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Attractiveness of *Melaleuca leucadendra* Oil, Hydrolatee and Leaf Powder *on Bactrocera dorsalis* Fruit Flies in the Niayes, Senegal

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Abstract

The cultivation of the mango *Mangifera indica* L. occupies an important place in the national economy both in terms of foreign exchange income and jobs filled. However, mango recorded huge losses due to fruit flies, including *Bactrocera dorsalis*. To control this quarantine pest, this study contributes to the implementation of resilient and agro-ecological control methods. To this end, the attractiveness of extracts of the plant *Melaleuca leucadendra* (essential oil, hydrolatee, powder and paste) has been studied on fruit flies, in order to determine their effectiveness and duration of action. The hydrosol was more attractive than the essential oil, leaf powder and paste. In terms of persistence, the essential oil and powder are active for four weeks in the orchards, while the hydrosol must be renewed after two weeks with evaporation. Hydrolatee is more attractive with a peak of 906 flies/day/trap followed by essential oil which is at 251 flies/day/trap, then powder 108flies/day/trap and finally paste with 47 flies/day/trap.

Keywords

Bactrocera dorsalis, Plant Extracts, *Melaleuca leucadendra*

1. Introduction

Agroecology is now widely recognised as a viable and sustainable agricultural pro-

duction method, offering an alternative to intensive agriculture [1]. The fundamental principles of agroecology focus on crop protection, with an emphasis on preventive measures such as stopping the use of pesticides, implementing prophylactic measures, managing soil health and diversifying vegetation. This approach aims to bring about positive and sustainable changes in agri-food systems, with the ultimate goal of eliminating pesticides and solving the major agronomic, food, socio-economic, environmental and health challenges of the 21st century [2]. Agro-ecological crop protection is an ambitious scientific field, requiring a transition towards an integrative approach that goes beyond the traditional model of intensive agriculture [3]. This is the context for this study, which aims to develop a set of technologies for the creation of a biopesticide against the oriental fruit fly, *Bactrocera dorsalis*, which is particularly harmful to mango cultivation, which is widespread in West Africa. Fruit flies belonging to the Tephritidae family have been a factor in major crop losses in the horticultural sector in many countries where they are present [4]. The fruit and vegetable industry in West Africa is growing rapidly and is a major driver of job creation and poverty reduction. This industry offers many employment opportunities in rural areas during the dry season and generates substantial income, particularly for young people and women who market the produce [5]. Mango, particularly the *Mangifera indica* L. variety, is a major export fruit crop in West Africa, especially Senegal. In Senegal, mango is particularly threatened by *B. dorsalis*, which is the main threat to this fruit crop. Essential to the livelihoods of many producers. In addition to this species, mangoes are also attacked by various other types of fruit fly [6] [7]. As such, this investigation could form the basis of an agroecological fruit fly management strategy. In general, it contributes to improving the technological package for agro-ecological control of these pests and reducing mango production losses. The aim of this work is to assess the attractiveness of *M. leucadendra* plant extracts (essential oil, hydrolatee, powder and paste) on fruit fly populations. It also aims to determine the duration of efficacy of these by-products derived from the forest tree *Meulaleuca leucadendra*.

2. Materials and Methods

2.1. Equipment

The first trial developed from 11/06/2022 to 7/10/2022 in Notto Gouye Diama using 6 McPhail traps including DDVP (Dichlorvos) an organophosphate insecticide known for its broad effectiveness against pests. This first trial included empty McPhail trap without lure (T0), and other 5 McPhail traps bearing lures like 3 ml oil essential of *Melaleuca leucadendra* (T1), 10 g of leaf powder of *M. leucadendra* (T2), 20 g of leaf powder of *M. leucadendra* (T3), 30 g of leaf powder of *M. leucadendra* (T4) and Methyl eugenol commercial tablet as positive control (T5). The 6 treaments of this trial (T0, T1, T2, T3, T4 and T5) were replicated in four randomised blocks.

