricultural Statistics Service, 1999). Twenty percent of the remaining peach orchards are located on coarser textured soils classified as sand or loamy sand, and 5% are grown on various finer textured soils. The purpose of this study was to compare peach performance in the first four years of orchard establishment using different methods of land preparation, including raised beds, on an Aura sandy loam.

Materials and methods

The study was carried out on an Aura gravelly sandy loam (Red Yellow Podzolic, 60.7% sand, 31.2% silt, 8.1% clay) at the Rutgers Agricultural Research and Extension Center, Bridgeton, N.J., from 1996 to 1999. The soil has a family classification of fine loamy, mixed, mesic, of the subgroup Hapludults (U.S. Department of Agriculture, 1973). The site was flat and at the inception of the study, the soil pH was 6.5, with an organic matter content of 2.0%, and a cation exchange capacity of 5.7 meq/100 mL. The land was under grass fallow for several years before the study. Treatments comprised four methods of orchard floor preparation: 1) flat, no-till (FNT); 2) flat, cultivated (FCT); 3) mounded, unmulched (MUN); and 4) mounded mulched (MMU). Each treatment was replicated six times in a randomized complete block design. In Fall 1995, mounds were constructed and grass was established. In March 1996, before planting trees, spring

grass regrowth including all vegetation was killed with glyphosate [$1.0 \text{ kg}\cdot\text{ha}^{-1}$ ($0.89 \text{ lb}/\text{acre}$)] and left in place as a killed sod mulch. The drive-rows of the peach orchard were maintained with a planted mixture of 'Kentucky-31' tall fescue (*Festuca arundinaceae*) or 'Reliant' hard fescue (*F. longifolia*) initiated in Fall 1995. Herbicides used for weed control in the tree rows were applied with a backpack sprayer calibrated to deliver $234 \text{ L}\cdot\text{ha}^{-1}$ at 225 kPa ($25.0 \text{ gal}/\text{acre}$ at $32.6 \text{ lb}/\text{inch}^2$) using 8004 nozzle tips. The FNT treatment involved the application of 2,4-D [$0.3 \text{ kg}\cdot\text{ha}^{-1}$ ($0.27 \text{ lb}/\text{acre}$)] plus preemergence (PRE) herbicides: pendimethalin plus simazine or isoxaben [$3.4 + 3.4$ or $0.84 \text{ kg}\cdot\text{ha}^{-1}$ ($3.03 + 3.03$ or $0.749 \text{ lb}/\text{acre}$)] to control weeds within the 2-m (6.6-ft) tree row width. Herbicide applications were made two times per year, one in mid-April and another in early to mid-September. The FCT treatment was applied to both the tree row and the drive-row using a disk harrow to a depth of 10 cm (3.9 inches), twice at a 14-d interval. Preemergence (PRE) herbicides (pendimethalin plus simazine or isoxaben) were subsequently applied for weed control in the tree row. The herbicide treatment in the fall included 2,4-D for the control of emerged annual broadleaves. In the mounded treatments, mounding was limited to the 2-m tree row and the mounds were constructed from topsoil plowed from the drive-row on either side of the tree row with a moldboard plow. The mounds were about 2 m wide at the base and 1.3 m (4.27 ft) wide at the top. Mound height was about 80 cm (31.5 inches). Weeds were controlled with PRE herbicides in the spring and 2,4-D combined with PRE herbicides in fall. The tree row in the MUN treatment was left bare, but was mulched in the MMU treatment with grass clippings blown with a mower from the drive-row. Grass was cut and blown monthly during the growing season and the amount of clippings utilized varied by season. Only mulch materials from the adjacent drive-row were used in the MMU treatments. The grass mulch dry weight was estimated at $1.4 \text{ t}\cdot\text{ha}^{-1}$ ($0.62 \text{ ton}/\text{acre}$) and about 1.5 cm (0.59 inch) thick at clipping.

