Detection of bud abscission of pistachio via histological analysis

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Abstract

Alternate bearing is a very widespread phenomenon occurring in both deciduous and evergreen trees. Alternate bearing, also known as irregular bearing, is the phenomenon by which trees bear an irregular crop year after year, usually heavy yields ("ON" year) which are followed by light ("OFF") ones. Generally, the presence of fruit is the key factor controlling flower initiation. Bud abscission caused by alternate bearing phenomena is one of the most important problems in pistachio also. In Turkey, due to the abscission of inflorescence buds, alternate bearing occurs especially on commercially grown 'Uzun' pistachio severely. In 'Uzun' pistachio fruit production fluctuates between an "on" year of high yields and an "off" year of low yields. As far as we know there are very limited papers previously published on histological analysis on pistachio related to flower bud abscission. Therefore, in this study it was aimed to detect the beginning of the flower bud abscission time on 'Uzun' pistachio by histological methods. For this purpose, "on" and "off" year of flower buds of 'Uzun' pistachio cultivar was used as experimental materials. The paraffin sectioning method used for detection of the abscission layer formation period.

Keywords: *Pistacia vera*, bud abscission, light microscope, "on" year

INTRODUCTION

Alternate bearing phenomena occurring in both deciduous and evergreen trees have been investigated since many years and varied depending on the fruit trees. Alternate bearing in fruit trees is the result of poor flower initiation in most cases but in pistachio (*Pistacia vera* L.) it is unusual and arises as a result of inflorescence bud abscission during the year in which a heavy crop is produced (Crane and Nelson, 1971) and tree's fruit production fluctuates between 'on' years of high yields and 'off' years of low yields. These cropping patterns result in irregular production and this affects price, marketing, quality, labor and cultivation applications (Chung et al., 1995; Kallsen et al., 2007; Picchioni et al., 1997; Rosecrance et al., 1998; Ferguson et al., 1995). Monselise and Goldschmidt (1982) described the possible external and internal factors, which might cause alternate bearing in fruit trees. Although the mechanisms of abscission are not yet clear, it seems that the process for leaves, flowers and fruit in several species is dependent on a reduction of auxin and an elevation of ethylene, and perhaps ABA levels, in the abscission zone. An increase in respiration, protein and RNA synthesis usually occurs before the abscission in the abscission zone cells compared. Abscission of inflorescence buds in pistachio is still unknown. For this purpose, in this study, it was aimed to detect bud abscission zone and the initiation time of abscission layer via histological analysis in "on" and "off" years of flower buds in 'Uzun' cultivar.

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MATERIALS AND METHODS

Materials

The experiments were conducted in 2014 growing period at the Research and Experimental area of Ministry of Agriculture Pistachio Research Institute of Gaziantep. 33-years old *Pistachio vera* 'Uzun' trees (grafted on *Pistacia atlantica* Desf., planted at 10×10 m intervals) were used as plant material (Figure 1).



Figure 1. A view of "off" (left) and "on" (right) 'Uzun' trees.

Methods

Flower buds were sampled from "on" and "off" year trees every 10 days after full flowering time as given in Table 1. Flower buds collected including woody part with "on" and "off" year trees. For paraffin sectioning studies, samples were fixed in FPA 70 (formaldehyde-propionic acid-alcohol) and the tip of flower buds were cut off to facilitate rapid penetration of the fixative and paraffin. All flower bud samples were dehydrated using ethyl and tertiary butyl alcohol series for 4-5 h in each solution, then embedded in paraffin, sectioned longitudinally (10-12 µ) with a rotary microtome (Leica RM2134), stained with 0.125% hematoxyline and mounted in Entellan (Johansen, 1940). Prepared slides were examined for time of abscission layer formation below the bud inside the woody part with light microscope (Olympus BX51) comparatively and photographed by DP72 camera.

Table 1. Sampling schedule for histological analysis.

Physiological periods	Date
NDAFF[1]-26	02.05.2014
NDAFF -36	12.05.2014
NDAFF -46	22.05.2014
NDAFF -56	02.06.2014
NDAFF -76	13.06.2014
NDAFF -86	23.06.2014
NDAFF -96	02.07.2014

[1]NDAFF: Number of days after full flowering.

RESULTS AND DISCUSSION

The "on" and "off" year flower buds of 'Uzun' pistachio cultivar were compared with paraffin sectioning method in order to detect initiation time of cell metamorphosis in the abscission layers. The views obtained from light microscope photographs, from combining line between flower bud and wood layer zone of "on" and "off" year samples were given in Figure 2. According to the light microscope photographs abscission layer zone or cell differentiation were not observed when the samples were taken on 2 May, 2014. As seen in Figure 2, cells were intensely between bud and wood layer and no differences were observed between "on" and "off" year samples on this date.