The second trial was set up in Sinthiou Dara. The trapping equipment consisted

of modified 10-litres empty bottles, which were used as traps because of their accessibility and availability. Extracted from the leaves, the essential oil has a chemical composition of 99.5% methyl eugenol. The essential oil used was obtained by hydrodistillation of these leaves and it was analyzed by GC/FID and GC/MS [8]. The work done by Sambou [9] has shown that the 0.5 ml and 1ml of essential oil of *M. leucadendra* give satisfactory results in terms of attractiveness to fruit fly. Similarly, Mendy and Diallo [8] have shown that 3 ml of this oil per trap could be an optimal dose for attractiveness to *B. dorsalis*. The powder is obtained by grinding the leaves using a mill. Following previous work in the dissertation, a weight of 2 g was used, giving considerable results [9]. Leaves of *Ocimum americanum*, used for several years to control *B. dorsalis*, contain 77% methyl eugenol in their essential oil, as revealed by our study [9]. *Melaleuca leucadendra* used in Senegal to fight soil salinity was reported as a plant which is rich in methyleugenol [8], a compound known for its effectiveness in controlling *B. dorsalis* for this trial, a weight of 20 g/trap was used. Hydrolatee is a residual aromatic water obtained after separating the product of distillation, which is the essential oil. It is much less concentrated in active ingredients. A dose of 500 ml/trap was used. The paste is made up of *Melaleuca leucadendra* leaf powder (20 g) and water (**Figure 1**).

Figure 1. Essential oil, powder, hydrolatee and trap with hydrolatee.

2.2. Experimental Set-Up

In this randomised set-up, orchards of at least 150 m × 150 m are used. 3 water bottle traps were used for each treatment. The distance between the traps was 100 m to limit cross-actions between the products. The products will be renewed every month for 3 months. The protocol for studying the attractiveness of *Melaleuca leucadendra* plant products, including Essential Oil (3 ml/trap), Leaf Powder (20 g/trap), Hydrolatee (500 ml/trap) and Leaf Powder Paste (20 g powder + water/trap) was implemented on Saturday 08/07/2023 at Sinthiou Dara in the Niayes area. The orchards were grouped into blocks with different characteristics (**Table 1**). Each of these four products was considered as a treatment in a one-hectare block arrangement. A random system was placed in 7 orchards of at least 1 ha where 4 traps were placed at a distance of 100 m each in the form of a square or

diamond. Twelve replications were set up with 4 traps Essential Oil (3 ml/trap), Powder (20 g/trap), Hydrolatee (500 ml/trap) and Paste (20 g powder + water). (Figure 2).

Table 1. Dispersed experimental blocks.

Orchard	Locality	GPS coordinates	Area	Number of replications
Orchard 1	Keur Issa Ka	N 14˚48'43" O 17˚7'45";	4 ha	2 replications
Orchard 2	Santhie Dara	N 14˚48'40", O 17˚7'49"	4 ha	2 replications
Orchard 3	Santhie Dara	N 14˚48'46", O 17˚7'15"	1.5 ha	1 replications
Orchard 4	Santhie Dara	N 14˚48'40", O 17˚7'49"	6 ha	3 replications
Orchard 5	Santhie Dara	N 14˚48'36", O 17˚7'30"	4 ha	1 replications
Orchard 6	Santhie Dara	N 14˚48'36", O 17˚7'30"	1.2 ha	1 replications
Orchard 7	Santhie Dara	N 14˚48'35", O 17˚7'59"	4 ha	2 replications

Figure 2. Steam extractor.

2.3. Parameters Measured

The chemical composition of the essential oil of *M. leucadendra* was supplied by the laboratory appointed for this purpose. The number of flies caught per trap per day (FTD) was weekly registrated at the same specific time. The flies collected are identified and counted by species. The data collected will be subjected to analyses of variance and Fisher's test or Friedman test for paired samples, will be used for comparisons of catch averages using R software and Xlstat.

