Pear Pruning and Training for Economically Sustainable Production

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Abstract

To obtain dwarfed easy-to-manage pear trees while keeping the autonomy of vigorous rootstocks, we developed a small open vase training system fully manageable by the ground with 550 trees per hectare, utilizing four clones of a local germplasm cultivar 'Pera Angelica di Serrungarina' and the synonym Santa Lucia. Training was characterized by: 1) minimal summer and winter pruning, 2) no heading back of shoots and branches (taille longue), and 3) selection of permanent fruiting branches (main scaffolds) after two to three years of growth. Two experimental trials were planted in Marche Region (Central Italy), grafted on microprogated 'Conference' (only in one trial) and 'Old Home' × 'Farmingdale' 40 - Farold 40® and on cuttings of quince BA29. In the present paper we limit the discussion to branch architecture to show different flowering aptitudes of Pera Angelica di Serrungarina in relation to the position and the vigor of the shoots. Minimal pruning without heading back helped direct the partitioning of strong rootstock vigor to many growing shoots, inducing early bearing. At the third year, branches had to be thinned and the central part of the vase cleared. No differences among Pera Angelica clones and Santa Lucia were detected. BA29 induced the highest flowering intensity at both sites, Farold 40® had an intermediate performance and micropropagated 'Conference' the lowest flowering. For BA29 and Farold 40® it was necessary to apply iron-chelates and organic fertilizer every year, to avoid chlorosis in the spring (mainly on BA29). Reddish leaves appeared during the hottest summer on Farold 40®.

INTRODUCTION

Labour costs for pruning and training are reduced in dwarf trees. In high-density orchards, dwarfing is achieved by using several techniques such as grafting pear cultivars on low vigor rootstocks. This solution requires favorable climatic and soil conditions, and rigorous attention to nutrient application and irrigation to avoid tree stunting and poor fruit quality. As an alternative, trees grafted on pear seedlings have higher growth autonomy but they exhibit delayed fruit bearing and need accurate training and pruning. In such a case, manual operations and harvest are time-consuming because of the low density planting, size and shape of the trees. A very simple idea is to temporarily train pear trees as small bushes, which are completely manageable from the ground, using minimal winter and summer pruning and delaying the clearing of the tree center after bearing to finally obtain a Small Open Vase (SOV). These principles were applied to manage the delayed open vase system of training in peach (Sabbatini et al., 2006).

Nevertheless, there are some complications with pear cultivars and it is not easy to achieve positive practical results with this technique. Pear growth is robustly acrotonic, since proleptic shoots tend to be facilitated in the terminal part of the limbs with narrow crotch angles. In addition, pear shoots generally present a strong apical dominance and they do not easily create sylleptic ramifications, which on the contrary have wide crotch angles (Neri, 2004). Because of these two characteristics, traditional training systems require several years to achieve good productive lateral limbs. A lot of manual work is also required, due to the need for repeated heading back of shoots and branches and the intensive use of divaricators (spreaders) to widen the crotch angles and to bend the limbs.

To overcome both of these problems, which cause bearing delays (up to 5–6 years) and cost increases (due to the time consuming manual operations), ideal high density planting (HDP) systems employ dwarfing rootstocks and well-feathered scions from the nursery (Robinson, 2007). As a consequence, the HDP systems require favorable climatic and soils conditions and a particular attention to irrigation and nutrient control to avoid stunting and poor fruit quality and to maintain the compact tree shape and size.

On the contrary, in more sustainable low-input systems in lower vigor growing areas), dwarfing should not be excessive so as to avoid the loss of plant growth autonomy, thus dwarfing rootstocks are banned but feathered scions can be very helpful in controlling plant vigor. In the nursery, several acrotonic species, such as pear, cherry and apple, even if grafted on vigorous rootstocks, can be induced to produce sylleptic shoots by increasing growth rate and applying specific growth regulators or leaf deblading (Neri et al., 2004; Neri, 2004). The main benefits in the use of sylleptic shoots are their wide natural crotch angles and the possibility of achieving a precocious high shoot to root ratio. In this way, therefore, they help to induce regular fruit bearing and to reduce plant size.