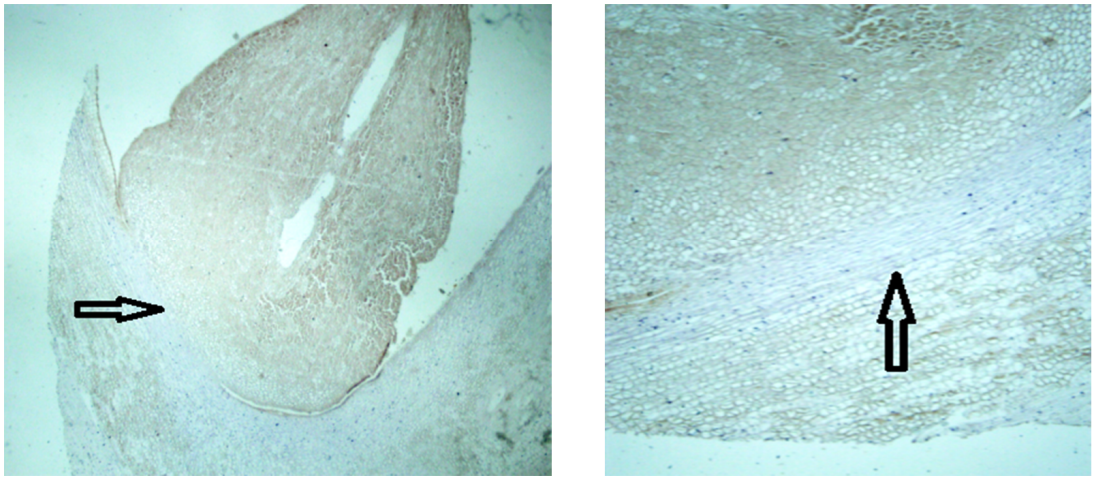


Figure 2. Views of line between flower bud and wood layer zone of “on” years of ‘Uzun’ cultivar on 2 May, 2014 (NDAFF-26).

According to the light microscope photographs, abscission zone or cell differentiation were not observed and no differences were observed between “on” and “off” year trees samples on 12 May, 2014, also. The light microscope results indicated that abscission zone or cell differentiation were observed and abscission layers obtained from “on” year samples on 22 May, 2014 (Figure 3). However, abscission zone layers were not observed from “off” year plant samples.

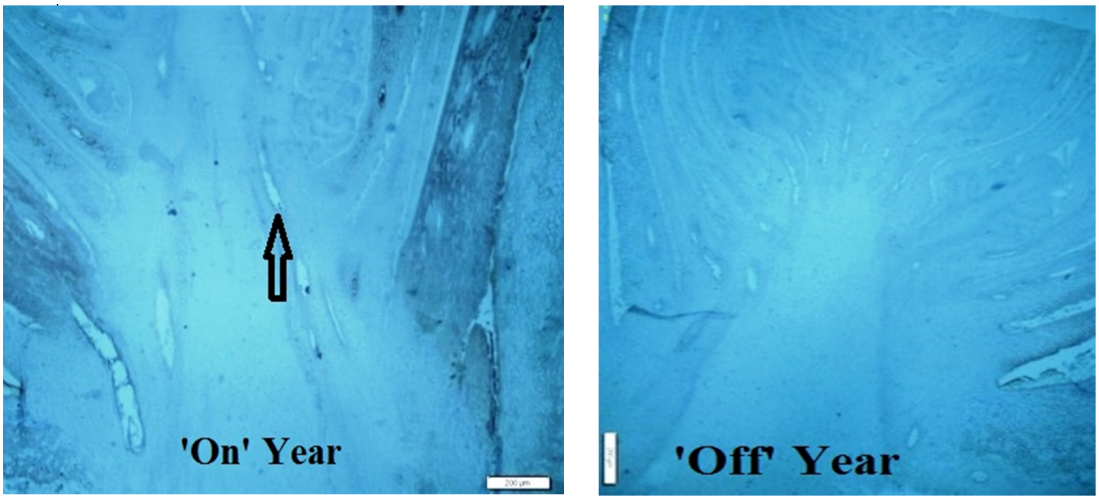


Figure 3. Views of line between flower bud and wood layer zone of “on” and “off” years of ‘Uzun’ cultivar (22 May, 2014).

