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Flower bud fly infestation and its relationship with the morphological and phenological aspects of sour passion fruit (*Passiflora edulis*) in southern Santa Catarina state

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Abstract: The objective of this work was to evaluate the infestation of the flower-bud-fly in different sizes of flower buds and to relate the infestation with the plant phenology and weather variables. In the 2017/18 and 2018/19 seasons, flower buds of plants were collected to obtain pupae, adults, and parasitoids in a commercial orchard of sour passion fruit, in Sombrio, state of Santa Catarina. The level of infestation, pupal viability, and percentage of parasitism were calculated. Every fortnight, the vegetative and reproductive structures of 12 orchard plants (0.25 m² per plant), randomly distributed, were monitored, as soon as they reached the height of the trellis. Three population peaks of the floral bud fly were observed in the seasons, which preferred to oviposit in buds larger than 2 cm. The critical period for pest monitoring and control occurred between November and December. The average temperature and precipitation were the main factors that influenced the production of sour passion fruit. The average temperature was correlated with the emission of flower buds and the emergence of lonqueids. *D. inedulis* was the predominant species in flower buds, in which *Dasiops* sp. 1, *Dasiops* sp. 2, and *Neosilba certa* were reported for the first time. It was also the first report of *Utetes anastrephae* and *Aganaspis pelleranoi* as parasitoids of larvae-pupae of the flower bud fly of the sour passion fruit tree in Santa Catarina.

Index terms: Lonchaeidae; parasitoids; population fluctuation; temperature.

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Infestação da mosca-do-botão-floral e sua relação com aspectos morfológicos e fenológicos do maracujazeiro-azedo (Passiflora edulis) no sul de Santa Catarina

Resumo: O objetivo deste trabalho foi avaliar a infestação da mosca-do-botão-floral, em diferentes tamanhos de botão floral, e relacionar a infestação com a fenologia da planta e variáveis meteorológicas. Nas safras de 2017/2018 e 2018/2019, foram coletados botões florais das plantas para obtenção de pupas, adultos e parasitoides, em um pomar comercial de maracujazeiro-azedo, em Sombrio-SC. Foi calculado o nível de infestação, a viabilidade pupal e o percentual de parasitismo. Quinzenalmente, foram monitoradas estruturas vegetativas e reprodutivas de 12 plantas do pomar (0,25 m² por planta), distribuídas ao acaso, assim que atingiram a altura da latada. Ocorreram três picos populacionais da mosca-do-botão-floral nas safras, que preferiu ovipositar em botões maiores de 2 cm. O período crítico para monitoramento e controle da praga ocorreu entre novembro e dezembro. A temperatura e a precipitação médias foram os principais fatores que influenciaram a produção de frutos de maracujazeiro-azedo. A temperatura média foi correlacionada com a emissão de botões florais e na emergência de lonqueídeos. D. inedulis foi a espécie predominante nos botões florais, sendo relatadas pela primeira vez, Dasiops sp. 1, Dasiops sp. 2, e Neosilba certa. Também foi o primeiro relato de Utetes anastrephae e Aganaspis pelleranoi como parasitoides de larvas-pupas da mosca-do-botão-floral do maracujazeiro-azedo em Santa Catarina.

Termos para indexação: Lonchaeidae; flutuação populacional; temperatura; parasitoides.

Introduction

Passion fruit (*Passiflora edulis* Sims) is native to Brazil (CERQUEIRA-SILVA., 2014) and its production is important for Brazilian fruit growing, with about 700 thousand tons produced in 2010 and an average yield of 15.26 t ha^{-1} (IBGE, 2021). The Brazilian northeast region stands out as the leading producer (69.59%), followed by the southeast (11.78%) and south (10.71%). In the State of Santa Catarina, the average production yield in 2021 was 25.16 t ha^{-1}, which is higher than the national average (IBGE, 2021).

One factor that can reduce the production and yield of the crop is the occurrence of insect pests, such as the passion fruit flower bud fly, *Dasiops inedulis* Sims. (Diptera, Lonchaeidae), which have been growing in importance and standing out as one of the main phytosanitary problems to be tackled. Its infestation can lead to an early fall of flower buds and fruits and, in most cases, generate economic losses for the farmer (NORRBOM; MCALPINE, 1997; AGUIAR-MENEZES, 2004; LEMOS et al., 2015).

Two genera of the Lonchaeidae family, *Dasiops* and *Neosilba*, have been reported to cause damage to passion fruit growing in Colombia and Peru, particularly the species *D. inedulis* (NORRBOM; MCALPINE, 1997; AGUIAR-MENEZES et al., 2004; WYCKHUYS et al., 2012). In these countries, the flower bud fly has already been one of the main pests of Passifloraceae for over three decades, and the use of hydrolyzed corn protein for monitoring adults is recommended (WYCKHUYS et al., 2012; QUINTERO et al., 2012; CARRERO et al., 2013; SALAZAR-MENDONÇA et al., 2019). In Colombia, Integrated Pest Management – IPM strategies were established for *D. inedulis*, by associating the monitoring of adults with hydrolyzed corn protein and that of larvae in flower buds of 30 plants per hectare, considering the level control when 30% of the buds have larvae (QUINTERO et al., 2012; SALAMANCA et al., 2015). More recently, Devia et al. (2020), established as a control, the level of 10% of infested buds in orchards up to one-year-old and 30% in two-year-old orchards.

In Brazil, *D. inedulis* is recorded as causing great damage to passion fruit orchards, where losses of up to 100% of production were reported (AGUIAR-MENEZES et al., 2004; LEMOS et al., 2015). At the national level, studies focused on lonqueids that affect the passion fruit crop are concentrated on varietal resistance (JESUS-BARROS et al., 2015), infestation records (UCHÔA-FERNANDES et al., 2002; 2003; AGUIAR-MENEZES et al., 2004; OLIVEIRA; FRIZZAS, 2014; PEREIRA et al., 2017; DE LORENZI et al., 2020), and indication of food attractant for control (HARTER-MARQUES et al., 2021).

Knowledge of taxonomy, damage, trophic relationships, and ecology of this family, associated with Passifloraceae, is still considered incipient (WYCKHUYS et al., 2012; SALAZAR-MENDONZA et al., 2019). Thus, the objective of this work was to evaluate the infestation of the flower bud fly in different sizes of flower buds and to relate the infestation with the plant phenology and meteorological variables, serving as a basis for the establishment of strategies of integrated pest management.

