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Effect of Training System on Yield in 'Early Redhaven' Peach[1]

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Abstract

Yield performance, efficiency of tree management and ease of harvest were evaluated in 'Early Redhaven' peach subjected to five training systems. Yield per plot in the first 5 and 10 years of production was higher in the modified-leader trees and the angled double-trees than in trees from most of the other training systems, respectively. Plots were single trees in all systems except for the angled double-tree system where 2 trees planted at 45° in opposing directions occupied each site. Extrapolation of the data to a per hectare basis indicated comparable yields in the angled single-tree, palmette and open-center systems but which were higher than in the modified-leader and angled double-tree systems. Ladders were required for the open-center and modified-leader trees by the 6th year of production but trees from the angled single-tree, palmette and angled double-tree systems could be harvested from ground level into their 10th year of production.

Introduction

Acceptance of a training system by a grower is dependent upon several considerations: capital investment and returns per tree, labor input, cultural requirements and traditional practices in the area. Renaud (7) has outlined some of the same systems used for peaches; Y, upsilon, open center, flattened forms, palmette and pyramid. Other systems include the Tatura trellis (2) and the ultra high-density meadow (3). The traditional systems in the Okanagan area of British Columbia have been the open-center and central leader. Trees in both systems usually require ladders for pruning, thinning and harvesting and this need for ladders augments labor costs and the incidence of bruising.

A study was undertaken to evaluate the effect of several training systems on yield and ease of harvest in 'Early Redhaven' peaches during a 10-year period.

Materials and Methods

1. Peach training.

One-year-old 'Early Redhaven' peach trees on Siberian C seedling rootstock were planted at 3.6 x 4.5 or 4.5 x 4.5 m. The five training systems within each of 2 blocks were single rows of either 11 trees (4.5 x 4.5 m apart) or 15 trees (3.6 x 4.5 m apart). Both blocks were adjacent to each other and had the same sequence of training systems. Alleyways were in sod but vegetation within the tree row was controlled with paraquat. Irrigation was provided by sprinklers on portable pipes in the first few years, and later by a solid-set under-tree sprinkler system. Water was ejected at a 7° angle. Fertilizer (16-20-0) was applied yearly at 200 $kg.ha^{-1}$. The training systems were:

i) **Modified leader (4.5 x 4.5 m):** Trees were headed at 75 cm in their first year. No support system was needed. Bearing limbs were trained to a cup shape and the weak modified leader was allowed to fill the center area of the tree. Trees were maintained at a height of 2.7 to 3.0 m.

ii) **Angled double-tree (3.6 x 4.5 m):** Two trees were planted in the same hole but pointing in opposite directions at 45° within the row. Stakes supported the trees for the

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first 2 years. The limbs were trained to form a fanshaped tree of approximately 2.1 m in height.

iii) **Angled single-tree (3.6 x 4.5)**: The trees were planted at 45° and staked. The most basal shoot to grow from the scion was staked and trained at 45° in the opposite direction. Both limbs were trained to form a fan-shaped tree of approximately 2.1 m.

iv) **Palmette (3.6 x 4.5 m)**: Trees were headed at 30 cm in their first year. Limbs were selected first year. Two strong shoots were selected and trained at 45° within the row. Limbs were trained to form a fan-shaped tree and pruned to a height of 2.1 m.

v) **Open center (4.5 x 4.5 m)**: Trees were headed at 75 cm in their first year. Limbs were selected to form a cup-shaped tree leaving the center open. No support system was needed. Trees were pruned to a height of 2.6 to 2.7 m,

Fruit from each plot within each training system was harvested at commercial maturity (as a 3 day peach) and weighed. Plots were single trees in the angled single-tree, open-center, modified-leader and palmette systems and paired trees in the angled double-tree systems. The number of plots for the training systems were 30, 22, 22, 30 and 30, respectively.

Data was analyzed as a completely randomized design but the limitations placed on the analysis by the experimental lay-out are fully recognized.

Results and Discussion

No training system was consistently superior in yield on a year to year basis (Table 1). However, cumulative yields on a per plot basis during the first 5 years of production were higher in the modified-leader trees than in trees from the other training systems. Plot yields over the first 10 years of production were higher in the angled double-tree system than in most of the other systems. Calculation of cumulative yields on a per hectare basis over the first 5 years of production indicated higher yields in the palmette and angled single-tree systems but over the first 10 years of production it was higher in the angled single-tree, palmette and open-center systems (Table 1). Only trees within the modified leader system had not utilized their space and therefore could have been planted at 4.2 x 4.5 m or 494 trees ha^{-1}. Potential production would be 36 and 158 t ha^{-1} instead of 30 and 133 t ha^{-1} for the periods of 1976-1980 and 1976-1985, respectively. However, the possibility of excessive upright growth in a denser planting could reduce yield and necessitate ladders for harvesting.

