Effectiveness of Clays and Copper Products in the Control of *Bactrocera Oleae* (Gmelin) and *Ceratitis Capitata* (Wiedemann) in Organic Farming

Caleca V.,[1] Lo Verde G.,[2] Palumbo Piccionello M.,[3] & Rizzo R.[4]

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Abstract

Tests on the effect of clays (kaolin and bentonite) and copper products (hydroxide and oxychloride) in the control of olive fruit fly, Bactrocera oleae *(Gmelin), and Mediterranean fruit fly, Ceratitis capitata (Wiedemann),* were *carried out from 2003 to 2006 in olive groves, and in 2005 and 2006 in organic orange orchards (early ripening cv. Navelina).*

Results demonstrate an efficacy of kaolin products in reducing attacks of Bactrocera oleae to olives and those of Ceratitis capitata to oranges. In olive groves, they gave similar or better results than copper hydroxide. Bentonite AG/W8 showed a significant reduction in punctures towards C. capitata. Bentonite products and BPLK kaolin are clearly washed off by the rainfall more easily than Surround WP.

Clays are very useful tools to control tephritid and other insects, and are also environmental friendly. Until now, however, they are not allowed as products for plant protection in European and Swiss organic farming.

Differently from the effect towards B. oleae, no tested copper product showed a significant reduction in C. capitata punctures on oranges.

Introduction

The control of tephritid flies is problematic in organic farming; olive fruit fly, *Bactrocera oleae* (Gmelin), is the key pest in olive growing, while the Mediterranean fruit fly (medfly), *Ceratitis capitata* (Wiedemann), is the key pest of early ripening citrus cultivars and many other fruits. Their control in organic orchards is so difficult that in European organic farming two pyrethroids (deltamethrin and lambdacyhalothrin) are permitted in traps only against *B. oleae* and *C. capitata.* In spite of this, table olive orchards and peach orchards in Sicily are limited to very few hectares.

For these reasons, the use of repellent and antiovipositional products in the control of Tephritidae finds a great interest in organic farming. The effectiveness of clays and some copper products was tested on *B. oleae* in the past (Russo 1937; 1954); kaolin was recently tested on this species (Saour & Makee, 2004) and on *C. capitata* (Mazor and Erez; 2004). In the laboratory, Prophetou-Athanasiadou et al. (1991) demonstrated an ovipositional deterrence of copper hydroxide to *B. oleae;* a similar effect was shown for copper sulphate in *C. capitata* by Marchini and Wood (1983).

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[1] Dipartimento S.En.Fi.Mi.Zo., Sezione di Entomologia, Acarologia e Zoologia, Università degli Studi di Palermo, Viale delle Scienze, 90128 Palermo, Italia, e-Mail: caleca@unipa.it

[2] ,[3,4] Ibid.

Copper products have been positively tested in the field against the olive fruit fly (Belcari et al., 2005), while they have not yet been tested against the medfly.

In this research, we tested the effectiveness of some clays (kaolin and bentonite) and some copper products (hydroxide and oxichloride + sulphate) in the control of *B. oleae* and *C. capitata,* in olive groves and orange orchards.

Materials and methods

Olive groves

From 2003 to 2006, a product containing 95% of kaolin, Surround WP, was tested in three olive groves of Trapani province (Sicily, Italy). In 2004, in the Castelvetrano and Paceco fields, this kaolin was compared with BPLK kaolin, a 100% kaolin product utilized for ceramic and other purposes, but never used in agriculture. In 2004 and 2006, Surround WP was compared with Coprantol Ultramicron, containing 35% of copper as hydroxide. In 2005 and 2006, in a Partanna field, the other two products were tested: Cuprobenton (a whitish product containing 15% of copper as oxychloride and sulphate, and 70% of bentonite) and Biobenton (a product containing 100% of bentonite). Moreover, the synergic action of Surround WP plus Coprantol was tested in 2005 and 2006.

The doses of a treatment were 5 kg of clay (kaolin or bentonite), 0.3 kg of Coprantol Ultramicron, and 0.8 kg of Cuprobenton per hl of water. The first spray was performed after reaching the threshold of five percent of total infestation; the next one was done when the fruits were no longer covered by the clays because of the rain and the wind. Olive trees were sprayed from one to three times.

Each year, 3-10 weekly or biweekly samplings were performed. Collected fruit (60-100 per thesis) were analyzed under the stereomicroscope to detect eggs, larvae, pupae, exit holes, empty galleries and punctures without oviposition. The infestation level was expressed as total infestation (live eggs + 1st, 2nd and 3rd instar larvae + pupae + exit holes in absence of larvae or pupae).

