

## Economic relevance and adoption of monitoring and management of the fruit fly in citrus orchards of western Santa Catarina

*Relevância econômica e adoção do monitoramento e manejo da mosca-das-frutas em pomares de citros do oeste catarinense*

**Thiago Marchi**<sup>1</sup> \*(ORCID 0000-0001-8418-7703), **Rodolfo Vargas Castilhos**<sup>2</sup> (ORCID 0000-0002-0521-5727), **Ivan Tormem**<sup>2</sup> (ORCID 0009-0008-0894-7203), **Mariangela Pirotti**<sup>3</sup> (ORCID 0009-0008-0641-207X), **Eduardo Cesar Brugnara**<sup>2</sup> (ORCID 0000-0001-9894-2714), **Rafael Roveri Sabião**<sup>2</sup> (ORCID 0000-0003-1910-4064)

<sup>1</sup>Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina, Lajeado Grande, SC, Brasil. \* Author for correspondence: thiagomarchi@epagri.sc.gov.br

<sup>2</sup>Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina, Chapecó, SC, Brasil

<sup>3</sup>Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina, Lacerdópolis, SC, Brasil

Submission: 14/07/2022 | Acceptance: 12/09/2022

### ABSTRACT

The west of Santa Catarina is the main citrus producing region in the state. The objective of this work was to carry out a survey about the citriculture economic relevance and the monitoring and management of fruit flies by citrus growers in the west of Santa Catarina. A questionnaire with 13 questions was applied *in loco* to 58 citrus growers and the responses were organized for results analysis. In the west of Santa Catarina, for most of the respondents (67.8%), the citriculture is a complementary activity of another main activities practiced in the farm. Most citrus growers (91.38%) consider the fruit fly one of the main phytosanitary problems of the crop and only 12.07% report a low level of incidence of this pest in their orchards. However, most farmers do not monitor the insect (41.4%) or are unaware of the subject (13.8%). Of those who monitor, 56.25% use traps, while 43.75% monitor by visual observation of the fruits. Chemical control is carried out by almost half of citrus growers, erroneously based on the presence of fallen fruit or even by calendar applications. These presented data are worrying and reveal the negligence of citrus growers with the practice of monitoring this important pest.

**KEYWORDS:** *Anastrepha fraterculus*; orange; tangerine; integrated pest management.

### RESUMO

A mesorregião do Oeste catarinense é a principal região produtora de citros do estado. O objetivo deste trabalho foi realizar um levantamento acerca da relevância econômica da atividade citrícola e do monitoramento e manejo de mosca-das-frutas adotado pelos citricultores do oeste catarinense. Um questionário com 13 perguntas foi aplicado *in loco* a 58 citricultores e as respostas foram organizadas para análise dos resultados. No oeste catarinense, para grande parte dos entrevistados (67,8%), a citricultura é uma atividade complementar de outras principais. A maioria dos citricultores (91,38%) considera a mosca-das-frutas um dos principais problemas fitossanitários da cultura e apenas 12,07% relatam como baixo o grau de incidência desta praga em seus pomares. No entanto, boa parte dos agricultores não faz monitoramento do inseto (41,4%) ou desconhece o assunto (13,8%). Dos que realizam monitoramento, 56,25% o fazem com uso de armadilhas, enquanto 43,75% monitoram por meio da observação visual dos frutos. O controle químico é realizado por praticamente metade dos citricultores, tendo, erroneamente, como base de decisão a presença de frutos caídos ou ainda por meio de aplicações por calendário. Os dados apresentados são preocupantes e revelam a negligência de boa parte dos citricultores com o monitoramento desta importante praga.

**PALAVRAS-CHAVE:** *Anastrepha fraterculus*; laranja; tangerina; manejo integrado de pragas.

In Santa Catarina (SC), in the 2017/18 harvest, the 1,317 producers of orange trees [*Citrus sinensis* (L.) Osb.] and tangerines (*Citrus* spp.) harvested 27,000 tons of fruits, these in 1,500 hectares of cultivation, whose average area was 1.24 ha. The mesoregion of Western Santa Catarina represents about 57% of the area, the number of producers and production, standing out as an important citrus producing region in this State (EPAGRI 2022).

