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Short communication. Incidence of the OLIPE mass-trapping on olive non-target arthropods

M. Porcel[1]*, F. Ruano[2], O. Sanllorente[2], J. A. Caballero[3] and M. Campos[1]

[1] *Department of Environmental Protection. Estación Experimental de Zaidín, CSIC, Profesor Albareda nº 1, 18008, Granada. Spain.*

[2] *Department of Animal Biology. University of Granada. Facultad de Ciencias. Campus de Fuentenueva s/n 18071, Granada. Spain.*

[3] *"Los Pedroches" S.C.A. Olive Co. Carretera Circunvalación s/n. 14400, Pozoblanco (Córdoba). Spain.*

Abstract

Due to the widespread of mass-trapping systems for *Bactrocera oleae* (Gmelin) (Diptera: Tephritidae) control in organic olive cropping, an assessment of the impact on arthropods of the olive agroecosystem was undertaken for the OLIPE trap type. The sampling was carried out in "Los Pedroches" valley (Córdoba, southern Spain) in three different organic orchard sites. Six OLIPE traps baited with diammonium phosphate were collected from each site (18 in total) from July to November 2002 every 15 days on average. Additionally, in the latest sampling dates, half the traps were reinforced with pheromone to assess its impact on non-target arthropods. From an average of 43.0 catches per trap (cpt) of non-target arthropods during the whole sampling period, the highest number of captures corresponds to the Order Diptera (that represents a 68.5%), followed distantly by the family Formicidae (12.9%) and the Order Lepidoptera (10.4%). Besides the impact on ant populations, other beneficial groups were recorded such as parasitoids (Other Hymenoptera: 2.6%) and predators (Araneae: 1.0%; Neuroptera s.l.: 0.4%). Concerning the temporal distribution of catches, total captures peaked on July and had a slight increase at the beginning of autumn. No significant differences were observed between traps with and without pheromone. The results evidence that a considerable amount of non-specific captures could be prevented by improving the temporal planning of the mass-trapping system.

Additional key words: *Bactrocera oleae*, beneficial arthropods, olive fruit fly, olive grove, organic management.

Resumen

Comunicación corta. Efecto del trampeo masivo tipo OLIPE sobre los artrópodos no objetivo del olivar

Debido a la extensión del trampeo masivo como método de control para *Bactrocera oleae* (Gmelin) (Diptera: Tephritidae) en el cultivo ecológico del olivo, se llevó a cabo una evaluación del efecto de la trampa tipo OLIPE sobre los artrópodos del agroecosistema del olivar. El muestreo fue realizado en el valle de "Los Pedroches" (Córdoba, sur de España), en tres olivares ecológicos distintos. De cada olivar se recogieron 6 trampas OLIPE cebadas con fosfato diamónico (18 en total) desde julio a noviembre de 2002 con una periodicidad media de 15 días. Además, en las últimas fechas de muestreo, la mitad de las trampas fueron reforzadas mediante la adición de feromona para evaluar su impacto. De una media de 43,0 capturas por trampa (cpt) de artrópodos no objetivo a lo largo del periodo total de muestreo, la mayor parte de las capturas correspondieron al Orden Diptera (representando el 68,5%) seguidos por la familia Formicidae (12,9%) y el Orden Lepidoptera (10,4%). Aparte del impacto sobre la población de hormigas, se registraron capturas de otros grupos de beneficiosos tales como parasitoides, (Otros Hymenoptera: 2,6%) y depredadores (Araneae: 1,0%; Neuroptera s.l.: 0,4%). En cuanto a la distribución temporal, las capturas totales tuvieron un máximo en julio y un ligero incremento al comienzo de otoño. No se hallaron diferencias significativas entre las capturas de trampas con feromona y sin ella. Los resultados indican que una mejora de la planificación temporal del sistema de trampeo masivo permitiría evitar una importante cantidad de capturas no específicas.

Palabras clave adicionales: artrópodos beneficiosos, *Bactrocera oleae*, manejo ecológico, mosca del olivo, olivar.