Material and Methods

The experiment was carried out in a commercial passion fruit orchard located between the coordinates 29°06’14.8” S and 49°62’54.1” W, altitude of 22 m, in the municipality of Sombrio, in the extreme south of Santa Catarina. During the execution of the experiment, the orchard received routine cultural treatments, such as mowing to maintain spontaneous vegetation about 10 cm high, the use of herbicides in the cultivation line and fungicides, and the use of mineral fertilizers. The producer was instructed to suspend the use of insecticides in the experimental area so as not to influence data collection. The municipality of Sombrio has a Cfa-type climate, according to the Köppen classification (ALVARES et al., 2013) with a humid subtropical climate and hot summers. The average annual temperature was 19.9°C and rainfall was 1,671 mm (CLIMATEMPO, 2022).

The work was carried out in the 2017/18 and 2018/19 harvests, from November to May, through the collection of floral buds and the evaluation of the fluctuation of lonqueids and level of infestation per collection date. During the 2017/18 season, an area of one hectare was split into 20 sampling points where, every two weeks, 10 flower buds were collected from the plants, regardless of size, totaling 200 buds per collection date. The flower buds were transported to the laboratory in paper bags and subsequently placed in plastic trays lined with paper towels and covered with voile fabric, and kept under controlled conditions (BOD at 25±1°C; 70% RH; in the dark). Over two weeks, the presence of pupae was counted daily and placed in Petri dishes, covered with filter paper moistened with distilled water, and also kept in a BOD chamber for the emergence of adult flies and their parasitoids. In the 2018/19 season, in the same area, from November to May, flower buds were collected fortnightly directly from the plants to determine, in addition to the fluctuation of lonqueids and the level of infestation in the flower buds, the existence of preference for oviposition per size of flower bud, where 30 buds of 0-2 cm, 2.1-3 cm, and 3.1-5 cm sizes were collected with the aid of a plasticized card template.

The emergence of adults was monitored daily and the emerged flies were fed with a 5% molasses solution, allowing the full extension of their wings. Emerged individuals were stored in 70% alcohol 24 h after emergence.

For the two assessed seasons, infestation rates (1), pupal viability (2), and percentage of parasitism (3) were calculated using the following formulas:

$$\%IF = \left(\frac{total\ number\ of\ the\ obtained\ pupas}{total\ number\ of\ collected\ buds}\right)*100$$

$$\%VP = \left(\frac{total\ number\ of\ emerged\ adults}{total\ number\ of\ obtained\ pupas}\right)*100$$

$$\%VP = \left(\frac{total\ number\ of\ emerged\ parasitoids}{total\ number\ of\ obtained\ pupa}\right)*100$$

Lonchaeidae adult individuals that emerged from flower buds were identified using entomological taxonomic keys at the genus and species level, whenever possible (MCALPINE, 1987; NORRBOM; MCALPINE, 1997, HERNANDEZ, 2011). The emerged parasitoids were identified by the expert taxonomist in the group, Dr. Jorge Anderson Guimarães (Embrapa/CNPH), and the vouchers deposited in the entomological collection of the Entomology Department of Embrapa Hortaliças, in Brasília, DF.

The emission of flower buds (less than or equal to 2 cm and greater than 2.1 cm to 5 cm) and fruits of 12 plants in the orchard, chosen at random, was monitored from September 2018 to March 2019. The monitoring of vegetative and reproductive structures of these plants was carried out fortnightly, using a 0.25 m² wooden frame, to standardize the evaluated area of each plant. Monitoring started from the moment the plant reached the trellis wire and, as the plants developed, the coverage area was increased, to monitor their development on the trellis wire, on one side of the plant, until reaching 1 m² of the evaluated canopy area. On each evaluation date, the number of flower buds, flowers, pollinated flowers, and fruits present in the evaluated area was counted (adapted from CARRERO et al., 2013). The average number of each reproductive structure evaluated per plant was estimated, through the proportionalities of the value obtained in the samples, in the area evaluated in each plant, concerning the area occupied by them in the function of their spacing (6 m² per plant - spacing of 3 x 2 m) over the study period.

The climatic parameters of average temperature and precipitation were obtained from a meteorological station located in the municipality of Sombrio, provided by EPAGRI/CIRAM (EPAGRI, 2020) and, used in correlation with data on population fluctuation of flies in flower buds and with the aspects phenology of the sour passion fruit followed in the second harvest of the experiment.

From the collected data, a Box Plot graph was constructed to evaluate the infestation rate of the floral bud flies in the different sizes of collected buds. In addition, regression charts were also set up to check the normality of both the data and their residuals. Once normality was not met, it was decided to use the non-parametric Kruskal-Wallis test, at a probability level of 5% and, to observe where the differences were in the emergence, the Dunn Post Hoc Test was used (MANGIAFICO, 2016).

To evaluate the effect of climatic parameters, both on the emergence of the lonqueids and on the phenology, the data were plotted in scatter plots and analyzed regarding their normality and their residues. Given that the assumptions of normality were not met, a correlation test was used by Kendall's Tau method (MANGIAFICO, 2016). All graphics and tests were prepared in the R program (R DEVELOPMENT CORE TEAM, 2021).

Results and Discussion

In the 2017/18 harvest, 2,000 flower buds were collected and from these, 50 pupae of lonqueids were obtained, out of which 34 adults emerged and 28 were identified as *D. inedulis* and one as *Neosilba certa* (WALKER, 1850). In the 2018/19 harvest, 1,260 flower buds were collected. Of this amount, 545 pupae were obtained, out of which 394 adults emerged, enabling the identification of 167 *D. inedulis* females and two *Dasiops* sp. 1 and *Dasiops* sp. 2 females.

The bud infestation rate and pupal viability in 2017/2018 harvest were 2.5% and 68%, respectively. From the collection of buds in the field, pupae were obtained in the laboratory for approximately 11.43 ± 7.42 days. The pupal period lasted an average of 14.52 ± 6.57 days, that is, from pupation to adult emergence. The mean time and standard deviation to obtain pupae after the collection of flower buds was 5.5 ± 3.80 days, while the mean duration of the pupal period was 13.05 ± 18.94 days.