As seen in Figure 4, strict abscission layers were observed between flower bud and wood layer zone from “on” year samples (left) and similar but scarce abscission layers obtained by “off” year samples (right).

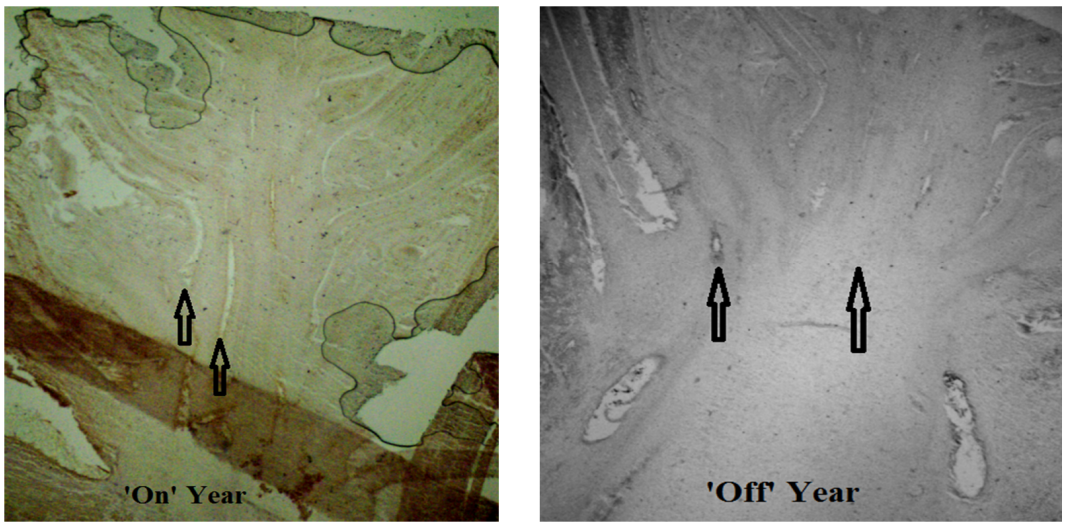


Figure 4. Views of between flower bud and wood layer zone of "on" and "off" years of 'Uzun' cultivar (2 June, 2014).

As seen in Figure 5, abscission layers were observed excessively between flower bud and wood layer zone on 13 June, 2014. Similar observation but very few abscission layers were also observed from "off" year samples.

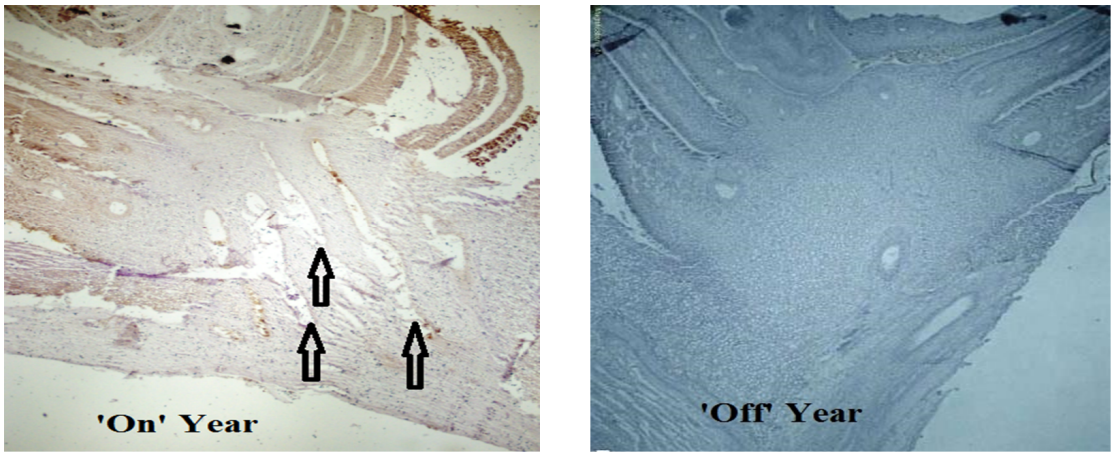


Figure 5. Views of between bud and wood layer zone section of "on" and "off" years of 'Uzun' cultivar dated on 13 June, 2014 (NDAFF-66).

As seen in Figure 6, abscission layers were observed excessively and much more visible clearly between flower bud and wood layer zone from "on" year samples on 23 June, 2014. As seen in the Figure, closely, the cells are looking not alive, brownish and crumpled due to the loss of their water.

