Evaluation of Small Vase and Y-trellis Orchard Systems for Peach and Nectarine Production in Mediterranean Regions.

Tiziano Caruso, Riccardo Lo Bianco, Francesco Paolo Marra
Dipartimento Scienze Agrarie e Forestali, Università degli Studi di Palermo
Palermo
Italy

Francesco Guarino
OSAS-OPSIBARIT-CAMPOVERDE
Castrovillari (CS)
Italy

Keywords: fixed costs, fruit size, management labor, profit, Prunus persica, training system, yield.

Abstract

Two peach planting systems, Small Vase (SV) and Y-trellis (Y), were evaluated and compared in the Mediterranean settings of Southern Italy. The two orchards were located next to each other on relatively uniform soil and terrain, and the observations included two peach (Rich May and Summer Rich) and two nectarine (Big Bang and Nectaross) cultivars. In the SV system, trees were spaced at 4.5 x 2.5 m (888 trees/ha), whereas in the Y system, trees were spaced at 5.5 x 2 m (909 trees/ha) and no roof gap was left between rows. Yield per tree, fruit size grade, unit price of sold peaches for each size grade, materials and labor for cultural management and associated costs, fixed costs at planting, and grower's profit were quantified during the first six years from planting. Fixed costs at planting were twice as much in the Y system, and no significant yield was recorded in the first two years in any of the two systems. Regardless of cultivar, the Y system reported 20% higher yields, 31% greater amount of management labor, and 10% lower labor efficiency (kg fruits/hr) than the SV system. Fruit unit value (euro/kg) was similar in the two systems. Profit varied greatly depending on the cultivar, and only 'Nectaross' generated a greater profit in the Y than the SV system. For this cultivar, the pay-back period (years needed to pay off the additional investment of establishing a Y trellis by its additional profit) was 2.5 years, indicating an advantage of the Y system over the SV by the 4th year. The yield gap between the two systems tended to decrease after the 5th year. The latter trend, along with the high initial investment and management costs in the Y system, suggests better performance and more sustainable productions in the SV than in the Y system.

INTRODUCTION

Over the last 50 years, several planting systems for peach orchards have been developed to reach high early yields and improved fruit quality. Modern orchard planting systems are based on higher tree densities ranging from 1000 to 1500 trees per hectare (Loreti and Massai, 2002). However, increasing planting density alone does not provide an efficient tool to increase yield and improve fruit quality, as planting density and yield are not linearly related and a threshold can be found beyond which a further increase in density may not result in greater yield (Sansavini and Corelli-Grappadelli, 1997). Indeed, with age high-density orchards may pose serious problems for canopy management and ultimately compromise fruit quality (Jackson, 1980; Sansavini and Corelli-Grappadelli, 1997).

Over the last 30 years, double wall systems like Tatura trellis and its variants (Y-trellis, perpendicular V, KAC-V, etc.) have become increasingly popular and account for a significant portion of new fruit plantings in developed countries (DeJong et al., 1994). The primary advantage of V or Y systems is high yields per hectare (Caruso et al., 1998b; Van den Ende et al., 1987), high levels of light interception (Grossmann and DeJong, 1998) and improved fruit quality (e.g. increased cover color and soluble solid content and more uniform fruit size) (Caruso et al., 1998a; Van den Ende et al., 1987), especially in southern Mediterranean areas with high levels of irradiance. V or Y systems typically allow for higher tree densities than other open center or vase-shaped canopies; they also show better light interception than spherical canopies or vertical systems and improve light distribution within the canopy due to their two-dimensional light exposure (De Salvador and DeJong, 1989; Wagenmakers, 1991). On the other hand, labor efficiency or yield per unit of labor is generally low in those systems due to the high incidence of establishment and management costs.

A recent modification of the standard vase is the Spanish bush or Small Vase, initially developed in

Spain for cherry and subsequently extended to peach orchards. In this variant, the vase-shaped canopy is contained within 2.5 m of height by frequent toppings; the result is a relatively compact tree suitable for medium-high density plantings, good light interception by the fairly open canopy, and significantly reduced training and management labor (Long, 2001).

The right choice of training system and orchard density must take into account the costs involved for orchard establishment and management. In this study, a yield and economic analysis was performed on peach and nectarine varieties to evaluate Y-trellis and Small Vase orchard systems.

MATERIALS AND METHODS

The study was conducted in orchards of the OSAS-OPSIBARIT-CAMPOVERDE cooperative located near Castrovillari (39°49' N; 16°12' E and 90 m a.s.l.), in Southern Italy. Two neighboring plots with relatively uniform soil and terrain were selected, one with trees trained to Small Vase (SV) and the other with trees trained to Y-trellis (Y); the observations included two peach (Rich May and Summer Rich) and two nectarine (Big Bang and Nectaross) cultivars and were carried out on 3.5- to 7.5-ha plots. In the SV system (a modification of the Spanish bush), trees were spaced at 4.5 x 2.5 m (888 trees/ha), whereas in the Y system, trees were spaced at 5.5 x 2 m (909 trees/ha) and no roof gap was left between rows. Trees were grafted on either Cadaman or seedling rootstocks and received conventional cultural cares.