'Candor' peach tree seedlings, purchased as 2-year-old bare-rooted whips, were planted in April 1996 using a 61-cm (24.0-inch) diameter

screw type soil auger at a spacing of $6 \times 6 \text{ m}$ (19.7 ft) in 30-m (98.4-ft) long plots. Each experimental plot had a total of five trees, with the three in the middle serving as the data trees and the two on either end serving as guard trees. Trees were headed at planting to about 50 cm (19.7 inches) and were minimally pruned each spring to an open vase system for maximum tree size expression. Pest management was based on the New Jersey Commercial Tree Fruit Production Guide (Belding and Lokaj, 1999). Fruit were hand thinned 4 to 6 weeks after full bloom

to a spacing of 15 cm (6.0 inches) between fruit. Normal supplemental irrigation and fertilizers were not used in this study so as to apply a more rigorous challenge to the grass mulch and mounding which both impact available water and nutrients.

Trunk cross-sectional area, as calculated from trunk diameter, is a reliable measure of tree growth and was measured each fall following leaf drop. Trunk diameters were measured 15 cm above the graft union or midway between the root taper and the first lateral branch if 15 cm above the graft

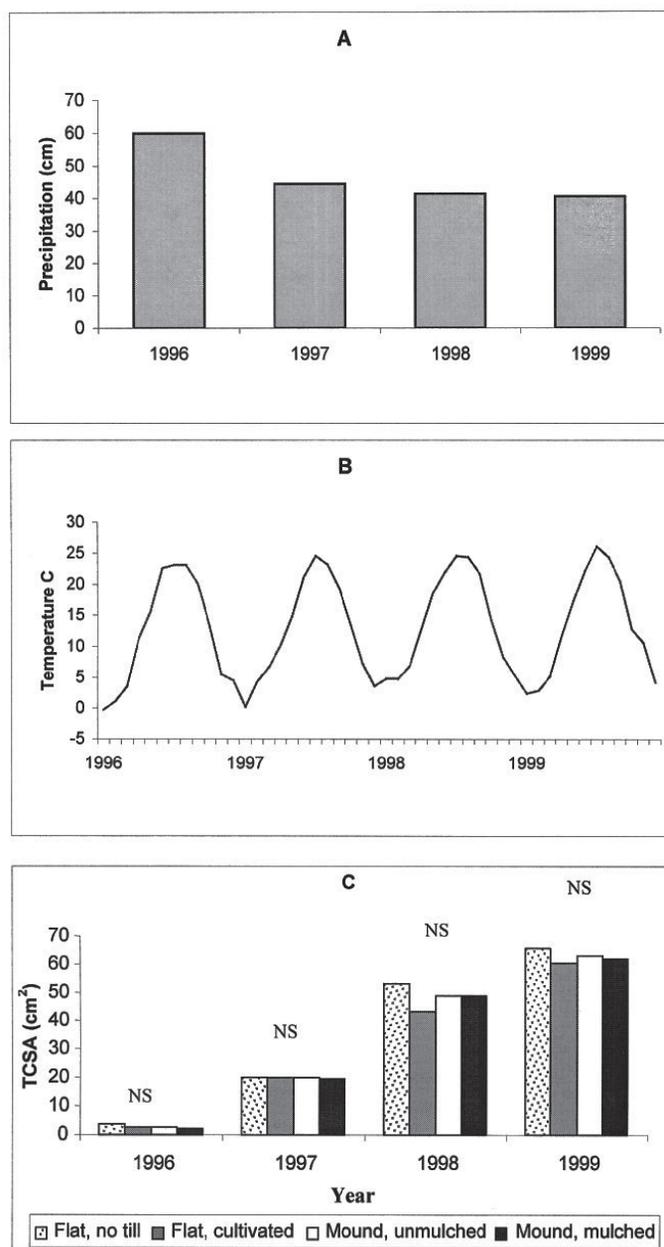


Fig. 1. (A) Precipitation (April–August), (B) mean daily temperature, (C) and trunk cross sectional area (TCSA) of peach trees grown under different methods of orchard floor preparation (orchard was established in 1996); $2.54 \text{ cm} = 1.0 \text{ inch}$, $^{\circ}\text{F} = 1.8(^{\circ}\text{C}) + 32$, $6.45 \text{ cm}^2 = 1.0 \text{ inch}^2$.