3. Results

3.1. Specific Richness of Tephritidae Caught in Sinthiou Dara and Notto Gouye Diama

The trial installed in Notto Gouye Diama from 11/06/2022 to 07/10/2022 recorded 162,397 flies and *Bactrocera dorsalis* was overwhelmingly dominant, accounting for more than 99% of the total (Table 2). Among the ceratites, *Ceratitis cosyra* was the most significant species with 827 individuals.

The trial installed at the Sinthiou Dara site during the period 08/07/2023 to 29/09/2023 enabled us to capture 1,030,210 fruit flies in total. These flies belonged to different species, including a single species of the genus *Bactrocera* and 2 species of the genus *Ceratitis*. These were *Bactrocera dorsalis*, *Ceratitis bremii* and *C. cosyra*. Table 2 below shows the numbers of flies caught per species.

Table 2. Breakdown of numbers by species of Tephritidae caught.

Species	Sinthiou Dara	Notto Gouye Diama
Bactrocera dorsalis	99.95%	99.49%
Ceratitis bremii	0.04%	0%
Ceratitis cosyra	0.01%	0.51%

3.2. Attractiveness of *Melaleuca leucadendra* Extracts versus Synthetic Methyl Eugenol in Notto Gouye Diama

The first trial included empty McPhail trap without lure (T0), and other 5 McPhail traps bearing lures like 3 ml oil essential of *Melaleuca leucadendra* (T1), 10 g of leaf powder of *M. leucadendra* (T2), 20 g of leaf powder of *M. leucadendra* (T3), 30 g of leaf powder of *M. leucadendra* (T4) and Methyl eugenol commercial tablet as positive control (T5). The number of males caught was significantly different between treatments ($P < 0.005$) and was statistically higher in traps baited with essential oil 46 flies/trap/day followed by synthetic methyl eugenol 31 flies/trap/day then leaf powder 20 g and 30 g which had 14 flies/trap/day and 10 g which had 9 flies/trap/day (Figure 3).

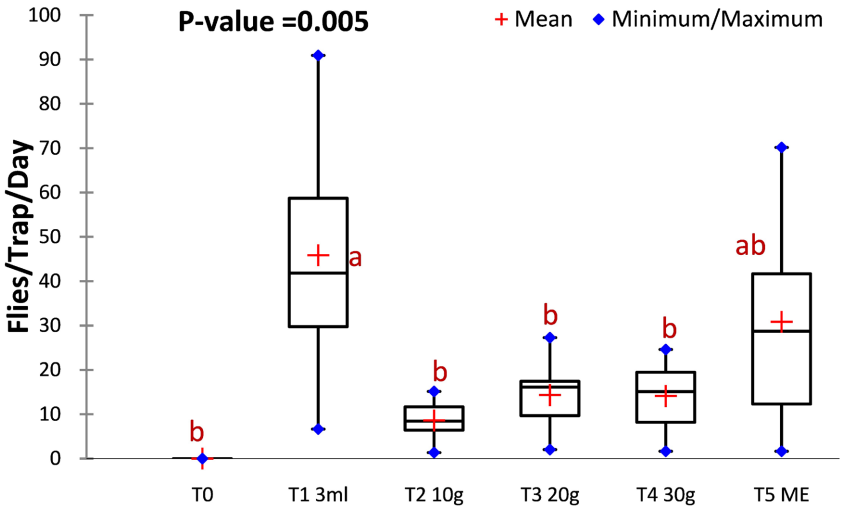

Figure 3. Fly catches using the plant extract attractants in Notto Gouye Diama.

The dynamics of trap captures by these compared attractants were followed from 11/06/2022 to 07/10/2022 at Notto Gouye Diama. The Friedman's test attested a significant difference between the fluit fly yielded by the different attractants with $Q_{(Observed\ value)} = 75.99$; $Q_{(Critical\ value)} = 11.07$; DF = 5; $p\text{-value}_{(Two\text{-}tailed)} <$

0.0001. The Multiple pairwise comparisons using Nemenyi's procedure/Two-tailed test presented the rank mentionned with the different letters as shown in Figure 4 and Table 3.

