BACTROCERA OLEAE (GMELIN) CONTROL IN ORGANIC OLIVE FARMING

B-ECONOMIC ASPECTS

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In the Mediterranean area the olive fly control, difficult to realise in conventional farming, becomes even more arduous in organic farming, owing to the restrictions laid down by Regulation. The EC Reg. 2092/91 which implements organic farming and its updates provide standards allowing only the use of natural origin substances for crop protection contained in annex IIB, forbidding the chemical pesticides use. The present study has been performed in Calabria (Southern Italy) in two different pedoclimatic olive areas (Mirto-Crosia and Terranova da Sibari) and in two observation years (2005-2006) in order to assess the efficacy of substances listed in the annex IIB as copper (antibacterial substance) and biopesticides azadiracthin and rotenone and the efficacy of kaolin and the antibacterial substance propolis. These substances were compared among them and with theses used as control (treated only with water) and in Mirto-Crosia field with conventional product dimethoate. The present research confirms the need to restrain the *Bactrocera oleae* (Gmelin) infestation in olive areas of the Southern Italy. The results obtained in the two different investigated areas in both years indicated that kaolin has great potential for the control of *B. oleae* infestation. The use of copper and propolis showed a good efficacy both on adult and preimago population. Rotenone application confirms its known efficacy in Terranova da Sibari area while it does not appear very efficacious in Mirto-Crosia area. Azadiracthin turned out to be not so efficacious for olive fly control in both olive areas and years. On the basis of the results of the most recent studies, a revision of the Regulation is needed.

Key words: olive fly control, biopesticides, antibacterial substances, Italy

INTRODUCTION

In many Mediterranean areas, characterised by ecoclimatic conditions favourable to the development of the olive fly *Bactrocera oleae* (Gmelin, 1790), the restraining of its infestations is needed. The olive fly control, difficult to realise in conventional farming, becomes even more arduous in organic farming, owing to the restrictions laid down by Regulation. The European Community Regulation which implements organic farming and its updates provide standards allowing only the use of natural origin substances for crop protection contained in annex II part B, forbidding the chemical pesticides use. Recently, many studies concerning the efficacy, the environmental impact and toxicological risk of the substances allowed in organic farming (biopesticides) have been performed. They led to several results which do not appear completely homogeneous, especially in relation to their efficacy in some olive areas in which the olive fly, the key phytophagous of olive ecosystem, causes serious damages to the production yield and quality (Iannotta, 2003). The Southern Italy turns out to be among these areas characterised by constant high infestation percentages of olive fly. The present study has been performed in Calabria (Southern Italy) in order to assess the efficacy of substances listed in the annex II part B and the efficacy of other substances as kaolin and propolis (antibacterial substance). The trials have been performed in two different pedoclimatic olive areas located on the Cosenza Ionic coast and in the Sibari plain considering the main Calabria genotypes. The active substances allowed in EC Reg. 2092/91 and its updates in the annex II part B, propolis and kaolin tested for *B. oleae* control, were compared with not treated plots and with plots treated with dimethoate product, utilised in conventional farming.

MATERIALS AND METHODS

The trials have been performed in the observation two-year 2005-2006 in two different olive areas characterised by very high infestation of olive fly. The first experimental field is placed on the Cosenza Ionic coast (Mirto-Crosia) and it was made up by an orchard with 15-18 years old plants belonging to the main Calabrian cultivars (Carolea, Cassanese and Dolce di Rossano). The second field, located in the plain of Sibari (Terranova da Sibari), consists of a 30-years old orchard characterized by the presence of Calabrian cultivars (Carolea, Dolce di Rossano and Tondina). Both field were divided in different plots corresponding to experimental theses in which substances allowed in organic farming were tested and the plants belonging to the theses used as control were treated only with water. Applied concentrations and treatment dates of tested substances in the 2005-2006 observation years are summarised in table 1.

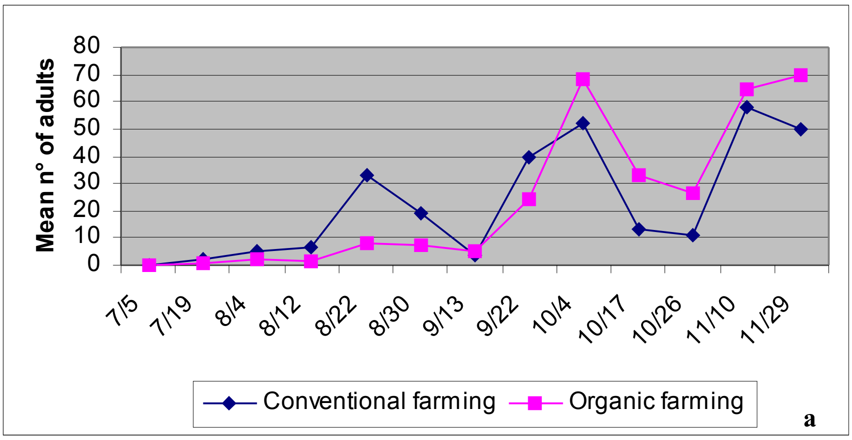
Table 1. Detailed information concerning active substances whose efficacy has been investigated in both olive areas in 2005 and 2006.