* Corresponding author: mario.porcel@eez.csic.es
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The olive fruit fly, *Bactrocera oleae* (Gmelin) (Diptera: Tephritidae), is the key pest affecting olive groves (*Olea europaea*, Linneus) in the Mediterranean basin with losses estimated at least 15% of the production (Montiel-Bueno and Jones, 2002). This pest has been conventionally controlled by bait spray (pesticides plus attractant) (Zervas, 1982; Haniotakis *et al.,* 1991; Broumas and Haniotakis, 1994; Montiel-Bueno and Jones, 2002), with the resulting risk of pesticides residue contamination of olives and oil (Leandri *et al*., 1993) and high mortality rates of non-target arthropods (Cirio, 1997; Civantos, 1999; Ruano *et al*., 2001; Rodríguez *et al*., 2003). Since organic farming promotes biological diversity and high quality products (Guillou and Scharpé, 2000), the use of wide spectrum synthetic pesticides is forbidden (OJ, 1991). The olive fruit fly is an agent responsible for important olive oil quality reduction (Civantos, 1999; Pereira, 2004); therefore quality standards expected from organic olive oil may not be attained at certain infestation levels. Thus, the development and improvement of alternative control methods able to achieve acceptable olive fruit fly protection in organic olive orchards is a pressing issue nowadays (Altolaguirre-Obrero *et al*., 2003). Among the licit options for pest control in organic management is the mass trapping method (OJ, 1991). The OLIPE trap has been used since 1997 and for several years in "Los Pedroches" (Spain) to control the olive fruit fly in organic orchards with over a million units set up in the zone. Due to its low-cost and effectiveness, it has turned out to be a promising option (Caballero, 2002; Altolaguirre-Obrero *et al*., 2003). However, although its environmental impact is estimated considerably lower than that of chemical control, and as appointed by several authors, mass-trapping may also alter arthropod communities due to undesirable catches of non-target arthropods either beneficial or not (Neuenschwander, 1982; Zervas, 1982; Bagnoli, 2000; García-Rojas *et al*., 2002; Luque-López and Pereda-Cruz, 2003; Ragoussis, 2005). In this context, this study aims to make a preliminary assessment of the effect of the OLIPE mass trapping system on arthropods of organic olive groves, establish which groups are affected and to what extent as well as temporal distribution of catches.

The study was carried out in "Los Pedroches" region (Cordoba, Spain, latitude 38º22' N and longitude 4º51' W) the largest organic olive-growing area in the world with over 9,000 ha of olive orchard under organic management. Three different organic orchard sites under mass-trapping control and with similar environmental conditions were sampled. The orchards, situated roughly at 600 m.a.s.l., are planted with trees between 100 and 130 years old with a density of 10x10 m (110 to 130 trees ha^{-1}). The main cultivar is 'Picual' followed by 'Nevadillo negro' (Guzmán and Alonso, 2008) with a yield of less than 1,500 kg of olives ha^{-1} (low yield olive groves) (Parra-López *et al.*, 2005). According with farmers' information no spray treatment has been done against pest in the past 5 years, using as olive fruit fly control method the mass trapping with OLIPE type traps. Ploughing to a shallow depth is performed in the zone usually in September or October. For fertilization only organic and mineral nutrients are applied. Pruning is done every three years on average. Orchards are not irrigated.

The OLIPE trap consists of a PET translucent bottle with 1.5 L capacity (30 cm high, 9 cm diameter and 825 cm^2 of outer surface) as described by Zervas (1982) but with the inclusion of five holes (5 mm diameter) pierced into the shoulders of the bottle instead of using filter paper for attractant diffusion. Traps were hung in the side of the tree facing north, in the shade, between 1.5 and 2.0 m high. The attractant used as bait was a 4% aqueous solution of diammonium phosphate, the most common attractant for the OLIPE trap in the zone. Six OLIPE traps were collected from each site (18 in total) from July to November 2002 every 15 days on average. The traps that fell off the tree were discarded. Additionally, in the latest sampling dates (18 September, 3 October and 22 November), half the traps were reinforced with a pheromone liquid formulation (1 cm^3 of Spiroketal 15%, Polycore™ SKL 15 EC, Agrisense BSC, UK) as usually done in the zone as part of the OLIPE trapping system and in an attempt of enhancing traps olive fly attraction power. The trap content was filtered with a nylon mesh obtaining the arthropods captured. Catches were counted, taxonomically classified up to the level of order (as exception to family level in the case of Formicidae) and recorded into 11 groups, mainly adopting the taxa order, with the exception of the groups Formicidae and Other Hymenoptera (Hymenoptera not belonging to the family Formicidae).