Table 1. Influence of orchard floor preparation on peach mortality, fruit number, fruit size, and yield on an Aura sandy loam.

Orchard floor preparation	1996 Mortality (%)	1998			1999		
		Fruit/tree (no.)	Fruit size (g) ^z	Fruit yield/tree (kg) ^y	Fruit/tree (no.)	Fruit size (g) ^z	Fruit yield/tree (kg) ^y
Flat, no till	15	72	250	18.0	224	190	42.6
Flat, cultivated	10	63	190	11.9	204	200	40.8
Mound, unmulched	10	74	210	15.5	212	170	36.0
Mound mulched	13	46	230	10.5	215	210	45.2
Significance at $P < 0.05$	NS	NS	NS	NS	NS	NS	NS
Analysis of variance P value	0.98	0.42	0.37	0.39	0.79	0.52	0.63

^z28.35 g = 1 oz.

^y0.454 kg = 1 lb.

union included the swell from tree limbs. The total annual precipitation, as well as annual temperature fluctuations, was reported during the active crop growth period of April to August. Moisture in early spring is most often sufficient and not of serious concern.

In 1998 and 1999, fruit were harvested twice weekly as they matured, totaling three to four harvests per plot annually. Fruit number and total fruit weights were recorded at each harvest. Data were analyzed with SAS using analysis of variance and the Waller-Duncan K ratio t test (SAS Institute, 2000) for means separation.

Results and discussion

PRECIPITATION AND TEMPERATURE.

From 1996 to 1997, annual precipitation during the active growth season for peaches (April to August) ranged from 40 to 60 cm (15.7 to 23.6 inches) (Fig. 1A). Precipitation was highest (60 cm) in 1996, the year of orchard establishment, and lower in subsequent years. For the experiment location the 30-year average precipitation during these months is 49.5 cm (19.50 inches), which is similar to the precipitation averages for the years of this study.

In all the years compared, precipitation was reasonably evenly distributed throughout the active growth period for peaches (data not shown). The range of precipitation seemed adequate for good peach growth and development, and was not expected to significantly bias peach growth and development from year to year. There is inadequate information on the influence of precipitation amount and temporal distribution on peaches in the mid-Atlantic region, therefore the impact of variations between 40 and 60 cm total precipitation, as well as monthly amounts, could not be established in this study.

Temperature regimes were similar from 1996 to 1999 (Fig. 1B). The lowest winter monthly average temperatures ranged from 0 to 5 °C (32.0 to 41.0 °F) and the highest monthly average summer temperatures ranged from 23 to 26 °C (73.4 to 78.8 °F). The average temperatures (Fig. 1B) from 1996 to 1999 were similar. More studies are needed to understand the level of variation in temperature that might influence peach growth and development, especially at the critical growth stages, in the early years of orchard establishment.

PEACH PERFORMANCE. From 1996 to 1997, TCSA, a parameter closely associated with growth in peach trees (Welker and Glenn, 1988), did not differ among the four methods of orchard floor preparation (Fig. 1C). Early season growth during the establishment year is often significantly influenced by the condition of the trees from the nursery and therefore, treatments require substantial duration for any growth impact to be observed. Also, orchard floor preparation had no significant effect on peach tree mortality in 1996 or fruit number, size, or yield in 1998 and 1999 (Table 1). The relatively high mortality (10% to 15%) was due primarily to vertebrate pest damage, including deer and voles, during the establishment year. Yield in 1998, the first fruiting year, ranged from an average of 10.5 to 18 kg (23.1 to 39.7 lb) per tree and from 36.0 to 45.4 kg (79.4 to 100.0 lb) per tree in 1999. Fruit number per tree averaged 64 in the first fruiting year and increased to an average of 214 fruit per tree in 1999. Average fruit size also did not vary significantly, averaging 207 g (7.3 oz) per fruit for 1998 and 1999 (Table 1). This suggests that under the conditions of this study, mounding

and mulching did not enhance early peach tree performance as had been reported elsewhere (Funt et al., 1997; Glenn and Welker, 1989; Tanaka and Anderson, 1997). Funt et al. (1997) noted that average fruit size was unaffected by external stresses while other tree growth measurements showed significant differences. Further, in associated work by the authors, trunk cross sectional area and fruit yield were significantly different due to external plant stresses, yet average fruit size was notably unaffected.