Active substances	Concentration / 100 l of water	Treatment dates			
		Mirto-Crosia		*Terranova da Sibari*	
		2005	2006	2005	2006
Azadiractin	200 ml	10-Aug; 7-Sep; 17-Oct		11-Aug; 17-Sep	24-Aug; 28-Sep
Copper	500 g			24-Sep; 18-Oct	24-Sep
Copper +Propolis	250g +150ml		25-Aug; 28-Sep		21-Aug; 29-Sep
Kaolin	5 Kg	4-Aug; 7-Sep; 17-Oct	21-Aug; 28-Sep	4-Aug; 8-Sep 17-Oct	21-Aug; 29-Sep
Propolis	150 ml	4-Aug; 7-Sep; 17-Oct		4-Aug; 8-Sep 17-Oct	
Rotenone	300 ml	10-Aug; 7-Sep; 17-Oct	25-Aug; 20-Sep	11-Aug; 17-Sep	24-Aug; 28-Sep
Dimethoate	150 ml	5-Aug, 2-Sep; 27-Sep	2-Aug; 1-Sep; 2-Oct		

In Mirto-Crosia field the theses treated with kaolin (SURROUND®WP Crop Protectant, Engelhard Corporation, Iselin, NJ, USA) and propolis (PROPOLI+®progetto Geovita Div. Agricom, Turin, Italy) were sprayed on 4th August, 8th September and 17th October in 2005 while in 2006 kaolin was sprayed on 21st August and 29th September and propolis, used as mixture with copper oxycloride (Cupravit Blu WG®Bayer Cropscience, Milan, Italy) was sprayed on 25th August and 28th September. The rotenone (ROTENA®Serbios, Rovigo, Italy) and azadiracthin (DIRACTIN® Serbios, Rovigo, Italy) treatments were performed on 10th August, 7th September and 17th October in 2005 while only rotenone was tested in 2006 spraying it on 25th August and 20th September. In the thesis treated according to conventional method, three dimethoate treatments (ROGOR 40, Isagro s. p. a., Milan, Italy) were performed on 5th August, 2nd and 27th September in 2005 and on 2nd August, 1st September and 2nd October in 2006. Treatments were performed by spraying active substances adding to solutions 50 ml of wetting agent. In Terranova da Sibari field three kaolin and propolis treatments were performed in 2005 (4th August, 8th September and 17th October) while two kaolin treatments were performed on 21st August and 29th September and two propolis treatments (used as mixture with copper oxycloride) were performed on 21st August and 29th September in 2006. Rotenone and azadiracthin were sprayed on 11th August and 17th September in 2005 and on 24th August and 28th September in 2006. Two copper treatments were performed in 2005 (24th September and 18th October) and only once copper was sprayed in 2006 (24th September). Substances concentration for treatments in Terranova da Sibari field was in agreement with Mirto-Crosia employment. In both field, the flight trend of *B. oleae* were carried out by decadal reading of chromotropic traps placed in number of 3 per hectare (Raspi and Malfatti 1985) in July-December (2005) and in June-December (2006). Active and total infestation were determined by microscopy analysis of drupe samples (200/thesis) collected every ten days, on which preimago stages (eggs, larvae, pupae) and emergence holes and feeding tunnels were registered. Climatic conditions concerning temperature and humidity, were also monitored.

RESULTS

The trend of mean adult captures concerning the Mirto-Crosia field in 2005 is shown in figure1a. The theses treated with conventional product dimethoate and substances allowed in organic farming, display a similar trend even if the conventional thesis is characterised by lower values at the harvesting time (end of October). The demographical trend is referred to the conventional thesis and altogether called organic thesis, because adult capture data concerning the theses treated with azadiracthin, kaolin, propolis and rotenone were not registered owing to their reduced width. The corresponding active infestation trend shows that the thesis treated with kaolin turns out to be the less infested in comparison with the control thesis, the other organic substances treated theses and the conventional treated thesis (Fig. 1b).



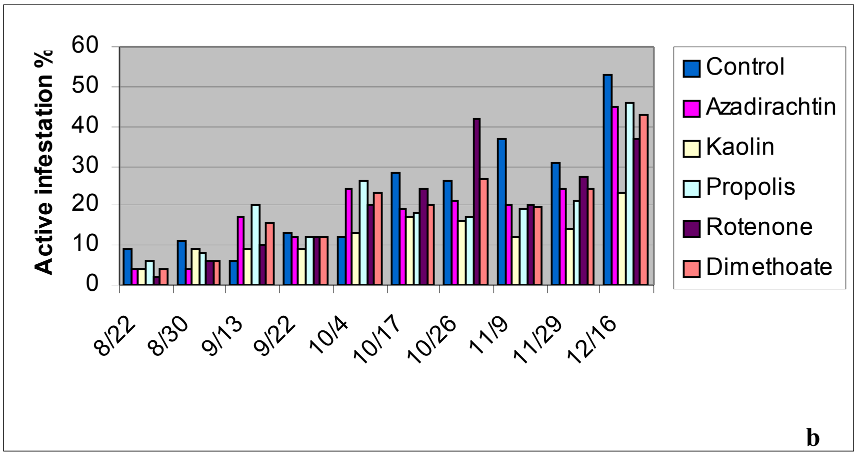
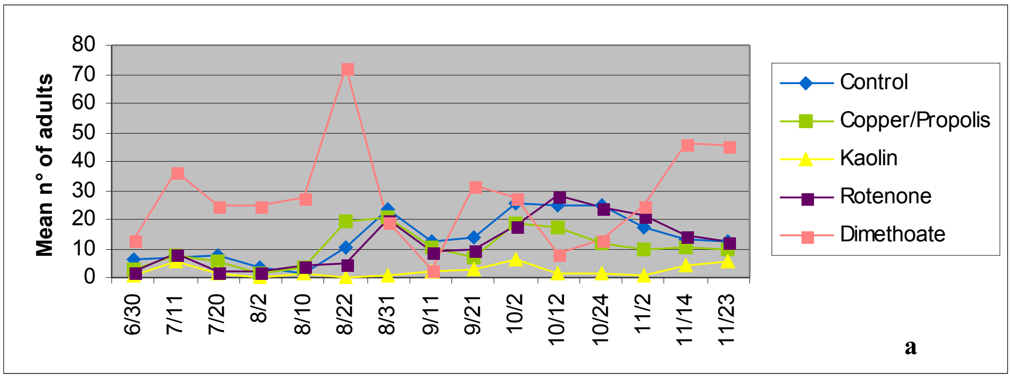


Figure 1. *B. oleae* demographical trend (a) and active infestation percentage (b) registered in Mirto-Crosia field in 2005.

