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Efficacy of Food Attractants and Attract-and-Kill System to Control *Dacus ciliatus* (Loew) (Tephritidae: Diptera): New Recorded Pest in Northern Tunisia

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ABSTRACT

Some morphological features of *Dacus ciliatus* (Loew) reported for the first time in Tunisia were studied herein. Also during this study, the efficacy of food attractants and attract-and-kill devices were tested against *D. ciliatus*. To do so, McPhail® traps baited with diammonium phosphate (DAP©) and protein hydrolysate (Ceratrap©), already known as food attractants for fruit flies, were compared in zucchini and cucumber crops. A novel attract and kill system (Ceranock© female and male) was also applied in the two cited crops. Moreover, our data highlighted the usefulness of DAP© as effective food attractant with a high number of trapped adults compared to Ceratrap© baited traps. Few adults were recorded by Ceratrap© only in Zucchini treated crop 1 (0.42±0.49 and 0.28±0.69 respectively for males and females) compared to the other surveyed crops. Attract and kill system achieved good control of the pest by decreasing the number of captured flies in treated crops compared to the untreated crops. The use of attract and kill system showed promising results and can successfully be used to manage the lesser pumpkin fly in Tunisian cucurbit crops.

Keywords: The lesser pumpkin fly, DAP©, Ceratrap©, Ceranock®, trap catches, cucurbits.

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INTRODUCTION

The Ethiopian fruit fly, *Dacus ciliatus* (Loew) (Diptera: Tephritidae), is a serious pest of cucurbits (e.g. cucumber, zucchini, and melon) (Alagarmalai et al, 2009; Rempoulakis, Nemny-Lavy, Castro, & Nestel, 2016) already reported in many countries of Africa, Asia and the Middle East (Arghand, 1979; EPPO/CABI, 2006; Fetoh, 2009; Kamali, Karimi, Hosseini, Campos-Herrera, & Duncan, 2013). Recently, *D. ciliatus* was reported in Turkey and Iraq (Al-Muffti & Al-Maronsy, 2018; Çalışkan Keçe, Özbek Çatal, & Ulusoy, 2019). Various control methods are used to manage cucurbit fruit flies worldwide (Qureshi & Hussain, 1992; Hussein, El-Wakeil, & El-Sebai, 2006; Alagarmalai et al, 2009; Kamali et al, 2013; Rempoulakis et al, 2016; Mohammadpour, Faghih, & Araghi, 2017; Shaked et al, 2017). Current approaches for pest management based on behaviour-modifying chemicals are successfully applied for management of fruit flies (El-Sayed et al, 2009; Piñero, Mau, McQuate, & Vargas, 2009; Navarro-Llopis, Primo, & Vacas, 2012; Bouagga et al, 2014; Hafsi, Abbes, Harbi, Duyck, & Chermiti, 2015b). Among these approaches, there is attract-and-kill method which is considered as an efficient method thanks to its beneficial effects towards human health and biodiversity (El-Sayed et al, 2009; Piñero et al, 2009; Bouagga et al, 2014). Different forms of attract-and-kill systems, which consist of killing the target fly by the chemical product once attracted by the semiochemical lure, have already been tested for their efficacy worldwide (Piñero et al, 2009; Ryckewaert, Deguine, Brévault, & Vayssières, 2010; Bouagga et al, 2014; Hafsi et al, 2015a). As example, bait station systems were found to be efficient for the control of some Tephritidae species including *Bactrocera dorsalis* (Hendel), *B. cucurbitae* (Coquillett), and *Ceratitis capitata* (Wiedemann) **(**Piñero et al, 2009; Navarro-Llopis et al, 2012; Bouagga et al, 2012; Hafsi et al, 2015a).

To our best knowledge, there is no available data confirming the occurrence of *D. ciliatus* in Tunisia. From this point of view, this work aimed firstly, to study some morphological aspects of *D. ciliatus*. Secondly, we tested the efficacy of food attractants and attract and kill systems for the fruit fly management in zucchini and cucumber crops.

