

Histological Studies on Pistachio Vegetative Organs as Related to Fructification

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Keywords: *Pistacia vera*, fruiting, histology, crop load

Abstract

Effects of fruiting on histological structure and histochemical characteristics of shoots, leaves and roots of pistachio (*Pistacia vera* L.) were microscopically examined on tissues sampled from trees with different crop-loads and carbohydrate reserves availability (bearing, non-bearing and trees subjected to inflorescence-bud removal twenty days before full bloom for four consecutive years). Differences in cambium activity and xylem and phloem structure in several developmental stages are reported. Starch content was higher in “deblossomed” than in non-bearing and bearing trees.

INTRODUCTION

Pistillate pistachio trees (*Pistacia vera* L.) present a mechanism of alternation that is quite different from that of other typical biennial bearing species (Crane and Nelson, 1971). A large number of inflorescence buds are initiated every year but most of them abscise in the summer of the “on” year, during active embryo growth. Inflorescence bud abscission has been related with carbohydrate availability and, therefore, with competition with crop load (Crane et al., 1973; Takeda et al., 1980; Wolpert and Ferguson, 1990). Recently, it has been demonstrated that presence of the fruits affects inflorescence bud drop and dry-matter partitioning between reproductive and vegetative organs of the trees (Barone et al., 1995; Marra et al., 1998). The aim of this study was, therefore, to investigate the histological structure and histochemical characteristics of the different organs of the trees, as related to fructification.

MATERIALS AND METHODS

This study was carried out on 15 adult pistachio trees of cultivar ‘Bianca’ on *Pistacia terebinthus* rootstock spaced 8 x 8 m, grown at Racalmuto, Sicily (250 m a.s.l.), 37°41' N.

Five trees were prevented from fruiting for a period of four consecutive years by deblossoming treatments twenty days before full bloom (“D-NB”). In 1998, 10 more trees in a normal alternation cycle, 5 bearing (B) and 5 non-bearing (NB) trees, were randomly selected.

The following organs were sampled and sectioned, after fixation in FAA following the procedure described elsewhere (Caruso et al., 1995): terminal shoots (at sprouting time; at the beginning of the lignification (July) and at leaf drop (end of September); fully expanded leaves and roots (July).

RESULTS AND CONCLUSIONS

Terminal Shoots

At the earliest sampling date no anatomical differences were observed between the young active growing shoots of D-NB and B trees. Differences could however be detected starting the second date of sampling (July). Shoots of D-NB trees had a thicker xylem and phloem, more parenchyma cells, less porosity and a reduced number of vessels of smaller diameter than in the shoots of bearing trees (Fig. 1-2). In the case of D-NB trees cambium activity seemed to have produced a higher number of cell layers in the xylem denoting a more intense activity.

From an histochemical point of view, shoots of D-NB trees showed a greater starch accumulation than in B trees; an intermediate degree of starch accumulation was detected in the shoots of NB trees (Fig. 3-4).

Also the size of starch grains was affected by the crop-load status of the trees (Fig. 5-6). Resin ducts were smaller in the shoots of D-NB trees than in the other treatments.

In the shoots of D-NB trees sampled in September substantial starch accumulation was evident also in the central cylinder, unlike the other treatments.

Leaves

Anatomical investigations showed that leaves in the D-NB trees were thicker than in the other trees, with a greater number of palisade cell layers. On average, the length of the palisade cells was greater than in B trees.

As in the shoots, the highest accumulation of starch was found in the leaves of the D-NB trees (Fig. 7-8).

Roots

No sign of starch accumulation was observed in the finest fraction of the sampled roots (< 2 mm) whereas different levels of starch accumulation could be found in the intermediate fraction (2-5 mm), depending upon the different crop-load status. Lastly, no starch was detected in the largest size fraction of fine roots (> 5 mm), probably due to its utilisation by the tree canopy. In general terms, it could be said that roots sampled in July showed an opposite behaviour to that of the shoots. In fact, the lowest accumulation of starch was recorded in the roots of the D-NB trees (Fig. 9-10), probably due to the intense active vegetative growth of these trees at this stage (Marra et al., 1998). Furthermore, a reduced vascularisation of the roots of B trees was observed compared to that of D-NB trees.

