VEGETATIVE GROWTH AND INFLORESCENCE BUD ABSCISSION IN BEARING AND NON BEARING PISTACHIO TREES

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Abstract

A study on shoot growth, leaf area development and inflorescence bud abscission in bearing and non-bearing deblossomed trees, has been carried out in a commercial pistachio orchard located at Agrigento (Sicily, 37°30'N).
Growth pattern of shoots, leaves and inflorescence buds was monitored in an "on" year on twenty Bianca/*P. terebinthus* trees. Twenty days before full bloom half of the selected trees were deblossomed by excising inflorescences from the entire tree whereas the remaining trees were used as control. Starting from the date of deblossoming until the onset of bud drop, two-year branchlets per tree were periodically collected and divided into two and one-year old wood, fruits, leaves, inflorescence buds and current year stem. On such material data concerning growth and dry matter accumulation were collected. The results are discussed and referred to the alternate bearing phenomenon.

Additional index words: *Pistacia vera*, partitioning, alternate bearing.

1. Introduction

The Pistachio (*Pistacia vera* L.) is a typical biennial bearing species but its alternation is due to an unusual inflorescence bud abscission that occurs in the year a heavy crop is produced (Crane and Nelson, 1971; Monselise and Goldschmidt, 1982).
The bud-drop phenomenon in the on-year has been related to competition for assimilates between newly formed inflorescence buds and fruit, during active embryo growth (Crane and Nelson, 1972; Crane et al., 1973). Data obtained by Takeda and co-workers (1980) strongly supported this idea proving that developing fruit acts as a stronger sink than inflorescence bud, accumulating most of the photosynthate.
Nevertheless, the mechanism of such competition is still unclear in detail and the influence of factors other than crop load have been also invoked (Crane and Iwakiri, 1987).

The effect of crop load reduction treatments, performed at different dates, clearly demonstrated that inflorescence bud retention is positively correlated with the percentage of the removal treatment (Caruso et al., 1993), and with the earliness of the removal itself (Wolpert and Ferguson, 1990). Together, these studies stressed the importance of evaluating the quantitative effect of crop load on a “whole-plant basis” since bud retention response can be affected by the crop load of parts of the tree others than those submitted to the removal treatments.

This experiment was designed to study: a) the seasonal dry matter accumulation and partitioning in shoots of bearing and completely deblossomed pistachio trees and b) whether a possible modification of the distribution of dry matter, caused by the early suppression of the developing reproductive organs, may influence the subsequent bud drop phenomenon.

2. Materials and Methods

Twenty Bianca/*Pistacia terebinthus* trees in a 80-year-old commercial orchard at Racalmuto, Sicily, spaced 8 x 8 m, were selected for uniformity of vigour of growth and expected crop load. On the 7th of April,1994, 20 days before full bloom, all inflorescences were removed from ten trees (Non Bearing Trees - NB) whereas the remaining 10 trees were left untouched as Control (Bearing Trees - B).

Four branches per tree in B and NB trees were tagged, and used for periodic determination, from bloom to harvest time, of shoot length and diameter, n° of leaves, n° of inflorescence buds on the new growth, and for B trees only, n° and length of infructescences and n° of fruits per infructescence.

Two branchlets per tree were sampled periodically from May to September and brought to the laboratory to replicate the above mentioned measurements and to the determinate the dry matter content of each sub-sample, i.e. shoot (leaf, axis, and inflorescence buds) infructescence (rachis and fruit).

Furthermore, in two different sampling dates, leaflet and whole leaf area, from fully expanded leaves, were measured by 'Delta T' Leaf Area Meter.

Data from all sampling organs and dates were analyzed to find the highest correlation between the measured values and the dry wt of each sub-sample, e.g. between “infructescence length” and “n° of fruits” vs. “infructescence dry wt”, or between “shoot length” and “shoot diameter” vs. “shoot dry wt”.

The best predictors of dry wt of each component(sub-sample) were applied to non destructive measurements taken on the tagged branches to estimate the evolution of newly formed dry matter.

3. Results

The pattern of dry matter accumulation of vegetative axis in current-season’s shoot for B and NB trees is reported in Fig. 1. NB trees showed a high and rapidly increasing dry weight gain in vegetative axis throughout its development. The highest dry wt observed in the NB trees were due to a higher basal shoot diameter (NB 0.96±0.02 cm; B 0.75±0.02 cm), whereas shoot growth in length, that stopped at about 30 days AFB, did not differ significantly between B and NB trees (8.9±0.8 and 7.3±0.9 cm, respectively). In spite of a similar average number of leaves per shoot (B 5.7±0.14; NB 6.1±0.19), total leaf dry weight per shoot (Fig. 2) was greater in NB trees since early stages (twice by 35 days AFB). Furthermore, increasing differences were observed throughout the period of observations, attaining a maximum at about 100 days AFB when total leaf dry wt per shoot in B trees began decreasing due to an early, intense leaf drop (B 37.6%±5.3; NB 4.4%±1.2). The differences observed along the season in total leaf dry wt were due to leaf area and dry wt per unit leaf area of fully expanded leaves of B and NB trees (Tab. 1).

