RESEARCH REPORTS & NOTES

A High-density Peach Orchard[1]

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Abstract. **Peach (*Prunus persica* (L.) Batsch) at 1157 and 868 trees per ha and trained as either palmette or hedgerow produced nearly twice as much fruit in the first 5 years as did trees trained to a modified central leader at 397 trees per ha at Jordan Station, Ontario, Canada. In addition to dormant pruning to shape the trees and restrict their size, the palmette and hedgerow plantings were pruned each year in mid-summer when about half of the current year's growth was removed. Insects and mites were no greater problem, and brown rot was significantly less in the high- than in the low-density planting.**

The ability of peach growers to increase substantially their unit area production may well decide the future of the peach industry in Southern Ontario. The productivity of apple orchards has been greatly increased by planting more trees per unit area while the use of size-controlling rootstocks and spur-type trees have provided the growth control necessary for such high density plantings. Though fully satisfactory growth-controlling tree types have not yet been developed for peaches (3, 4), some orchards of closely spaced trees have been planted in which pruning is used to restrict growth of the trees (1, 2).

If trees are spaced closer than is now the practice in peach orchards, other changes in orchard management will undoubtedly be necessary. In anticipation of these changes and to assess the problems that may arise from them, especially with regard to insects and diseases, an experimental, high density, peach orchard of about 1 ha, consisting of 'Cresthaven', 'Olinda', and 'Redskin', on Rutgers Red Leaf understock was planted at Jordan Station, Ontario, in 1970.

Training systems and spacing

The spacing of the trees and the methods of training and pruning in the experimental orchard were as follows (Fig. 1):

Palmette: 216 trees (1157 trees/ha) spaced 2.4 m x 3.6 m were each pruned to 2 main scaffold limbs one on each side in the row.

Hedgerow: 216 trees (868 trees/ha) spaced 2.4 m x 4.8 m were each trained to a central leader with 3 or 4 branches on each of 2 sides in the row.

Standard (Modified central leader): 128 trees (397 trees/ha) spaced 4.2 m x 6.0 m were each trained to a central leader with from 5 to 7 lateral branches equally spaced about the trunk.

All the trees were pruned each year about bloom time to shape the scaffold of the trees, hereinafter referred to as dormant pruning. The palmette and hedgerow plantings were also pruned during the summer. In 1971 the trees were summer-pruned in mid-July with hand-operated hedging shears; in 1972 during the second week of August with electric hedge clippers; and in 1973 and 1974, on July 11 and 12, respectively, with a tractor mounted Fossum Tree Trimmer®. In 1971 and 1972 the trees were summer pruned more severely between rows than within rows to encourage growth in the rows, and in 1973 and 1974 they were pruned as a hedge. It was originally intended that in the summer only current season's growth would be cut, but in both 1973 and 1974 some year-old wood was also cut.

The main purpose of the pruning was to restrict lateral growth of the trees to certain set limits and to reduce their height so that most of the fruit could be harvested without ladders. However, there was little previous experience to indicate the effects of summer pruning on the tree growth and yield or the best size and shape of tree for which to aim. In 1973 and 1974, therefore, the palmette and hedgerow plantings were each summer pruned to 4 shapes using the Fossum Tree Trimmer (Fig. 2). The palmette trained trees were pruned either flat or gable roof-shaped at the top at either 2.1 m or 2.4 m high, with the sides sloped or uncut. The sides of the hedgerow trees were sloped with a base width of either 1.7 m or 2.0 m and either cut flat on top at either 2.4 m or 2.7 m high, or left uncut.

Each year some growth occurred after the summer pruning. In 1972 growth continued to nearly the end of Sept. and numerous laterals from 15 to 20 cm long developed below the pruning cuts. However, die-back of this growth during the winter of 1972-73 was negligible and very few canker infections occurred in either pruning cuts or winter-killed shoots. Considerable dormant pruning was required in 1973 to thin out and remove the clustered shoot growth below the pruning cuts of the previous summer. Because fewer laterals developed on summer pruned shoots in 1973 than in 1972, dormant pruning in 1974 consisted mainly of thinning out branches to encourage new growth from inside the trees and of reducing tree size to the limits imposed.