This study confirms, on the basis of anatomical and histochemical findings, previous observations carried out in terms of dry matter accumulation and partitioning (Barone et al., 1995) and of starch analysis content (Marra et al., 1998).

Differences observed in this study confirm that even anatomical and histochemical aspects of vegetative pistachio organs are affected by fructification. Long-lasting effects were particularly evident in the case of the trees that were subjected to consecutive deprivation of the reproductive organs.

Thus, it can be concluded that the presence of the infructescences not only strongly affects growth of all tree parts, but also contributes to the mobilisation of tree reserves, thus determining the appearance of early competition phenomena and limiting the recovery of a good nutritional status for the next year. Further research, extended to other sampling dates, is needed to better clarify the role exerted by roots in the time course of utilisation of available assimilates reserves.

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Figures

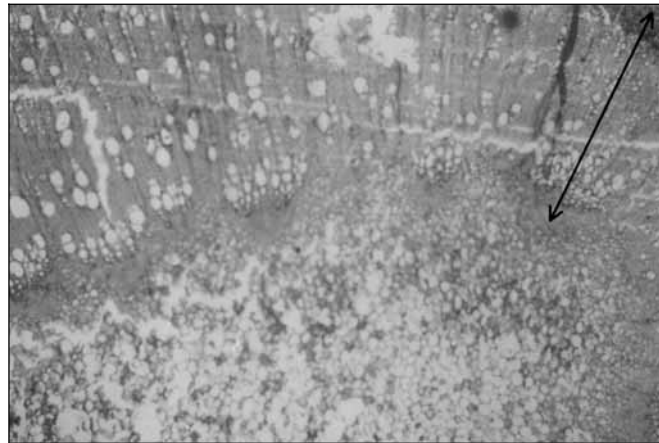


Fig. 1. Xylem and pith in D-NB shoots in July, 25 \times .

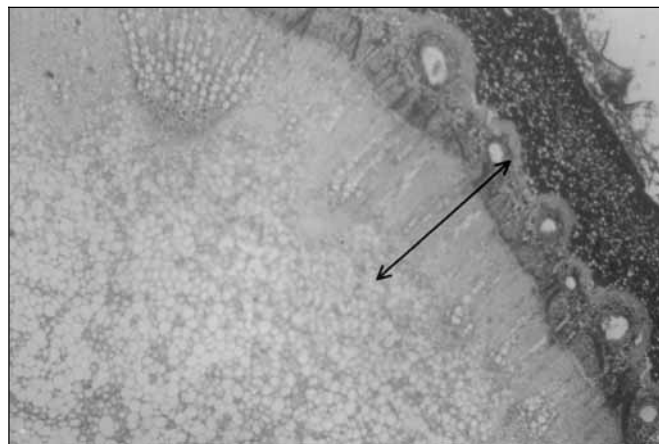


Fig. 2. Section of a B shoot in July, 25 \times .

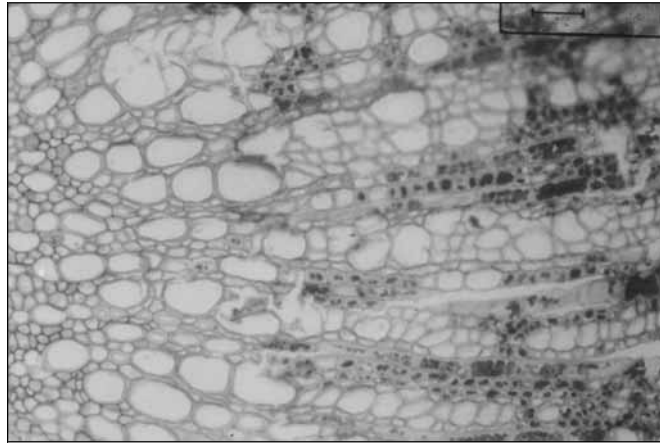


Fig. 3. Section of a B shoot in July, 100 \times . Starch is only present in the outer portion of medullary rays.