These crops are often attacked by pests that cause damage to orchards, either by direct action or by transmitting pathogens to plants. According to RAGA & SOUZA-FILHO (2021) the fruit fly of the species *Anastrepha fraterculus* (Diptera: Tephritidae) and *Ceratitidis capitata* (Diptera: Tephritidae), are among the main insects responsible for the fall of citrus fruits in Brazil, with variations in incidence of attacks according to the agricultural year, producing and cultivating region. In Santa Catarina, *A. fraterculus* is the most frequent and abundant species in orchards (PEREIRA et al. 2022).

Because it causes direct damage to production, which makes it impossible to commercialize the fruits, the fruit fly needs to be constantly monitored in orchards, so that management measures are foresaw and adopted when the pest population reaches the control threshold (0.5 flies/trap/day), which increases control efficiency and prevents damage caused by high populations. Given the considerable number of citrus growers in the west of Santa Catarina, the objective of this work was to conduct a survey on the economic relevance of citrus activity and the monitoring and management of fruit flies adopted by citrus growers of the west of the Santa Catarina. We interviewed 58 citrus growers from municipalities belonging to the EPAGRI (Agricultural Research and Rural Extension Company of Santa Catarina) Regional Management of Campos Novos, Concórdia, Xanxerê, Chapecó, Palmitos and São Miguel do Oeste, which correspond to Technical Management Units 2 (Midwest), 1 (west) and 9 (extreme west) (Figure 1).



Figure 1. Demonstration of the regions where the study was carried out: municipalities belonging to the Epagri regions of Campos Novos, Concórdia, Xanxerê, Chapecó, Palmitos and São Miguel do Oeste, which correspond to Technical Management Units 1 (west,) 2 (middle west) and 9 (far west), indicated with arrows. Adapted from: <https://www.epagri.sc.gov.br/index.php/a-epagri/unidades/>.

The interviews were conducted between April and September 2021, with the application of a questionnaire with 13 questions about the economic relevance of citrus in the farms, as well as about the realization and characterization of the monitoring and control of fruit flies in citrus orchards (Table 1). The questionnaire was conducted *in loco*, with the answers collected and organized in the "Google workspace" environment. After it, the interpretation of the answers was performed.

Based on the responses of citrus producers, it was found that citrus is the main source of income for 32.2% of the interviewees, and for 67.8%, this is a complementary activity to other main ones of the property, such as swine farming, milk production, olericulture, among others. The participation of citrus in the composition of family income can be found in Figure 2A.

Table 1. Questionnaire applied to citrus growers in the west region of Santa Catarina.

Questionnaire
1- Is Citrus culture your main source of income? ( ) Yes ( ) No
2 - Approximately, what percentage of your family income is attributed to citrus?
3 - What is the main destination of your production? ( ) Free fairs ( ) Markets ( ) Other (specify)
4 - What are the three main phytosanitary problems (insects, diseases, or weeds) that arise in your orchard?
5 - Regarding the fruit fly, what is your perception of the degree of incidence and damage in your orchard? ( ) Low incidence, no damage to production ( ) Average incidence, some fallen fruits with symptoms of attack ( ) High incidence, many fallen fruits and with symptoms of rot resulting from the attack
6 - Do you monitor the fruit fly? ( ) Yes ( ) No ( ) Unaware of the subject
7 - What are the main reasons why you do not adopt monitoring, or if you adopt it, what are the main difficulties faced? ( ) High cost of attractants ( ) Do not find attractants available in the market ( ) I do not know how to identify the fruit fly ( ) Difficulty in acquiring or making traps ( ) Lack of time
8 - If you do monitoring, how do you do it? ( ) Visual observation on fruits ( ) Through the use of attractants and traps
9 - If you monitor through trap, which type is used? ( ) Homemade (pet bottle) ( ) Commercial (McPhail type or ball)
10 – Which attractant(s) do you use?
11 - How often do you survey the traps?
12 - Do you perform chemical control of the fruit fly? ( ) No ( ) Yes. Name which insecticides uses
13 - How do you decide whether to spray to control fruit fly? ( ) Number of flies caught per trap (control threshold) ( ) Calendar ( ) Presence of fallen fruits with signs of larva