In the kaolin treated thesis, the active infestation percentage does not exceed the threshold of 20.0%, considered compatible with the achievement of a quality oil production, until the end of November and attaining the maximum value of 23.0% on 16th December, much more later the usual harvesting time. In all observation time the mean active infestation turned out to be equal to 12.6%. The thesis treated with azadiracthin displays a good trend of preimago population (mean active infestation = 19.0%), attaining values about 20.0% in the harvesting time. Also propolis treated thesis showed a good active infestation trend (mean=19.3%) especially shortly before the harvesting time. In all the other observed theses, including that one treated with dimethoate, an active infestation percentage higher then 20.0% at the harvesting time, was registered.
The demographical trend obtained as mean value of adult captures in the Mirto-Crosia field in 2006 is reported in figure 2a which shows that the kaolin treatment causes a considerable reduction of field adult population (mean=2,3) in comparison with all the other theses included the dimethoate treated thesis where the lower values registered on the 11th September and 12th October (2.8 and 8.5, respectively) are obtained immediately later dimethoate spraying.



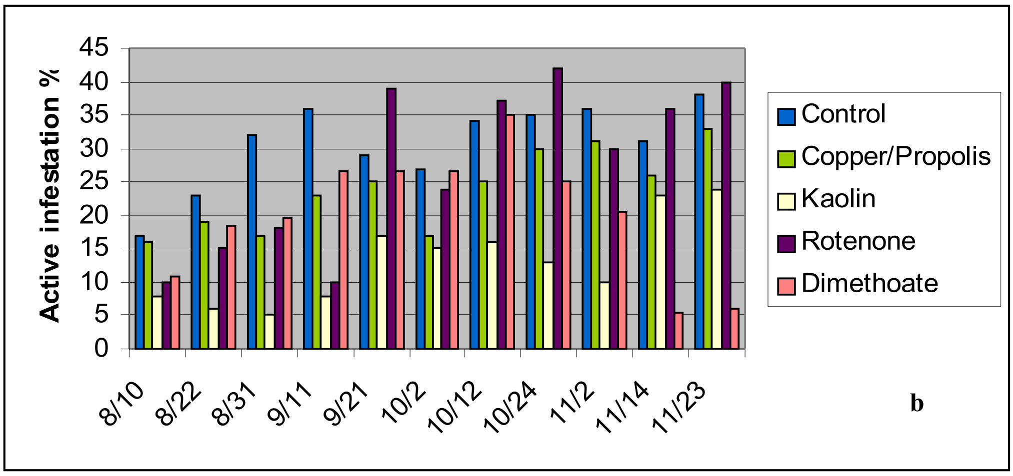


Figure 2. *B. oleae* demographical trend (a) and active infestation percentage (b) registered in Mirto-Crosia field in 2006.

In the same figure, it is also displayed that in the thesis treated with a mixture composed by propolis and copper oxycloride, a low capture trend was registered especially in the post-treatment time (25th August and 28th September). In any observation time, the lower mean active infestation percentage (13.2%) is again registered in the thesis treated with kaolin. In all other investigated theses, the active infestation percentage exceeded the threshold of 20.0% at the harvesting time (Fig. 2b).

The trend of mean adult captures registered in the Terranova da Sibari field in 2005 is displayed in figure 3a. All the observed theses show a similar trend of adult population also if the lowest values are displayed by thesis treated with copper (mean=17.4). The corresponding active infestation trend emphasises the efficacy of all tested substances in comparison with the control thesis until the harvesting time (end of October) restraining the active infestation percentage under the threshold of 20% (Fig. 3b). A greater copper and rotenone efficacy (9.0%) and propolis (10.0%) is evident at 26th October while kaolin turns out to be more efficacious at 9th November (8.0%).
The kaolin treated thesis showed a lower mean active infestation percentage (16.1%), followed by rotenone (18.7%), copper (19,5%) and propolis (20.1%).

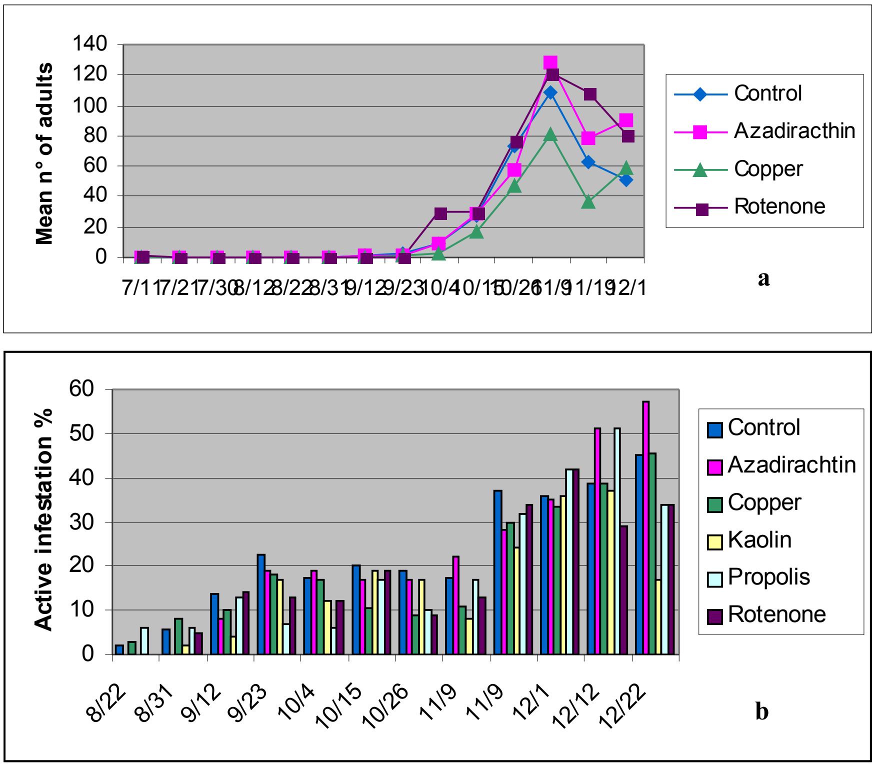


Figure 3. *B. oleae* demographical trend (a) and active infestation percentage (b) registered in Terranova da Sibari field in 2005.