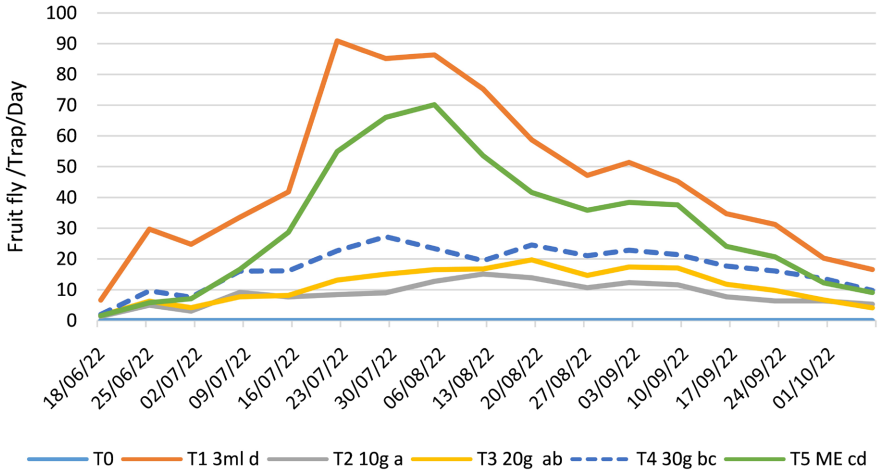

Figure 4. Dynamics of *Bactrocera dorsalis* attracted by *Melaleuca leucadendra* extracts in Notto Gouye Diama.

Table 3. P-values from Nemenyi's procedure/two-tailed test.

	T0	T1	T2	T3	T4	T5
T0	1					
T1	<0.0001	1				
T2	0.504	<0.0001	1			
T3	0.001	0.002	0.197	1		
T4	0.000	0.005	0.131	1.000	1	
T5	<0.0001	0.238	0.002	0.626	0.742	1

3.3. Fruit Fly Captures Dynamics in Sinthiou Dara

The essential oil, hydrolatee, powder and paste are extracts from the *Melaleuca leucadendra* plant. Their attractiveness, presented in Figure 5, shows a significant difference between the different treatments (Figure 5 and Table 4). The hydrolatee was the most attractive with a peak of 906 flies/day/trap, followed by the essential oil at 251 flies/day/trap, then the powder at 108 flies/day/trap and

Table 4. Matrix of p-values from pairwise multiple comparisons of attractants using the Nemenyi procedure/two-tailed test.