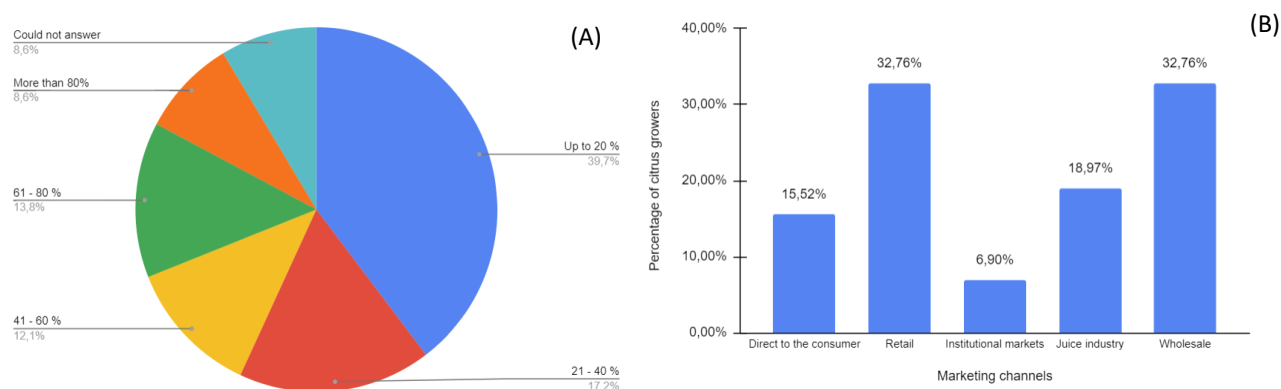


Figure 2. Economic characteristics of the citrus growers interviewed: (A) participation of citrus in the composition of family income and (B) main marketing channels for citrus produced in western Santa Catarina.

Most of the group of interviewees (39.7%) obtains less than 20% of the family income from citrus production, while only 8.6% have more than 80% of their income in citrus. For 17.2% of the interviewees, citrus production makes up 21 to 40% of income; for 12.1% the citrus activity has intermediate importance, making up 41 to 60% of income, and for 13.8% this activity makes up 61 to 80% of family income. A group of 8.6% of the interviewees could not answer. These results show that the production units with citrus in SC are diversified, and citrus, in most cases, is a secondary activity, complementing agricultural income. The main channels of commercialization of fruits produced in Western Santa Catarina are wholesale (32.76%) and retail (32.76%) (Figure 2B). The commercialization to the juice industry (18.97%), direct to the consumer (15.52%) and to institutional markets (6.90%) are also used for production flow.

Among the citrus growers interviewed, 91.38% consider fruit fly one of the three main phytosanitary problems of the crop. Based on the perception reported by citrus growers, the degree of incidence of this

pest in orchards is considered low, without damage to production, by only 12.07% of the producers. For 48.28% of citrus growers, the attack is considered average, with the presence of some fallen fruits and few symptoms of attack, and 39.66% consider it high, with many fallen fruits and symptoms of rot, which evidences the relevance of this pest for Santa Catarina citrus.

According to ARIOLI et al. (2018), monitoring is a fundamental strategic measure for fruit fly management in orchards, however, this measure is adopted by less than half of the interviewees (44.8%), while 41.4% do not monitor the fruit fly and 13.8% are simply unaware of the subject (Figure 3A).