In figure 4a the demographical trend of Terranova da Sibari field in 2006 is reported. All the theses show a similar trend with values lower than the control thesis (mean=95.0). Only the thesis treated with kaolin displayed a different trend characterised by the lowest value of field adult population (mean=58.4). The active infestation trend, registered in the same field and in the same year, shows that in the control thesis the preimago population of olive fly exceeds the threshold of 20% as from the beginning of September and for the whole observation time (Fig. 4b).

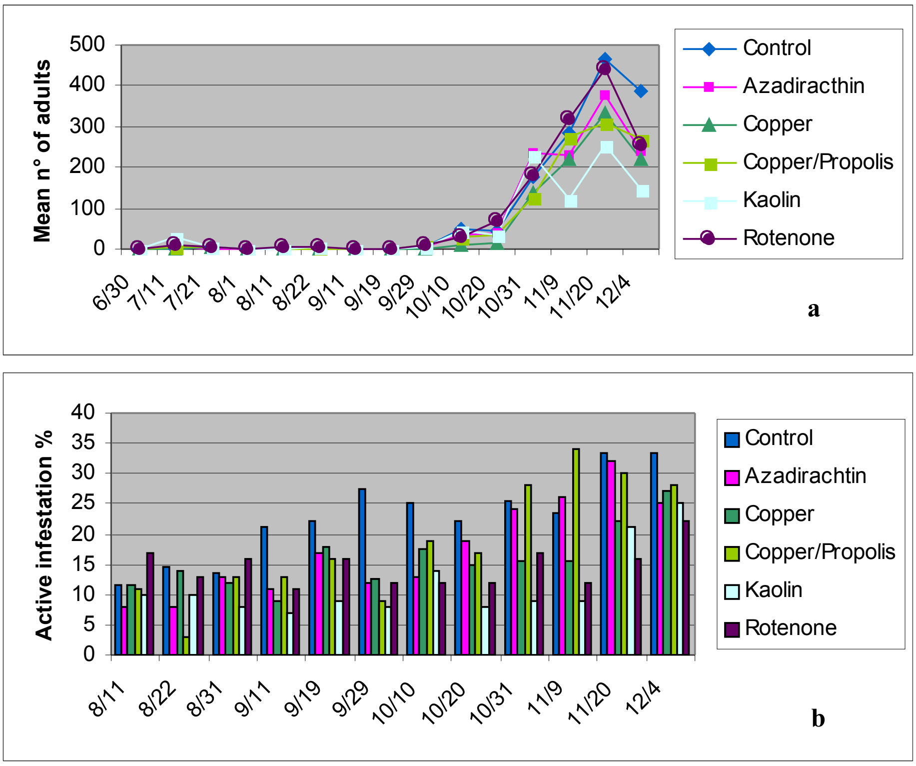


Figure 4. *B. oleae* demographical trend (a) and active infestation percentage (b) registered in Terranova da Sibari field in 2006.

All the other treated theses restrain the active infestation under the threshold until the 20th October while only the theses treated with copper, rotenone and kaolin do not attain the threshold at 31st October displaying active infestation percentages equal to 15.5%, 17.9% and 9.0%, respectively and at 9th November (15,5%, 12.0% and 9.0%). Preimago stages, emergence holes and feeding tunnels registered in the Mirto-Crosia field and in Terranova da Sibari field registered in 2005 and 2006 are displayed in tables 2, 3, 4 and 5.

Table 2. Detailed data concerning weight, fertile (FE) and aborted eggs (AE), sterile stings (SS), emergence holes (EH), larvae (L), pupae (P), larvae and pupae causing reinfestation (RL) and (RP), active (AI) and total infestation (TI) percentages obtained in the Mirto-Crosia field in 2005.