MATERIALS AND METHODS

Traps

McPhail® traps, provided by (Russell IPM®), were used to monitor fruit flies herein. The survey was conducted from 01/06/2020 to 24/08/2020 in cucurbit crops located in Takelsa region (Northeast Tunisia). Three Zucchini (cvs. Nesta) and two Cucumber (cv. Thomson) crops were fixed for this study. Each crop had an area of one ha. Traps were baited with two food attractants. The first attractant was DAP© (diammonium phosphate), while the second was Ceratrap© (composed of protein hydrolysate). Contents of traps were renewed weekly and the number of captured adult flies were counted and removed. Adults were transferred to the laboratory of entomology and acarology at National Agronomic Institute of Tunisia (INAT) and examined using a stereo microscope.

Attract-and-kill systems

Ceranock® female (bait station) and male (gel) supplied by (Russell IPM®), an innovative "attract-and-kill" technology for Med-fly control**,** were tested for their efficacy, in Takelsa region, where *D. ciliatus* was found. Experiments were conducted from 15/07/2020 to 24/08/2020 in Zucchini and Cucumber crops already described. All crops were planted in June 01, 2020. Distance between plants and rows were 50 cm and 100 cm respectively for each crop. No chemical treatments were done during the experiment period. As recommended by the supplier, 100 Ceranock® female per ha were hanged at a height of 50 cm on 100 cucurbits plant distributed homogeneously within each treated crop. Females were attracted to an attractant and killed by an insecticide after contact. The used attractant were protein hydrolysate and plant extract (5 g/bait station), while the insecticide was cypermethrin (0.01 g/bait station). According to the supplier, the tested device consisting on three components (plastic hook, plastic case and a sponge impregnated with attractant and insecticide) should be renewed every 120 days under natural conditions. Ceranock® male is a specialized wax emulsion formulation commercialized as a tube containing trimedlure (35%) and abamectin (0.5%). This product, was applied as droplets of paste (2 gr) put in a small plastic device attached on each plant at a height of 0.5 m. The gel was applied only once on plants located at the border of each crop.

Two Zucchini and one Cucumber crops were treated while one Zucchini and one Cucumber crops were left as untreated controls. Both treated and untreated crops contained two McPhail traps baited with DAP© and Ceratrap© for *D. ciliatus* monitoring during the experiment.

Morphological identification of *D. ciliatus*

Fruit flies were collected from McPhail® liquid traps and examined using a stereo microscope (EPPO, 2018). Morphological identification was made based on published Keys for fruit flies (White & Elson-Harris, 1992; Drew & Romig, 2013).

Statistical analysis

Levene and Shapiro-wilk test were applied to check the homoscedasticity and normality of the obtained data. The effect of factors 'treatment', 'crop' and 'food attractant' on fruit fly catches was analysed using a Generalized Linear Model (GLM) followed by one-way ANOVA (Duncan test at $P < 0.05$). Statistical analysis was performed using IBM SPSS Statistics for Windows version 21.0 (IBM Corp, 2012).

RESULTS

Morphological identification of *D. ciliatus*

Taxonomy

Adults belonging to the Genus *Dacus* were identified based on published keys for Tephritidae species (White & Elson-Harris, 1992; Drew & Romig, 2013). *Dacus ciliatus*

adults have a pale orange-brown color. Femur of mid leg has brown color. Katatergite and not the anatergite is covered by yellow spot compared to *D. frontalis*. Wings have a brown color with a narrow costal band. The distance between eyes slightly exceed 0.5 mm for *D. ciliatus* males and females.

Effectiveness of attract-and-kill system

Figure 1 indicates that the number of trapped males and females in DAP© baited traps was significantly higher than it recorded in Ceratrap© baited traps for Zucchini and cucumber crops. No adults were captured by Ceratrap© baited traps except for Zucchini treated crop 1 (0.42±0.49 and 0.28±0.69 respectively for males and females) (Figure 1). The interaction between treatment, crop and food attractant significantly influenced the number of captured *D. ciliatus* flies (F=4.48; df=9; p<0.001 and F=2.74; df=9; p=0.009) for males and females respectively). For DAP© baited traps, statistical analysis showed that there is a significant difference between treated and untreated crops for the number of captured males and females ($F_{4, 34}$=4.85; p<0.001 and $F_{4, 34}$=3.24; p=0.02) respectively for males and females). However, for Ceratrap©, there is only significant difference for the number of captured males ($F_{4, 34}$=4.50; p<0.001) and not for females ($F_{4, 34}$=1.00; p=0.42). Furthermore, there is a significant difference between DAP© and Ceratrap © for the number of captured adults in Zucchini crops ($F_{1, 41}$=16.78; p<0.001 and $F_{1, 41}$=17.65; p=0.001 respectively for males and females) and the Cucumber crops ($F_{1, 27}$=19.89; p=0.001 and $F_{1, 27}$=15.13; p=0.001 respectively for males and females).