With ten or more lateral shoots per one-year-old nursery tree, after bud break dozens of growing points in the central part of the scion will compete against the acrotonic shoots. In this way it is possible to change the natural assurgent character of pear trees to a more controllable bush shape. At the same time, the high number of shoots per plant should reduce the average shoot length favoring flower induction and differentiation, as was found in other species (Zucconi, 2003, 2007).

The present work was devoted to studying the vegetative and flower shoot positions or the architecture of the twigs of Pera Angelica di Serrungarina (Fig. 1) in a small open vase system, which is able to manage the naturally vigorous trees, making them more amenable to pedestrian sustainable orchards, with less intensive attention to nutrition and irrigation necessary. To test this hypothesis we described the branch architecture of pear trees grafted on different rootstocks and trained as small open vases in comparison with trees trained as free spindles.

MATERIALS AND METHODS

Small Open Vases: Training and Pruning

To reduce the vegetative part of the life cycle of medium-vigorous trees, the plants were trained, starting in the nursery, to obtain the maximum number of sylleptic shoots. In the nursery and during the first year in the field, the standard fertilization practices induced strong vigor, and therefore, sylleptic shoot growth. During the second and the third years, all short shoots were left unpruned. After getting the first fruit production, the equilibrium was maintained by appropriate winter pruning, clearing the center of the tree crown and avoiding heading back of vigorous shoots.

To make this training system completely amenable to pedestrian management, after planting the main shoot was headed back to 10 cm above the height of the future branching, leaving on the plant as many laterals as we were able. During the spring, the growth was very strong and a large number of branches and shoots per plant were produced. Manual summer pruning was applied during the first two years to reduce the excess vigor in the terminal parts of the internal shoots, by tearing the terminal segment off vigorous shoots (Figs. 2 and 3).

During the first three years no further heading back of shoots and branches was performed. This part of the pruning strategy per single branch was comparable to that for the apple “taille long” system (Lauri et al., 2007). The bush was then opened up to form a vase by progressive cutting out of extra branches in the central crown part, reducing their numbers to 3–4 per plant (Fig. 4).

Plant Material and Experimental Design

The experimental trials were planted in: A) Serrungarina (Pesaro Urbino) in March 2004 and B) Chiaravalle (Ancona) in March 2005, both places are located around 43° latitude North, at 200 and 10 m above sea level, respectively. The soil in site A) was calcareous (160 g/kg), pH = 8.1 with heavy clay (40%) without irrigation; in site B) the soil was very fertile and drip irrigation was applied from the first growing season.

In site A) well-feathered one-year-old ‘Pera Angelica di Serrungarina’ trees, grafted on microprogated ‘Conference’ (185 trees), and Old Home x Farmingdale 40 - Farold 40® (190 trees) or on cuttings of quince BA29 (150 trees) were planted at the following distances: 5 x 3 m in four different farms. At each farm, the trees were planted in uniform soil conditions and trained as SOV, using single plots per each rootstock. Trunk cross sectional area was measured and flower intensity estimated at the third year.

At site B) four different clones of ‘Pera Angelica di Serrungarina’ (collected in Serrungarina area) and ‘Santa Lucia’ (coming from the national germplasm repository and considered synonym) grafted on micropropagated ‘Old Home’ × ‘Farmingdale’ 40 - Farold 40®, and cuttings of quince BA29 were planted at the following distances: 5 x 2 m. Twenty well-feathered trees per treatment were used for a total of 200 plants. Half of the trees were trained as free spindles and half as small open vases in a split split plot. For each training system (split, Fig. 5), the two rootstocks (split) were randomized in two replications, and then the five clones were established in plot of five plants. Trunk cross sectional area was measured and flower intensity estimated in the second year.

Branch and Shoot Description

At site B), ten branches (five vegetative and five reproductive) per rootstock were studied to describe vegetative and flower shoot positions. On each shoot, the numbers of flower buds were counted at the end of second year.

RESULTS AND DISCUSSION

From the architecture observation of adult trees, ‘Pera Angelica di Serrungarina’ seemed to have lateral brindles and short extension shoots (less than 50 cm) as preferred sites for flower development. Spurs were destined to be vegetative. Therefore, this cultivar tended to have a very peculiar production sequence without any significant differences among its clones. Vigorous shoots were vegetative during the first year; the following year proleptic growth induced in the apical part of the limb two to three vegetative shoots and, along the limb, a number of short vegetative spurs (Figs. 4 and 6).