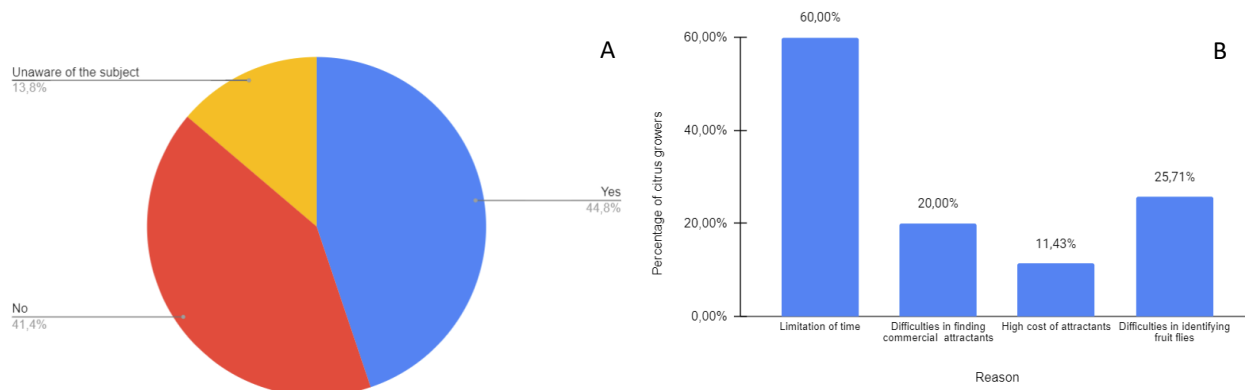


Figure 3. Monitoring of fruit fly: (A) percentage of citrus growers who carry out the monitoring and (B) reasons given for not carrying out or difficulties encountered in carrying out fruit fly monitoring.

The main reason for lack or difficulty in performing the monitoring of fruit flies indicated by citrus growers is the limitation of time, according to 60% of the interviewees (Figure 3B). The difficulties in identifying the insect (25.71%), finding commercial attractants (20.00%) and the high cost of attractants (11.43%) were also mentioned.

Figure 4 shows the characterization of the monitoring performed by citrus growers who adopt it. Among these, 56.25% of the producers evaluate the population density of fruit flies using traps, while 43.75% monitor through visual observation of fruits (Figure 4A).