Stembridge and Gambrell (8) reported much higher yields with an angle planting of 1195 trees ha^{-1} than with a conventional planting of 269 trees ha^{-1}. Although the labor inputs in their study were nearly 5-fold greater with the angle plant, the higher production (assuming good quality in the harvested fruit), would offset the added costs by substantial margin. Palmette systems tend to be more productive than cup-shaped trees (4, 5, 9) trees but are also more labor consumptive (5, 9) because of their greater density. A grower would, therefore, have to be certain that the higher production in palmette systems would more than compensate for the added costs of management in such a system. The trees in our trial were comparable for labor inputs during the first 7 years of growth but thereafter, approximately 30% more time was spent on the open-center and modified-leader trees. Ladders were also required for blossom thinning, fruit thinning and harvesting in these trees by their 6th year of production. Fruit quality was comparable in all of the training systems but where ladders were required for harvesting, incidence of bruising became appreciable. Although the open-center trees were more productive than the modified-leader trees (t/ha) they were comparable in production

Table 1. Effect of training system on yield in 'Early Redhaven' peach.

Year	Modified leader	Angled double-tree	Angled single-tree	Palmette	Open Center
	Yield (kg $plot^{-1}$)[z]				
1976	4.0 a[y]	3.2 ab	3.8 a	2.6 b	3.4 ab
1977	11.1 a	7.9 c	10.0 ab	9.0 bc	8.7 bc
1978	6.7 ab	4.5 c	6.9 a	7.7 a	5.2 bc
1979	23.2 a	16.3 bc	20.2 ab	19.4 ab	12.3 c
1980	51.3 a	41.5 b	48.6 a	46.1 ab	41.0 b
1981	45.9 bc	52.1 a	41.9 cd	38.7 cd	48.3 ab
1982	33.9 b	40.4 a	29.2 c	26.7 c	33.8 b
1983	48.8 a	42.1 b	38.6 bc	36.4 c	43.0 b
1984	43.4 a	40.9 ab	37.0 b	38.0 ab	40.7 ab
1985	71.9 a	68.3 ab	55.9 c	60.7 bc	60.2 bc
1976-1980 (5 years)	96 ab	73 cd	90 ab	85 bc	71 d
1976-1985 (10 years)	321 ab	340 a	292 bc	286 c	297 bc
	Potential yield (t ha^{-1})[x]				
1976-1980	30 c	40 b	49 a	47 a	40 b
1976-1985	133 b	141 b	163 a	161 a	165 a

[z]Plots were single trees for all training systems except the angled double-tree system where 2 trees occupying the same site were considered a plot.
[y]Mean separation within rows of year or time period by Duncan's multiple range test, 5% level.
[x]Estimated values calculated by extrapolating per plot yields to a per hectare yield basis.

to the palmette and angled single trees. The open-center trees also required more pruning in order to contain them within their allotted space. Since the purpose of this study was that of managing trees entirely from ground level, both the open-center and modified-leader systems failed to meet our objective. The angled double-tree system had two disadvantages, one, it had a lower yield on a per hectare basis than other systems and two, it incurred higher costs because of the extra trees needed for the system. The 2 systems that met our objective of management from ground level were the angled single-tree and palmette systems. Both were comparable in yield (Table 1) but other features make the angled single-tree more attractive. First, the union formed by the second leader is less likely to break as do unions between leader and trunk in the palmette system. Second, the single-angle trees produce strong upright shoots, of which, one can be selected for the second leader. Trees in the nursery, on the other hand, must be specially grown to assure the availability of shoots for opposing leaders.

Since the training systems and cultivar are known to interact (6) it is not known whether the results in our study would apply to other cultivars.

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Arthropods in a Scab, *Venturia inaequalis* (Cke.) Wint., (Ascomycetes:Mycosphaerellacea), and European Red Mite, *Panonychus ulmi* (Koch), (Acari:Tetranychidae), Resistant Apple Orchard in Indiana

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Abstract

Three years of sampling an apple orchard with seven apple scab, *Venturia inaequalis* (Cke.) Wint., resistant selections, five of which were also resistant to European red mite, *Panonychus ulmi* (Koch), growing on three different rootstocks (EMVII, MM106, and MM111), showed a faunal composition consisting of nine orders from which 26 families were identified. Two specimens, a homopteran and a lepidopteran, were identified only to order. Seventy-four specimens were identified to genus only, and 59 to species. Three groups (aphids, leafhoppers, and ladybird beetles) and nine species of arthopods were found most frequently. Of these the ladybird beetles (grouped together), the green lacewing, *Chrysopa carnea* (Stephens), and the smooth yellow mite, *Zetzellia mali* (Ewing), were reported to be beneficial by other investigators. Significant differences ($P<0.05$) in the incidence of aphids and codling moth were found between rootstocks and between selections. Similar differences in incidence were found between rootstocks for ladybird beetles and between selections for Z. mali. These data suggest that the spectrum of arthropods found on selections developed through breeding efforts may require a less complicated pesticide protocol for management when compared with that required for cultivated apple cultivars. The protocol may depend on the trait/s for resistance that each selection carries.

Introduction

The cultivated apple is not a distinct species but is the product of interspecific hybridization; hence the legitimate nomenclature should be *Malus* x *domestica* Borkh. (14) Apple orchards support complexes of arthropod and disease species, the compositions of which vary among geographic regions (5, 15, 16, 17, 21) Reports by Cleveland and Hamilton (5) and Oatman *et al.* (17) deal with arthropods occurring on the aerial parts of the apple tree.

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