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FOODSIM'2010

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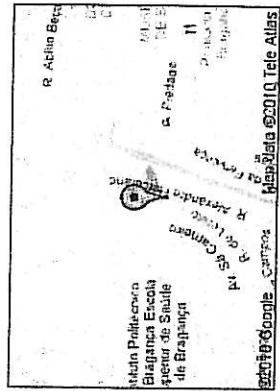
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CONFERENCE DINNER – 20.00 -23.00



The conference dinner will be held on the
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 restaurant **GEADAS**.
 (<http://www.geadas.net/site/site.htm>)
 Rua do Loreto 32
 Bragança, 5300-184 BRAGANÇA
 ☎ +351.273326002
 📠 +351.273331711



We will go by bus to the restaurant. Information will be available at the site.

Parallel Sessions - Friday



ANALYSIS OF YEARLY VARIATION ON OLIVE YIELDS AND ITS RELATION TO ALTERNATE FRUITING

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KEYWORDS

Alternate bearing, Olive yield, *Olea europaea*.

ABSTRACT

In this study, the variability in olive yields per individual tree within homogeneous plots of trees was analyzed as well as the variability on the mean olive yields of each plot of trees over a period of years. Data supporting this work were recorded from two dry farmed olive orchards located in Bragança and Mirandela, NE Portugal. From each olive orchard data were collected separately from two different plots, where the ground was managed by conventional tillage or by using post-emergence herbicides. The number of tagged trees per plot was 10 and 12, respectively in the plots of the orchards of Bragança and Mirandela. The olive yields were recorded per tree during a period of eight consecutive harvests (Dec. 2001 to Dec. 2008). The sequential analysis of the olive yields of each tree showed individual alternate bearing cycles likely caused by source/sink relationships. The trees would adjust the crop load as a function of their reserves. The collapse in the production involving all the trees in a plot (an off year) was probably caused by external environmental factors such as freezing, warm air conditions or drought. In this study, the off years were more frequent in Bragança, located in the North of the ecological range for olive growth.

INTRODUCTION

Alternate bearing has been recognized as one of the most significant constraints facing the olive growers (Delgado et al. 1994; Bouranis et al. 2001; Sibbett and Ferguson 2002; Rodrigues and Correia 2009). After a year of a good crop a lighter one usually follows. However, the costs of fertilisers, pesticides, pruning, irrigation and harvest are almost constant for a certain level of management and almost independent of the crop load, which significantly reduces the profit in the off years.

The fructification habits of olive, with the apparent overlap of two consecutive production cycles, may have a significant role in biennial bearing. It seems that floral induction can occur by summer (Fernández-Escobar et al. 1992). Thus, the flowering potential for the next year is determined by the presence of more or fewer fruits in the preceding year, as reported by Ramos et al. (2000). Fernández-Escobar et al. (1992) tried to relate the gibberellins produced by seeds with the inhibition of floral induction. Lavee et al. (1986) reported the possible involvement of phenols found in the

leaves during the bearing years in the regulation of the alternate fruiting in olive trees.

A large crop in a year depresses tree reserves. It is widely accepted that biennial bearing is mainly regulated by the competition for resources between shoots and fruits which develop simultaneously. The sink capacity of a high number of fruits limits the vegetative growth, reducing the length of the new shoots. The reduction in the number of nodes and in leaf area reduces, respectively, the potential sites for flower initiation and the source size for the next season (Rallo and Suarez 1989).

A mature olive tree produces about 500,000 flowers although only 1.2 % of the population are required as fruit to establish a commercial crop (Martín 1990). Part of the flowers in an olive tree is staminate due to pistil abortion. Pistil abortion can occur through the entire period of pistil development, but increases during the phase of rapid growth, around a month before bloom (Cuevas et al. 1999). Then, a massive abscission of flowers and young fruits can be observed in the first 35 to 40 days following full bloom (Rallo et al. 1981). In spite of genetic factors having been proposed as responsible for the intense pistil abortion and abscission, since there are some cultivars showing more accentuated alternate bearing cycles (Medeira et al. 2002), the number of fruits that persist is mainly regulated by available carbohydrates. The inflorescence behaves as a unit of fruitfulness, where the competition for reserves among the developing fruits seems to be the main factor in regulating final crops (Suarez et al. 1984; Rallo and Fernández-Escobar 1985; Cuevas et al. 1995). Thus, the higher the crop in the preceding year, the higher is the depletion of tree reserves and the smaller the next crop. Cropping conditions may have also an important role in fruit set. A poorly managed orchard, with regard to pruning, fertilisation or irrigation may accentuate the severity of biennial bearing (Lavee et al. 1983; Sibbett and Ferguson 2002).