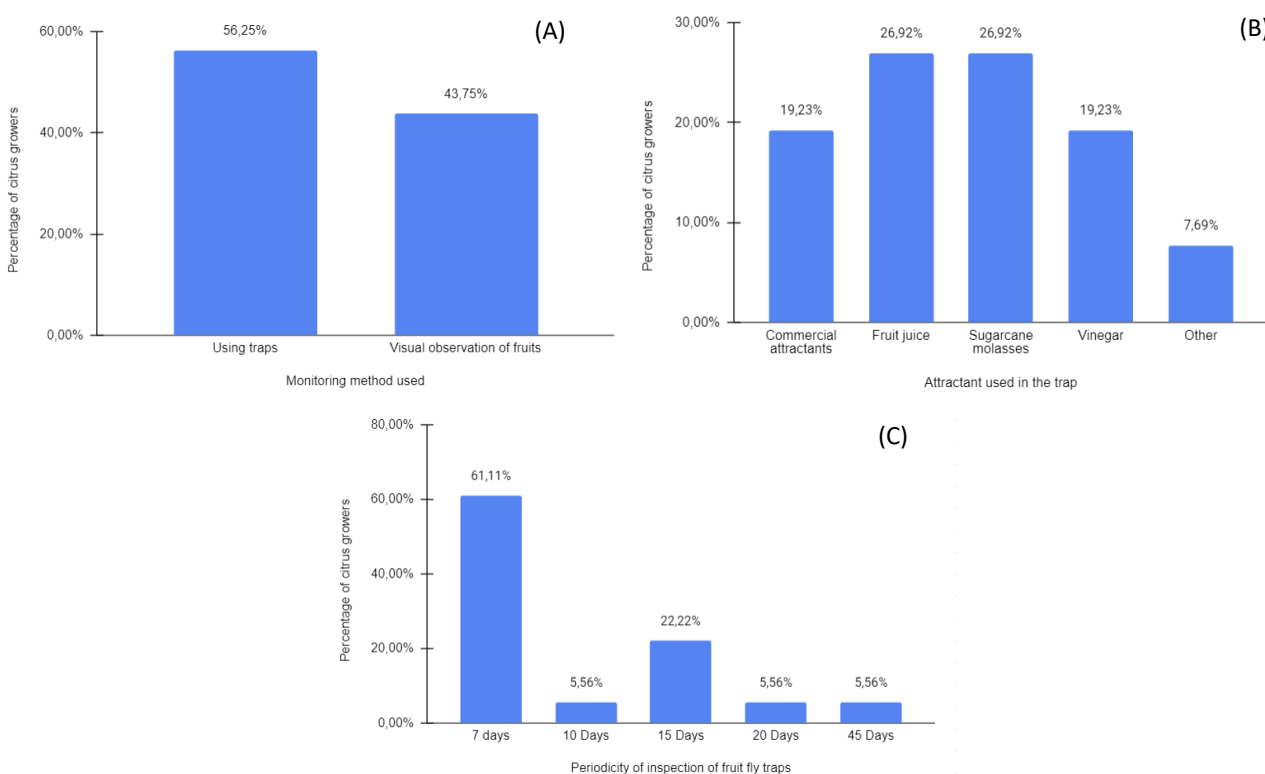


Figure 4. Characterization of the monitoring carried out by citrus growers: (A) monitoring method used, (B) attractant used in the trap and (C) periodicity of inspection of fruit fly traps.

All citrus growers who monitor with the use of traps use homemade traps with transparent PET (Polyethylene Terephthalate) bottles probably due to the lower cost compared to the commercial McPhail-type trap. Although McPhail traps are recommended and widely used for fruit fly monitoring, some alternative models of traps, when manufactured correctly, are equivalent to the commercial model in capturing *A. fraterculus* adults (ARCARI et al. 2020).

Approximately 27% of the citrus growers interviewed use fruit juice, mainly 25% diluted whole grape, and 7% diluted sugarcane molasses in fruit fly traps (Figure 4B), because they are low cost and easy to prepare. According to RAGA et al. (2006) these attractants are the most commonly used in Brazil. However, the monitoring results are compromised due to the lack of quality standard and, consequently, low efficacy of insect capture. Around 19.23% of citrus growers use commercial attractants (5% plant hydrolyzed protein and undiluted animal hydrolyzed protein) and another 19.23% use diluted red wine vinegar in 25% in traps.

Regarding the periodicity of the trap inspection, 61.11% of citrus growers do it every seven days (Figure 4C), following the technically recommended (ROSA et al. 2017). The other do it every 10 days (5.56%), 15 days (22.22%), 20 days (5.56%) or 45 days (5.56%). Weekly inspection of traps is important for accurate monitoring, and prevents the citrus grower from adopting control measures late. Another important factor is the periodicity of exchange of attractants, which for most should not exceed 15 days, because otherwise they may lose attractiveness, which leads to incorrect conclusions about the population density of the fruit fly.

Chemical control, as a population control strategy of fruit flies, is performed by 49.12% of the citrus growers interviewed, while the rest use other methods or do not perform any type of control (Figure 5A). Among those who perform chemical control, 60% mistakenly use as the main criterion for spraying the presence of fallen fruits on the ground. The application by calendar is performed by 31.43% of citrus growers and only 8.57% use as main criterion the presence of flies in traps above the control threshold (Figure 5B). This data is extremely concerning, since according to RAGA & SOUZA-FILHO (2021) the citrus grower only visualizes the damage, in general, when there is already a significant drop in fruits and the population of the pest has already caused significant damage to production. The monitoring in citrus orchards with traps and attractants should be constant, and serves to guide the realization of chemical control, which should be carried out whenever the population reaches the control threshold (0.5 fly/trap/day) in order to prevent severe damage such as fruit fall (BORTOLI et al. 2016).