	8/22	8/30	9/13	9/22	10/4	10/17	10/26	11/9	11/29	12/16
Control										
Weight (g)	188.5	207.6	227.9	266.5	286.7	276.7	212.6	368.9	391.4	258.7
FE (AE)	6 (2)	11 (5)	6 (2)	13 (4)	2 (0)	14 (4)	4 (0)	4 (0)	11 (0)	0 (0)
SS (EH)	10 (6)	19 (2)	23 (0)	17 (0)	12 (5)	8 (15)	12 (22)	18 (21)	16 (27)	3 (34)
L (P)	3 (0)	0 (0)	0 (0)	0 (0)	4 (6)	5 (9)	9 (13)	12 (7)	14 (6)	10 (15)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	8 (6)	0 (0)	9 (19)
AI (TI)	9 (27)	11 (37)	6 (31)	13 (34)	12 (29)	28 (55)	26 (60)	37 (76)	31 (74)	53 (90)
Azadirachtin										
Weight (g)	161.7	208.1	223.8	255.4	242.3	271.4	397.9	291.7	386.8	237.6
FE (AE)	4 (2)	4 (9)	17 (9)	3 (0)	14 (7)	15 (3)	4 (0)	2 (0)	3 (0)	10 (0)
SS (EH)	8 (0)	15 (2)	22 (0)	16 (5)	13 (6)	9 (7)	7 (35)	5 (29)	10 (31)	0 (34)
L (P)	0 (0)	0 (0)	0 (0)	2 (7)	4 (6)	2 (2)	6 (11)	11 (7)	16 (5)	14 (21)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	4 (14)	4 (30)	17 (48)	12 (33)	24 (50)	19 (38)	21 (63)	20 (54)	24 (65)	45 (79)
Kaolin										
Weight (g)	176.5	235.9	206.2	281.3	284.7	302.8	338.0	292.3	374.5	277.6
FE (AE)	4 (2)	9 (4)	7 (0)	2 (0)	8 (3)	10 (2)	2 (0)	2 (0)	5 (3)	2 (0)
SS (EH)	8 (0)	8 (0)	16 (0)	13 (4)	11 (7)	6 (4)	14 (8)	6 (13)	7 (11)	0 (7)
L (P)	0 (0)	0 (0)	2 (0)	2 (5)	2 (3)	3 (4)	2 (2)	5 (3)	7 (2)	8 (9)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (7)	0 (2)	0 (0)	0 (6)
AI (TI)	4 (14)	9 (21)	9 (25)	9 (26)	13 (34)	17 (29)	16 (38)	12 (31)	14 (35)	23 (30)
Propolis										
Weight (g)	186.5	185.8	229.0	255.3	242.5	255.4	259.2	335.5	342.4	259.6
FE (AE)	6 (4)	8 (8)	20 (7)	7 (2)	15 (7)	8 (5)	5 (0)	4 (1)	7 (0)	8 (0)
SS (EH)	10 (0)	21 (0)	13 (0)	8 (2)	16 (6)	14 (14)	12 (24)	8 (26)	3 (15)	0 (15)
L (P)	0 (0)	0 (0)	0 (0)	1 (4)	3 (8)	3 (7)	5 (7)	7 (8)	8 (5)	21 (8)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	7 (2)
AI (TI)	6 (20)	8 (37)	20 (40)	12 (24)	26 (55)	18 (51)	17 (53)	19 (54)	21 (39)	46 (61)
Rotenone										
Weight (g)	208.7	225.9	225.4	237.3	235.4	355.4	361.5	305.0	337.4	428.1
FE (AE)	2 (2)	6 (4)	10 (6)	4 (0)	5 (4)	4 (1)	0 (0)	3 (0)	12 (0)	4 (0)
SS (EH)	12 (0)	19 (5)	17 (0)	14 (9)	7 (14)	8 (11)	8 (31)	4 (36)	16 (28)	0 (39)
L (P)	0 (0)	0 (0)	0 (0)	4 (4)	4 (11)	4 (16)	14 (10)	7 (10)	14 (1)	14 (19)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	11 (7)	0 (0)	0 (0)	0 (0)
AI (TI)	2 (16)	6 (34)	10 (33)	12 (35)	20 (45)	24 (44)	42 (81)	20 (60)	27 (71)	37 (76)
Dimethoate										
Weight (g)	215.1	303.9	221.9	283.9	295.1	312.6	324.0	353.6	389.4	313.5
FE (AE)	7.7 (2.7)	9.3 (5)	6.3 (3)	8.3 (2)	8.7 (5.3)	9.3 (6)	6.7 (1.3)	5 (0)	3 (1)	4 (0.7)
SS (EH)	18 (5.7)	12.7 (4.3)	18 (1.7)	12.3 (4)	17 (5.3)	9 (6.3)	11 (15)	9 (15.3)	13.3 (17.3)	8.7 (15)
L (P)	1.7 (1.3)	0.3 (0)	1.3 (0)	2.7 (0.7)	5 (5.7)	2.7 (2.7)	5 (7)	4 (6.7)	7.7 (5.3)	9 (5)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.7 (0.7)	0 (0)	0 (0)	0 (0)	4 (2)
AI (TI)	10.7 (37)	9.7 (31.7)	7.7 (30.3)	11.7 (30)	19.3 (47)	16 (37.3)	18.7 (46)	15.7 (40)	16 (47.7)	24 (48.3)

Table 3. Detailed data concerning weight, fertile (FE) and aborted eggs (AE), sterile stings (SS), emergence holes (EH), larvae (L), pupae (P), larvae and pupae causing reinfestation (RL) and (RP), active (AI) and total infestation (TI) percentages obtained in the Mirto-Crosia field in 2006.

	8/10	8/22	8/31	9/11	9/21	10/2	10/12	10/24	11/2	11/14	11/23
Control											
Weight (g)	181.0	249.2	233.6	244.3	282.7	333.4	252.5	342.6	408.0	330.6	366.5
FE (AE)	7 (2)	13 (5)	12 (4)	21 (5)	18 (1)	12 (6)	12 (8)	16 (6)	15 (2)	9 (2)	13 (3)
SS (EH)	14 (6)	10 (9)	8 (13)	10 (3)	10 (12)	7 (8)	4 (11)	0 (8)	2 (6)	7 (13)	1 (12)
L (P)	9 (1)	4 (6)	12 (8)	9 (6)	9 (2)	5 (10)	13 (9)	6 (13)	8 (13)	15 (7)	11 (14)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	17 (39)	23 (47)	32 (57)	36 (54)	29 (52)	27 (48)	34 (57)	35 (49)	36 (46)	31 (53)	38 (54)
Copper/Propolis											
Weight (g)	186.7	209.4	221.8	263.9	221.4	331.3	344.1	319.5	304.7	357.8	342.4
FE (AE)	11 (6)	7 (3)	8 (3)	19 (5)	5 (2)	7 (2)	10 (5)	9 (3)	8 (7)	9 (7)	12 (2)
SS (EH)	14 (1)	16 (6)	9 (7)	10 (3)	8 (9)	12 (4)	6 (11)	1 (6)	2 (15)	5 (6)	2 (14)
L (P)	3 (2)	7 (5)	3 (6)	3 (1)	14 (6)	8 (2)	9 (6)	12 (9)	11 (12)	11 (6)	4 (17)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	16 (37)	19 (44)	17 (36)	23 (41)	25 (44)	17 (35)	25 (47)	30 (40)	31 (55)	26 (44)	33 (51)
Kaolin											
Weight (g)	202.8	218.1	249.2	307.3	224.1	316.2	458.3	390.3	398.1	397.7	358.6
FE (AE)	5 (2)	2 (0)	2 (0)	6 (3)	13 (7)	7 (2)	8 (3)	5 (9)	5 (3)	12 (4)	6 (4)
SS (EH)	3 (3)	12 (7)	11 (3)	6 (7)	14 (0)	8 (4)	7 (4)	2 (8)	2 (7)	7 (8)	6 (11)
L (P)	2 (1)	3 (1)	1 (2)	2 (0)	2 (2)	5 (3)	2 (6)	3 (5)	4 (1)	6 (5)	6 (12)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	8 (16)	6 (25)	5 (19)	8 (24)	17 (38)	15 (29)	16 (30)	13 (32)	10 (22)	23 (42)	24 (45)
Rotenone											
Weight (g)	208.7	228.6	234.6	268.6	325.0	297.7	357.2	306.7	335.2	333.5	317.2
FE (AE)	0 (0)	5 (2)	9 (119	3 (2)	17 (3)	6 (3)	9 (4)	14 (3)	9 (5)	19 (3)	17 (3)
SS (EH)	14 (7)	26 (9)	12 (8)	11 (17)	4 (12)	8 (13)	4 (15)	3 (16)	0 (19)	5 (13)	4 (15)
L (P)	4 (6)	8 (2)	2 (7)	4 (3)	7 (15)	11 (7)	17 (11)	7 (21)	4 (17)	6 (11)	16 (7)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	10 (31)	15 (52)	18 (49)	10 (40)	39 (58)	24 (48)	37 (60)	42 (64)	30 (54)	36 (57)	40 (62)
Dimethoate											
Weight (g)	207.4	260.6	253.7	330.1	296.1	327.9	359.4	354.0	347.0	363.9	331.8
FE (AE)	5.5 (2)	10 (5)	13.5 (4.5)	16.5 (7)	23 (7.5)	14.5 (5.5)	15 (3)	10 (7)	8.5 (2)	3 (4)	3 (1.5)
SS (EH)	16 (3.5)	16 (4)	15 (11)	16 (7)	13 (0)	11 (1.5)	13 (8)	16.5 (4)	16 (11)	12 (7)	20 (13)
L (P)	2 (3.5)	6 (2.5)	4.5 (1.5)	6.5 (3.5)	1 (2.5)	10.5 (1.5)	11.5 (8.5)	8 (7)	9.5 (1.5)	0 (2.5)	1.5 (2.5)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)
AI (TI)	11 (32.5)	18.5 (43.5)	19.5 (50)	26.5 (56.5)	26.5 (47)	26.5 (44.5)	35 (59)	25 (52.5)	20.5 (49.5)	5.5 (28.5)	6 (40.5)