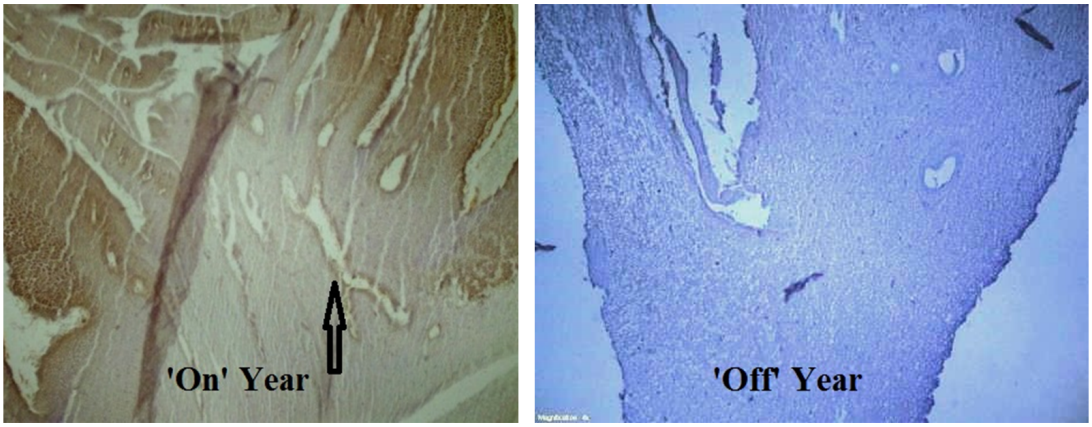


Figure 6. Views of abscission layer zone of "on" (left) and "off" (right) year samples of 'Uzun' cultivar (23 June, 2014).

The abscission layer zone enlarged excessively and started to growing in wood layer as horizontally on the samples that were taken 2 July, 2014 and abscission layer completely enlarged and this event induced flower bud abscission event from "on" year samples. In this period bud abscission also occurred on very few samples of "off" year trees (Figure 7).

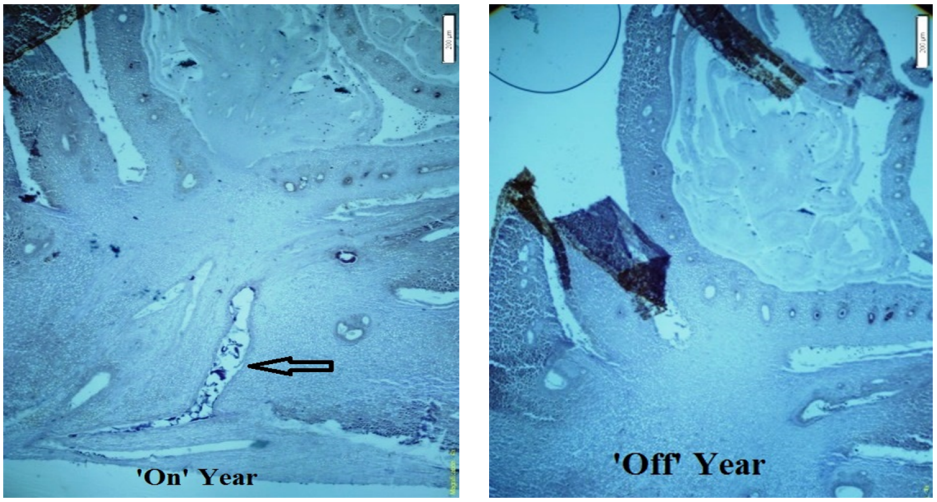


Figure 7. Views of sharp abscission layer zone of "on" (left) and "off" (right) years of 'Uzun' cultivar (2 July, 2014).

Esmailpour (2005) reported abscising of inflorescence buds of four commercial cultivars of Iranian pistachio cultivars ('Ohadi', 'Kalle-Ghoochi', 'Ahmad-Aghai' and 'Akbari'). The same authors reported that, although it is generally accepted that decreasing of leaf area and increasing of load level induce abscission and flower bud, abscission intensity depends on the genetic characteristics. The same author implied that only a significant relationship was detected between leaf area and load level on abscising of inflorescence buds in 'Ohadi' pistachio. Abscission of inflorescence buds might be in relation to vegetative growth of current branches, which was different among cultivars. Genetic characteristics might be responsible for the possible involvement of plant growth substance(s) or other metabolites originating in the leaves of different cultivars.

As a result of this study, abscission layers initiated on 22 May, 2014 (NDAFF -46) and accomplished on 2 July, 2014 (NDAFF -56 - NDAFF -66) from "on" year samples and bud abscission also occurred on very few samples of "off" year samples during this period.

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