ROOT RESTRICTION OF APPLE AND PEACH WITH IN-GROUND FABRIC CONTAINERS

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Abstract

Unfeathered trees of 'Golden Delicious'/MMIII apple and 'Winblo'/Lovell peach were planted conventionally (control) or in-ground fabric containers of 0.02, 0.043 or 0.1 m³ volume. Apple trees were trained to a central leader with minimal pruning. Peach trees were unpruned and developed natural crown. Peach and apple trees in all treatments were developed as nonsupported, free-standing trees. All trees were allowed to crop naturally and remained unthinned.

Root restriction reduced canopy volume in apple and peach; and within container treatments, growth control increased linearly with decreasing container volume. During the third growing season, there was no treatment difference in fruit number per tree, total fruit weight per tree, or mean fruit size in peach. An average 44% reduction in tree size resulted in an increase in yield efficiency in root-restricted peach trees. Fruit-maturity period was concentrated and advanced in peach trees grown in fabric containers.

In the third season of growth, apple trees grown in fabric containers had a higher flower cluster number and percent fruit set than control trees. Within container treatments, flower cluster and fruit number per limb increased linearly with decreasing container volume.

1. Introduction

Fruit production has been related to tree density per unit area (Ferree, 1980). With a specific training system, early production increases with increasing tree density (Wertheim et al., 1986). As growers increase tree density in orchards to increase yield efficiency, it has become necessary to evaluate methods for controlling tree size.

Size-controlling rootstocks have been used to control tree size. However, lack of these rootstocks in many fruit species, poor adaptability of stocks to North American conditions and susceptibility of stocks to insect and disease organisms limit utility of rootstocks at present.

Pruning of shoots (Barden et al., 1989) and roots (Schupp, 1988) effectively controls growth of fruit trees. However, pruning young trees decreases tree size, root growth and trunk diameter at the expense of early fruit production in proportion to pruning severity (Barden et al., 1989).

Physical restriction of peach tree roots decreased growth compared to nonrestricted trees (Richards et al., 1977). Peach tree vigor has been related to the volume of soil available to roots (Cockroft et al., 1966). Peach trees grown in fabric-lined trenches had more flowers and higher yield efficiency than control trees, although fruit were extremely small throughout the experiment. (Williamson et al., 1990).

This study evaluates the effects of root confinement via in-ground fabric containers on growth and early fruiting of peach and apple trees.

2. Materials and methods

Unfeathered trees of 'Golden Delicious'/MMIII apple and Winblo/Lovell peach were planted at a spacing of 3.0 x 5.0 m in spring, 1988 at the University of Georgia Horticultural Research Farm in Athens. Trees were conventionally planted (control) or planted in in-ground fabric containers of 0.02, 0.043 or 0.1m³ volume.

The fabric container used in this study was the Root Control Bag, (Root Control, Inc., Oklahoma City, OK). Containers are made of 5.3 oz. UV-stabilized Duon®, a nonwoven synthetic fabric (Phillips Fibers Corp.). Fabric containers are cylindrical, with one end closed with clear plastic to form the bottom of the bag.

Immediately after planting, all trees were headed at 60 cm above ground. Apple trees were developed as central leader trees by selecting five scaffolds for a lower tier of limbs. Scaffolds were selected during the first growing season and all other laterals removed to minimize pruning severity. Scaffolds were developed without pruning but were uniformly spread to a 50° angle from the central leader. With the exception of the initial heading cut, peach trees were untrained and allowed to develop natural crown from and size through three seasons of growth. In all treatments, apple and peach trees were developed as freestanding trees with no additional support.

Trees were uniformly trickle irrigated, fertilized and maintained under contact herbicide strip culture based on standard cultural practices. In 1990, all trees received a total of 22.7 liters of water daily from 10:00 to 12:00 AM during the entire growing season.

Apple and peach trees did not fruit during the second season of growth. During the third season of growth, peach and apple trees bloomed but were not thinned. In each apple tree, two representative scaffold limbs per tree were selected for measurement of flower cluster number, fruit number, and percent set. In 1991, two scaffold limbs were selected in peach for measurement of flower number and percent set.

In 1990, peach fruit were harvested at uniform maturity based on ground color, using a color chip method described by Delwiche and Baumgardner (1983). A weighted-average harvest date was calculated as described by Stembridge and Gambrell (1974) to determine treatment effect on fruit maturation.

Trunk diameter, tree height and width and scaffold diameter were measured at the end of the three growing seasons following planting.