Table 4. Detailed data concerning weight, fertile (FE) and aborted eggs (AE), sterile stings (SS), emergence holes (EH), larvae (L), pupae (P), larvae and pupae causing reinfestation (RL) and (RP), active (AI) and total infestation (TI) percentages obtained in the Terranova da Sibari field in 2005.

	8/22	8/31	9/12	9/23	10/4	10/15	10/26	11/9	11/19	12/1	12/12	12/22
Control												
Weight(g)	299.4	318.8	400.0	402.2	464.7	447.8	538.6	569.9	529.0	523.5	492.7	490.5
FE(AE)	2(5.5)	5.5(1)	13.5(4)	10.5(0)	10(3.5)	9(3.5)	5(0)	2(0.5)	7.5(1)	2.5(0)	9.5(2.5)	0(0)
SS(EH)	8.5(0)	16.5(0)	11.5(0)	6.5(5.5)	9.5(5.5)	6.5(11)	10(13.5)	5(19.5)	3.5(16)	5.5(14.5)	6(17.5)	0(18.5)
L(P)	0(0)	0(0)	0(0)	9(3)	4(3.5)	7.5(3.5)	6.5(7.5)	8.5(4)	15(2.5)	17(5)	16.5(5)	19(11)
RL(RP)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(1)	6.5(5.5)	7(4.5)	5(2.5)	4.5(10.5)
AI(TI)	2(16)	5.5(23)	13.5(29)	22.5(34.5)	17.5(36)	20(41)	19(42.5)	17.5(42.5)	37(57.5)	36(56)	38.5(64.5)	45(63.5)
Azadirachtin												
Weight(g)	210.7	229.5	296.2	348.4	371.2	436.9	448.1	584.6	496.4	511.5	419.8	428.6
FE(AE)	0(5)	-	8(2)	9(4)	16(8)	14(2)	10(0)	5(2)	4(2)	8(0)	7(0)	0(0)
SS(EH)	6(0)	-	10(0)	7(3)	12(0)	9(2)	5(8)	7(14)	6(16)	4(21)	4(18)	0(13)
L(P)	0(0)	-	0(0)	8(2)	3(0)	1(2)	2(5)	12(4)	9(8)	11(7)	27(5)	31(12)
RL(RP)	0(0)	-	0(0)	0(0)	0(0)	0(0)	0(0)	0(1)	6(1)	4(5)	2(10)	4(10)
AI(TI)	0(11)	-	8(20)	19(33)	19(39)	17(30)	17(30)	22(45)	28(52)	35(60)	51(73)	57(70)
Copper												
Weight(g)	254.5	309.9	359.4	363.6	394.2	424.0	508.7	582.4	524.8	553.4	518.0	510.6
FE(AE)	3(0)	8(3)	10(4.5)	13(2.5)	13(4.5)	6(2)	2(0.5)	2(1)	7.5(0)	5.5(2)	4.5(1)	0(0)
SS(EH)	14(0)	15(0)	21(0)	6(5)	8.5(5.5)	5(8.5)	5.5(5)	13(10.5)	8(11.5)	6.5(12)	3.5(13.5)	0(17)
L(P)	0(0)	0(0)	0(0)	4(0)	2.5(1.5)	2(2.5)	2(5)	4.5(4.5)	9(5.5)	13(6.5)	14.5(7)	19.5(11.5)
RL(RP)	0(0)	0(0)	0(0)	1(0)	0(0)	0(0)	0(0)	0(0)	3.5(4.5)	4(4.5)	6(6.5)	5(9.5)
AI(TI)	3(17)	8(26)	10(35.5)	18(31.5)	17(35.5)	10.5(26)	9(20)	11(35.5)	30(49.5)	33.5(54)	38.5(56.5)	45.5(62.5)
Kaolin												
Weight(g)	207.3	274.3	315.9	344.3	325.1	377.4	435.4	523.2	507.7	432.6	497.1	467.4
FE(AE)	0(0)	2(0)	4(0)	11(0)	12(7)	9(6)	10(4)	6(3)	5(2)	4(0)	1(0)	0(0)
SS(EH)	6(0)	12(0)	18(0)	10(2)	17(0)	4(6)	3(8)	7(9)	0(5)	2(4)	3(19)	4(17)
L(P)	0(0)	0(0)	0(0)	6(0)	0(0)	7(2)	2(5)	1(1)	10(6)	9(4)	15(6)	7(5)
RL(RP)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0)	0(0)	0(0)	3(0)	12(7)	12(3)	2(3)
AI(TI)	0(6)	2(14)	4(22)	17(29)	12(36)	19(35)	17(32)	8(27)	24(31)	36(42)	37(59)	17(38)
Propolis												
Weight(g)	234.2	239.5	304.5	369.2	467.1	436.2	459.2	493.2	507.7	411.4	429.7	392.2
FE(AE)	6(0)	6(0)	13(2)	6(1)	6(2)	10(3)	0(0)	10(2)	2(0)	1(0)	9(2)	0(0)
SS(EH)	5(0)	12(0)	8(0)	6(12)	14(0)	5(8)	6(12)	8(13)	6(20)	4(16)	2(10)	4(29)
L(P)	0(0)	0(0)	0(0)	1(0)	0(0)	2(5)	4(6)	3(3)	19(7)	15(8)	21(6)	11(7)
RL(RP)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(0)	0(4)	16(2)	12(3)	1(15)
AI(TI)	6(11)	6(18)	13(23)	7(26)	6(22)	17(33)	10(28)	17(40)	32(58)	42(62)	51(65)	34(67)
Rotenone												
Weight(g)	248.2	239.0	271.4	298.6	352.1	450.1	484.8	548.8	473.5	465.3	486.1	422.7
FE(AE)	0(4)	5(3)	14(4)	10(5)	10(4)	11(2)	4(1)	10(4)	3(0)	12(2)	4(29	0(0)
SS(EH)	13(0)	15(0)	5(0)	2(7)	6(0)	4(9)	8(6)	5(7)	7(9)	8(14)	6(18)	0(26)
L(P)	0(0)	0(0)	0(0)	3(0)	2(0)	3(5)	2(3)	3(0)	21(7)	19(4)	16(4)	11(8)
RL(RP)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(1)	5(2)	2(3)	2(13)
AI(TI)	0(17)	5(23)	14(23)	13(27)	12(22)	19(34)	9(24)	13(29)	34(50)	42(66)	29(55)	34(60)