This work focuses on the analysis of the olive yields of individual trees of two orchards during a period of eight years, as a contribution to the better understanding of the main factors regulating the alternate bearing cycle in olive.

MATERIALS AND METHODS

Data supporting this work were recorded from two dry farmed olive orchards located in Mirandela (41° 31' N; 7° 12' W) and Bragança (41° 48' N; 6° 44' W) in north-eastern Portugal. Mirandela experienced a warmer and drier climate

than Bragança and represents the main region of olive in NE Portugal. Bragança is the northern limit of the expansion of olive. In Mirandela the mean annual temperature and precipitation are 14.2 °C and 520 mm, whereas in Bragança the mean values of temperature and precipitation are 11.8 °C and 741 mm. Both the Mirandela and Bragança orchards are planted on Leptosols derived from schist. Some physical and chemical properties of soils before the trial start, in October 2001, were presented in table 1. The Mirandela orchard is a 20-years-old plantation of the cv. 'Cobrançosa', spaced at 7 m x 6 m. The Bragança orchard is an old plantation of more than 70 years, of the cv. 'Cobrançosa', spaced at 7 m x 7 m.

Table 1. Some properties of soils before the trial start in October 2001.

Parameters	Mirandela	Bragança
pH (soil:water, 1:2.5)	5.5	6.0
Organic C (W.-Black) (g kg ⁻¹)	3.7	5.8
Extract. P (Eg.-Rhiem) (mg kg ⁻¹)	23	24
Extract. K (Eg.-Rhiem) (mg kg ⁻¹)	48	67
Exchang. bases (ammonium acetate, pH 7)		
Ca (cmol _c kg ⁻¹)	3.2	11.4
Mg (cmol _c kg ⁻¹)	2.4	3.2
Soluble B (Boiling-Water, Azomethine-H) (mg kg ⁻¹)	0.11	0.13
Bulk density (Mg m ⁻³)	1.6	1.5
Texture (USDA)	Loam	Loam

From each olive orchard data were collected separately from two different plots, where the ground was managed by conventional tillage (two tillage yr⁻¹ in spring with a scarifier) or by using post-emergence herbicides (glyphosate, 360 g/L of active ingredient, applied once early in the spring in a rate of 4 L/ha). The number of tagged trees per plot was 10 and 12, respectively in the plots of the orchards of Bragança and Mirandela. The pre-selection of trees was performed in October 2001, before the ground-cover systems had been established, and was based on the size of the tree canopies.

A compound 10:10:10 (10% N, P₂O₅ and K₂O) fertiliser was applied annually at a rate of 1 and 1.5 kg per tree, respectively in the orchards of Mirandela and Bragança. Boron was also applied every year in a rate of 5.5 and 7.7 g B per tree (as Borax, 11% B) in the orchards of Mirandela and Bragança, respectively. The fertilisers were applied beneath the trees' canopy. The orchard of Mirandela was pruned in 2002 and 2006 and the orchard of Bragança was pruned in 2001, 2003 and 2006. The pruning was done by local workers, consisting on the removal of 15 to 33% of the leaf area of the trees.

Olive yields were recorded per tree during a period of eight consecutive years (Dec. 2001 to Dec. 2008). The harvest of the Bragança orchard was performed by using wood-sticks to pull the fruit down and sheets on the floor to recover it. In

the Mirandela orchard, the harvest was performed by a trunk-shaker machine.