As a consequence, during the second year flower production was very low and essentially due to the presence of flower-differentiated brindles in the apical parts of the limbs. Only during the second growing season, were the shoots growing in the terminal positions able to set their terminal buds in advance and, therefore, to differentiate florally. As a result, a certain amount of flower induction was detected during the second growing season on the sylleptic shoots formed in the nursery. In the fields of site A) during the third growing season the flower capacity was high and so was the fruit set.

At the fourth year the influence of the rootstocks was greater and ‘Conference’ and BA29, compared to Farold 40®, showed greater trunk cross sectional areas. Flowering intensity was also influenced by rootstock: BA29 induced the highest flowering intensity at both sites, Farold 40 had an intermediate performance and micropropagated ‘Conference’ showed the lowest flowering (Fig. 7). It is worth noting that for BA29 and Farold 40® it was necessary to apply iron-chelates and organic fertilizer every year, to avoid chlorosis in the spring (mainly on BA29) and reddish leaves during the summer (on Farold 40®) at Site A.

As has been found on other pear cultivars, the influence of the rootstock may change the behavior of shoot growth, and the position of fruiting shoots on the branch. In particular, Du Plooy et al. (2002) found very different numbers of latent and vegetative buds on ‘Forelle’ when grafted on Quince A or on BP1 rootstocks. Generally, the coexistence of vegetative growth and cropping is ensured in trees by temporal and spatial separation of these two functions (Crabbé, 1987).

From the field management of this cultivar (Santa Lucia did not show any consistent difference in comparison with the other four local clones belonging to Pera Angelica di Serrungarina), mature small open vases, it can be inferred that the three-year cycle of fruiting branches does not need heading back to induce early bearing. Eventually, the limbs after two years of heavy production should be shortened to induce new vegetative water sprouts and start a new productive cycle. As shown in Figure 8 (right), in fact, the position of the shoots bearing flower buds was mainly in the apical part of the branch for both rootstocks at Site B, hence, incorrect heading back would have cut off the fertile part of the branch.

The shoots, which showed the highest flower capacity, were 40 and 50 cm long. The very short ones (less than 20 cm) exhibited poor flowering potential. The trend was confirmed in both rootstocks but Farold 40® expressed the tendency to have high fertility in shorter shoots (Fig. 8 left).

Spindle training dramatically reduced the amount of pruning at the third year, in comparison with the open vase system, while the difference in trunk cross sectional areas was much less evident. Flower intensity was similar, indicating that the vigor of single shoots, which are not headed back in the second and third year, can channel into the reproductive cycle also in vigorous plants. These results open the possibility for taille long even for pear, at least in this terminal shoot productive type of cultivar (Figs. 9 and 5).

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Figures

Fig. 1. Eighty-year-old ‘Pera Angelica di Serrungarina’ trees trained as traditional open vases in mixed cultivation.

Fig. 2. Summer pruning during the second year: left, open vase; right, free spindle.

Fig. 3. Healing of summer pruning (tearing of the shoots) with no vegetative re-growth.