The percentage of parasitism of lonqueid pupae was 4.0% in the 2017/2018 harvest and 4.4% in the 2018/2019 season. The most abundant sampled family was Braconidae (Opiinae), with 16 individuals of the species *Utetes anastrephae*, followed by Figitidae (Eucoilinae), with 15 individuals, four specimens of *Aganaspis pelleranoi* (Brèthes, 1924) and 11 of the genus *Ganaspis* (it was not possible to identify them at the species level).

Regarding the preference of the fly for the different sizes of flower buds sampled in the 2018/2019 harvest, a lower rate of infestation of lonqueids emerged in 0-2 cm flower buds (25.24%) was found. For 3.1-5 cm flower buds, the highest infestation rate was recorded (66.19%) and for 2.1-3 cm buds, a rate of 45.48% (Figure 1) was observed. The Kruskal-Wallis test showed a statistically significant difference ($p = 0.004$) between *Dasiops* spp. in the buds, and Dunn's test revealed that this difference occurred between the 0-2 cm buds from the 2.1-3 cm buds ($p = 0.01$) and 3.1-5 cm buds ($p = 0.03$) (Table 1).

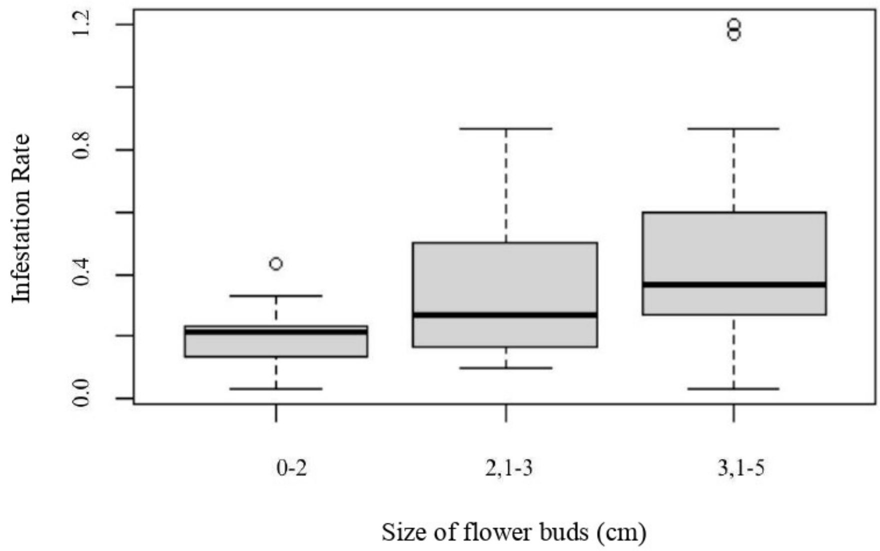

Figure 1 - Infestation rates of lonqueids emerged in different sizes of flower buds sampled in a commercial passion fruit orchard, Sombrio, SC.

Table 1 - Mean rank and standard error (SE) of flower bud fly emergence, infestation index (IV), and pupal viability (VA) per flower bud size.

Bud size	Mean Rank * ± EP	IV (%)	VP (%)
0-2 cm	51.53a ± 0.14	25.24	58.49
2.1-3 cm	78.35b ± 0.14	45.48	65.45
3.1-5 cm	74.02b ± 0.13	66.19	59.35

* Values followed by the same letter are not different by the test of Dunn at the level of 5%.

In line with these results, Galindo et al. (2014) recorded *D. inedulis* infestation rates in orchards in Colombia of 20.3% in flower buds between 2-3 cm, with an average of one larva per bud, and 79.7% in flower buds with the length between 3.1-5 cm, with an average of two larvae per bud. Peñaranda et al. (1986) show that small buds (less than 2 cm) hinder the complete development of the larvae and only allow the creation of one larva per bud, while buds with more than 3.5 cm were detected up to 12 larvae and all managed to complete their development. Thus, larger bud sizes promote the full development of the larvae.

Although *D. inedulis* has great potential to affect passion fruit production, experiments conducted by Salamanca et al. (2015) demonstrated that *P. edulis* has a mechanism of adaptation to herbivory by modifying the natural abortion rates of floral and fruit structures. The authors cited above observed that the plants began to suffer production losses only when the abortion rate was greater than 20%. At rates of less than 20%, these authors reported a capacity for compensatory action of the crop, mainly in orchards with well-nourished plants, under a manual pollination system, and at a more advanced phenological age.

If we consider 20% of abortion of flower buds as a pest control level, it is observed that, on average, this index was reached throughout this experiment, for all sizes of buds evaluated. For example, in the 2017/2018 season, at the fly's first peak in November, the infestation rate started at 10% and reached 30% by the end of the month. Afterward, it remained at 10% and, in February, at the second peak, it reached 40%. In the second assessed harvest, it was observed that in the 2.1-3 cm and 3.1-5 cm buds, the infestation rate reached 20% in March and progressively increased until reaching 40% in April.

Therefore, the importance of monitoring the flower bud fly throughout the crop's production cycle is reinforced. However, it should be observed that there is still no established level of control for orchards in the extreme south of Santa Catarina. Furthermore, the work by Salamanca et al. (2015) was not conducted with natural infestations of the flower bud fly, but with damage simulation. It should also be observed that this work focused on understanding the dynamics of infestation and population fluctuation of this fly, under natural conditions, throughout the crop's production cycle and that there are still gaps in relation to how this fly behaves in the off season and the sanitary void.

It was observed in this experiment, an emergence of species of lonqueids from the flower buds of sour passion fruit that have not been reported yet. In addition to *D. inedulis*, two species of *Dasiops* emerged whose identifications were not possible so far, because they were not registered in any of the keys used and also because of the lack of a specialized taxonomist, and one individual of *N. certa*.

To date, in Brazil, only *D. inedulis* has been recorded in passion fruit buds (AGUIAR-MENEZES et al., 2004; RAGA et al., 2015; JESUS-BARROS et al., 2015). This work corroborates the survey and identification of the passion fruit flower bud fly as the predominant *D. inedulis* species in *P. edulis* (GALINDO et al., 2014; SALAZAR-MENDONÇA et al., 2019). The distribution of this species of lonqueids is wide in the various countries that produce Passifloraceae, and it can become a pest of economic importance (STRIKIS et al., 2011) as losses of up to 100% of production have been reported which was caused by the early abortion of flower buds in northern Brazil (LUNZ et al., 2006).