RESULTS

Figure 1 shows the yearly production per tree, the mean olive yields per tree after eight harvests and the mean confidence limit ($\alpha < 0.05$) of each population data. The figure shows a huge variability in olive yields among trees within a year. In

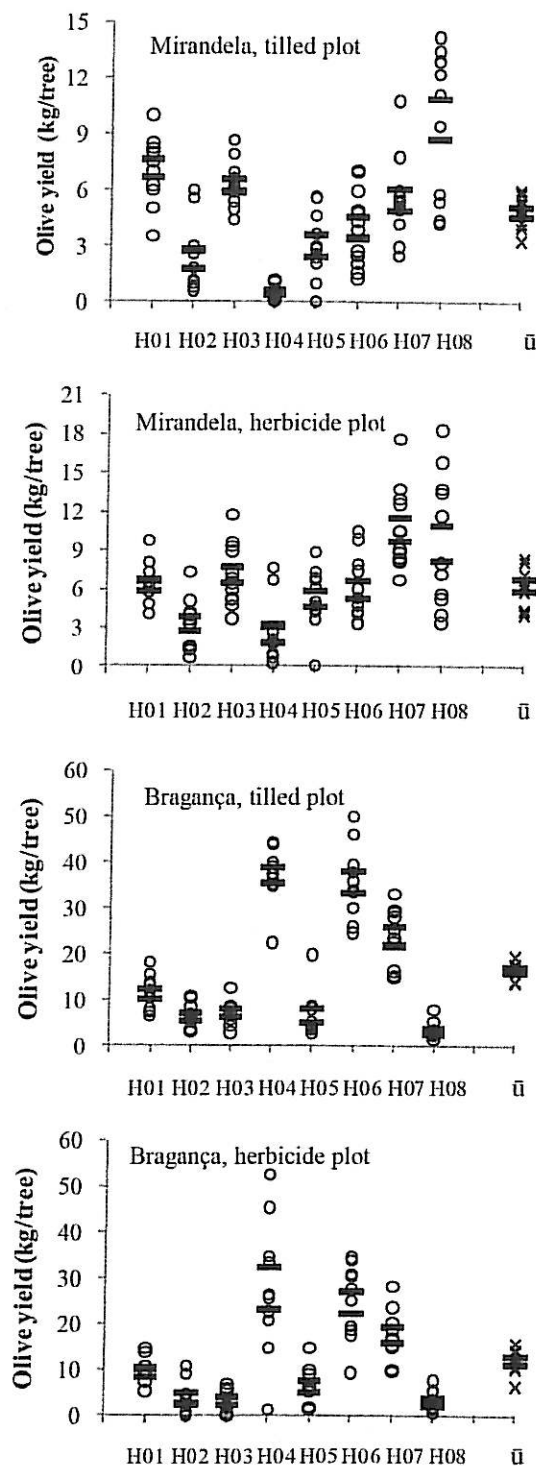


Figure 1: Olive yields per tree in the eight consecutive harvests from 2001 to 2008 (H01 to H08), and mean olive

yield of each tree after the eight harvests (\bar{u}). The horizontal marks are the boundaries of the mean confidence limits ($\alpha < 0.05$).

Mirandela, in the harvest of 2008 and in the herbicide plot, for instance, the olive yields per tree varied from 3.3 to 18.3 kg/tree. In the tilled plot, in 2008, the olive yields ranged from 4.2 to 14.2 kg/tree. In Bragança, the olive yields in the herbicide plot in the harvest of 2004 varied from 1.2 and 52.7 kg/tree. The mean olive yields in each plot also showed great variability over the years. In Mirandela, in the tilled plot, for instance, the mean olive yields varied from 0.5 and 9.8 kg/tree, respectively in the 2004 and 2008 harvests. In Bragança, in the tilled plot, the mean olive yields varied between 3.0 kg/tree in 2008 and 37.1 kg/tree in 2004. In average, the olive yields of the orchard of Bragança were higher than that found in the Mirandela orchard, mainly due to the smaller canopy sizes of the younger trees of the Mirandela orchard.

The figure 1 also shows a higher variability on olive yields within a year than the variability on the mean olive yields over the eight years. In spite of the great variability among trees in each year, the time reduced the differences among trees contrary to that would be expected. A poor performance of a tree in a year was compensated by a better one in the next year, which balanced the results among trees over time.

Figure 2 shows the evolution of olive yields over the years. It is possible to observe years where all the trees produced almost the same and other years where the performance of each tree was completely different to the others. In some years, all the trees revealed very small crops, for instance, showing themselves to be in the same phase in the alternate bearing cycle, whilst in other years each individual tree followed its own alternate bearing pattern.