From 1971 to 1973 the palmette and hedgerow plantings required nearly twice the time per tree row for dormant pruning as did the standard planting. However, by 1974 when the standard trees required considerable shaping, the time required to prune these trees was only slightly less than the times required to prune an equal area of either pal--mette of hedgerow trees. There was a considerable difference between the 3 pruning required to maintain the shape of the trees. 'Olinda' produced numerous shoots from larger branches within the canopy of the tree whereas 'Redskin' tended to produce new shoots

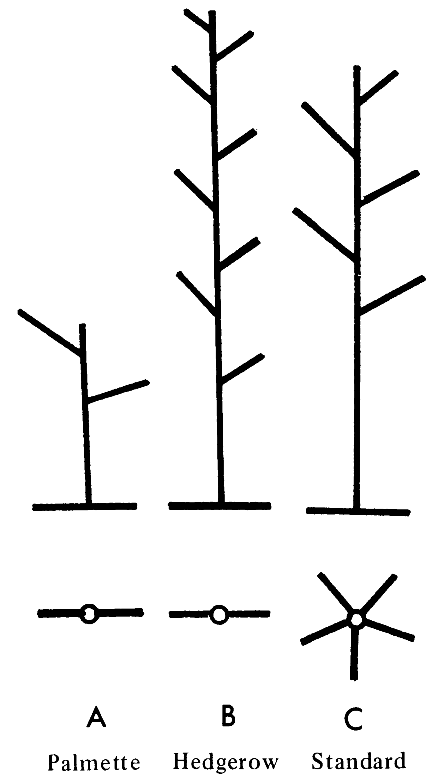

Fig. 1. Diagramatic representation of the first year training of peach trees in the experimental orchard, showing elevation and plan arrangement of branches. A. Palmette; B. Hedgerow; C. Standard.

[1]Received for publication March 27, 1975.

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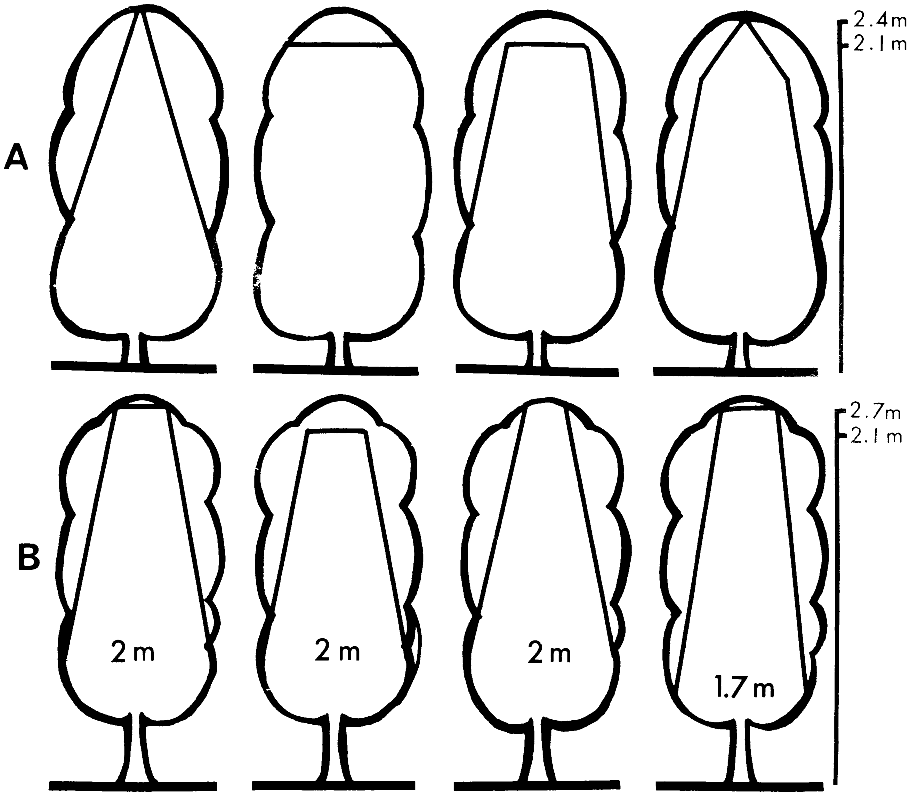

Fig. 2. Diagramatic representation of shapes to which trees in the high density peach orchard were pruned with a Fossum Tree Trimmer in July of 1973; A. Palmette trees; B. Hedgerow trees.

toward the ends of the branches. How these differences in growth habit will affect the suitability of cultivars for high density plantings will probably be determined only by more extensive experience.

Yield

Fruit yield was recorded in 1972, 1973, and 1974. In all years yields per unit area were much higher from both palmette and hedgerow trees than from the standard trees (Table 1). Within each training system there were no consistent differences between the yields of fruit from trees summer pruned to different shapes.

Fruit size differed more between cultivars than between training systems (Table 2). 'Redskin' set heavier crops than the others in both 1973 and 1974 and our failure to thin this cultivar sufficiently in 1974 resulted in numerous undersized fruit.