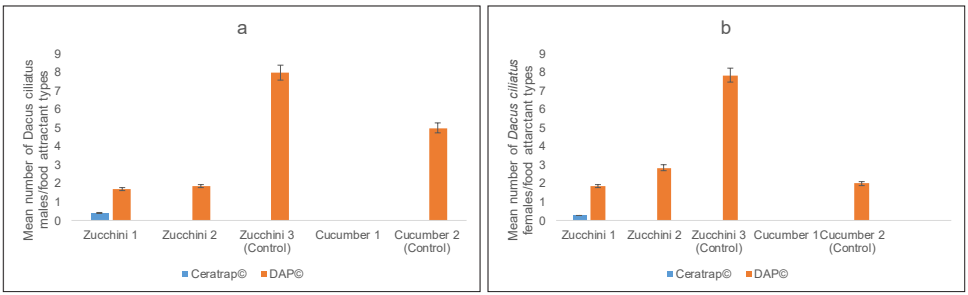

Figure 1. Comparison between two food attractants baited traps (DAP© and Ceratrap©) in treated and untreated crops. a) males, b) females.

DISCUSSION AND CONCLUSIONS

Fruit flies (Diptera: Tephritidae) are classified among the most destructive pests representing a limiting factor for safety food production in the world (Alagarmalai et al, 2009; Deploux & Dequine, 2015; Díaz-Fleischer, Pérez-Staples, Cabrera-Mireles, Montoya, & Liedo, 2017; Dias, Zotti, Montoya, Carvalho, & Nava, 2018). These pests can cause direct damage to fruits and vegetables by decreasing their quality values (Navarro-Llopis et al, 2012; Lasa & Cruz, 2014; Dias et al, 2018). Various factors (e.g. biology, available hosts…) can negatively influence the efficiency of control tactics

undertaken for flies' management (Dias et al, 2018). A correct identification of fruit flies using morphological or/and molecular methods, may represent a basic premise for an efficient and successful pest management strategy (Dias et al, 2018). Here, it has been shown that the distance between compound eyes slightly exceed 0.50 mm for *D. ciliatus* adults which confirm results of Fetoh (2009). Usually, pest prevention measures may represent a primordial step to be taken for a successful management of fruit flies (Aluja, 1999). Traps are used for fly monitoring which may help not only to estimate possible induced damages but also to judge the efficacy of control tools (Enkerlin, Lopez, & Celedonio, 1996; Eliopoulos, 2007). Despite the disadvantages of manufactured traps such as the high cost and time handling (Goldshtein et al, 2017), different trap types are commercialized to monitor fruit flies including *D. ciliatus*, worldwide (Mohammadpour et al, 2017; Shaked et al, 2017; Dias et al, 2018). As example, yellow electronic traps are proved to be attractive to *D. ciliatus* in melon plastic tunnels (Shaked et al, 2017). In the present study, we demonstrated that McPhail® traps filled with DAP© and Ceratrap© as food attractants can attract both *D. ciliatus* males and females. Also, DAP© are significantly more attractive to *D. ciliatus* compared to Ceratrap©. Despite the lack of information regarding the use of attractants and traps for *D. ciliatus* monitoring, it has been shown previously that *D. ciliatus* adults may be captured by yellow sticky traps and Mc-Phail® traps filled with *Torula* as food attractant (Deguine, Lavigne, & Atiama, 2012). Furthermore, this fly can be attracted to volatile compounds released by melon variety (*C. melo* L. cv. reticulates group) (Alagarmalai et al, 2009). Blends consisting in a mixture of four or five identified acetates were the most attractive to this fly with octanyl acetate and (Z)-3-octenyl acetate the main compounds (Alagarmalai et al, 2009).

Liquid and lure traps are tested for their efficacy against fruit flies within monitoring or mass trapping programs (Leblanc, Vargas, & Rubinoff, 2010; Lasa & Cruz, 2014; Hafsi, Abbes, Harbi, & Chermiti, 2019b; Demirel, 2019). The effectiveness of DAP© and Ceratrap© were already tested against a wide range of fruit flies worldwide. In this context, Braham (2013), highlighted the efficacy of DAP© compared to Lysatex® (commercial protein hydrolysate) in terms of trap catches against *Ceratitis capitata* Wiedemann in Tunisian citrus orchard. Various studies indicated that Ceratrap® is more efficient in decreasing fruit flies' population than other food attractants such as Starce® or proteinaceous lures (Lasa & Cruz, 2014; Hafsi et al, 2019a).