DISCUSSION

There were years where all the trees were in the same phase of the alternate bearing cycle. Comparing the olive yields among the trees of each plot and year, they were more similar in the off years and very close to zero. Since these low crops were recorded in the same years for the different plots of each orchard and in different years when the comparison was made between orchards (different regions), one may speculate that the off years were caused by environmental variables, such as freezing or warm air conditions probably during the flowering and fruit set. In the years after a peak of low yields, the production greatly varied among trees in the same plot (see, for instance, data for Mirandela in tilled plot, figure 1). This trend suggests that each tree adjusted the crop load as a function of its own available resources. Thus, the performance of each tree would be influenced by micro-local environmental variables, such as soil fertility, and crop husbandry, in particular the irregular and severe pruning, usually carried out in these regions. The lower variability of mean olive yields than of yearly olive yields may also support that alternate bearing is regulated by the available carbohydrates. Each tree balances the crops over the long-term following its own alternate bearing cycle. A lack of reserves caused by a previous high

crop may increase pistil abortion and decrease fruit persistence (Martin 1990). The competition between growing organs (fruits and new shoots) reduces the number of nodes and the leaf area of the new shoots that support the production for the following year (Rallo and Suarez 1989). The degree of depression caused by a heavy crop also depends on the orchard management (pruning, fertilisation, ground management, ...) and on the environmental conditions for crop growth (available water, temperature, ...).

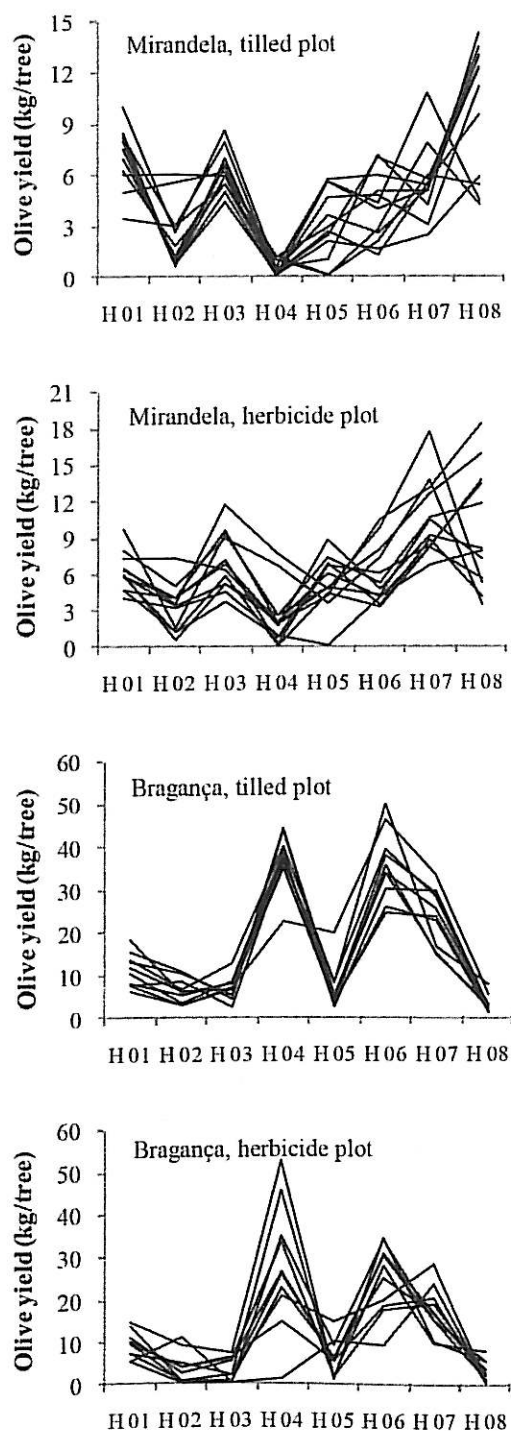


Figure 2: Evolution over the years [harvest of 2001 (H01) to harvest of 2008 (H08)] of the olive yields of each individual tree.

CONCLUSIONS

The sequential analysis of the olive yields of each tree indentified individual alternate bearing cycles likely motivated by source/sink relationships. The tree adjusts the crop load as a function of its reserves. The collapse in the production involving all the trees in an orchard (an off year) was probably caused by an external environmental factor such as freezing, warm air conditions or drought. In this study, off years for all trees were more frequent in Bragança, located at the northern ecological limit for olive growth.

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BIOGRAPHIES

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