	HE	HYD500ML	P20G	PASTE
HE	1			
HYD500ML	0.485	1		
P20G	0.229	0.005	1	
PATE	0.000	<0.0001	0.168	1

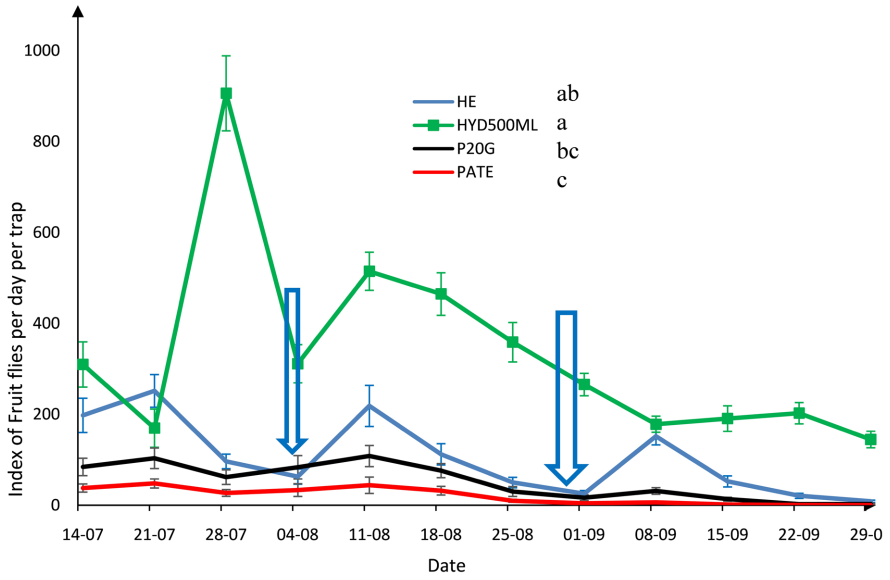

Figure 5. Dynamics of *Bactrocera dorsalis* attracted by *Melaleuca leucadendra* extracts including Hydrolatee.

finally the paste at 47 flies/day/trap. The dynamics of infestations revealed a significant variation in the daily catch index as a function of time and the attractant used, with a Friedman test concluding with values of $Q_{(\text{Observed value})} = 32.70$; $Q_{(\text{Critical value})} = 7.81$; DDL = 3 with a p-value$_{(\text{two-tailed})} < 0.0001$.

3.4. Variability of Catches between Orchards in Sinthiou Dara

Regression of the catch variable on the Orchard and Attractiveness factors revealed a very strong correlation with r = 0.953. However, the orchards monitored showed relatively similar catch levels. However, the attractants used in each orchard had different catch rates depending on their type. In fact, there was no difference in catches between orchards for values of ddl = 3; SCE = 376913.32; F = 0.705 and Pr > F = 0.556 (**Figure 6**).

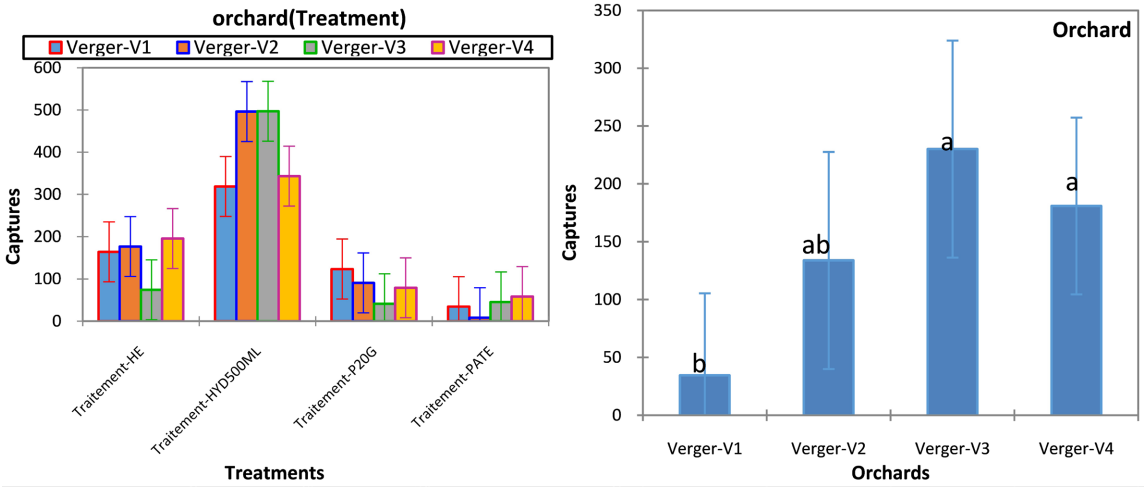

Figure 6. Variation of trap captures by treatment and orchard.