Regarding the emerged parasitoids, the braconid *U. anastrephae* was the most abundant. It had been reported for the first time, the infesting larvae-pupae of *D. inedulis*, in Colombia, by Quintero et al. (2012). Until then, this species was recorded only for other genera of Tephritoidea, such as *Anastrepha*, *Ceratitis,* and *Tomoplagia* (UCHÔA-FERNANDES et al., 2003). Parasitoids of the genus *Aganaspis* (Figitidae) had already been reported in Colombia parasitizing *D. inedulis* pupae by Quintero et al. (2012). The species *A. pelleranoi* was recorded for the first time for fly species of the genus *Dasiops* by Santamaría et al. (2016) and was also recorded in the present study, which is the first report of this association in the country. Furthermore, this parasitoid is also known to parasitize larvae-pupae of *Neosilba* sp., in addition to several species of the genus *Anastrepha* (GUIMARÃES et al., 2003).

The small number of parasitoids collected in the experimental area is likely to have been the result of the use of pesticides by farmers and by the type of crops, orchards, and vegetation adjacent to the experimental area.

According to Carrero et al. (2013), the lack of parasitoids in their work was explained by the exacerbated use of pesticides in orchards in the experimental region. The authors still consider that the current management against pests needs to be reviewed. In line with this idea, Quintero et al. (2012) established a MIP for the population control of *D. inedulis* in Colombia. However, Bateman (1972) justifies the low occurrence of natural enemies in field experiments because most fruit fly parasitoids, under natural conditions, do not occur in sufficient density to interfere with infestation levels of fruit flies in commercial orchards.

According to Quintero et al. (2012), there are records of parasitoid hymenopteran families Braconidae, Figitidae, and Pteromalidae parasitizing flies of the Lonchaeidae family. This parasitism index varies among the producing regions in Brazil, due to the environment, the time of collection, the host plant species and the fly to be parasitized (OVRUSKI et al., 2000).

Regarding the number of adults emerging from flower buds, two peaks were recorded in the 2017/2018 harvest (Figure 2) and a peak in the 2018/2019 harvest (Figure 3). For the 2017/2018 harvest, the value of Kendall's Tau (τ) did not indicate a correlation between lonqueids emergence and precipitation ($p = 0.33$; $\tau = 0.06$) and a poor correlation with average temperature ($p = 0.1$; $\tau = 0.16$). The same was observed for the second assessed harvest (2018/2019), where Kendall's Tau value for data referring to precipitation ($p = 0.93$; $\tau = -0.09$) and average temperature ($p = 0.99$; $\tau = -0.14$) indicated a non-correlation and a weak correlation.

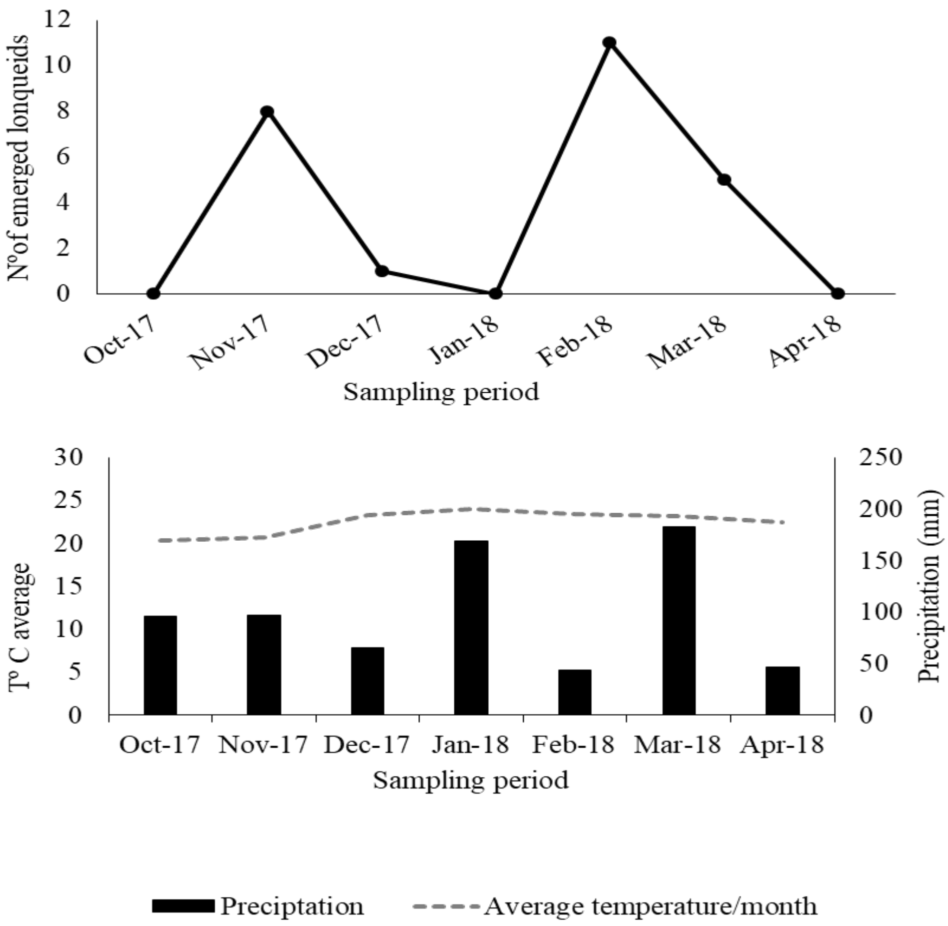

Figure 2. Population fluctuation of lonqueids emerged from flower buds of sour passion fruit, 2017/2018 harvest, Sombrio, SC. A) Number of emerged lonqueids per collection date; B) weather parameters of the evaluation period (Source: Epagri, 2020).