Yield, fruit size grade, unit price (UP) of sold peaches for each size grade, materials and labor for cultural management and associated costs, fixed costs at planting (FC), and grower's profit (P) were quantified on an hectare basis using average data per year (3^{rd} through 6^{th}) and cultivar.

Only P was cumulated over the six years of orchard life and calculated as $P = (UP - VC) \times$ Yield in euro/ha, where VC are variable costs as the sum of production costs (all cultural practices including pest control and fertigation) divided by yield (kg/ha, cumulated over the six years) in euro/kg. The pay-back period (PBP) indicating the time in years that it takes to pay off the additional investment needed to establish the Y system by its additional profit was calculated as $PBP = (FC_Y - FC_{SV})/(P_Y - P_{SV})$.

Yield and labor data were analyzed using SYSTAT (Systat Software Inc., Richmond, CA, USA) GLM procedures with training system and cultivar as main factors, their interaction as the sole interaction and year as a random factor in the model. When appropriate, Tukey's test at $P < 0.05$ was used to separate means.

RESULTS AND DISCUSSION

As expected, fixed costs were higher in the Y than in the SV system, and specifically 45% higher at planting, 11% higher for fertilization, and 23% higher for pest control (Tab. 1). Overall, 43% higher fixed costs were associated to the Y compared to the SV system. This result was essentially due to the cost of labor and support structures needed to establish the trellis, as well as to the greater growth and size of trees trained to Y compared to those trained to SV. Also labor associated to cultural practices and tree management was 31% greater in the Y than in the SV system (Tab. 2). As for partitioning of labor among main cultural practices, labor needed for fruit thinning was similar in both systems, whereas a greater percentage of labor was used for pruning in the Y system and for harvesting in the SV system. Pruning generally requires more skilled labor than harvesting, making Y system management even more difficult and expensive.

In all observed cultivars, the Y system exhibited greater yields than the SV system, with an average 20% difference in favor of the former (Tab. 3). Yet, it is worth to mention that the yield gap between the two systems tended to decrease after the 5^{th} year. Previous studies had already documented higher yields in the Y system compared to central leader (Caruso et al., 1998b) or standard vase (Grossman and DeJong, 1998) and attributed the increased cropping to greater and better light interception (De Salvador and DeJong, 1989; Grossman and DeJong, 1998).

In the SV system a greater percentage of fruit fell into the large size categories, namely A and B, while in the Y system more fruit fell into the C and D categories (Fig. 1). This indicates that fruit were bigger in the SV than in the Y system. Also, if we consider that yields were lower in the SV than in the Y system, then bigger fruit can only be justified by fewer fruit on the tree (lower crop load) in the SV than in the Y system. An inverse relationship between peach crop load and fruit size is expected and it has been documented in several studies (Berman and DeJong, 1996; Blanco et al., 1995; Inglese et al., 2002; Naor et al., 1999; Rowe and Johnson, 1992).

As a result of yield levels and amount of labor needed, the SV system was about 10% more efficient than the Y system in terms of kg of fruit produced per hour of labor needed. The difference in favor of the SV system was particularly evident in 'Summer Rich' trees (Tab. 4). The levels of profit cumulated

over the first six years of orchard life depended strongly on the cultivar, with three out of four cultivars (namely Big Bang, Rich May and Summer Rich) generating higher profit under the SV system and one nectarine (Nectaross) generating a higher profit under the Y system (Tab. 5). Even for the latter cultivar with higher profit under the Y system, the PBP (years needed to pay off the additional investment of establishing a Y by its additional profit) was 2.5 years, indicating an advantage of the Y system over the SV by the 4th year.

The yield trends and amount/cost of labor observed in this study, along with the high initial investment costs in the Y system, suggest better performance and more sustainable productions in the SV than in the Y system.

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Tables

Table 1. Fixed costs (euro/ha) for small vase (SV) or Y-trellis (Y) training systems in 2006 near Castrovillari, Italy.

Operations and materials	*SV*	*Y*
Planting	**6,552**	**11,898**
Deep ploughing/fertilizing	1,000	1,000
Grafted plants	3,552	3,636
Lining/planting	200	1,200
Trellis system	-	3,680
Irrigation system	1,800	2,382
Fertilization	**387**	**434**
Pest control	**800**	**1200**
TOTAL	**7,739**	**13,532**

Table 2. Partitioning of labor (%) among main cultural practices for small vase (SV) or Y-trellis (Y) training systems near Castrovillari, Italy. Data are averages of the four cultivars and six years.