4. Discussion

The number of *Bactrocera dorsalis* captured in the Niayes area is greater than that of *Ceratitis*. This could be explained by the pheromone used, which is specific to *Bactrocera dorsalis*—essential oil, hydrolatee, powder and paste of *Melaleuca leucadendra* containing methyl eugenol. Males of *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) are strongly attracted to Methyl Eugenol (ME) (1,2-dimethoxy-4-(2-propenyl) benzene), a phenylpropanoid compound present in many plant species. Feeding ME is known to enhance the competitiveness of *B. dorsalis* males during mating [10]. A number of specimens belonging to different species of *Ceratitis bremii* and *C. cosyra* were collected in methyl eugenol traps. These results do not corroborate those of Ndiaye *et al.* [11]-[13] who obtained a greater diversity of flies in the Niayes area *Bactrocera dorsalis*, *Ceratitis bremii*, *C. capitata*, *C. cosyra*, *C. ditissima* and *C. silvestrii*. In addition to these species, Dieng *et al.* [6] [7] mentioned the presence of *C. ditissima*, *Dacus longistilus* and *Zeugodacus cucurbitae* in the Niayes. However, these earlier studies used more attractants such as methyl eugenol, terpinyl acetate, Cuelure and trimedlure, whereas our work used only derivatives of the *Melaleuca leucadendra* plant containing only methyl eugenol. This could explain the low specific diversity of Tephritidae captured.

Two derivatives (powder and essential oil) of the *Melaleuca leucadendra* plant were compared with synthetic methyl eugenol, with the essential oil predominating, followed by synthetic methyl eugenol and then leaf powder. Intakes of *Melaleuca leucadendra* powder increased in proportion to the quantity used, and persisted for 4 weeks. The phenolic compounds contained in this powder explain its attraction for *B. dorsalis*. The release of attractive substances from *Melaleuca leucadendra* powder is similar to that of the methyl eugenol tablet. However, these substances appear to be released more rapidly than in the case of the methyl derivative, resulting in a more rapid reduction in the catch with the powder. This difference is not significant compared to catches made with quantities of 20 g to 30 g. The results obtained with *Melaleuca leucadendra* leaf powder confirm those of Ndiaye *et al.* [11] regarding the attraction of *B. dorsalis* males to nutmeg powder. Analysis of weekly catches according to attractants reveals a highly significant difference between catches made with powder, essential oil and synthetic methyl eugenol. However, there was a difference in the persistence of the attractants, with *Melaleuca leucadendra* powder lasting 4 weeks and nutmeg powder lasting only 15 days. Similar results to those obtained in Senegal were observed in Côte d'Ivoire, where *Ocimum basilicum*, an aromatic plant containing methyl eugenol in its leaves, proved to be an attractant for *Bactrocera dorsalis*. In this study, a basil powder formulation gave a persistence of 28 days at a weight of 10 g [14]. The effectiveness of different baits such as hydrolatee, essential oil, powder and paste revealed significant variations in their attractiveness. In particular, hydrolatee showed twice the attractiveness of essential oil, five times that of powder, and ten times that of paste, with a persistence of one week. These results corroborate the findings of previous studies [14], where basil macerate was observed to be capable of attract-

ing and capturing *B. dorsalis*, as was methyl eugenol in mango orchards, at a rate of 250 ml with a persistence of one week. Waters of distillation and must extracts of *M. bracteata* and *Ocimum sp*. also retained their effectiveness for a week in the orchards, at a rate of 4 ml. It should be noted that the essential oil of *Ocimum sp*. contains 73.5% methyl eugenol, while the distillation water of *Ocimum sp*. contains only 0.43% [9] [15]. This variation in methyl eugenol concentration influenced the duration of trapping efficiency, as indicated by A. Kardinan *et al*. [16]. Methyl eugenol mixed with distilled water and must extract evaporates easily due to their aqueous base. In addition, it is noted that methyl eugenol is not affected by photolysis of the UV spectrum in the atmosphere, due to the absence of absorption in the environmental UV spectrum [17]. Regarding biodegradation, empirical data from a study on methyl eugenol showed an ultimate biodegradation of around 90% over 28 days using an activated sludge inoculum [18]. However, differences in results were observed in terms of attractiveness between Senegal and Indonesia. In guava and carambola orchards, the essential oils of *M. bracteata* and *Ocimum sp*. trapped significantly more fruit flies than the distillation water and must extracts of the two plants [19]. And in terms of persistence, studies conducted by A. Kardinan *et al*. [16] showed a persistence of 5 weeks in mango orchards with the essential oil of *Ocimum sp*. whereas the essential oil of *Melaleuca leucadendra* had a persistence of 4 weeks in mango orchards. Works carried out by Vayssières, Korie, and Ayegnon [20] showed that the fluctuation of the *B. dorsalis* population between orchards is due to the presence of wild hosts near the orchard and/or dispersed in the savannah.