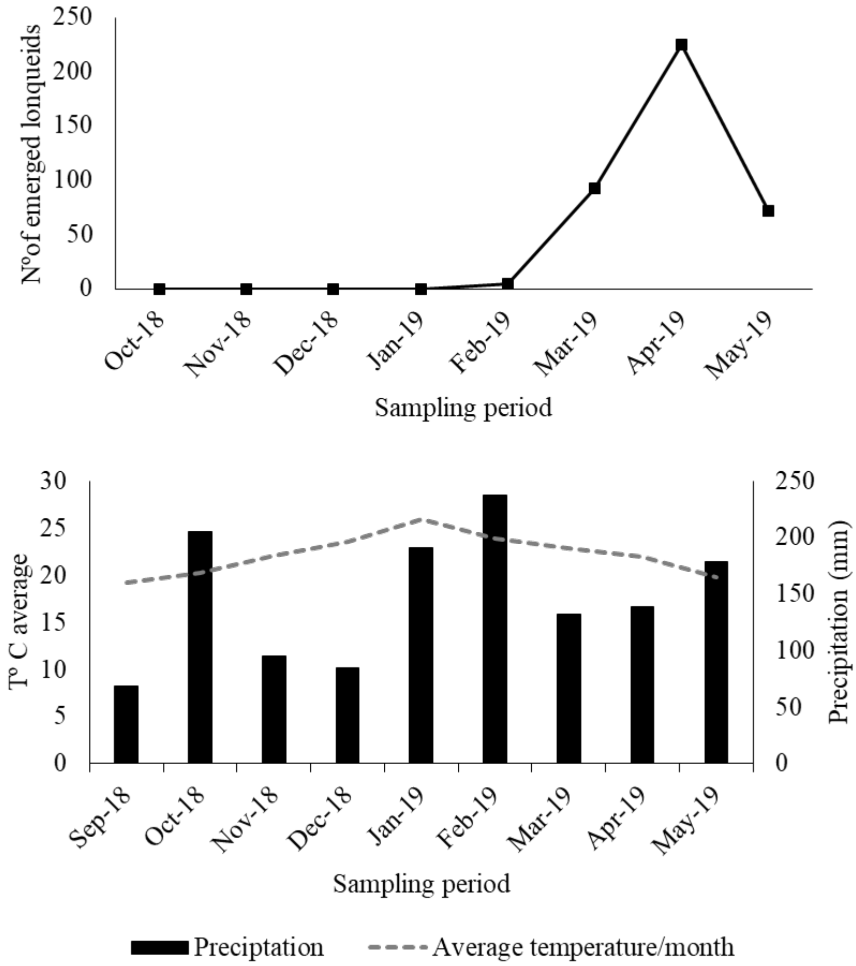

Figure 3 – Population fluctuation of lonqueids emerged from flower buds of sour passion fruit, 2018/19 harvest, Sombrio, SC. A) Number of emerged lonqueids collection date; B) weather parameters of the evaluation period (Source: Epagri, 2020).

In the 2018/2019 harvest, the highest numbers of lonqueids emergence were observed between March and May (Figure 3), which are the months following the highest number of flower buds and fruits produced, according to the evaluations of the reproductive structures carried out from September 2018 to May 2019 (Figure 4).

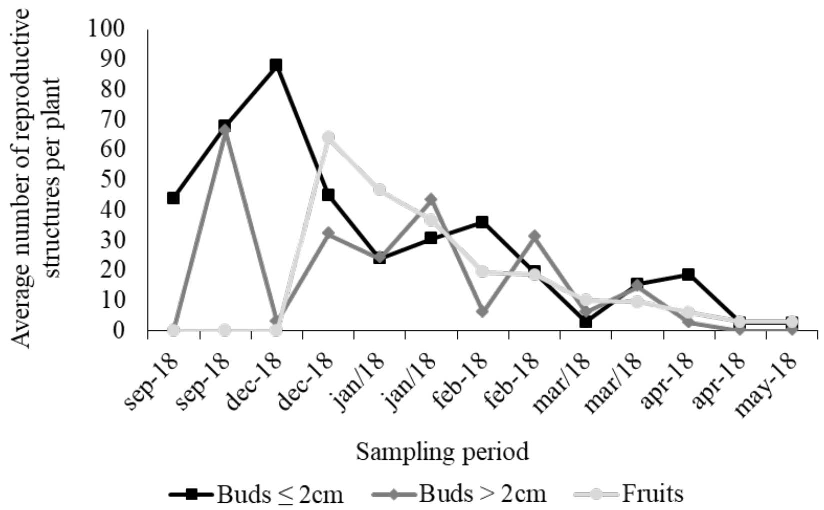

Figure 4 – Average number of reproductive structures per plant recorded from September /2018 to March /2019, Sombrio, SC.

It can be seen through Kendall's Tau test a strong and inversely proportional correlation between the emission of buds smaller than 2 cm and the emergence of lonqueids ($p = 0.9$; $\tau = -0.75$) and a moderate and inversely proportional correlation between the emission of buds larger than 2.1 cm and the emergence of lonqueids ($p = 0.9$, $\tau = -0.47$). No correlation in terms of fruit emission ($p = 0.8$; $\tau = -0.24$) was observed. Thus, it can be seen that the emergence peaks of lonqueids in November and February in the 2017/18 season and April in the 2018/19 season (Figures 2 and 3) are related to the emission peaks of flower buds (Figure 4).

The test also indicated a weak correlation between the mean temperature and the emission of flower buds smaller than 2 cm ($p = 0.05$; $\tau = 0.35$) and a moderate one for buds larger than 2.1 cm ($p = 0.005$; $\tau = 0.56$) and fruits ($p = 0.002$; $\tau = 0.63$). For fruits, a moderate correlation was also observed between mean precipitation and its occurrence ($p = 0.004$; $\tau = 0.57$). No correlation was found between precipitation and the emission of flower buds smaller than 2 cm ($p = 0.7$; $\tau = -0.13$) and buds larger than 2.1 cm ($p = 0.2$; $\tau = 0, 17$).

In the first evaluation carried out in this experiment, the plants had already shown the emission of floral buds (Figure 4). After two weeks, a peak in the production of buds larger than 2 cm was observed, with an increase in the emission of new buds also occurring during this period. The peak of emission of floral buds (up to 2 cm) occurred at the beginning of December 2018 and the peak of observation of the presence of large fruits occurred one month after the peak of floral buds, which was a period with the highest production over the crop's vegetative cycle. This period coincides with the well-known production of the first flowering of the passion fruit, also considered the one with the best quality and profitability for the region (PIEVA et al., 2017).

