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EFFICIENCY OF FOOD LURES FOR CAPTURE AND MONITORING OF SOUTH AMERICAN FRUIT FLY IN ASIAN PEAR ORCHARD[1]

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ABSTRACT - The South American fruit fly, *Anastrepha fraterculus* (Diptera: Tephritidae) is the most important insect pest in pear tree crops in Southern Brazil. Several studies pointed to the controversial efficacy of some food lures used for capture and monitoring this species in various fruit species. This study aimed to evaluate the efficacy of food lures available in the Brazilian market in capturing and monitoring *A. fraterculus* in relation to grape juice. The experiment was conducted during the 2014/2015 and 2015/2016 crop seasons in an Asian pear (*Pyrus* spp.) orchard located in Caçador, State of Santa Catarina, Brazil. The food lures evaluated were CeraTrap®, BioAnastrepha®, Torula®, Isca Mosca®, BioFruit®, and grape juice (a standard food lure in Southern Brazil). For each attractant substance, population fluctuations of *A. fraterculus* were recorded as well as the average number of female and male specimens captured, the FTD (fly/trap/day) rate of capture, the number of control indications, and mean weekly evaporation. The first *A. fraterculus* adults were captured in November, and in both crop seasons the population peak was found in January. CeraTrap® was more effective in capturing females and males and indicated a higher number of control indications compared to the other food lures. Grape juice presented lower effectiveness compared to CeraTrap®, including the evaporation parameter. It was concluded that CeraTrap® is the most effective food attractant in capturing adults of *A. fraterculus* and more accurate in detecting its population levels in Asian pear orchards, therefore, it is recommended rather than the usual grape juice.

Keywords: *Anastrepha fraterculus*. *Pyrus* spp. Pest threshold assessment. Integrated pest management.

EFICIÊNCIA DE ATRATIVOS ALIMENTARES NA CAPTURA E NO MONITORAMENTO DE MOSCA-DAS-FRUTAS SUL-AMERICANA EM POMAR DE PEREIRA ASIÁTICA

RESUMO - A mosca-das-frutas sul-americana, *Anastrepha fraterculus* (Diptera: Tephritidae) é a principal praga da pereira na região Sul do Brasil. Vários estudos apontaram informações controversas quanto à eficácia de alguns atrativos alimentares usados na captura e no monitoramento dessa espécie em diversas frutíferas. Este trabalho objetivou avaliar a eficiência de atrativos alimentares disponíveis no mercado brasileiro usados na captura e no monitoramento de *A. fraterculus* em relação ao suco de uva. O experimento foi conduzido nas safras 2014/2015 e 2015/2016, em pomar de pereiras asiáticas (*Pyrus* spp.), em Caçador, Santa Catarina, Brasil. Os atrativos avaliados foram CeraTrap®, BioAnastrepha®, Torula®, Isca Mosca®, BioFruit® e suco de uva (atrativo padrão no Sul do Brasil). Para cada atrativo avaliado, registrou-se a flutuação populacional de *A. fraterculus*, o número médio de fêmeas e machos capturados, os índices de captura MAD (mosca/armadilha/dia) e mosca/armadilha/semana, o número de indicações de nível de controle e a evaporação média semanal. Os primeiros adultos de *A. fraterculus* foram capturados em novembro, sendo que, em ambas as safras, o pico populacional foi registrado em janeiro. CeraTrap® apresentou maior captura de fêmeas e machos e maior número de indicações de controle em relação aos demais atrativos. O suco de uva foi menos eficaz em relação ao CeraTrap®, inclusive no parâmetro evaporação. Concluiu-se que o CeraTrap® é o atrativo mais eficaz na captura de adultos de *A. fraterculus* e de maior precisão na detecção de seus níveis populacionais em pomar de pereiras asiáticas, portanto, mais recomendável do que o usual suco de uva.

Palavras-chave: *Anastrepha fraterculus*. *Pyrus* spp.. Detecção de limiar de ação. Manejo integrado de pragas.

