Establishment of Economic Thresholds for Olive Moth, *Prays oleae* (Bern.) in Tras-Os-Montes Region

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Abstract

A mathematical model is presented which aims to establish the economic thresholds for the flower generation of olive moth, *Prays oleae* (Bern.) in Tràs-os-Montes (north-eastern Portugal). The model is based on observations taken between 1993 and 1998, on olives of the oil variety Cobrançosa, grown under rain-fed conditions and without pesticide treatments for several years. It takes into account factors such as cost and efficacy of spraying, environmental impact, expected yield, price and crop losses. According to this model the control of the pest is justified when the percent of flower infestation is between 4.0 % and 6.0 % during the years of intermediate and high expected yields, (i.e., about 2400 kg/ha) and between 8.0 % and 11.0 % in the years of lower expected yields (i.e. approximately 1000 kg/ha) for prices usually practised in the region.

INTRODUCTION

The olive moth, *Prays oleae* (Bern.) (*Lepidoptera: Yponomeutidae*), is one of the most serious pests of olives in the Mediterranean basin. This moth has three generations a year, attacking in succession flowers, fruits, and leaves. Usually the leaf generation does not affect very much the trees, but the damage by the flower and the fruit generations can often lead to significant losses (Bento, 1999). In response to the growing requirement for more efficient methods to control the pest, research is needed on economic thresholds (ET), which could enable the growers to determine the need for intervention with a specific control measure and to apply integrated systems for olive cropping. In this work a mathematical model is presented which aims to establish the economic thresholds for the flower (anthophagous) generation of *P. oleae* in the Tràs-os-Montes region (north-eastern Portugal).

MATERIALS AND METHODS

Experiments were carried out over a six year period, 1993 to 1998, in an olive grove near Mirandela, on olives of cv Cobrançosa about 40-year-old, grown under rain-fed conditions and without pesticide treatments for several years. An initial and basic inequation was posed in order to calculate a population threshold which justify the need of a treatment, and will determine the minimum damage from which the application of such a treatment would be economically advantageous.

$$\textit{Cost of treatment} < \textit{Losses} \qquad (1)$$

Each member of the inequation is defined by several factors, which are:

Cost of Treatment

The cost of the treatment (C_t) was calculated on the assumption of using a cover spray from the ground of a commercial formulation of *Bacillus thuringiensis* (Berl.) or a chitin synthesis inhibitor. As the treatment does not completely eliminate the losses, an efficacy factor (E) of 80% was added to this cost. Also an environmental factor (E_f) that focuses on the impact of the treatment on the environment and the beneficial organisms was added to this cost, according to Hoyt and Tanigoshi (1983), Kapatos and Fletcher

(1983), Pedigo et al. (1986) and Montiel and Madueno (1995a, 1995b). This factor, which depends on both the toxicity of the pesticide and the importance of the occurring beneficial organisms, was assumed to be equal to 1.1 when spraying with *B. thuringiensis* and to 1.4 when spraying with a chitin synthesis inhibitor.

Thus the expression *cost of the treatment* can be given as:

$$\textit{Cost of treatment} = (C_t / E) \times E_f \quad (2)$$

Losses

Losses were expressed as the percentage of attacked flower clusters, on the basis of the following parameters: (i) level of blossoming and rate of fruit formation; (ii) expected yield, which depends on several factors, such as climatic conditions, tree physiology and level of blossoming; (iii) market value per production unit.

The percentage of attacked flower clusters as well as the level of blossoming, the rate of fruit formation and the expected yield, were estimated each year by analysing samples of 100 marked branches from 25 selected trees within the experimental orchard. Four branches per tree were considered, each with a minimum of 15 flower clusters and of lenght 20 to 30 cm. The compensation in response to premature fruit drop was assumed to be equal to 0.9, according to Neueschwander et al. (1980). Three market values per production unit were used, the minimum, the medium and the maximum usually practised in the region.

Then, we try to explain *P. oleae* losses, from the percentage of attacked flower clusters and the average potential crop yield per tree, throughout the equation:

$$Pj = (a \times P_a + b \times P_p + c) \quad (3)$$

Pj - are losses per tree, including the compensation for increasing the weight of the remaining fruits in 10 percent;

P_a - is the percentage of attacked flower clusters

P_p - is the average potential crop yield

a, b and c - are model coefficients

To express losses in monetary terms, we obtain

$$Pj = (a \times P_a + b \times P_p + c) \times P_r \quad (4)$$

P_r - is the market value per production unit

Therefore, equation (1) becomes

$$(Ct / E) \times E_f = (a \times P_a + b \times P_p + c) \times P_r \quad (5)$$

where P_a, represents the percentage of attacked flower clusters per tree that cause economic damage equal to the cost of the treatment, that is the economic threshold (ET). Then, by solving the equation (5) for ET, we obtain:

$$ET = \frac{C_t / E \times E_f - (b \times P_p + c) \times P_r\, a \times P_r}{a \times P_r} \quad (6)$$

RESULTS AND CONCLUSIONS

Losses due to the flower generation of *P. oleae*, were highly variable between the studied years, ranging from 1.75 kg and 5.90 kg per tree, for a potential crop yield of respectively 14.02 kg and 56.16 kg per tree (Table 1). The percentage of attacked flower cluster was also highly variable, ranging from 1.76 % and 12.96 %, exceeding most years the economic thresholds recommended in Spain of 5.0 % of attacked flower cluster. Of utmost importance on the expression of losses was the rate of fruit formation, which ranged from 3.23 % and 15.86 % (Table 1).