Abbreviations used: cpt (catches per trap), cptd (catches per trap and day), m.a.s.l. (altitude, meters above sea level), SE (standard error), s.l. (sensus lato).

Mean values of catches per trap (cpt) for the complete sampling period and catches per trap and day (cptd) were calculated. Statistical analysis was performed with SPSS 14.0 for Windows. Kolmogorov-Smirnov and Shapiro-Wilk tests were applied to test normal distribution goodness of fit of catches with and without pheromone. Statistical differences in non-target catches with and without pheromone addition were established with Mann-Whitney U test.

Data did not show a normal distribution. No significant differences in total catches of non-target arthropods were observed in traps with pheromone (29.3 cpt) and without pheromone (27.8 cpt) addition. Therefore, traps with pheromone have been considered equal in experimental conditions to those without pheromone, and hence, included in calculations with the rest. The results suggest that the use of olive fly pheromone has no effect on non-target arthropods catches.

A total of 132 traps from the three sites were sampled throughout the sampling period. In these traps 5,672 non-target arthropods (not including *B. oleae*) were captured. Catches belonged to the groups: Araneae, Coleoptera, Dermaptera, Diptera, Hymenoptera Formicidae, Other Hymenoptera, Hemiptera, Lepidoptera, Neuroptera s.l., Psocoptera and Thysanoptera. The groups Araneae, Dermaptera, Hymenoptera Formicidae, Other Hymenoptera and Neuroptera s.l. (5 out of 11) were regarded as beneficial arthropods in the olive agroecosystem, due to their role in controlling phytofagous pest species through depredation and parasitism (Neuenshwander, 1982; Varela and González, 1999; Ruano *et al*., 2001). From an average of 43.0 cpt of non-target arthropods in the complete sampling period, the highest number of captures corresponds to the Order Diptera, being this group widely dominant to the rest in number in the complete sampling period (Fig. 1). This group was followed in number by the family Formicidae, the order Lepidoptera, Coleoptera and Other Hymenoptera. Captures recorded for the rest of the groups accounted for a 1.6% of the total (Fig. 1).

With respect to the groups regarded as beneficial in this study, total captures of these groups in the whole sampling period represented a 17.0% of captures of non-target arthropods. It is noteworthy the impact on ant populations, generalist predators in the olive agroecosystem, for their predatory action on *B. oleae* larvae and pupae in canopy and soil (Arambourg, 1986; Katsoyannos, 1992) and other phytophagous species (Varela and González, 1999). Besides the group Formicidae, other beneficial groups were recorded. In order of

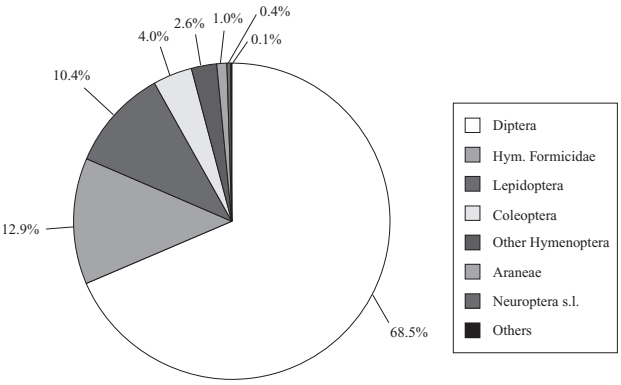

Figure 1. Relative importance of each arthropod group captured.

catches importance, parasitoids (Other Hymenoptera) and predators (Araneae, Neuroptera s.l.) were also collected, but however, catches of the latter were significantly lower with only 0.4% of the total arthropods.