In an Ohio study, combined silt and clay made up more than 80% of the Cardington/Bennington silt loam soil, making it a fine soil with higher than average water holding capacity. Raised beds on these soils improved fruit mass by 56% over flat beds. TCSA and fruit numbers were strongly affected (Funt et al., 1997). Surprisingly in the Ohio study, irrigation did not significantly increase yield, average fruit mass, or TCSA when used on this fine soil with good water holding capacity. A study of peach tree growth in Ontario on soils with very poor water holding capacity showed positive responses to irrigation in terms of tree growth, decreased winter injury, reduced perennial canker, and promoted tree survival (Layne and Tan, 1984). Annual and cumulative yield was also increased with irrigation, particularly in the later years of this 11-year study (Layne and Tan, 1984). It appears that soil moisture, particularly soil water-holding capacity, played the critical role in determining if mounding is a beneficial practice.

The site of this study was flat and water infiltration depended more on the soil characteristics, and less on the topography. The well-drained characteristic of Aura sandy loam formed

into raised beds prevented the tree growth and yield advantages reported for raised beds on fine particle soils (Funt et al., 1997). Soil type among these three studies reveal a basic finding, heavier soils benefit from mounding (aeration) and not from irrigation while the lighter soils benefit from irrigation and not mounding. Optimizing growth requires an understanding of what limits growth and production. Mounding increased tree growth and yield only where soils were heavy and trees on heavy soils did not respond to supplemental irrigation. Mounding soils on lighter soils without irrigation will not improve tree growth and yield. Only irrigation had that effect. Determining what soil type will benefit from mounding must then be based on soil gas exchange capacity caused by the lack of adequate drainage.

The well-drained Aura soil did not respond to the moisture conservation benefits of mulching with killed sod. In defense of the mulch, the amount used was designed to be thin and temporary to avoid providing winter habitat for voles that damage tree bark. With that concern limiting mulch deposition, the benefits to available soil moisture were lost (Glenn and Welker, 1989; Tanaka and Anderson, 1997).

This study showed that mounding and/or the use of mulching under conditions of flat terrain and an Aura sandy loam soil was not effective for enhancing early peach performance. Mounding and/or mulching, without irrigation, did not result in significant improvements in tree growth or yield compared to the standard commercial practice in New Jersey of planting on flat terrain and using chemical weed control. The results of this study would likely be different on finer textured soils.

The major benefit of mounding fine textured soil has been to increase soil air space to prevent root stress from anaerobic conditions. Since increased soil moisture has been positively correlated with the distribution of *Phytophthora cactorum* spores (Horner and Wilcox, 1996), mounding poorly drained soils would be expected to decrease tree death from phytophthora root rot. Since studies of soil mounding in peach orchards have contradictory results where soil type and orchard floor management

vary, future studies should be extended over a range of soils to determine when mounding, mulching, and/or irrigation should be considered.

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A Foam Mulching System to Control Weeds in Tomatoes and Sweet Basil

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SUMMARY. A foam mulch system was developed that can be applied as an aqueous mixture of cotton and cellulose fibers, gums, starches, surfactants and saponins and dries to an one inch thick mat. This mulch may overcome the difficulty in applying and lack of persistence with natural mulches. Foam mulch also has the advantage of being able to be incorporated into the soil without requiring disposal like some plastic mulches. The objective of our study was to determine the effect of foam mulch and its color on weed control within the crop row and on yields of basil (*Ocimum basilicum*) and tomatoes (*Lycopersicon esculentum*). The foam mulch maintained its integrity for the entire growing season and provided weed control within the crop row comparable to black plastic mulch. The only weeds that emerged in the crop row were through holes in either the black or foam mulch. Foam mulch color did not affect weed control because regardless of color it did not allow light penetration and

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