Environmental friendly control tools including attract-and-kill technique, are considered as excellent alternatives to chemical insecticides for management of fruit flies (e.g. *C. capitata*, *Anastrepha sp…)* worldwide (Piñero et al, 2009; Ryckewaert et al, 2010; Bouagga et al, 2014; Hafsi et al, 2015; Díaz-Fleischer et al, 2017). Our data indicated that trap catches decreased in Zucchini and cucumber crops where Ceranock© female and male devices were applied compared to untreated ones. Currently, no economic threshold is fixed for *D. ciliatus* management (Deguine et al, 2012). Previously, it has been shown that Nu-lure bait stations having a lifespan of 21 days, were more efficient in decreasing the number of *D. ciliatus* larvae compared to protein hydrolysate bait and insecticide treatments in white gourd crop (Qureshi

& Hussain, 1992). The authors recommended to use the Nu-lure system each three weeks for better control of *D. ciliatus* (Qureshi & Hussain, 1992). The efficacy of Ceranock® bait station was already tested against *C. capitata* in Tunisia (Bouagga et al, 2014; Hafsi et al, 2015). This device has shown effectiveness in decreasing both the number of adults (up to 70%) and fruit damages of peach orchards (Bouagga et al, 2014; Hafsi et al, 2015).

The present study provides useful data for a future application of alternative control methods against *D. ciliatus* in Tunisia. Our results confirmed the efficacy of two tested food attractants (DAP© and Ceratrap©) and attract-and-kill technique (Ceranock®) for *D. ciliatus* control in Tunisia. Ceranock® male and female showed good achievement in reducing the lesser pumpkin fly's population in cucumber and Zucchini crops. Despite the clear potential of attract-and-kill system in decreasing the number of *D. ciliatus* adults, further studies are needed to investigate the risk of this technique towards beneficial insects occurring in the field. Other researches are also required to confirm the optimum timing and duration of the application. As it is difficult, in most of cases, to eradicate an exotic fly once established, attempts for management using other effective control methods are strongly needed for food production safety.

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REFERENCES

Alagarmalai, J., Nestel, D., Dragushich, D., Nemny-Lavy, E., Anshelevich, L., Anat Zada, A., & Soroker, V. (2009). Identification of host attractants for the ethiopian fruit fly, *Dacus ciliatus* Loew. *Journal of Chemical Ecology*, 35, 542-551. https://doi.org/10.1007/s10886-009-9636-2.

Al-Muffti, S.A & Al-Maronsy, G.H. (2018). Record a new species of cucurbit fly *Dacus ciliatus*, loew (Diptera: Tephritidae) in Kurdistan Region, Iraq. *Materials Science and Engineering*, 454, 012168. https://doi.org/10.1088/1757-899X/454/1/012168.

Aluja, M. (1999). Fruit fly (Diptera: Tephritidae) research in Latin America: myths, realities and dreams. *Anais da Sociedade Entomológica do Brasil,* 28, 565-594. https://doi.org/10.1590/S0301-80591999000400001.

Arghand, B. (1979). Introduction on *Dacus sp* and preliminary examination in the hormozgan province. *Applied Entomology and Phytopathology*, 51, 3-9.

Bouagga, S., Hassan, N., Kamel Ben Halima, M., Jammazi, A., Djelouah, K., & Al-Zaidi, S. (2014). Evaluation of an "attract and kill" system to combat *ceratitis capitata* on peach trees in Tunisia. *Journal of Agricultural Science and Technology*, 4, 612-619.

Braham, M. (2013). Trapping adults of the Medfly *Ceratitis capitata* and non-target insects: comparison of low-cost traps and lures. *Tunisian Journal of Plant Protection*, 8(2), 107-118.

Çalışkan Keçe, A.F., Özbek Çatal, B., & Ulusoy, M.R. (2019). A new invasive species in Turkey: *Dacus ciliatus* Loew, 1862 (Diptera: Tephritidae). *Türkiye Entomologi Dergisi*, 43(1), 25-30. http://dx.doi.org/10.16970/entoted.474420.