Peach and apple trees were maintained in separate plots, each plot set up in a randomized complete block design with 10 single-tree replications. Statistical analysis was preformed using PROC GLM to test control treatment against the average of the container treatments; and linear and quadratic components were determined within container treatments.

3. Results

In peach and apple, root confinement resulted in smaller tree size, as measured by canopy volume, in all three seasons following planting. By the end of the third season, canopy volume of trees grown in containers averaged 44% and 59% for peach and apple, respectively, compared to control trees. Even after the first season of growth, peach trees in the 0.02-m^3 container had a trunk cross-sectional area 52% the size of control trees. By the third season, trunk cross-sectional area of peach trees that were root restricted averaged 58% the size of control trees. However, trunk cross sectional area of apple trees was not affected by root confinement.

Within root restriction treatments, canopy volume of peach and apple decreased linearly with decreasing container volume.

In 1990, root restriction treatments increased flower cluster number, fruit number, and percent fruit set on a per-limb basis in apple. Trees in the 0.02-m^3 containers had a 3-fould increase in fruit number compared to control trees. Within root restriction treatments, flower cluster and fruit number per limb increased linearly with decreasing container volume. In 1990, there was no treatment effect related to flower cluster number in apple.

In 1990, root restriction treatments had no effect on total fruit number per tree in peach. At harvest, there were also no treatment effects on total fruit weight per tree or mean fruit weight in peach. Fruit collected form all treated trees attained normal size and quality for the cultivar. However, the maturity period of peach was concentrated and advanced on trees grown in the root restriction treatments advanced maturity an average of 2.7 days compared to control trees.

In 1991, there were no treatment differences in flower number, fruit number, or percent fruit set in peach. Throughout four seasons of growth and two seasons of fruiting, there have been no visible signs of tree leaning in any root restriction treatment. In addition, there has been no tree mortality that can be ascribed to treatment.

4. Discussion

In this study, root restriction via use of in-ground fabric containers provides growth control and increased precocity of peach and apple trees. The effect translated into an increase in yield efficiency on a tree basis. Extrapolations of yield per unit are with tree densities based on various tree sizes in the root restriction were not made. If smaller trees that resulted from root restriction were spaced more closely together, yield efficiency per unit area would be significantly higher than in control trees.

Root restriction has potential as a cultural component in the development of high-density orchard systems. This would be most significant in tree fruit that have no suitable size-controlling rootstocks are poorly adapted.

The mechanism by which root restriction controls growth and increases precocity has not been elucidated. Clearly, additional research is needed to study physiological responses such as water relations and growth regulators in tree fruit grown in root-restriction systems. Additional research in respect to specific economic, water, nutrient and other cultural parameters also will be required to determine the potential for commercial use of root restriction in tree fruit.

References

Barden, J.A., DelValle, T.B.G. and Myers, S.C. 1989. Growth and fruiting of ‘Delicious’ apple trees as affected by severity and season of pruning. J. Amer. Soc. Hort. Sci. 114:184-186

Cockcroft,B. and J.C. Wallbrink. 1966. Soil properties and tree vigor in the Goulburn Valley. Austral. J. Expt. Agr. Anim. Husb. 6:204-208.

Delwiche, M.J. and R.A. Baumgardner. 1983. Ground color measurements of peach. J. Amer. Soc. Hort. Sci. 108:1012-1016.

Feree, D.C. 1980. Canopy development and yield efficiency of ‘Golden Delicious’ apple trees in four orchard management systems. J. Amer. Soc. Hort. Sci. 105:376-380.

Richards, D. and Rowe, R.N. 1977. Effects of root restriction, root pruning and 6-benzylaminopurine on growth of peach seedlings. Ann. Bot. 41:729-740.

Savage, E.F. and Cowart, F.F. 1942. The effect of pruning upon the root distribution of peach trees. Proc. Amer. Soc. Hort. Sci. 41:67-70.

Schupp, J.R. 1988. Physiological responses of apple trees to root pruning. PhD Diss., The Ohio State University.

Stembridge, G.E. and Gambrell, C.E., Jr. 1974. Measuring peach thinning and maturation responses. HortScience 9:29-30.

Wertheim, S.J., deJager, A. and Duyzens, M.J.J.P. 1986. Comparison of single row and multi-row planting systems with apple, with regard to productivity, fruit size and color, and light comparisons. Acta Hort. 160:243-258.

Williamson, J.G. and Cosston, D.C. 1990. Planting method and irrigation rate influence vegetative and reproductive growth of peach planted at high density. J. Amer. Soc. Hort. Sci. 115:207-212.