Based on the supply of buds and fruits throughout the 2018/2019 harvest (Figure 4), it is possible to observe that peaks in the offer of floral buds are followed by peaks in the offer of fruits. In this harvest (Figure 2), only one peak of the emergence of lonqueids was observed, in April (Figure 3), at the end of the productive cycle of the crop, with no peaks of lonqueids at the beginning (November) and middle (February) of the productive cycle as observed in the 2017/18 harvest. Considering that the peaks of the emergence of lonqueids are associated with the peaks of emission of flower buds and that these peaks of the emergence of lonqueids had a weak correlation with the climatic assessed variables, other factors influenced the dynamics of the pest, such as the use of pesticides in the adjacent sites to the experimental area.

However, as emergence peaks of flower bud fly adults were observed from November to April (Figures 2 and 3) in both assessed harvests, and the variation in the months with the highest occurrence of the pest, we reinforce the importance of monitoring populations throughout the productive period.

When considering that the fruits produced during the first flowering of the passion fruit tree in the extreme south of Santa Catarina are those that generate the greatest income for producers in the region (PIEVA et al., 2017), the monitoring and control of the pest must be focused on flower buds which will produce fruits in December and January (Figure 4), thus establishing a critical period beginning between November to December.

Throughout the entire crop cycle, three emission peaks of floral buds were observed (Figure 4). Not all flower buds produced at the beginning of the crop's vegetative cycle corresponded to the fruit formation, given their lower peak. It is possible that some of the buds that did not set were aborted by factors of the plant's physiology or could still be related to the occurrence of pests and diseases.

When considering that passion fruit is a plant that needs at least 11 hours of photoperiod to flower (JUNQUEIRA et al., 2001), it was expected that fruit production would be directly affected by temperature. Furthermore, Cavichiolli et al. (2008) demonstrated that artificial lighting, as a way to increase the photoperiod in unfavorable seasons, increased the average fruit weight, confirming the importance of temperature on plant productivity.

Based on the results of this work, it can be considered that buds larger than 2 cm are most sought after by the floral bud fly. In addition, the temperature seems to be a factor that influences both the occurrence of *Dasiops* in flower buds and their emission, although the correlations obtained in this experiment were considered moderate to weak. On the other hand, precipitation had no influence either on the population dynamics of *Dasiops* or on the emission of plant structures.

Conclusions

The floral bud fly prefers to oviposit on buds larger than 2 cm. The emergence peaks of lonqueids (November, February, and April) in the two assessed harvests are related to the emission peaks of flower buds. November and December are the most critical in case of population peaks of the pest in floral buds in orchards, and monitoring and controlling should be focused on during this period.

Precipitation does not influence the emergence peaks of lonqueids and the average temperature poorly explains these peaks. The average temperature was a weak and moderate influence on the emission of flower buds. Average temperature and precipitation are the main factors that influence the production of sour passion fruit in southern Santa Catarina.

D. inedulis was the predominant species in flower buds, where *Dasiops* sp. 1, and *Dasiops* sp. 2, both in the process of identification and *Neosilba certa* were reported for the first time. *Utetes anastrephae* and *Aganaspis pelleranoi* are reported for the first time as parasitoids of larvae-pupae of the flower bud fly of sour passion fruit in Santa Catarina.

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References

AGUIAR-MENEZES, E.L.; NASCIMENTO, R.J.; MENEZES, E.B. Diversity of fly species (Diptera: Tephritoidae) from *Passiflora* spp. and their hymenopterous parasitoids in two municipalities of the Southeastern Brazil. **Neotropical Entomology**, Dordrecht, n.33, v.1, p.113-6, 2004. Disponível em: *https://www.scielo.br/j/ne/a/vmvJ7ZT5LW9cLqd59LrnknD/?lang=en*. Acesso em: 26 ago. 2022.

ALVARES, C.A.; STAPE, J.L.; SENTELHAS, P.C.; DE MORAES GONÇALVES, J L.; SPAROVEK, G. Köppen's climate classification map for Brazil. **Meteorologische Zeitschrift**, Berlin, v.22, n.6, p.711-28, 2013. Disponível em: *https://www.schweizerbart.de/papers/metz/detail/22/82078/Koppen_s_climate_classification_map_for_Brazil?af=crossref*. Acesso em: 26 ago. 2022.

BATEMAN, M.A. The ecology of fruit flies. **Annual Review of Entomology**, Palo Alto, n.17, p.493-518, 1972.

CARRERO, D.A.; MELO, D.; URIBE, S.; WYCKHUYS, K.A.G. Populations dynamics of *Dasiops inedulis* (Diptera: Lonchaeidae) and its biotic and abiotic mortality factors in Colombian sweet passionfruit orchards. **Journal of Pest Science**, Heidelberg, n.86, p.438-47, 2013. Disponível em: *https://link.springer.com/article/10.1007/s10340-013-0487-9*. Acesso em: 26 ago. 2022.

CAVICHIOLI, J.C.; RUGGIERO, C.; VOLPE, C.V. Caracterização físico-química de frutos de maracujazeiro-amarelo submetidos à iluminação artificial, irrigação e sombreamento. **Revista Brasileira de Fruticultura**, Jaboticabal, v.30, n.3, p. 649-56, 2008. Disponível em: *https://repositorio.unesp.br/handle/11449/1504*. Acesso em: 26 ago. 2022.

CERQUEIRA-SILVA, C.B.M.; JESUS, O.N.; SANTOS, E.S.L.; CORRÊA, R.X.; SOUZA, A.P. Genetic breeding and diversity of the genus passiflora: progress and perspectives in molecular and genetic studies. **International Journal of Molecular Sciences**, Basel, v.15, p.14122-52, 2014. Disponível em: *https://www.alice.cnptia.embrapa.br/alice/handle/doc/1005585*. Acesso em: 29 ago. 2022.

CLIMATEMPO. **Climatologia em Sombrio, BR**. 2022. Disponível em: *https://www.climatempo.com.br/climatologia/4698/sombrio-sc*. Acesso em: 29 ago. 2022.

DE LORENZI, E.F.P.; EMERICK, B.; MORITZ, D.R.; PETRY, H.B. Estudo da flutuação populacional da mosca-do-botão floral no maracujazeiro-azedo por meio de armadilhas adesivas amarelas. **Agropecuária Catarinense**, Florianópolis, v.33, n.2, p.29-31, 2020. Disponível em: *https://publicacoes.epagri.sc.gov.br/RAC/article/view/499*. Acesso em: 26 ago. 2022.