Deguine, J.P., Lavigne, A., & Atiama, M. (2012). Dynamiques des populations de Mouches des légumes durant l'hiver austral à La Réunion. *Cahiers Agricultures*, 21, 395-403. https://doi.org/10.1684/agr.2012.0596.

Delpoux, C. & Deguine, J.P. (2015). Implementing a Spinosad-Based Local Bait Station to Control *Bactrocera cucurbitae* (Diptera: Tephritidae) in High Rainfall Areas of Reunion Island. *Journal of Insect Science,* 15, 1-6. https://doi.org/10.1093/jisesa/ieu177.

Demirel, N. (2019). Efficacy of various attractants to Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) on persimmon fruits in Turkey. *Fresenius Environmental Bulletin*, 28(7), 5390-5397.

Dias, N.P., Zotti, M.J., Montoya, P., Carvalho, I.R., & Nava, D.E. (2018). Fruit fly management research: A systematic review of monitoring and control tactics in the world. *Crop Protection*, 112,187-200. https://doi.org/10.1016/j.cropro.2018.05.019.

Díaz-Fleischer, F., Pérez-Staples, D., Cabrera-Mireles, H., Montoya, P., & Liedo, P. (2017). Novel insecticides and bait stations for the control of *Anastrepha* fruit flies in mango orchards. *Journal of Pest Science*, 90(3), 865-873. https://doi.org/10.1007/s10340-017-0834-3.

Drew, R.A. & Romig, M.C. (2013). Tropical fruit flies (Tephritidae Dacinae) of South-East Asia: Indomalaya to North-West Australasia. *CABI*.

Eliopoulos, P.A. (2007). Evaluation of commercial traps of various designs for capturing the olive fruit fly *Bactrocera oleae* (Diptera: Tephritidae). *International Journal of Pest Management*, 53, 245-252. https://doi.org/10.1080/09670870701419000.

El-Sayed, A.M., Suckling, D.M., Byers, J.A., Jang, E.B., & Wearing, C.H. (2009). Potential of "Lure and Kill" in Long-Term Pest Management and Eradication of Invasive Species. *Journal of Economic Entomology*, 102(3), 815-835. https://doi.org/10.1603/029.102.0301.

Enkerlin, W., Lopez, L., & Celedonio, H. (1996). Increased accuracy in discrimination between captured wild unmarked and released dye-marked adults in fruit fly (Diptera: Tephritidae) sterile released programs. *Journal of Economic Entomology*, 89, 946-949. https://doi.org/10.1093/jee/89.4.946.

EPPO/CABI. (2006). *Dacus* species. In Smith IM, McNamara DG, Scott PR, Holderness M (Eds.) Quarantine Pests for Europe 2nd edn. Wallingford, CAB International. pp 14.

Fetoh, B.E.S.A. (2009). Molecular, morphological and histological differentiation between the lesser pumpkin fly, *Dacus ciliatus* (Loew) and the greater pumpkin fly, *Dacus frontalis* Becker. *Egyptian Journal of Genetics and Cytology*, 38, 285-293.

Goldshtein, E., Cohen, Y., Hetzroni, A., Gazit, Y., Timar, D., Rosenfeld, L., Grinshpon, Y., Hoffman, A., & Mizrach, A. (2017). Development of an automatic monitoring trap for Mediterranean fruit fly (*Ceratitis capitata*) to optimize control applications frequency. *Computers and Electronics in Agriculture*, 139, 115-125. https://doi.org/10.1016/j.compag.2017.04.022.

Hafsi, A., Abbes, K., Harbi, A., & Chermiti, B. (2019b). Field efficacy of commercial food attractants for *Ceratitis capitata* (Diptera: Tephritidae) mass trapping and their impacts on non-target organisms in peach orchards. *Crop Protection*, 128,104989. https://doi.org/10.1016/j.cropro.2019.104989.

Hafsi, A., Abbes, K., Harbi, A., Duyck, P.F., & Chermiti, B. (2015). Attract-and-kill systems efficiency against *Ceratitis capitata* (Diptera: Tephritidae) and effects on non-target insects in peach orchards. *Journal of Applied Entomology*, 140(1-2), 1-9. https://doi.org/10.1111/jen.12259.