Table 1. Effect of pruning system and density on yield of peach planted in 1970.

			Yield (ton/ha)			
			All fruit		Marketable fruit	
Cultivar	Pruning system	No. trees/ha	1972	1973	1974	Total
Cresthaven	Standard	397	1.9	1.0	10.5	13.4
	Hedgerow	868	5.0	3.2	18.1	26.3
	Palmette	1157	3.9	4.1	22.5	30.5
Olinda	Standard	397	1.0	0.9	10.0	11.9
	Hedgerow	868	3.1	2.6	15.4	21.1
	Palmette	1157	3.5	4.5	16.3	24.3
Redskin	Standard	397	1.2	5.5	14.9	21.6
	Hedgerow	868	2.0	7.6	19.4	29.0
	Palmette	1157	1.7	15.9	26.9	44.5

Table 2. Effect of pruning system and density on fruit size of 3 peach cultivars.

Pruning system density	Avg fruit wt (g)					
	Cresthaven		Olinda		Redskin	
	1973	1974	1973	1974	1973	1974
Standard	145	167	142	145	128	99
Hedgerow	145	139	148	150	139	99
Palmette	136	153	142	156	130	113

Pest control

Before planting the trees were dipped for peach borer control. A spray of ferbam 76% WP (2.24 kg/ha) was applied each fall after the leaves were off, to control leaf curl. No other sprays were applied till 1973 when all the trees were sprayed with captan 50% WP (6.73 kg/ha) at late pink stage, 50% shuck fall and 14 days before the calculated harvest date of 'Cresthaven'; Imidan 50% WP (1.68 kg/ha) was added to the 50% shuck fall and the 14 days before harvest sprays on all cultivars. In 1974, a minimum spray schedule was followed, with four sprays of Imidan (2.24 kg/ha) and 5 sprays of benomyl, (Benlate 50% WP, 1.68 kg/ha) applied according to the local spray schedule. A special spray of dimethoate (Cygon 4E, 1.4 kg/ha) was applied at the pink stage to control tarnished plant bug. Spray materials were applied in about 840 liter water/ha. No miticides were used.

Fruit was examined at harvest and all injuries were recorded. The differences between the training systems in amount of insect injury were not significant (Table 3). Plant bug injury was abnormally high throughout the planting in 1973, ranging up to 24% of harvested fruit. It was reduced to a maximum of about 4% in 1974.

Brown rot was slightly but significantly less in the palmette and hedgerow plantings than in the standard planting in all years. The European red mite was present in 1973 and 1974, especially on trees at the south end of the planting, probably owing to excessive road dust deposits from an adjacent unpaved road. Though red mite reached a density of 17 active stages per leaf in early Sept., 1974, leaf injury was slight. San Jose scale developed rapidly on a few trees in 1973 but was no more abundant in the high density plantings than in the standard one. In 1974 saleable fruit averaged 78%, 75%, and 77% of the total crop for the standard, hedgerow, and palmette systems, respectively.

Peach canker is a serious problem throughout the planting in spite of care in pruning. However, very few pruning stubs resulting from summer pruning have become infected with canker. Tree loss to canker and other causes was palmette 5.6%, hedgerow 6.9%, and standard 20.5%. Much of this loss occurred in a less well drained part of the orchard but this does not entirely explain the large difference in tree mortality.

Feasibility

It is too soon to draw precise conclusions regarding the feasibility for commercial peach orchards, of the tree spacings and training systems described herein. It is interesting to note, however, that there was no increase in disease and insect problems in the more closely

Table 3. Effect of pruning system and density on defective fruit of peach.

	Defective fruit (% of fruit harvested)					
	Standard		Hedgerow		Palmette	
Fruit defect	1973	1974	1973	1974	1973	1974
Mechanical injury (wind, machinery, etc.)	8.7	9.2	11.8	9.2	12.4	10.6
Small fruit	1.2	5.5	1.1	9.5	2.0	4.3
Injury by mechanical pruner	–	0	–	2.9	–	1.4
Brown rot	2.0	0.4	0.9	0	0.8	0
Tarnished plant bug	22.2	3.6	22.0	1.9	24.6	3.4
Oriental fruit moth	12.5	1.1	9.6	0.7	7.0	0.8
Other insects	0.7	2.6	1.9	1.2	1.7	2.8

spaced and more severely pruned plantings. In fact insecticide applications at rates about one-half of those locally recommended gave satisfactory insect control throughout. The slightly lower incidence of brown rot in the palmette and hedgerow than in the standard planting was probably owing to summer pruning opening the young trees to air and light.