DEVIA, E.H.V.; BAQUERO, P.V.S.; ÁLVAREZ, K.L.B.; GÓMEZ, C.S. **Manejo de la mosca del botón floral en el maracuyá amarillo para el Huila**. Mosquera, Colômbia: Agrosavia, 2020. 36p. Disponível em: *https://editorial.agrosavia.co/index.php/publicaciones/catalog/book/171*. Acesso em: 27 abr. 2023.

EPAGRI - Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina. **Banco de dados de variáveis ambientais de Santa Catarina**. Florianópolis: Epagri, 2020. 20p. (Documentos, 310)

GALINDO, M.Y.S.; ÁVILA, A.P.C.; RAVELO, E.E.E.; BROCHERO, H.L.M. Caracterización de daños de moscas del género *Dasiops* (Diptera: Lonchaeidae) en *Passiflora* spp. (Passifloraceae) cultivadas en Colombia. **Revista Facultad Nacional de Agronomía Medellín,** n.67, v.1, p.7151-62, 2014. Disponível em: *https://www.scinapse.io/papers/1602537277* . Acesso em: 26 ago. 2022.

GUIMARÃES, J.A.; GALLARDO, F.E.; DIAZ, N.B.; ZUCCHI, R.A. Eucoilinae species (Hymenoptera: Cynipoidae: Figitidae) parasitoids of fruit-infesting dipterous larvae in Brazil. **Zootaxa**, Auckland, n.278, p.1-23, 2003. Disponível em: *https://www.biotaxa.org/Zootaxa/article/view/zootaxa.278.1.1*. Acesso em: 26 ago. 2022.

HARTER-MARQUES, B.; MICHELS, V.F.; PEREIRA, B.E.; DE LORENZI, E.F.P. Evaluation of different food attractants for capture of Lonchaeidae (Diptera: Tephritoidea) in passion fruit orchard in Southern Santa Catarina, Brazil. **International Journal of Tropical Insect Science**, Oxfordshire, v.41, n.2, p.1889-82, 2021.

HERNANDEZ, R.E.G. **Revisión taxonômica parcial del gênero *Dasiops* Rondani (Diptera Lonchaeidae) em la region neotropical**. 2011. Dissertação (Mestrado em Entomologia Geral) - Universidade do Panamá, Cidade do Panamá, 2011.

IBGE. **Produção agrícola municipal**: maracujá. Rio de Janeiro, 2021. Disponível em: *https://sidra.ibge.gov.br/tabela/5457#resultado*. Acesso em: 03 abr. 2023.

JESUS-BARROS, C.R; ADAIME, R.; LIMA, A.L.; SANTOS, J.A. **Ocorrência de *Dasiops inedulis* Steyskal (Diptera: Lonchaeidae) em maracujazeiro no Amapá**. Macapá: Embrapa, 2015. (Comunicado técnico, 137). Disponível em: *https://www.infoteca.cnptia.embrapa.br/handle/doc/1025251*. Acesso em: 26 ago. 2022.

JUNQUEIRA, N.T.V.; VERAS, M.C.M.; CHAVES, R. da C.; FIALHO, J. de F.; OLIVEIRA, J.A. de; MATOS, A.P. **Manejo da floração do maracujazeiro**. Brasília, DF: Embrapa/Cerrados, 2001. 3 p. (Recomendação técnica, 45). Disponível em: *https://www.infoteca.cnptia.embrapa.br/infoteca/bitstream/doc/566463/1/rectec45.pdf*. Acesso em: 26 ago. 2022.

LEMOS, L. do N.; ADAIME, R.; COSTA-NETO, S.V.; DEUS, E. da G.; JESUS-BARROS, C.R. de; STRIKIS, P.C. New findings on Lonchaeidae (Diptera: Tephritoidea) in the Brazilian Amazon. **Florida Entomologist**, Gainesville, v.98, n.4, 2015. Disponível em: *https://www.embrapa.br/busca-de-publicacoes/-/publicacao/1032737/new-findings-on-lonchaeidae-diptera-tephritoidea-in-the-brazilian-amazon*. Acesso em: 26 ago. 2022.

LUNZ, A.M.; SOUZA, L.A.; LEMOS, W.P. **Reconhecimento dos principais insetos-praga do maracujazeiro**. Belém: Embrapa Amazônia Oriental, 2006. 36 p. Disponível em: *https://www.infoteca.cnptia.embrapa.br/bitstream/doc/379352/1/Doc245.pdf*. Acesso em: 26 ago. 2022.

MANGIAFICO, S.S. **Summary and analysis of extension program evaluation in R. Version 1.19.10**. New Brunswick: Rutgers Cooperative Extension, 2016. Disponível em: *https://rcompanion.org/handbook/F_08.html*. Acesso em: 30 ago. 2022. McALPINE, J.F. Lonchaeidae. *In*: MCALPINE, J.F.; PETERSON, B.V.; SHEWELL, G.E.; TERKEY, H.J.; VOKEROTH, J.R.; WOOD, D.M. (ed.) **Manual of neartic diptera**. Otawa: Agriculture Canada Monograph, 1987. v.2, p.791-7.

NORRBOM, A.L.; MCALPINE, J.F. A revision of the neotropical species of *Dasiops* Rondani (Diptera: Lonchaeidae) attacking *Passiflora* (Passifloraceae). **Memorial Entomological Society of Washington**, Philadelphia, n.18, p.189-211, 1997.

OLIVEIRA, C.M.; FRIZZAS, M.R. **Principais pragas do maracujazeiro amarelo (*Passiflora edulis* f. *flavicarpa* Degener) e seu manejo**. Planaltina: Embrapa Cerrados, 2014. 43p. (Documentos, 323). Disponível em: *https://ainfo.cnptia.embrapa.br/digital/bitstream/item/124950/1/doc-323.pdf* . Acesso em: 26 ago. 2022.

OVRUSKI, S.; ALUJA, M.; SIVINSKI, J.; WHARTON, R. Hymenopteran parasitoids on fruit-infesting Tephritidae (Diptera) in Latin America and the Southern United States: diversity, distribution, taxonomic status and their use in fruit fly biological control. **Integrated Pest Management Reviews**, Andover, v.5, p.81-107, 2000. Disponível em: *https://www.academia.edu/8332208/Hymenopteran_parasitoids_on_fruit_infesting_Tephritidae_Diptera_in_Latin_America_and_the_southern_United_States_Diversity_distribution_taxonomic_status_and_their_use_in_fruit_fly_biological_control*. Acesso em: 26 ago. 2022.