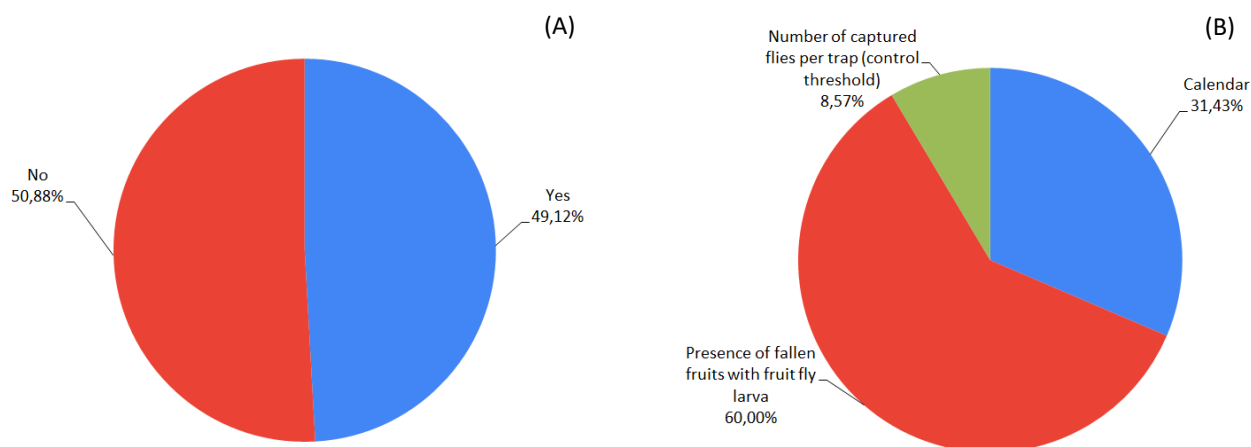


Figure 5. Chemical control of fruit fly in citrus: (A) adoption of chemical control by citrus growers, (B) parameter used to decide when to carry out chemical control.

The main insecticide - Trade name (active ingredient) [chemical group] - used for the control of fruit flies by the interviewees is Decis 25 EC® (deltamethrin) [Pyrethroid], reported by 67.86% of citrus growers who perform chemical control. In addition to this, Engeo Pleno® (thiamethoxam + lambda cyhalothrin) [Neonicotinoid + Pyrethroid] is used by 14.29%, Malathion 100 EC® (malathion [Organophosphate] is used by 10.71% and Karate Zeon 250 CS® (lambda-cyhalothrin) [Pyrethroid] is used by 7.14% of farmers. Eight other insecticides were reported, but in use by less than 4% of the interviewees. The insecticides Engeo Pleno® and Karate Zeon 250 CS® despite having registration for other citrus pests, are not recommended for fruit fly control (AGROFIT 2022).

The data presented are worrisome and reveal the negligence of the citrus grower with monitoring, which is performed by less than half of the interviewees. This information reflects in the erroneous practice of

producers to perform chemical control when they perceive fallen fruits in the orchard, which is ineffective since losses have already been caused. Monitoring is fundamental for the success of integrated management of fruit flies, since it allows for foreseeing high populations and performing control at the appropriate time.

Unlike reference citrus regions such as São Paulo, citriculture in Santa Catarina, because it is mostly practiced in small family properties and because it is an activity often complementary to income, is denied by producers, who fail to monitor the fruit fly. This neglect results in the ineffective management of this insect pest, and contributes to the occurrence of high and successive populations throughout the harvests.

Fruit fly management should not be restricted only to large orchards with a high level of technology but should be carried out in small properties and even by small producers, where monitoring is a fundamental practice for performing an effective control (MENEZES-NETO et al. 2016).