Table 5. Detailed data concerning weight, fertile (FE) and aborted eggs (AE), sterile stings (SS), emergence holes (EH), larvae (L), pupae (P), larvae and pupae causing reinfestation (RL) and (RP), active (AI) and total infestation (TI) percentages obtained in the Terranova da Sibari field in 2006.

	8/11	8/22	8/31	9/11	9/19	9/29	10/10	10/20	10/31	11/9	11/20	12/4
Control												
Weight (g)	312.8	313.0	243.1	254.6	292.5	436.6	413.7	414.1	432.4	406.0	400.7	364.0
FE (AE)	10.5 (3)	12 (4)	9.5 (3)	11.5 (3)	14.5 (5)	21.5 (7)	15.5 (7.5)	12 (3.5)	13 (1.5)	9 (2)	9 (3)	12 (1.5)
SS (EH)	15 (0)	11.5 (0)	21 (1)	17 (0)	14 (3.5)	12 (2)	4 (2)	14 (5)	10 (2.5)	6 (20.5)	6.5 (14.5)	6.5 (11.5)
L (P)	1 (0)	2 (0.5)	3 (1)	8.5 (1)	5.5 (2)	5.5 (0.5)	7 (2.5)	9 (1)	8.5 (4)	5 (11.5)	11 (13.5)	16 (5.5)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	11.5 (29.5)	14.5 (30)	13.5 (38.5)	21 (41)	22 (44.5)	27.5 (48.5)	25 (38.5)	22 (44.5)	25.5 (39.5)	23.5 (54)	33.5 (57.5)	33.5 (53)
Azadirachtin												
Weight (g)	310.7	314.8	283.1	270.6	347.7	361.2	416.7	482.7	458.8	476.9	463.8	431.1
FE (AE)	8 (2)	2 (1)	9 (2)	11 (3)	17 (9)	9 (6)	7 (5)	14 (1)	11 (4)	10 (4)	15 (3)	3 (0)
SS (EH)	17 (0)	18 (3)	15 (1)	6 (0)	10 (0)	14 (0)	11 (2)	6 (1)	6 (9)	2 (16)	3 (19)	0 (22)
L (P)	0 (0)	4 (2)	3 (1)	0 (0)	0 (0)	3 (0)	4 (2)	3 (2)	9 (4)	12 (4)	11 (6)	14 (8)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	8 (27)	8 (30)	13 (31)	11 (20)	17 (36)	12 (32)	24 (38)	19 (27)	24 (43)	26 (48)	32 (57)	25 (47)
Copper												
Weight (g)	255.1	245.1	211.8	227.0	214.2	395.6	341.1	361.7	321.4	390.9	374.6	383.1
FE (AE)	11.5 (3.5)	12.5 (5)	10 (7.5)	7.5 (9)	14 (3.5)	10.5 (8)	12 (3.5)	11.5 (4)	8.5 (3)	13.5 (1)	15 (2)	16.5 (4)
SS (EH)	11 (0)	11.5 (0)	11.5 (0)	7 (0)	17 (0)	10 (0)	11.5 (0)	7 (5.5)	13 (3.5)	9 (5.5)	12.5 (5)	9 (6)
L (P)	0 (0)	1 (0.5)	1 (1)	1.5 (0)	4 (0)	2 (0)	4 (1.5)	2.5 (1)	3.5 (3.5)	0.5 (1.5)	5 (2)	5.5 (4)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.5 (0.5)
AI (TI)	11.5 (26)	14 (30.5)	12 (31)	9 (25)	18 (38.5)	12.5 (30.5)	17.5 (32.5)	15 (31.5)	15.5 (35)	15.5 (31)	22 (41.5)	27 (46)
Copper/Propolis												
Weight (g)	298.2	237.2	188.6	247.3	272.8	380.1	366.7	344.2	375.9	369.6	382.3	304.4
FE (AE)	11 (1)	2 (1)	9 (1)	10 (7)	16 (6)	9 (9)	15 (7)	7 (2)	1 (0)	12 (3)	13 (4)	8 (0)
SS (EH)	13 (0)	12 (1)	14 (3)	18 (0)	4 (0)	25 (0)	16 (2)	13 (2)	3 (6)	2 (8)	6 (11)	4 (24)
L (P)	0 (0)	1 (0)	2 (1)	3 (0)	0 (0)	0 (0)	4 (0)	7 (3)	26 (1)	15 (7)	9 (8)	16 (4)
RL (RP)	0 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	11 (25)	3 (17)	13 (31)	13 (38)	16 (26)	9 (43)	19 (44)	17 (34)	28 (37)	34 (47)	30 (51)	28 (56)
Kaolin												
Weight (g)	192.9	257.5	198.2	204.4	244.2	353.5	287.3	320.7	395.8	388.3	480.1	382.2
FE (AE)	10 (1)	9 (4)	5 (7)	6 (3)	7 85)	6 (6)	19 (2)	4 (5)	4 (2)	6 (2)	13 (8)	18 (5)
SS (EH)	12 (0)	8 (0)	15 (2)	21 (0)	14 (4)	17 (3)	7 (2)	3 (1)	3 (2)	6 (1)	4 (13)	7 (9)
L (P)	0 (0)	0 (1)	0 (3)	0 (1)	2 (0)	2 (0)	1 (1)	4 (0)	3 (2)	1 (2)	6 (2)	5 (2)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
AI (TI)	10 (23)	10 (22)	8 (32)	7 (31)	9 (32)	8 (34)	14 (25)	8 (17)	9 (16)	9 (18)	21 (46)	25 (46)
Rotenone												
Weight (g)	306.7	302.4	273.5	201.7	288.6	476.5	306.0	323.0	431.1	495.9	456.5	403.1
FE (AE)	17 (4)	7 (4)	12 (6)	7 (4)	14 (8)	8 (8)	3 (2)	4 (1)	8 (0)	8 (6)	7 (4)	4 (1)
SS (EH)	9 (0)	9 (1)	13 (2)	19 (2)	16 (1)	19 (4)	10 (6)	16 (2)	19 (0)	11 (6)	7 (19)	0 (12)
L (P)	0 (0)	5 (1)	0 (4)	4 (0)	2 (0)	4 (0)	9 (0)	8 (0)	3 (6)	2 (2)	7 (2)	2 (12)
RL (RP)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4 (0)
AI (TI)	17 (30)	13 (27)	16 (37)	11 (36)	16 (41)	12 (43)	12 (30)	12 (31)	17 (36)	12 (35)	16 (46)	22 (35)