Analysis of the data showed that losses due to the flower generation of *P.oleae* on the observed samples were closely related with both, the percentage of attacked flower clusters and the potential crop yield per tree (R^2 = 96.4 %) (Fig.1).

From the obtained data, it is possible to conclude that spraying is economically advantageous when the percent of flower infestation by *P. oleae*, is between 4.0 % and 6.0 % during the years of intermediate and high expected yields, i.e. about 2400 kg/ha , in relation with a high rate of fruit formation. In the years of lower expected yields, i.e. approximately 1000 kg/ha, it is economically advantageous to spray when the percent of flower infestation by the pest, is between 8.0 % and 11.0 % (Fig.2).

The calculated economic thresholds revealed an variation of about 3.5 %, for the same potential crop yield, in accordance with the market value per production unit (Fig. 2). A more efficient use of these thresholds will depend on the possibility of predicting the rate of fruit formation, in relation with level of blossoming and the percentage of fertile flowers.

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Tables

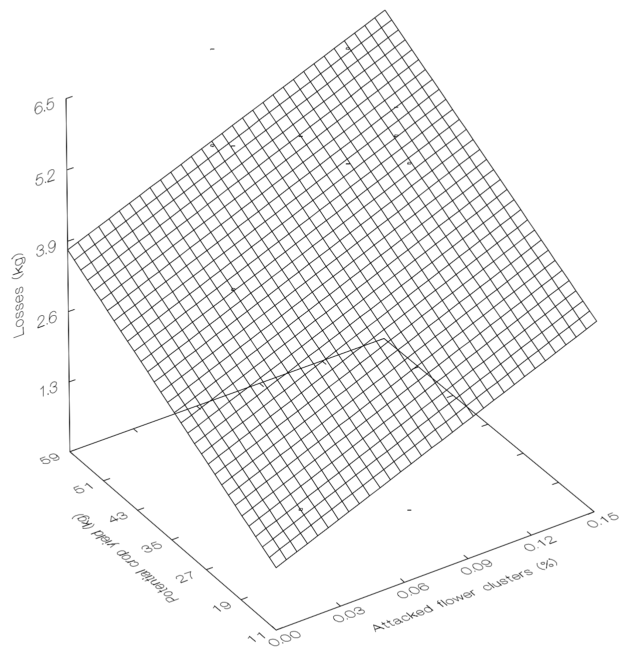
Table 1. Parameters used for the establishment of economic thresholds for the flower generation for the olive moth, *Prays oleae* (Bern.) in Tràs-os-Montes. Mirandela, 1993 to 1998.

Year / Parameter	1993	1994	1996	1997 [2]	1997	1998
Average flower clusters per tree	High	Low	High	Low	High	Medium
% of attacked flower clusters [1]	12.51	1.76	12.96	12.64	6.64	4.68
Average number of flower clusters per tree	22 285	6 790	27 886	8 096	31 425	13 141
Rate of fruit formation	4.76	4.90	3.23	15.86	3.40	9.59
Average number fruit per tree	18 576	4 105	13 781	18 233	19 150	18 249
Potential crop yield per tree (kg)	44.10	14.02	43.55	56.16	58.20	43.76
Losses due to *P. oleae* per tree (kg)	5.07	1.75	4.56	5.90	4.80	3.37
Average crop yield per tree (kg)	24.73	6.01	31.14	28.00	27.65	40.60

[1] flower clusters with viable or hatched eggs; average values from the 25 trees and the two last sampling in each year.

[2] two groves were studied in 1997.

Figures



Losses = 0.158 × % attacked flower clusters
+ 0.054 × potential crop yield + 0.550
R^2 = 96.4 %
P = 0.007
N = 6

Fig. 1. Relationship between losses due to the flower generation of *P. oleae*, the percentage of attacked flower clusters and the potential crop yield: multiple linear regression. Mirandela 1993 to 1998.

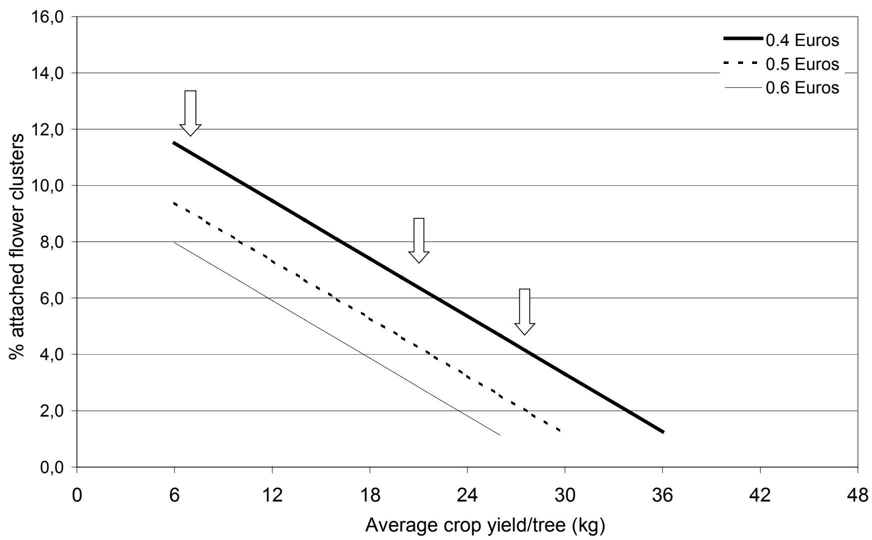


Fig. 2. Calculated economic thresholds for the flower generation for *P. oleae* in Tràs-os-Montes for three market values per production unit. Mirandela, 1993 to 1998.