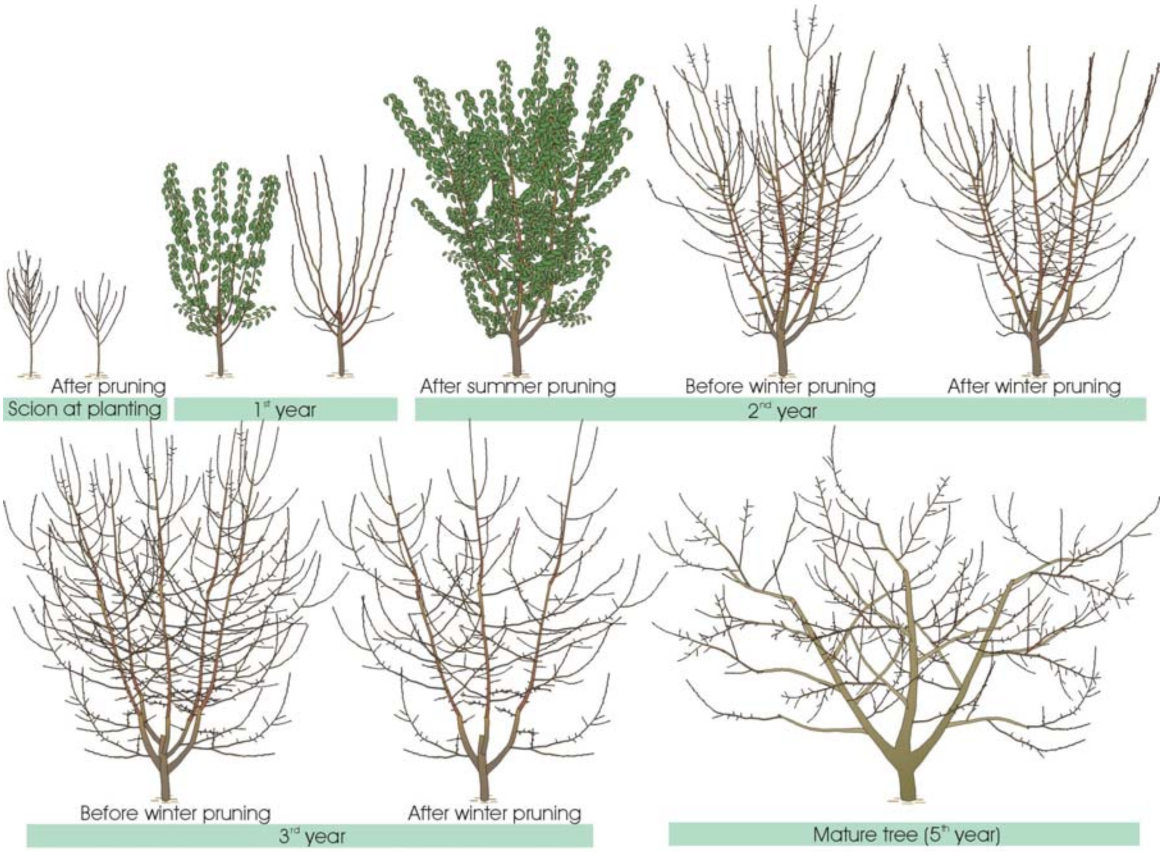

Fig. 4. Small open vase: training and pruning.

Fig. 5. Free spindle (left) and small open vase (right) at the end of the second year after winter pruning.

Fig. 6. Small open vase at blooming. Flowering is located on the terminal parts of the shoots. To achieve maximum flowering it is important to avoid any heading back of the shoots and of the limbs. During the winter, the soil is covered by a green mulching of spontaneous weeds. Only in the summer, to reduce water evapo-transpiration, in this Mediterranean climate, should minimum tillage be applied.