It seems probable that high density planting can contribute as much to high volume low cost production of peaches as it has done for apples. Until dwarf peach trees suitable for close planting are developed, summer pruning will be essential to keep trees within the limits set. Because there is only limited experience with summer pruning, further work is required to determine the number of prunings necessary, optimum pruning time, optimum shape and size of tree, length of life of an orchard under a high density management system, and suitable cultivars. Much of this knowledge will be gained only through grower experience. These preliminary results indicate that increased yields justify peach growers making small, experimental, high-density plantings.

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Influence of Controlled-atmospheres on the Quality and Condition of Stored Nectarines[1]

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Abstract. **The most favorable atmospheres for storage of nectarines** *(Prunus persica* **(L.) Batsch cv. Stark's Red Gold) at $-0.5°C$ contained about 5% CO_2 which was about equally effective when combined with air or with 2.5% O_2. Dessert quality of the fruit was good after 6 weeks in controlled atmosphere storage with either 5 or 2.5% CO_2, but maximum storage possible may vary from year to year. Breakdown and decay was excessive in all lots after 10 to 11 weeks' storage.**

Nectarines are not adapted to extended storage, but, depending on cultivar, they can be held commercially at $-1°$ to $0°C$ for 2 to 4 weeks with adequate retention of appearance, flavor, and texture.

To determine whether or not a modified atm might significantly extend the storage life of 'Stark's Red Gold', a cultivar with comparatively good storage characteristics, fruit was tested in 10 atm. The 3 most beneficial atm were again tested the following year in comparison with air storage.

Controlled-atmosphere (CA) chambers used in these tests consisted of 5-gal (ca. 19 liters) glass jars with metal screw-on lids. Ten experimental atm (Table 1) were compounded from cylinders of compressed O_2, CO_2, N_2, and air, and were circulated continuously through the jars. Capillary tubes, calibrated for rate of flow, were used to measure the desired proportions of each atmospheric constituent. The total rate of flow through each jar was approximately 5 liters/hr. Paper towelling in the bottoms of the jars became wet with water of condensation in the first tests and caused some fruit injury. To prevent this injury in later tests, discs of fibrous packing material, about 2.5 cm thick, were placed in the jars.

In the first experiment, 450 'Stark's Red Gold' nectarines, 7.0-7.5 cm in diam and commercially picked and packed on August 2, 1966, were randomly placed in the CA chambers. The following year, commercially packed fruit of the same size was similarly placed in 12 chambers, 3 replicates for each of 4 atm.

Fifteen fruits were removed from each jar for examination after 5, 6, and 8 weeks of storage. Upon removal from the jars, 5 fruits were evaluated immediately and the remainder were ripened 4 or 6 days in air at 18°C before examination. Flesh firmness was determined with a Magness-Taylor pressure tester on pared areas of the 2 cheeks of each fruit. Soluble solids in juice extracted from 2 wedges cut from opposite sides of each fruit were read on a hand refractometer, and total acid to pH 7.0 was determined with a glass electrode titrimeter. Appearance and dessert quality were evaluated organoleptically by 3 persons after the fruit had ripened.

The nectarines from all 10 atm were attractive and showed no visible ill effects of storage after 4 or 8 weeks (Table 1) except where fruit was in contact with water in the bottoms of the jars. The wet skin had darkened equally at the 8-week observation in all treatments.

Low levels of O_2 were not beneficial to the nectarines. Softening and acid loss were retarded by low O_2 concn in the absence of CO_2, but texture and flavor paralleled that of the check fruit in air.

The benefits from modified atm appeared to be due to CO_2. After 8 weeks of storage, the nectarines in atm with 5% CO_2 still had good-to-fair flavor and flesh color and they were superior to those held in 2.5 or 10% CO_2. The order of preference for the best 3 lots, as judged by condition and dessert quality, was 1) 5% CO_2 in air, 2) 5% CO_2, 2.5% O_2, plus N_2, and 3) 2.5% CO_2 in air. A combination of 2.5% O_2 and 5% CO_2 was no more beneficial than air with 5% CO_2. Storage for 11 weeks was too long for any of the atm used. Most fruit in all lots showed breakdown and decay after ripening at 18°C.

All nectarines stored in the 3 most promising atm were rated "good" after 5 weeks; after 6 weeks those from 5% CO_2 were in good condition; after 8 weeks those from 5% CO_2 were the only ones still with fair flavor (Table 2).

By use of CA, the storage life of nectarines held at $-0.5°C$ was extended

[1]Received for publication April 14, 1975.

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