Cultural practices	*SV*	*Y*
Topping (%)	0.7	0
Pruning (%)	26.9	35.9
Fruit thinning (%)	20.8	21.4
Harvest (%)	51.6	42.7

Table 2. Labor (hr/ha/year) needed for main cultural practices of the four cultivars in trial trained to small vase (SV) or Y-trellis (Y) systems near Castrovillari, Italy. P values indicate significance levels for training systems effect (ANOVA) whereas letters indicate differences among cultivars by Tukey's test at $P < 0.05$. Non-significant training system x cultivar interaction.

Cultivar	*SV*	*Y*	
Big Bang	470	612	a
Nectaross	476	687	a
Rich May	289	483	b
Summer Rich	420	608	ab
Average	**414**	**597**	**P<0.001**
Cumulated	**2,482**	**3,584**	**P<0.001**

Table 3. Yield (ton/ha/year) of the four cultivars in trial trained to small vase (SV) or Y-trellis (Y) training systems near Castrovillari, Italy. P values indicate significance levels for training systems effect (ANOVA) whereas letters indicate differences among cultivars by Tukey's test at $P < 0.05$. Non-significant training system x cultivar interaction.

Cultivar	*SV*	*Y*	
Big Bang	12.6	14.5	bc
Nectaross	22.8	32.0	a
Rich May	6.7	10.8	c
Summer Rich	16.4	16.9	b
Average	**14.6**	**18.5**	**P=0.070**

Cumulated	**87.9**	**111.3**	**P=0.132**

Table 4. Labor efficiency (kg/hr) for small vase (SV) or Y-trellis (Y) training systems from 3rd to 6th year near Castrovillari, Italy. P value by average levels indicates significance of training system main effect. P values for individual cultivars (from Tukey's test) reported only in presence of significant training system x cultivar interaction.

Cultivar	***SV***	***Y***	***P value***
Big Bang	27.5	24.7	n.s.
Nectaross	48.2	49.6	n.s.
Rich May	21.3	20.4	n.s.
Summer Rich	40.3	28.7	0.017
Average	**34.3**	**30.8**	**0.034**

Table 5. Cumulated profit (euro/ha over the six years of orchard life) and pay-back period (PBP) for small vase (SV) or Y-trellis (Y) training systems near Castrovillari, Italy.

Cultivar	***SV***	***Y***	***PBP***
Big Bang	13,915	11,570	-
Nectaross	15,562	28,511	2.5
Rich May	4,666	3,076	-
Summer Rich	10,430	9,540	-
Average	**11,144**	**13,175**	**15.8**

Figures

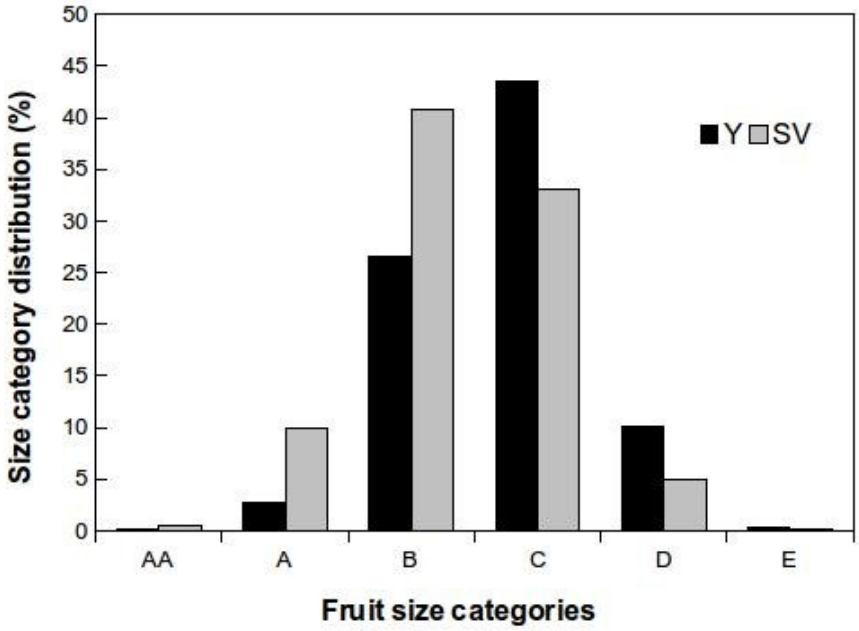

Fig. 1. Distribution of peach fruit (average of four cultivars and 3rd through 6th year) into various size categories for small vase (SV) or Y-trellis (Y) training systems near Castrovillari, Italy.