Concerning temporal distribution (Fig. 2), total catches of non-target arthropods peaked the first sampling date, the 3rd of July, corresponding with a period of high abundance and activity of parasitoids and predators in the olive agroecosystem (Ruano *et al*., 2001), and reaching a maximum of 8.43 catches per trap and day (cptd). The exceptionally high number of Lepidoptera catches this sampling date (Table 1) has had an important influence in total arthropods temporal distribution (Fig. 2). Additionally, a peak was registered for Diptera captures this date. Catches had a decreasing trend throughout the month of July, to eventually stabilize in August and September in roughly 3.00 cptd. At the beginning of autumn (29 September) a slight increase of captures up to 4.14 cptd was recorded, and from this sampling date on, catches dropt to minima levels during the month of October. Despite the total

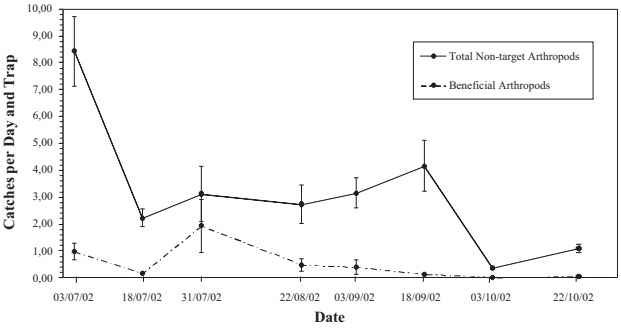

Figure 2. Temporal distribution of mean total catches of non-target arthropods and mean beneficial arthropods catches per day and trap (±SE).

Table 1. Number of individuals captured in traps and catches per trap (cpdt) in the different sampling dates (2002)

		03 Jul (N=9)	18 Jul (N=18)	31 Jul (N=18)	22 Aug (N=18)	03 Sep (N=18)	18 Sep (N=17)	03 Oct (N=16)	22 Oct (N=18)	Total 132
Diptera	Total	581	441	226	817	480	896	89	355	3885
	cpdt	4.30	1.63	0.97	2.06	2.35	3.73	0.33	1.04	
Hym. Formicidae[a]	Total	105	21	417	111	56	10	4	8	732
	cpdt	0.78	0.08	1.78	0.28	0.27	0.04	0.01	0.02	
Lepidoptera	Total	382	12	6	63	64	59	2	4	592
	cpdt	2.83	0.04	0.03	0.17	0.31	0.25	0.01	0.01	
Coleoptera	Total	43	102	44	9	16	8	2	2	226
	cpdt	0.32	0.38	0.19	0.02	0.08	0.03	0.01	0.01	
Other Hymenoptera[a]	Total	20	16	16	65	10	18	1	2	148
	cpdt	0.15	0.06	0.07	0.16	0.05	0.08	0.00	0.01	
Araneae[a]	Total	2	6	19	14	10	6	1	1	59
	cpdt	0.01	0.02	0.08	0.04	0.05	0.03	0.00	0.00	
Neuroptera s.l.[a]	Total	5	3	2	3	6	0	0	3	22
	cpdt	0.04	0.01	0.01	0.01	0.03	0.00	0.00	0.01	
Others	Total	0	1	1	1	1	1	2	1	8
	cpdt	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	

[a] Groups regarded as beneficial.

catches trend, variations may be established for the different groups. Araneae catches registered an important peak at the end of July (Table 1). Coleoptera catches were most abundant during July (over 0.30 cptd) to fall towards the end of the month. In contrast, the group of parasitoids Other Hymenoptera recorded a maximum the 22 August and another peak the first sampling date, these values being remarkably higher than for the rest of the dates. As dipterans, lepidopterans and coleopterans, the important predators group Neuroptera s.l., registered the top value the 3 July in accordance with a well established population maximum this month (Campos and Ramos, 1986). An important decrease in catches occurred the following sampling months for this group.

It is worthy of mention that different results regarding catches composition and number may be obtained for the variety of traps available for mass-trapping, due to features as form, colour, and mainly, number and size of access holes (Luque-López and Pereda-Cruz, 2003). Nevertheless, it seems clear that a large amount of unspecific catches can be prevented through adequate management of the technique, identifying the optimal period for *B. oleae* trapping that would take into account, not only olive fruit fly control parameters, but also distribution of non-target catches in time. By this means biodiversity impact could be minimized, as well as the hampering effect on natural ecological control of olive pest species that traps might cause.

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