Numerous tools such as traps and commercial attractants are available in the market to be used by citrus growers in fruit fly monitoring (ARIOLI et al. 2018). However, the results obtained in this study show the low use of these tools by citrus growers, especially with regard to traps, due to the high price. Thus, public policies that subsidize or facilitate the acquisition of traps and commercial attractants are welcomed, in order to enable their routine use by citrus growers.

Regarding the chemical management of fruit flies in citrus, almost all registered insecticides belong to the chemical group of organophosphates and pyrethroids, which are considered shock insecticides, with a broad spectrum of action and harmful effect on natural enemies when sprayed in full cover in orchards. Some native and exotic parasitoids have biological control potential of the fruit fly (PARANHOS et al. 2019). Thus, together with monitoring, control alternatives that cause less impact to these natural enemies, such as the use of toxic baits and mass capture, should be disseminated among citrus growers in western Santa Catarina. Finally, it is expected that this diagnosis will serve to better know the relevance of citrus in the state of Santa Catarina and to guide dissemination and awareness actions that contribute to greater adoption of monitoring and proper management of fruit flies by citrus growers, with sustainability and reduction of economic losses.

#### ACKNOWLEDGEMENTS

To Maykol Ouriques (Epagri) for the assistance on creating the questionnaire in 'Google Workspace'. To all the rural extensionists from Epagri who applied the questionnaire and to all the citrus growers who answered it.

#### REFERENCES

- AGROFIT. 2022. Sistema de Agrotóxicos Fitossanitários. Brasília: MAPA. Disponível em: [https://agrofit.agricultura.gov.br/agrofit\\_cons/principal\\_agrofit\\_cons](https://agrofit.agricultura.gov.br/agrofit_cons/principal_agrofit_cons). Acesso em: 06 set. 2022.
- ARCARI DR et al. 2020. Eficiência de atrativos alimentares e armadilhas no monitoramento da mosca das frutas em citros. In: RIBEIRO JC. (Org.) Desenvolvimento social e sustentável das ciências agrárias 2. Ponta Grossa: Atena. p. 62-71.
- ARIOLI CJ et al. 2018. Novas ferramentas para monitoramento e controle massal de mosca-das-frutas. *Synergismus scyentifica* 13: 5-20.
- BORTOLI LC et al. 2016. Evaluation of food lures for fruit flies (Diptera: Tephritidae) captured in a citrus orchard of the Serra Gaúcha. *Florida Entomologist* 99: 81-384.
- EPAGRI - CEPA. 2022. Painéis de Dados da Fruticultura. Levantamento de dados sobre a Fruticultura Catarinense - 2017/18. Florianópolis: Epagri/Cepa. Disponível em: <https://cepa.epagri.sc.gov.br/index.php/publicacoes/fruticultura/paineis-fruticultura/>. Acesso em: 17 mar. 2022.
- MENEZES-NETTO AC et al. 2016. Combate às moscas-das-frutas em pomares domésticos. Florianópolis: Epagri. 20p. (Boletim Didático 133).
- PEREIRA JP et al. 2022. Infestação de moscas-das-frutas em hospedeiros nativos na região do Alto Vale do Rio do Peixe, Santa Catarina. *Agropecuária Catarinense* 35: 31-36.
- PARANHOS BJ et al. 2019. Biological control of fruit flies in Brazil. *Pesquisa Agropecuária Brasileira* 54: 1-14.
- RAGA A & SOUZA-FILHO. 2021. Manual de moscas-das-frutas: medidas para o controle sustentável. Araraquara: Fundecitrus.
- RAGA A et al. 2006. Eficácia de atrativos alimentares na captura de moscas-das-frutas em pomar de citros. *Bragantia* 65: 337-345.
- ROSA JM et al. 2017. Effect of food lures for monitoring of *Anastrepha fraterculus* (Diptera: Tephritidae) in *Acca sellowiana* (Myrtaceae). *Revista Colombiana de Entomología* 43: 201-207