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INTRODUCTION

The Southern region of Brazil accounts for the largest production of pear, apple, grape, peach, and plum (IBGE, 2015) and an increasing production of citrus fruits, mulberry, raspberry, blueberry, strawberry guava, and Surinam cherry (BOTTON et al., 2016). The South American fruit fly *Anastrepha fraterculus* (Wiedemann, 1830) (Diptera: Tephritidae) has consistently caused damage to these fruit crops, adversely affecting the fruit quality and yields (NAVA; BOTTON, 2010; BOTTON et al., 2016). In pear orchards, damage is observed when the fruits are close to maturation (NORA; SUGIURA, 2001), being caused by female flies which puncture the fruits to lay eggs, as well as by larvae, which create galleries while feeding on the pulp.

Detection and quantification of fruit fly populations in orchards are key actions for the implementation of control strategies in integrated pest management (ALUJA et al., 2012) because they allow to determine the potential for populations to reach the economic and action thresholds, and to make decisions about the control strategies that should be used, such as total area insecticide spraying, or simply the application of toxic baits (ROSA et al., 2013; 2017).

In commercial orchards in Southern Brazil, monitoring of fruit fly populations is usually done with the use of McPhail traps containing one type of food lure to capture adult individuals (MONTEIRO et al., 2007; BOTTON et al., 2016). The food lures frequently used are sugarcane molasses, grape juice, vinegar, and hydrolyzed proteins, which are diluted in water at different concentrations (NORA; SUGIURA, 2001; KOVALESKI, 2004; MONTEIRO et al., 2007; BOTTON et al., 2016). Due to practical aspects and low cost, fruit juices and molasses are more commonly used than hydrolyzed proteins, for either monitoring or preparation of toxic baits (MONTES; RAGA, 2006).

In order to assess the effectiveness of food lures to control *A. fraterculus*, studies have already been conducted in Southern Brazil in orchards with peach (MONTEIRO et al., 2007; JAHNKE; REYES; REDAELLI, 2014), apple (TEIXEIRA et al., 2010; NUNES et al., 2013), guava (JAHNKE; REYES; REDAELLI, 2014), citrus fruits (BORTOLI et al., 2016), grape (BOTTON et al., 2016), feijoa, pear, and plum (ROSA et al., 2017). However, information on research findings is controversial.

In this context, the aim of this study was to assess the effectiveness of commercial food lures available in the Brazilian market to be used for capture and population monitoring of fruit flies in Asian pear orchard in Caçador, Santa Catarina, Brazil.

MATERIAL AND METHODS

This study was carried out in an Asian pear (*Pyrus* spp.) orchard, located in Caçador, State of Santa Catarina, Brazil (26º 51'10.5''S, 50º57'48.9''W, and 980 114 m altitude). The climate in the region, according to the Köppen classification, is Cfb, mesothermal, humid, without dry season, with fresh summer, and annual average temperature of 16.3 °C. The 19-year-old orchard had approximately 0.5 ha, spaced at 5 m between rows and 3 m between plants, and managed via a conventional production system. The orchard was composed of twelve Japanese cultivars (*Pyrus pyrifolia* Nakai var. culta): Shinsui, Okusankichi, Shinseiki, Kousui, Housui, Suisei, Nijisseiki, Niitaka, Hakucho, Choujuurou, Kikusui, and Hakkou, and one Chinese cultivar (*Pyrus bretschneideri* Rehd.): Ya-li. The Choujuurou, Hakkou, Okusankichi, and Ya-li cultivars were grafted on *Pyrus calleryana* Decne. rootstock and the others on *P. betulaefolia*.

The experiment was carried out during the 2014/2015 and 2015/2016 crop seasons. The traps were installed in the first week of November and kept in the field for 20 consecutive weeks, until the end of March of the following year, when they were then removed from the orchard. The evaluations were concentrated in the fruiting period (November to March), because the quantity of adult fruit flies captured in the off-season period is derisory and not economically important. However, two traps were kept in the orchard from May to October to verify the occurrence of fruit flies during the off-season period.

Control of invasive plants in the orchard was done using a micro-tractor to eliminate weeds between the rows and a motorized back cutter between the trees. Phytosanitary treatments were not performed for the control of pest arthropods, only for diseases control.