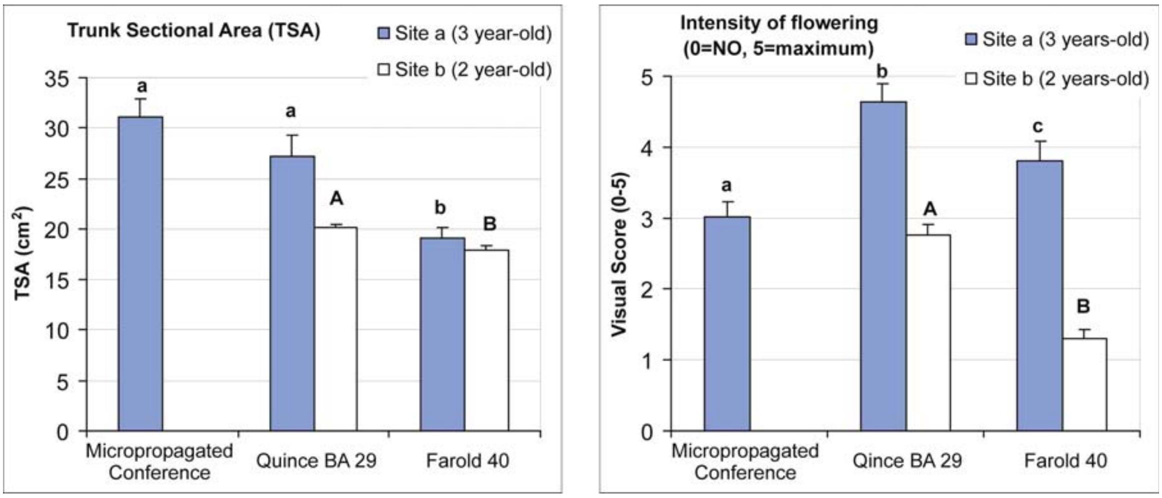

Fig. 7. Trunk cross sectional areas and flower intensities at site a, at the end of the third year, and at site b, at the end of the second year. Bars indicate Standard Errors. Different letters indicate significant differences (Duncan's test P>0,05).

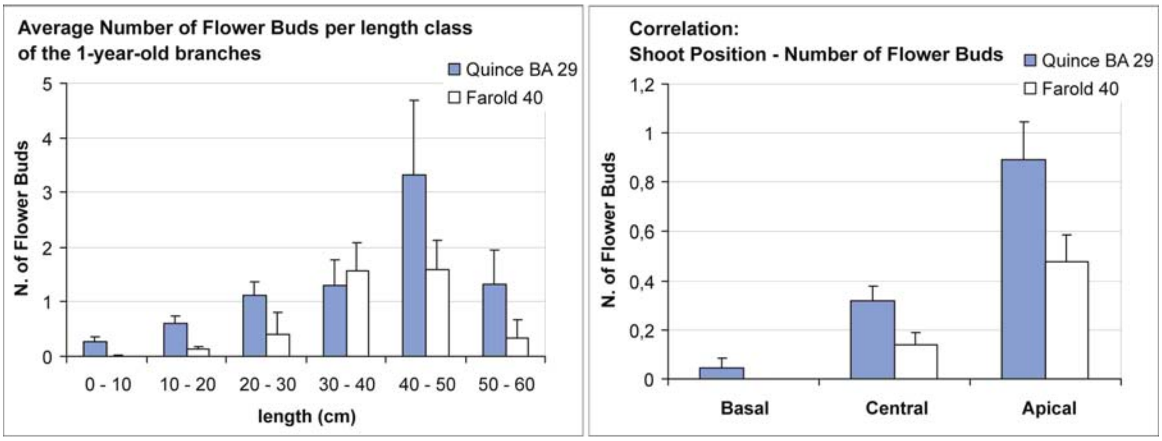

Fig. 8. Flower differentiation was also related to the length of the shoot (left) and to its position on the branch (right). Bars indicate Standard Errors.

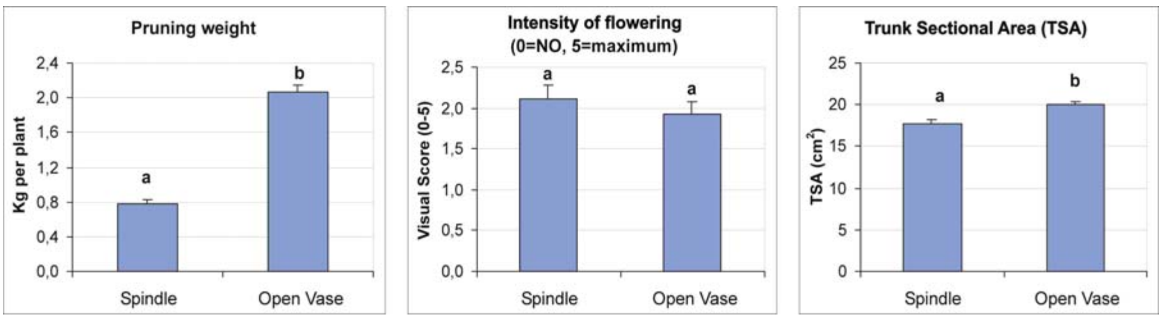

Fig. 9. Pruning weights, flowering intensities and trunk sectional areas in spindle and open vase trained trees. Bars indicate Standard Errors. Different letters indicate significant differences (Duncan's test P > 0,05).