Hafsi, A., Rahmouni, R., Ben Othman, S., Abbes, K., Elimem, M., & Chermiti, B. (2019a). Mass trapping and bait station techniques as alternative methods for IPM of *Ceratitis capitata* Wiedmann (Diptera: Tephritidae) in citrus orchards. *Orient Insects* 54(2), 285-292. https://doi.org/10.1080/00305316.2019.1623133.

Hussein, M.A., El-Wakeil, N., & El-Sebai, T. (2006). Susceptibility of melon fruit fly, *Dacus ciliatus*, to entomopathogenic nematodes (Rhabditida) and to insecticides. *International Journal of Nematology*, 16(1),13-18.

IBM Crop. (2012). IBM SPSS statistics for windows, version 21.0. Armonk, USA, IBM Crop.

Kamali, S., Karimi, J., Hosseini, M., Campos-Herrera, R., & Duncan, L.W. (2013). Biocontrol potential of the entomopathogenic nematodes *Heterorhabditis bacteriophora* and *Steinernema carpocapsae* on cucurbit fly, *Dacus ciliatus* (Diptera: Tephritidae). *Biocontrol Science and Technology*, 23(11), 1307-1323. https://doi.org/10.1080/09583157.2013.835790.

Lasa, R. & Cruz, A. (2014). Efficacy of new commercial traps and the lure Ceratrap against *Anastrepha obliqua* (Diptera: Tephritidae). *Florida Entomologist*, 97, 1369-1377. https://doi.org/10.1653/024.097.0411.

Leblanc, L., Vargas, R.I., & Rubinoff, D. (2010). Attraction of *Ceratitis capitata* (Diptera: Tephritidae) and endemic and introduced non target insects to BioLure bait and its individual components in Hawaii. *Environmental Entomology*, 39(3), 989-998. http://dx.doi.org/10.1603/EN09287.

Mohammadpour, K., Faghih, A.A., & Araghi, M.P. (2017). Population fluctuations of melon fly, *Dacus ciliatus* Loew (Dip.: Tephritidae) using Dome traps. Proceedings of the 2nd Iranian International Congress of Entomology. IICE, Karaj, pp1.

Navarro-Llopis, V., Primo, J., & Vacas, S. (2012). Efficacy of attract-and-kill devices for the control of *Ceratitis capitata*. *Pest Managment Science*, 69(4), 478-482. http://dx.doi.org/10.1002/ps.3393.

Piñero, J.C., Mau, R.F.L., McQuate, G.T., & Vargas, R.I. (2009). Novel bait stations for attract-and-kill of pestiferous fruit flies. *Entomologia Experimentalis and Applicata*, 133, 208-216. http://dx.doi.org/10.1111/j.1570-7458.2009.00912.x.

Qureshi, Z.A. & Hussain, T. (1992). Efficacy of Nu-lure and protein hydrolysate baits in controlling Ethiopian melon fly *Dacus ciliatus*. *Pakistan Journal of Agricultural Research*, 13(2), 150-154.

Rempoulakis, P., Nemny-Lavy, E., Castro, R., & Nestel, D. (2016). Mating behaviour of *Dacus ciliatus* (Loew) (Diptera:Tephritidae): comparisons between a laboratory and a wild population. *Journal of Applied Entomology*, 140, 250-260. http://dx.doi.org/10.1111/jen.12252.

Ryckewaert, P., Deguine, J.P., Brévault, T., & Vayssières, J.F. (2010). Fruit flies (Diptera: Tephritidae) on vegetable crops in Reunion Island (Indian Ocean): state of knowledge, control methods and prospects for management. *Fruits*, 65, 113-130. http://dx.doi.org/10.1051/fruits/20010006.

Shaked, B., Amore, A., Ioannou, C., Valdés, F., Alorda, B., Papanastasiou, S., Goldshtein, E., Shenderey, C., Leza, M., Pontikakos, C., Perdikis, D., Tsiligiridis, T., Tabilio, M.R., Sciarretta, A., Barceló, C., Athanassiou, C., Miranda, M.A., Alchanatis, V., Papadopoulos, N., & Nestel, D. (2017). Electronic traps for detection and population monitoring of adult fruit flies (Diptera: Tephritidae). *Journal of Applied Entomology*, 142(1-2), 43-51. http://dx.doi.org/10.1111/jen.12422.

White, I.M. & Elson-Harris, M.M. (1992). *Fruit flies of economic significance: their identification and bionomics*. CAB International, Wallingford UK.