The following food lures were evaluated in their respective proportions: (a) hydrolyzed protein of animal origin (CeraTrap®, Bioibérica S.A., Barcelona, Spain), undiluted (in water or any other liquid substance), only with replacement of the volume of evaporation loss; (b) aqueous solution of yeast Torula® (Isca Tecnologias Ltda., Ijuí, Rio Grande do Sul, Brazil) at 18g/L; (c) hydrolyzed protein of plant origin (Isca Mosca®, Isca Tecnologias Ltda., Ijuí, Rio Grande do Sul, Brazil) diluted in 5% water; (d) hydrolyzed protein of plant origin (BioAnastrepha®, Bio Controle Ltda., São Paulo, Brazil) diluted in 5% water; (e) hydrolyzed protein of plant origin (BioFruit®, Bio Controle Ltda., São Paulo, Brazil) diluted in 5% water; and (f) processed grape juice (Natus®, Pelegrinello & Cia - Indústria e Comércio de Sucos Ltda., Caçador, Santa

Catarina, Brazil) diluted in 25% water.

The experimental design consisted of randomized blocks with six treatments and four replications; 500 mL of the attractant substance was used in each trap (McPhail model, yellow base, Isca Tecnologias Ltda., Ijuí, Rio Grande do Sul, Brazil), placed in the canopy 1.7 m above the ground. The grape juice was replaced on a weekly basis and the other food lures were replaced every two weeks. In the case of the CeraTrap®, only the evaporated volume was replaced.

Once a week, the captured *Anastrepha* specimens were separated from the lure solution with the aid of a fine mesh sieve, washed with water, and placed into 50 mL plastic containers containing 70% alcohol. In the laboratory, the specimens were counted, separated by sex, and identified based on a dichotomous key for the species *Anastrepha* (ZUCCHI, 2000). The specimens were deposited in the entomologic collections of the Experimental Station of Caçador - Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina (EPAGRI).

For the assessment of food lure efficiency, the number of captured specimens of *A. fraterculus* was calculated by the average number of fruit flies per trap per day (FTD), which was determined by the following formula: FTD = quantity of flies captured/ (number of traps x number of days of exposure of the traps), considering the total number of individuals collected. The number of control indications was calculated according to the parameter used for decision making to control the South American fruit fly in temperate climate fruit crops in Brazil, where control of this pest is recommended from the capture of 0.5 FTD (flies per trap per day). Control is usually achieved in the form of cover sprays or in a mixture with a food lure in toxic bait formulations (NAVA; BOTTON, 2010). For each food lure, the number of females, males, and the total number of flies captured/trap/week were also calculated. During the 2015/2016 crop season, every week, from November to March, the amount of evaporated liquid in the traps was determined using a 500 mL graduated beaker.

The data were analyzed by the R statistical software program, using the Box-Cox transformation when the assumption of normality was not met, and means were compared by Tukey's test ($p < 0.05$). The captured female and male populations were compared by t-test ($p < 0.05$).

RESULTS AND DISCUSSION

During the 2014/2015 crop season, 1,676 flies of the genus *Anastrepha* Schiner were captured, of which 1,671 were *A. fraterculus*, three were *A. sinvali* Zucchi, 1982 (Diptera: Tephritidae), and two were *A. pickeli* Lima, 1934 (Diptera: Tephritidae). In the 2015/2016 crop season, 662 flies were captured (all *A. fraterculus*). Based on Garcia and Norrbom (2011), in the State of Santa Catarina, *A. fraterculus* is the most common species of fruit fly found in temperate-zone fruit orchards. In the South of Brazil, the prevalence of *A. fraterculus* among Tephritidae had already been recorded in pear tree crop (NORA; SIGIURA, 2001; NUNES et al., 2013).

The first adults of *A. fraterculus* were captured in November, and population peaks were found in January, in both crop seasons (Figures 1 and 2). In the two traps kept in the orchard during the off -season period (May to October), no specimen of *A. fraterculus* was captured. In Caçador (SC), pear tree crops enter a dormant state in May. In this period, temperatures begin to fall, with an average temperature below 13 ^{o}C until August. According to Taufer et al. (2000), at temperatures between 9 and 13 ^{o}C, there is no ovarian maturation in *A. fraterculus*. So, these insects can be present in the orchards during cold seasons but cannot reproduce and, therefore, are not responsive to food lure traps.