DISCUSSION AND CONCLUSIONS

The results obtained in the two different investigated areas in two observation years indicated that kaolin has great potential for the control of *B. oleae* population. It is sprayed onto canopy as a liquid suspension while water evaporates leaving kaolin as a white porous protective powdery film on the leaves and fruits surface. The kaolin-based particle film determined a reduction of adult population. Although it is not directly toxic to insects, its insecticidal properties are thought to be a result of its repellent nature, anti-ovipositional qualities and/or due to its highly reflective white coating (Saour and Makee, 2004). Moreover, as a consequence of the repulsion of gravid females due both to abovementioned behavioural reasons and to the tactile unsuitable texture of particle film-treated olives, data concerning active infestation percentages in the theses treated with kaolin registered a significant reduction. So, in the kaolin treated theses the threshold of 20% has been not exceeded. However, the environmental impact eventually associated with kaolin application should be evaluated. The use of antibacterial substances, as copper and propolis one by one or mixed sprayed, showed a good efficacy both on adult and preimago population. The copper application seemed to be particularly efficacious suggesting that it acts by interrupting the symbiosis among the olive fly female and larvae and some bacteria present on olive phylloplane (Rosi et al., 2005). Also for these antibacterial substances, the environmental impact should be assessed, especially at soil level since copper is a heavy metal and could determine direct damages on the soil biocoenosis. Moreover, it could be recovered in phreatic acquifer in relation to the different soil structure and as a consequence of water draining. Heavy metals are involved in the phenomenon of biological magnification (bioaccumulation) defined as the tendency for contaminant concentration in animal tissues to increase through successively higher trophic levels, especially in aquatic food chain. Laboratory studies showed that food may be an important source for the bioaccumulation of toxic heavy metals, particularly those that are essential trace elements as copper. Rotenone application confirms its known efficacy in Terranova da Sibari area while it does not appear very efficacious in Mirto-Crosia area. As concern rotenone application in olive crop protection, in some studies were reported the negative effects on the olive ecosystem, especially versus both the indifferent and beneficial entomocoenosis (Iannotta et al., 2007). Moreover, a toxicological risk for consumers and operators has been assessed amplified by the evidence that olive drupes transformation determines concentration of rotenone and its derivates in olive oil (Cabras, 2004) while many long-term epidemiological studies demonstrated a correlation between rotenone use and the onset of some diseases, implicating exposure to rotenone as significant risk factor (Zhang et al., 2006). The insect phagorepellent and systemic growth disruptor azadiracthin turned out to be not so efficacious for olive fly control in both olive areas and years. The threefold action of azadiracthin on the insects, not only pests, suggests that we have to proceed with great care as concerns its applicability, especially if olive crop protection is performed in organic farming because it could exhibit side-effects on non-target fauna.

In conclusion, we are able to affirm that olive fly control can be performed in organic farming also in very difficult ecoclimatic conditions as in the Southern Italy. The choice of strategies management, as time and number of treatments and the more efficacious substance, is related to the specific conditions of olive area in which crop protection is required and to the trend of climatic and production year. Consequently, in a rational crop protection strategy an accurate monitoring of climatic trend, of adult and preimago population trends and of drupe maturation indexes (inoliation and fall) trend is needed, both in organic and non organic farming. At last, a revision of the present Regulations is needed since they appear inadequate in relation to the environmental safeguard and hygienic features of product proposed by growing word of organic producers to the consumers. Since it hasn't been proved a greater content of desiderable substances in organic food in comparison with conventional one, only the hygienic and ecocompatible features can justify the higher prices of organic products on the market.

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