Dry wt of inflorescence bud on current growth was significantly higher in NB trees (Fig. 3). Dry weight gain in inflorescence bud of NB trees showed a trend towards a more rapid and almost constant increase throughout the entire period of observations. On the contrary, inflorescence bud of B trees practically ceased its growth at about 65 days AFB, i.e. at the time in which active embryo growth began (Crane and Al-Shalan, 1974). As a result, at about 100 days AFB, buds on B trees attained only 35% of the dry wt of the buds on NB. Differences in growth rate of inflorescence buds were apparent since the earlier stage of their development so that dry wt. of inflorescence of NB was twice than that of B trees as early as 35 days AFB, during the period of rapid growth of the pericarp.

Nevertheless, when total dry matter per shoot was calculated, it was evident that dry wt gain in shoot of B trees was significantly higher since it is strongly influenced by the wt of infructescence (Fig. 4). In fact, in B trees, infructescences (fruits + rachis) accounted for values ranging from 60% (40 days AFB) to about 85%, at harvest time, of the total dry matter per shoot, with the main contribution of the fruit itself (fruit 92% - rachis 8%) (Fig. 5).

In particular, dry matter partitioning on a shoot-basis indicated that in B trees, at harvest, fruits accounted for about 79% (i.e. 61.3 g), leaves (after the intense leaf drop) for 12% (9.4 g), infructescence rachises for 7% (5.42 g) and shoot axis for 2% (1.6 g), in contrast to 87% (28.7

g) of leaves and 13% (4.3 g) of shoot in NB trees.
Percentage of inflorescence bud drop was strongly different between B and NB trees. Bud drop resulted almost total in the former (B 89.6% ±2.8) and negligible in the latter (NB 9.8% ± 1.7).

4. Conclusions

Presence of infructescence on shoot strongly affected growth of all other parts of the shoot itself in terms of dry matter accumulation.
On the contrary, shoot length resulted to be less affected by the removal treatment. This result suggests that shoot growth in length is influenced by the crop load bore in the previous year, in our experiment similar (off year) for both B and NB trees. This is supported by the fact that non bearing branches in one year are able to store higher amounts of starch than bearing branches (Crane and Al-Shalan, 1977).
Absolute values of dry matter accumulation showed a generalized reduction of growth of leaves, shoots and buds in the B trees even at the earliest dates of observation. In fact, as early as 35 days AFB, half the dry matter was found in the shoots, leaves and buds of B trees of that found in the NB ones. Hence, the onset of this competition effect exerted by reproductive organs seems to occur prior to the period in which seed growth usually begin, i.e. earlier than generally observed (Porlingis, 1974).
In particular, inflorescence bud benefits by the removal treatment. In comparison to B trees, the lack of the sink strength of fruit allowed inflorescence buds on NB trees to continue to grow actively for an extra-period of about 40 days and, thus presumably, to receive more than twice as much the photosynthate as those on bearing trees, as observed also by Takeda and co-workers (1980).
Our results suggest that in B trees fruit growth polarizes the major part of the available photosynthate and finally may use also part of the tree reserves, since it continues to grow in spite of the loss of most of the leaves and, presumably, in spite of the early decline of their efficiency, as reported for other fruit species (Sams and Flore, 1982). In NB trees the absence of fruit determines a higher carbohydrate availability for the growth of organs others than fruit (shoot, inflorescence bud and leaf itself) and likely for storage. In spite of the lower leaf area per shoot, intense leaf drop and, presumably, the loss of photosynthetic capacity in B trees, total dry matter per shoot of B trees was more the twice that of NB. This could have been determined by different processes such as mobilization of excess assimilates to reserve organs in NB, a mobilization of carbohydrates from reserve organs and

leaf in B trees and, lastly, a higher photosynthetic rate in B trees due to the presence of fruit itself. The contribution of each of these processes to the dry wt balance of the trees still remains the main point to be elucidated.

Furthermore, the lack of the fruit sink determines in NB trees the prolongation of growth curves in all those organs. Finally, the onset of competition for photosynthate between developing inflorescence buds and nuts arises prior to seed growth, yet at the stage of pericarp development.

These competition effects evident from the striking differences observed in the bud dry wt are likely responsible for the subsequent evolution and degree of inflorescence bud drop phenomenon. Similarly, an effect of reallocation of assimilates from the leaves to the fruit can be responsible for the early senescence and the consequent abscission of the leaves observed.

However, these results pointed out the need of studying a complete dry matter balance to assess carbon fluxes within and out of the shoot both in the fruiting and defruited trees in order to better elucidate the possible correlation with the alternation phenomenon.