In the midwest region of Santa Catarina state (BR), Santos et al. (2017) found two periods of high incidence of Tephritidae in apple orchards (January and February), which was associated with semi-early maturing cultivars (hybrids and Gala mutations) and late maturing cultivars (hybrids and Fuji mutations), respectively. In the present study, for the same period, a high incidence of fruit flies was recorded, corresponding to the maturing time of different pear cultivars in the orchard.

Ribeiro (2012) reported that in commercial orchards in São Joaquim, Santa Catarina, the presence of *A. fraterculus* occurred between late November and early February. This author also points out that the greatest number of catches occurred between late December and late January, during which time the need for interventions with insecticide spraying in total area was indicated. Garcia, Campos, and Corseuil (2003) found in a peach orchard in the Western region of Santa Catarina that the highest density of *A. fraterculus* also occurred between December and January. Thus, monitoring of adults is recommended to be made continuously, beginning after flowering and maintained until all fruits are harvested, and in doing so the fruit growers will know the ideal time for detection and control of the pest.

In the two crop seasons, CeraTrap® was the most effective food lure for capturing adults in a McPhail trap, accounting for nearly 75% of the *A. fraterculus* adults captured (Table 1). In the 2014/2015 crop season, there was no difference between the BioAnastrepha®, Torula®, grape juice, and Isca Mosca® food lures, BioFruit® being the least effective. In the 2015/2016 crop season, there was no difference between these food lures (Table 1).