Orange orchards

Trials were carried out in an organic orange orchard consisting of 250 trees (Navelina cultivar), located at Castelvetrano (Sicily, Italy). The medfly population was monitored using three traps baited with trimedlure; the males caught were counted every two weeks. In 2005, four plots were sprayed once with Surround WP, Coprantol Ultramicron, Cuprobenton, and Blue Cuprobenton, the last two products differing only in the color; treated plots were compared with an untreated plot (control). In 2006, Surround WP, Bentonite AG/W8 (a product containing 100% of a bentonite, whiter than Biobenton) and Coprantol Ultramicron were tested and compared with an untreated plot (control); two sprays were performed. The doses of a treatment were 5 kg of clay (kaolin or bentonite), 0.3 kg of Coprantol Ultramicron, and 0.8 kg of Cuprobenton per hl of water. In 2006, all fruits on each tree of the plots were counted before the beginning of the trials; afterwards, from September 22nd to December 2nd, fruits dropped because of medfly attack were counted every 14 days. In 2005, the harvest occurred on 27th of November, and in 2006 it took place on the 15th, 24th, and 30th of November. In both years, 60 to 100 fruits per 10 trees of each plot were examined in each harvest, recording infested fruits.

Results

Olive groves

As shown in table 1, analyzing the total infestation level of the entire sampling period of each year, olives sprayed with Surround WP (with or without Coprantol Ultramicron) were significantly less infested than those of all other tests. In 2004, the plot with the other kaolin product, BPLK, recorded an infestation lower than the control in both sites, but higher than Surround WP in the olive groves with more intense rainfall. In addition, the product containing copper hydroxide, Coprantol Ultramicron, gave better results than the control; in 2004, its plot was more attacked than those sprayed with the two kaolin products, while in 2006 it did not differ from Surround WP. Plots sprayed with the other products containing copper oxychloride (Cuprobenton) and bentonite (Biobenton) were less infested than the unsprayed one, but without statistically significant differences over the whole period.

Tab. 1: *Bactrocera oleae* total infestation (no. attacks per olive) recorded in olive groves of Trapani Province (mean values of the whole sampling period ± standard error, different letters within each column denote statistically significant differences; repeated measurements ANOVA followed by Tukey post-hoc test; p< 0.05)

Thesis	2003	2004	
	Castelvetrano	Castelvetrano	Paceco
Untreated	0.32 ± 0.03 a	1.91 ± 0.09 a	0.89 ± 0.04 a
Surround WP	0.15 ± 0.03 b	0.17 ± 0.09 c	0.27 ± 0.04 c
BPLK Kaolin	----	0.86 ± 0.09 b	0.33 ± 0.04 c
Copper Hydroxide	----	----	0.48 ± 0.04 b

Thesis	2005	2006
	Partanna	Partanna
Untreated	0,90 ± 0.08 a	0.31 ± 0.02 a
Surround WP	0.25 ± 0.05 b	0.18 ± 0.02 b
Copper Hydroxide	----	0.19 ± 0.02 b
Surround WP + Copper Hydrox.	0.21 ± 0.05 b	0.10 ± 0.02 b
Cuprobenton	0.67 ± 0.05 a	----
Biobenton	0.64 ± 0.05 a	----

Orange orchards

As shown in tab. 2 in both years total *C. capitata* infestation in Surround WP sprayed fruits (19% in 2005, 60% in 2006) was significantly lower than in Coprantol Ultramicron (40% in 2005, 78% in 2006) and control (43% in 2005 and 83% in 2006) plots; no statistically significant difference was found between the last two theses. In 2005, white and blue Cuprobenton recorded infestation levels (27% and 32%) between those of control and Surround WP, with no significant differences with them. In 2006, punctured fruits sprayed with Bentonite AG/W8 were 70%, significantly lower than in the control and higher than in Surround WP plot (tab. 2).

Tab. 2: Percentages of oranges punctured by *C. capitata* recorded at harvest (mean values ± standard error, different letters within each column denote statistically significant differences; 1-way ANOVA followed by Tukey post-hoc test; p< 0.05)

Thesis	2005	2006
Untreated	43 ± 5.20 a	83 ± 2.20 a
Surround WP	19 ± 4.20 b	60 ± 2.20 c
Coprantol Ultramicron	40 ± 5.20 a	78 ± 2.20 a
Cuprobenton	27 ± 4.56 ab	----
Blue Cuprobenton	32 ± 4.75 ab	----
Bentonite AG/W8	----	70 ± 2.41 b

Discussion and conclusions

Our results demonstrate an efficacy of kaolin products in reducing attacks of *Bactrocera oleae* to olives and those of *Ceratitis capitata* to oranges. In olive groves, they gave similar or better results than copper hydroxide. The only bentonite showing a significant reduction in punctures was Bentonite AG/W8 towards *C. capitata*; this is a product whiter than Biobenton tested in olive groves. Bentonite products and BPLK kaolin are clearly washed off by the rainfall more easily than Surround WP, and their worse results are also linked to their limited permanence on fruits, since the need of protection for both olives and oranges occurs in a rainy period. Surround WP surely is very effective, but other tested clay products are much cheaper (5-7 times) than it. Attention has to be paid in improving the permanence of clays on fruits and in evaluation of the economic convenience of more treatments with clays less effective but cheaper than Surround WP.

Clays are very useful tools to control tephritid and other insect (Unruh et al. 2000; Pasqualini et al. 2002) and are environmentally friendly, but until now they are not allowed as products for plant protection in European and Swiss organic farming; only kaolin is allowed in organic farming in the US.

Differently from the effects of *B. oleae*, no tested copper product showed a significant reduction in *C. capitata* punctures on oranges.

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