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Long-term effects of managed grass competition and two pruning methods on growth and yield of peach trees

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ABSTRACT

Ground cover competition and tree training strongly affect development of newly planted peach trees and eventual productivity of peach orchards. This experiment characterized the long-term interactive effects of three levels of competition and two pruning criteria on yield, fruit size, and marketable yield efficiency. Trees of two cultivars ('Jersey Dawn', JD, and 'Redskin', RS, on Lovell) of peach (*Prunus persica* (L.) Batsch) were planted in an orchard in 1993 and grown for 14 years in a vegetation free area (VFA) width of 0.6 or 2.4 m. A separate group of trees that were in the 2.4 m VFA had grass seeded beneath them in 1998 to obtain 0 m VFA. All trees were pruned to maintain canopy size with wide-angled scaffold limbs and intense pruning (IP) or upright branch form with reduced pruning (RP). In general, RS had greater yield than JD and yield was greatest in the 2.4 m VFA with RP and least in the 0.6 m VFA with IP. Cumulative marketable (≥6.35 cm) and average annual total yield of both cultivars was similar for RP trees in 0 m VFA and IP trees in 2.4 m VFA's although more of the fruit were in the largest size class (>6.98 cm) in the IP trees. Reduced pruning increased crop load. Fruit weight decreased with increased crop load more in RS than JD and this response was similar for all VFA's within each cultivar. Grass competition tended to reduce both the number and weight of fruit per tree but the average weight of individual marketable fruit was reduced only in the 0.6 m VFA of RS. Tree size was reduced by grass competition and pruning times measured from 1995 to 2000 were less in RP than IP. Consequently, marketable yield efficiency of marketable fruit (grams fruit ≥6.35 cm/cm^2 trunk cross-sectional area, TCSA) measured from 2004 to 2007 was generally greater in trees with RP than IP and in the 0.6 than the 0 and 2.4 m VFA. The results indicate that persistent competition will reduce total annual yield per tree but with reduced pruning the concomitant increased crop load can help maintain marketable yield.

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1. Introduction

Peach tree size and canopy structure must be managed so the tree can efficiently access resources to sustain productivity and profitability for growers (Marini and Sowers, 2000). Novel approaches to regulate tree size and architecture will be needed as future orchard systems incorporate practices such as mechanization and high density plantings. New and innovative combinations of technologies will undoubtedly help fulfill these needs, including genetically distinct growth habits and size-controlling rootstocks for peach trees (Bassi et al., 1994; Grossman and DeJong, 1998; Scorza et al., 2006). Nonetheless, pruning remains the principle means to control peach tree size and shape in current management systems. Pruning combined with managed competition have been used to control the size of peach trees and enable high density plantings (Bussi et al., 1994; Glenn et al., 1996; Glenn and Welker, 1996). However, while tree size was reduced with managed grass competition, strong water-sprout growth was induced in heavily pruned trees (Tworkoski, 2000; Tworkoski and Glenn, 2001). In addition, grass competition appeared to reduce tree growth and productivity more in young than mature trees but there is limited information on competition, pruning, and tree age (Chalmers et al., 1981). The amount and timing of ground cover competition may substantially affect orchard floor management practices. Coordination of pruning and soil management is necessary to obtain productive tree growth (Fogle et al., 1965).

In the eastern United States, peach trees are often trained with wide-angled scaffold limbs and an open center which requires substantial pruning that can cause undesirable consequences. Early yields can be reduced. Repeated, intense pruning promotes dense proliferation of shoots in the crown that (a) limit light penetration late in the season, (b) reduce penetration of pesticide sprays, and (c) increase humidity that can facilitate disease development (Myers, 1993). Reduced vegetative growth and increased light penetration can result from improved training and pruning systems (Grossman and DeJong, 1998).

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Fig. 1. Peach trees grown in 2.4 m wide (A and B) and in 0.6 m wide (C and D) vegetation-free areas (VFA). Trees were heavily pruned to a wide-angled branching structure (IP) with an open center (B and D) or lightly pruned to an upright branching structure (RP) (A and C).

Williamson et al. (1992) reduced vegetative growth and flowering of peach trees with ground cover competition in a young, high density orchard. Although competition reduced tree size, pruning would likely be necessary to help manage tree size and shape as the orchard matured. We have used orchard floor management to reduce peach tree size but intense pruning of small pot-grown trees still resulted in dense regrowth as sprouts (Glenn and Welker, 1996; Tworkoski, 2000). The dense regrowth appears to result from the release of suppressed buds from correlative inhibition. Leaving an apical meristem, particularly on a shoot with a vertical orientation, reduces the vigorous growth of such buds (Wareing, 1970). A combination of grass competition and modified pruning could control canopy growth and maintain yield while avoiding the undesirable dense regrowth. Glenn and Newell (2008) demonstrated that pruning practices must be modified to leave more bearing wood in mature peach trees to maintain yield potential when sod competition is used to control vegetative growth. Shoots developing from branches with horizontal orientation (e.g. wide-angled limbs) tend to be longer than shoots developing from branches with more vertical orientations (Dann et al., 1990). The objective of the research was to determine the growth and yield of peach trees managed with grass competition, imposed at two times in the span of an orchard life, and to two pruning methods designed to stimulate or reduce excessive vegetative growth.

2. Materials and methods

2.1. Site preparation and planting

The experimental site was planted in tall fescue (*Festuca arundinaceae* Schreber) five years prior to peach orchard establishment. Grass was killed with 2 kg ha^{-1} glyphosate (N-(phosphonomethyl) glycine) 6 months prior to planting trees to establish the 0.6 and 2.4 m VFA's. Trees of two cultivars ('Jersey Dawn' (JD) and 'Redskin' (RS) on 'Lovell' rootstock) of peach (*Prunus persica* (L.) Batsch) were planted through the killed sod on April 18, 1993 with a 4.6 × 6.1 m spacing and grown in VFA width of 0.6 or 2.4 m. Planting rows were kept vegetation-free with 2 kg ha^{-1} oryzalin (4-(dipropylamino)-3,5-dinitrobenzenefulfonamide) applied each spring in 1993, 1994, and 1995. Combinations of 1 kg ha^{-1} terbacil (5-chloro-3-(1,1-dimethylethyl)-6-methyl-2,4(1H,3H)-pyrimidinedione) and 1 kg ha^{-1} diuron (N′-(3,4-dichlorophenyl)-N,N-dimethylurea) were used for vegetation control each spring from 1996 to 2007. Grass was re-established beneath half the trees grown in the 2.4 m VFA in the spring of 1998 to establish the 0 m VFA. Fertilizer (10 N–0.44 P–0.83 K) was applied at 136 kg/ha in June 1993 and 1994 and at 160 kg/ha each June 2001 through 2007. Insect and disease pests were managed using regional recommendations (Pfeiffer, Bulletin coordinator, 2010). Tall fescue-covered travel alleys between tree rows were mowed twice each season throughout the experiment. Fruit were hand thinned to 10-cm spacing when they were 1–2 cm in diameter.

2.2. Pruning criteria

Trees were pruned to maintain canopy size with wide-angled scaffold limbs and intensive number of pruning cuts (IP) or with upright-angled scaffold limbs and reduced number of pruning cuts (RP) (Fig. 1). The pruning methods contrasted a method (IP) that was likely to promote vigorous water sprouts with a method (RP) that was likely to have fewer and less vigorous water sprouts.

The RP used the following criteria: (a) cuts were made on upright branches (usually fewer than 12 per tree) from 1.8 to 2.4 m above the ground. These cuts were always above an existing lateral branch