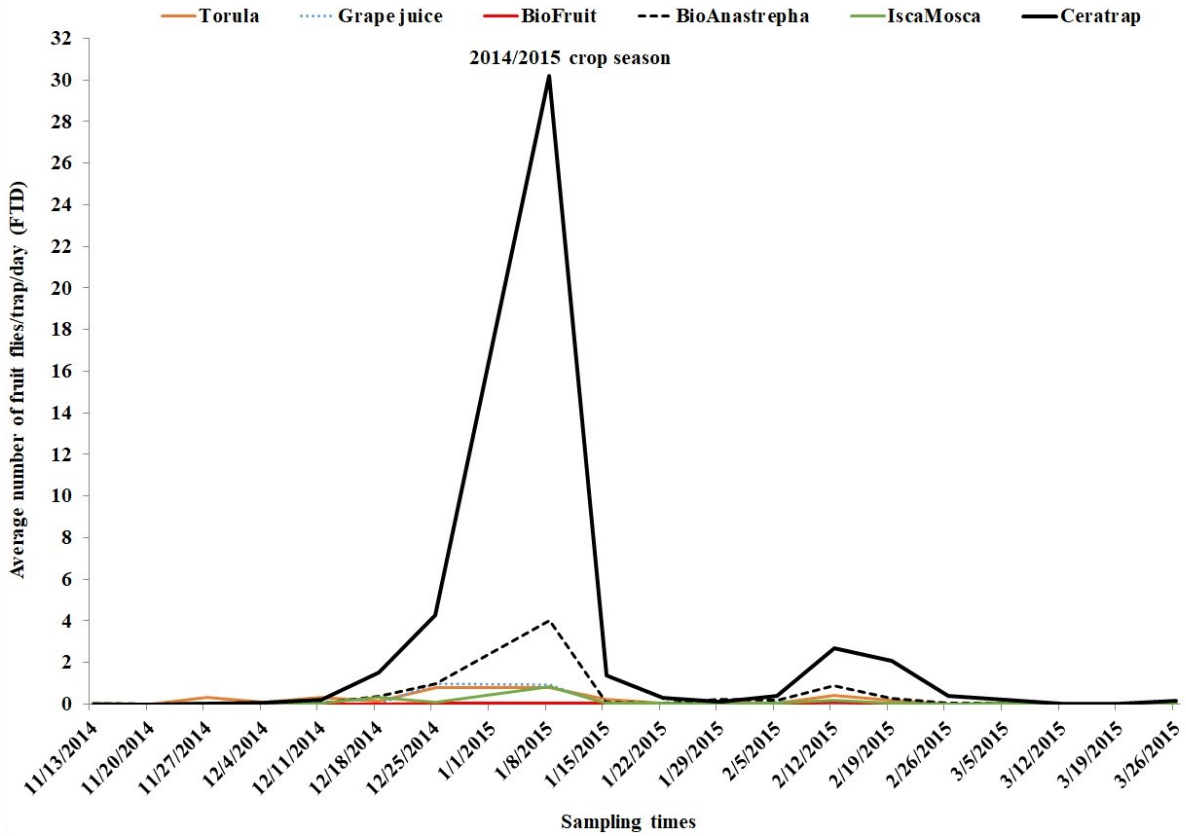

Figure 1. Population fluctuation of *Anastrepha fraterculus* (Diptera: Tephritidae) adults captured in traps with different food lures in Asian pear orchard. Caçador, SC, Brazil (November 2014 to March 2015).

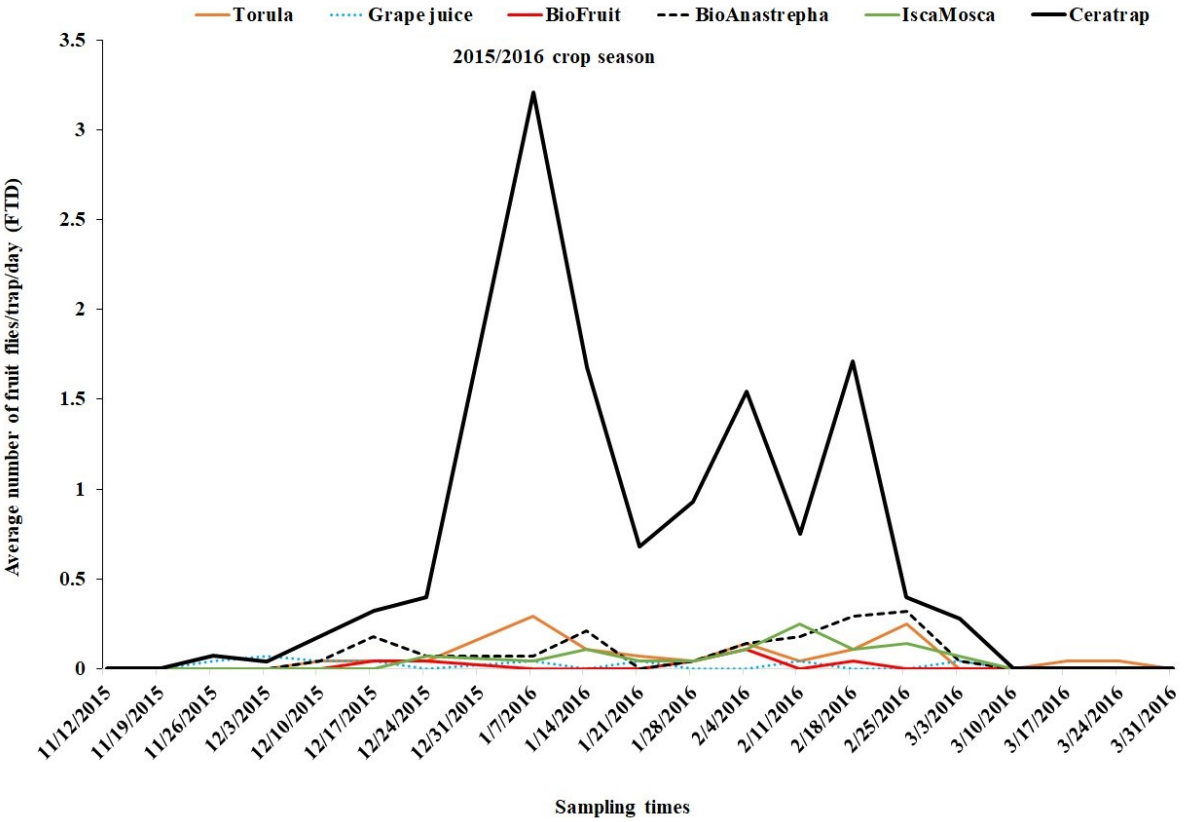

Figure 2. Population fluctuation of *Anastrepha fraterculus* (Diptera: Tephritidae) adults captured in traps with different food lures in Asian pear orchard. Caçador, SC, Brazil (November 2015 to March 2016).