PEÑARANDA, I.A.; ULLOA, P.C.; HERNÁNDEZ, M.R. Biología de la mosca de los botones florales del maracuyá Dasiops inedulis (Díptera: Lonchaeidae) en el Valle del Cauca. **Revista Colombiana de Entomologia**, Bogotá, v.12, n.1, 1986.

PEREIRA, B.E.; DE LORENZI, E.F.P.; HARTER-MARQUES, B. Primeiro registro de Dasiops spp. Rondani (1856) (Diptera: Lonchaeidae) em pomar comercial de Passiflora edulis Sims. (Passifloraceae) no Sul de Santa Catarina, Brasil. *In*: SIMPÓSIO BRASILEIRO SOBRE A CULTURA DO MARACUJAZEIRO, 7., 2017, Balneário Arroio do Silva, SC. **Anais** [...] Florianópolis, 2017.

PIEVA, D.C.; ELIAS, H.T.; GUGEL, J.T.; GOULART JÚNIOR, R. **Relatório de mercado agrícola na Ceasa/SC.** 2017. (Relatório, 6). Disponível em: *http://docweb.epagri.sc.gov.br/website_cepa/Relatorio_Ceasa/Relatorio_Mercado_Agricola_Ceasa_Mai_2017_n6.pdf*. Acesso em: 26 ago. 2022.

QUINTERO, E.M.; LÓPEZ, I.C.; KONDO, T. Manejo integrado de plagas como estratégia para el control de la mosca del botón floral del maracuyá *Dasiops inedulis* Steyskal (Diptera: Lonchaeidae). **Corpoica – Ciencia y Tecnologia Agropecuária**, Bogotá, n.13, v.1, p.31-40, 2012. Disponível em: *https://www.redalyc.org/articulo.oa?id=449945032004*. Acesso em: 26 ago. 2022.

R DEVELOPMENT CORE TEAM. **R**: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing, 2021.

RAGA, A.; DE SOUZA-FILHO, M.F.; STRIKIS, P.C.; MONTES, S.M.N.M. Lance fly (Diptera: Lonchaeidae) host plants in the State of São Paulo, Southeast Brazil. **Entomotropica**, Macaray, v.30, n.7, p.57-68, 2015. Disponível em: *http://mosfrut.com.br/PDF/2015,%20A.%20RAGA.pdf*. Acesso em: 26 ago. 2022.

SALAMANCA, L.; MANZANO, M. R.; BAENA, D.; TOVAR, D.; WYCKHUYS, K. A. G. Effect of simulated *Dasiops inedulis* (Diptera: Lonchaeidae) injury on yield and fruit quality parameter in yellow passionfruit. **Journal of Economic Entomology**, Maryland, n.108, v.1, p.201-19, 2015. Disponível em: *https://academic.oup.com/jee/article/108/1/201/794786*. Acesso em: 26 ago. 2022.

SALAZAR-MENDONZA, P.A.; PERALTA-ARAGÓN, I.E.; MISAILIDIS, M.L.; ROMERO-RIVAS, L.C.; STRIKIS, P.C. Lance flies associated with sweet passion fruit and contributions to the knowledge on Lonchaeidae in Peru. **Arquivos do Instituto Biológico**, São Paulo, v.86, p.1-4, 2019. Disponível em: *https://www.scielo.br/j/aib/a/BNqxKHy7HGptrLnztmDNbwz/?lang=en*. Acesso em: 26 ago. 2022.

SANTAMARÍA, M.; EBRATT, E.; CASTRO A.; BROCHERO, H.L. Hymenopterous parasitoids of *Dasiops* (Diptera: Lonchaeidae) infesting cultivated *Passiflora* spp. (Passifloraceae) in Cundinamarca and Boyaca, Colombia. **Agronomia Colombiana**, Bogotá, v.34, n.2, p.200-8, 2016. Disponível em: *https://pdfs.semanticscholar.org/6556/639b55cf007c5afc3c60681e33c16f911752.pdf?_ga=2.13157879.1709105043.1661537569-39436722.1661537569*. Acesso em: 26 ago. 2022.

STRIKIS, P.C.; DEUS, E.G.; SILVA, R.A.; PEREIRA, J.D.B.; JESUS, C.R.; MARSARO JÚNIOR, A.L. Conhecimento sobre Lonchaeidae na Amazônia brasileira. *In*: SILVA, R.A.; LEMOS, W.P.; ZUCCHI, R.A. (ed.). **Moscas-das-frutas na Amazônia brasileira**: diversidade, hospedeiros e inimigos naturais. Macapá: Embrapa Amapá, 2011. p.205-16.

UCHÔA-FERNANDES, M.A.; OLIVEIRA, I.; MOLINA, R.M.S.; ZUCCHI, R.A. Species diversity of frugivorous fies (Diptera: Lonchaeidae) from hosts in the Cerrado of the State of Mato Grosso do Sul, Brazil. **Neotropical Entomology**, Dordrecht, n.31, v.4, p.515-24, 2002. Disponível em: *https://www.scielo.br/j/ne/a/VNXRS64xQPsFPnqMhWbcDCt/abstract/?lang=en*. Acesso em: 26 ago. 2022.

UCHÔA-FERNANDES, M.A.; OLIVEIRA, I.; MOLINA, R.M.S.; ZUCCHI, R.A. Biodiversity of Frugivorous Flies (Diptera: Tephritoidea) Captured in Citrus Groves, Mato Grosso do Sul, Brazil. **Neotropical Entomology**, Dordrecht, v.32, n.2, p.239-46, 2003. Disponível em: *https://www.scielo.br/j/ne/a/3j9yWVNXCX4BPRMbr6qVmVk/?lang=en*. Acesso em: 31 mar. 2023.

WYCKHUYS, K.A.G.; KORYTKOWSKI, C.; MARTINEZ, J.; HERRERA, B.; ROJAS, M.; OCAMPO, J. Species composition and seasonal occurrence of Diptera associated with passionfruit crops in Colombia. **Crop Protection**, Amsterdam, n.32, p.90-8, 2012. Disponível em: *https://www.sciencedirect.com/science/article/abs/pii/S0261219411003255*. Acesso em: 26 ago. 2022.