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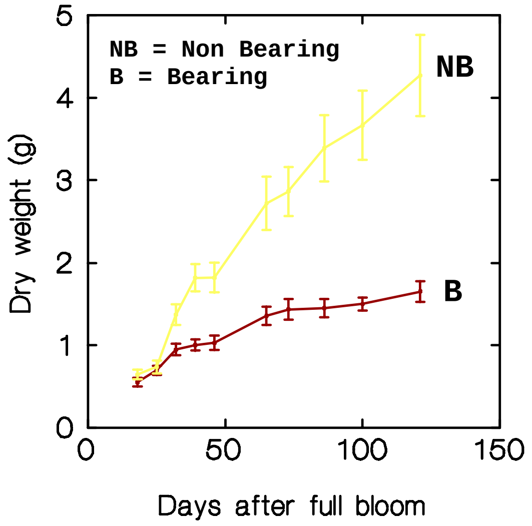

Fig. 1 - Seasonal dry matter accumulation in the newly formed vegetative axis

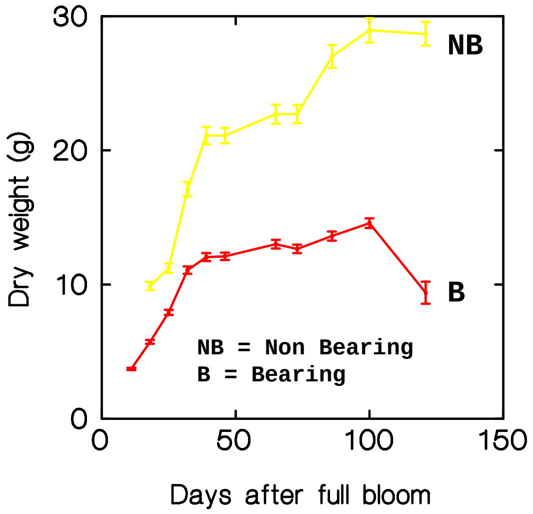

Fig. 2 - Total leaf dry wt. per shoot

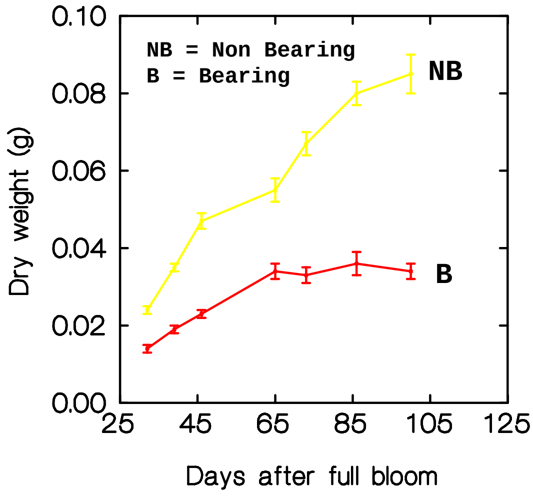

Fig. 3 - Inflorescence bud dry wt.

Tab. 1 - Leaf and leaflet area and dry wt per unit leaf area (DWU) in Bearing and Non Bearing trees

	Leaf area (cm^2)	S.E.	Leaflet area (cm^2)	S.E.	DWU (g/m^2)	S.E.
B	144.9	5.8	29.5	1.1	138.5	5.7
NB	201.2	5.9	42.1	1.1	159.2	5.4
T-test	***		***		*	

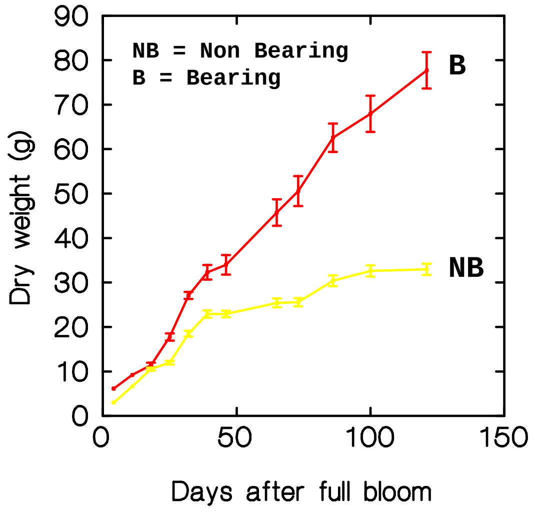

Fig. 4 - Total dry matter per shoot (cumulative dry wt. of shoot axis, leaves, buds and infructescence)

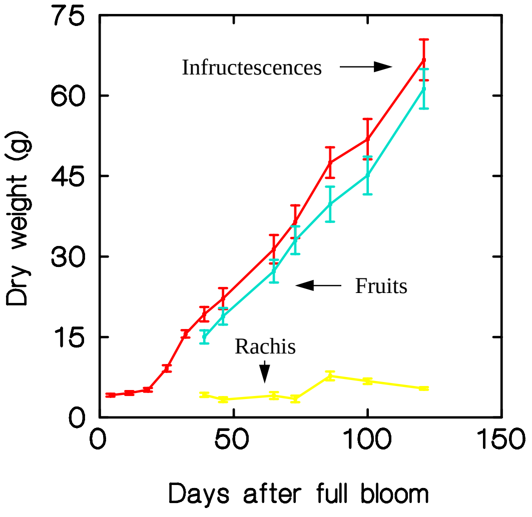

Fig. 5 - Whole infructescence, fruit and rachis dry wt. per shoot