5. Conclusion

The study carried out in the Niayes area revealed that *M. leucadendra* oil attracts *Bactrocera dorsalis*, *Ceratitis bremii and Ceratitis cosyra* species, with *Bactrocera dorsalis* predominating. Essential oil of *Melaleuca leucadendra* ensures its attractiveness such as its derivatives (hydrolatee, powder and paste) with the revelation of the hydrolatee. The essential oil and powder have a persistence of 4 weeks in orchards. Their attractive performance shows that they can replace synthetic methyl eugenol in the formulation of a bio-para-pheromone.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] FAO (2019) The Ten Elements of Agroecology, Guiding the Transition to Sustainable

Food and Agricultural Systems. Forty-First Session.

[2] Deguine, J., Aubertot, J., Bellon, S., Côte, F., Lauri, P., Lescourret, F., *et al.* (2023) Agroecological crop protection for sustainable agriculture. *Advances in Agronomy*, **178**, 1-59. https://doi.org/10.1016/bs.agron.2022.11.002

[3] Meynard, J.M. (2012) La reconception est en marche! Conclusion au Colloque «Vers des systèmes de culture innovants et performants: De la théorie à la pratique pour concevoir, piloter, évaluer, conseiller et former». *Innovations agronomiques*, **20**, 143-153.

[4] Goergen, G., Vayssières, J., Gnanvossou, D. and Tindo, M. (2011) *Bactrocera invadens* (Diptera: Tephritidae), a New Invasive Fruit Fly Pest for the Afrotropical Region: Host Plant Range and Distribution in West and Central Africa. *Environmental Entomology*, **40**, 844-854. https://doi.org/10.1603/en11017

[5] FASO, Burkina, et Scientifique et de l'Innovation (2018) Efficacité des extraits de plantes en traitement de la mangue de variété keïtt contre les agents fongiques responsables de la pourriture du fruit.

[6] Dieng, E.O., Ndiaye, S., Faye, P.D., Balayara, A., Badji, K. and Sembéne, P.M. (2019) New Inventory of the Diversity and Seasonal Abundance of Tephritid Fruit Fly Species on Mango Orchards in Senegal. *Journal of Entomology and Zoology Studies*, **7**, 975-986.

[7] Dieng, E.H.O., Ndiaye, S., Balayara, A., Faye, P.D., Coly, E.V. and Sembène, P.M. (2020) Parasitoids of Fruit Flies Diptera: Tephritidae) and Their Distribution along Mango Production Zones in Senegal. *Pest Management in Horticultural Ecosystems*, **26**, 123-132. https://doi.org/10.5958.0974/4541.2020.00001.6

[8] Diallo, A., Tine, Y., Sène, M., Diagne, M., Diop, A., Ngom, S., *et al.* (2022) The Essential Oil of *Melaleuca leucadendra* L. (Myrtaceae) from Fatick (Senegal) as a Source of Methyleugenol. Composition, Antibacterial and Anti-Inflammatory Activities. *Journal of Essential Oil Research*, **34**, 322-328. https://doi.org/10.1080/10412905.2022.2067254

[9] Tine, Y., Sinzogan, A.A.C., Ndiaye, O., Sambou, C., Diallo, A., Mbenga, I., *et al.* (2024) The Essential Oil of *Ocimum americanum* from Senegal and Gambia as a Source of Methyleugenol for the Control of *Bactrocera dorsalis*, Fruit Fly. *Journal of Agricultural Chemistry and Environment*, **13**, 133-141. https://doi.org/10.4236/jacen.2024.131009