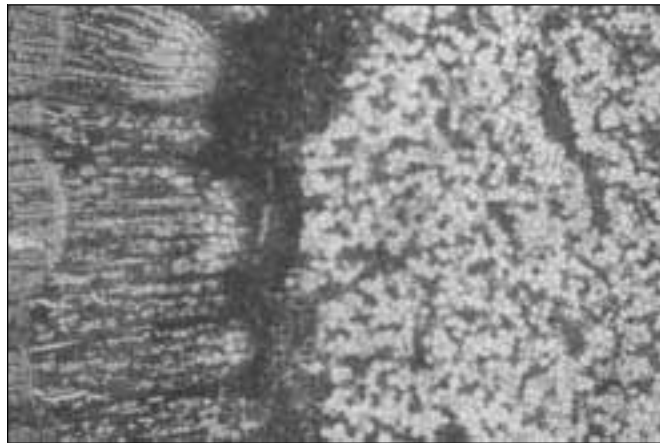


Fig. 4. Section of a D-NB shoot in July, 25 \times . Starch is present in all parenchyma cells of the xylem, and in many pith cells.

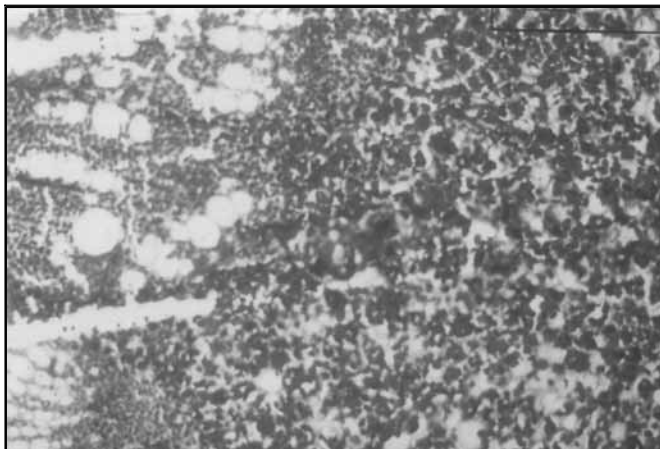


Fig. 5. Pith of a D-NB shoot, 25 \times .

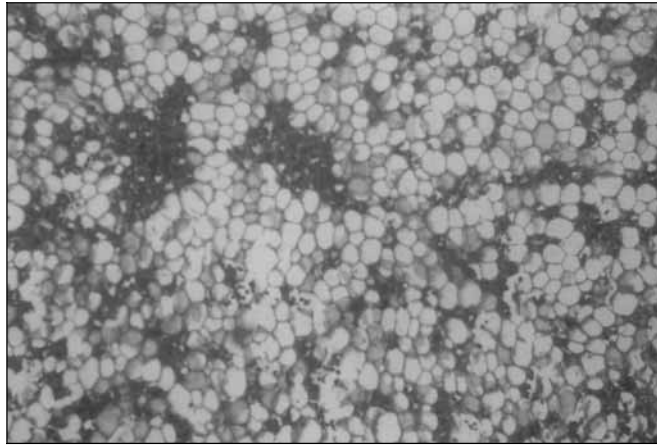


Fig. 6. Pith of a B shoot, 50 \times . Starch grains are of a smaller size.