[10] Haq, I.u., Cáceres, C., Meza, J.S., Hendrichs, J. and Vreysen, M.J.B. (2018) Different Methods of Methyl Eugenol Application Enhance the Mating Success of Male Oriental Fruit Fly (Dipera: Tephritidae). *Scientific Reports*, **8**, Article No. 6033. https://doi.org/10.1038/s41598-018-24518-5

[11] Ndiaye, S., Diédhiou, P.M., Ndiaye, O., Rey, Y., Mbaye, N., Ballayéra, A. and Touré, T. (2008) Dynamique des populations, tests d'attractivité, de contrôle dans des vergers de la zone de Niayes (06-11/2008). ENSA—PCE USAID & col, 31 p. https://doi.org/10.13140/RG.2.1.4942.7920

[12] Ndiaye, O. (2009) Plantes hôtes et foyers d'infestation des mouches des fruits mémoire agronomie et protection des cultures. ENSA, 74.

[13] Ndiaye, O., Vayssieres, J., Yves Rey, J., Ndiaye, S., Diedhiou, P.M., Ba, C.T., *et al.* (2012) Seasonality and Range of Fruit Fly (Diptera: Tephritidae) Host Plants in Orchards in Niayes and the Thiès Plateau (Senegal). *Fruits*, **67**, 311-331. https://doi.org/10.1051/fruits/2012024

[14] N'Dépo, O.R., Tano, D.K.C., Hala, N., Adopo, N.A. and Kouassi, K.P. (2020) Piégeage des Mouches des Fruits (Diptera: Tephritidae) À Base D'extraits de Ocimum Basilicum

L. (Lamiaceae): Cas de *Bactrocera dorsalis*, Principal Ravageur de Mangues en Côte d'Ivoire. *European Scientific Journal ESJ*, **16**, 458-471. https://doi.org/10.19044/esj.2020.v16n3p458

[15] Tine, Y., Diop, A., Diatta, W., Desjobert, J., Boye, C.S.B., Costa, J., *et al.* (2016) Chemical Diversity and Antimicrobial Activity of Volatile Compounds from *Zanthoxylum zanthoxyloides* Lam. According to Compound Classes, Plant Organs and Senegalese Sample Locations. *Chemistry & Biodiversity*, **14**, e1600125. https://doi.org/10.1002/cbdv.201600125

[16] Kardinan, A., Bintoro, M.H., Syakir, M. and Amin, A.A. (2020) Penggunaan selasih dalam pengendalian hama lalat buah pada mangga. *Jurnal Penelitian Tanaman Industri*, **15**, Article 101. https://doi.org/10.21082/jlittri.v15n3.2009.101-109

[17] Meylan, W.M. and Howard, P.H. (1993) Computer Estimation of the Atmospheric Gas-Phase Reaction Rate of Organic Compounds with Hydroxyl Radicals and Ozone. *Chemosphere*, **26**, 2293-2299. https://doi.org/10.1016/0045-6535(93)90355-9

[18] Wiegand, T., Wax, P., Smith, E., Hart, K. and Brent, J. (2013) The Toxicology Investigators Consortium Case Registry—The 2012 Experience. *Journal of Medical Toxicology*, **9**, 380-404. https://doi.org/10.1007/s13181-013-0352-5

[19] Kardinan, A.K. and Hidayat, P. (2013) Potency of *Melaleuca bracteata* and *Ocimum* sp. Leaf Extracts as Fruit Fly (*Bactrocera dorsalis* Complex) Attractants in Guava and Star Fruit Orchards in Bogor, West Java, Indonesia. *Journal of Developments in Sustainable Agriculture*, **8**, 79-84.

[20] Vayssières, J., Korie, S. and Ayegnon, D. (2009) Correlation of Fruit Fly (Diptera Tephritidae) Infestation of Major Mango Cultivars in Borgou (Benin) with Abiotic and Biotic Factors and Assessment of Damage. *Crop Protection*, **28**, 477-488. https://doi.org/10.1016/j.cropro.2009.01.010