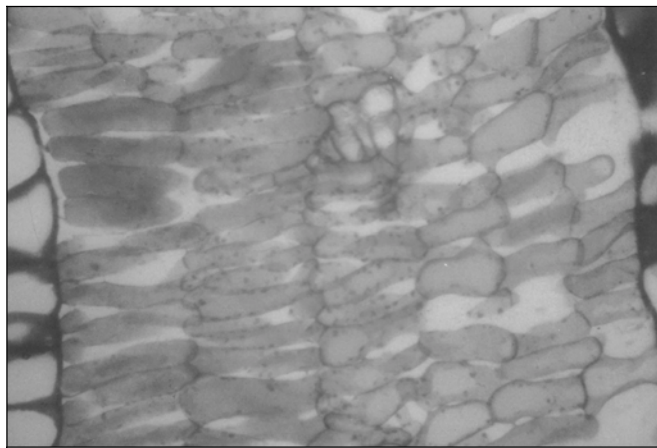


Fig. 7. Section of a B leaf, 100 \times . Palisade tissue has 5-6 cell layers. Starch is concentrated in the central layers.

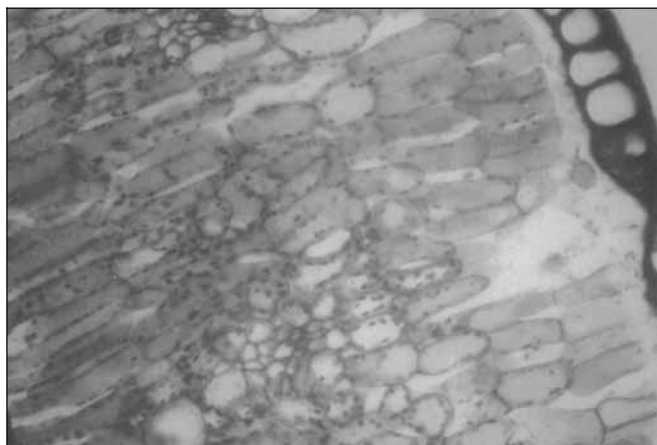


Fig. 8. Section of D-NB leaf, 100 \times . Starch is likewise in the central palisade layers, but is more abundant.

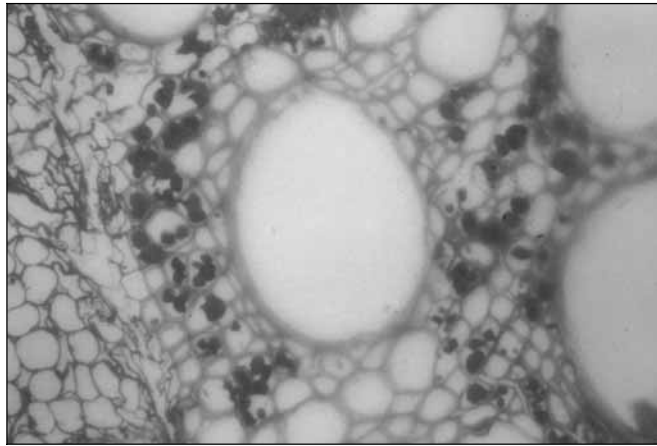


Fig. 9. Starch accumulation xylem parenchyma of fine roots of D-NB plants, 100×.

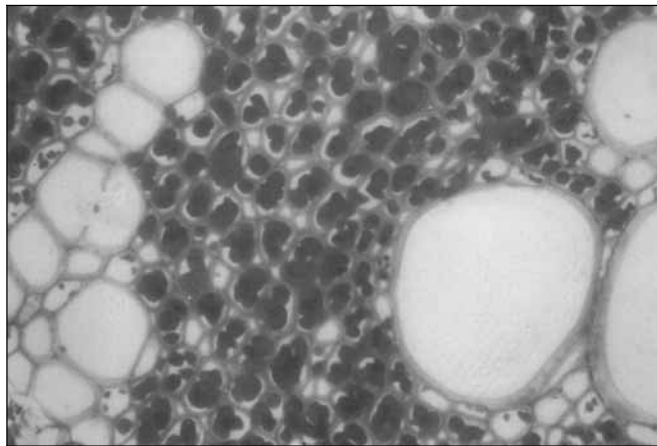


Fig. 10. Starch accumulation xylem parenchyma of fine roots of B plants, 100×.