Table 1. Average number (± standard deviation) of *Anastrepha fraterculus* (Diptera: Tephritidae) adults captured/trap/week and number of control indications for different food lures in Asian pear orchard, Caçador, SC, Brazil (2014/2015 and 2015/2016 crop seasons).

Food lures	2014/2015 crop season		2015/2016 crop season	
	Number of adult flies/ trap/week	Control indications	Number of adult flies/trap/ week	Control indications
CeraTrap®	15.63 ± 6.55 a	6	4.26 ± 2.98 a	7
BioAnastrepha®	2.59 ± 2.33 b	3	0.55 ± 0.24 b	-
Torula®	1.21 ± 1.24 b	2	0.43 ± 0.21 b	-
Grape juice	0.80 ± 0.34 b	2	0.11 ± 0.13 b	-
Isca Mosca®	0.58 ± 0.25 b	1	0.34 ± 0.27 b	-
BioFruit®	0.09 ± 0.06 c	-	0.09 ± 0.08 b	

Means within the same column followed by different letters are significantly different by the Tukey's test ($p < 0.05$). Comparison performed in transformed scale.

CeraTrap® was also more effective in capturing *A. fraterculus* than grape juice, BioAnastrepha®, and Torula® in citrus (BORTOLI et al., 2016), plum, pear, and feijoa tree crops (ROSA et al., 2017). Based on Monteiro et al. (2007), depending on the agroecosystem and the attractant's physicochemical characteristics, some formulations are more attractive to fruit fly adults, providing a better capture efficacy. In previous studies to the CeraTrap®, the highest rates of capture of *A. fraterculus* were recorded for Isca Mosca® in citrus tree crop (RAGA et al., 2006), Torula® in peach tree crop (MONTEIRO et al., 2007) and apple tree crop (ZUANAZZI, 2012), and BioAnastrepha® in citrus, peach, and apple tree crop (RAGA et al., 2006; MONTEIRO et al., 2007; TEIXEIRA et al., 2010). A low capture rate of *A. fraterculus* with grape juice at 25% was recorded for peach tree crop (MONTEIRO et al., 2007), apple tree crop (TEIXEIRA et al., 2010; ZUANAZZI, 2012), and grape tree crop (BOTTON et al., 2016). Grape juice at 25% was originally recommended as the standard food lure for capturing fruit flies in apple tree crops in Brazil (RIBEIRO, 2010).

Due to the importance of grape juice for population monitoring of *A. fraterculus* in apple tree crops, its use was extended to plum, pear, peach, and feijoa tree crops, where *A. fraterculus* is a key pest (ROSA et al., 2017). According to Botton et al. (2016), lack of standards for preparation of grape juice has contributed to failures in the detection of fruit flies, because the varying rates of capture may be related to the grape cultivar, harvest season, and processing and storage conditions of the product. Monteiro et al. (2007) comment that the use of ineffective food lures may provide unrealistic information about the population levels in the cultivated area, leading to control failures.

In the 2014/2015 crop season, 657 males and 1,014 females of *A. fraterculus* were captured, and in the 2015/2016 crop season, 232 males and 230 females of this species were captured. It was found that in both crop seasons, CeraTrap® accounted for the largest number of females captured, compared to the other food lures, which did not differ from each other (Table 2). The same pattern was observed in the capture of male specimens (Table 2). During the 2014/2015 crop season, BioAnastrepha® captured more males than females, and CeraTrap® more females than males. Regarding the other food lures there were no differences in the rate of capture between males and females. In the 2015/2016 crop season, BioAnastrepha® also captured more males than females, and for the other food lures no difference was found in the capture of males and females (Table 2). Nunes et al. (2013) observed that hydrolyzed protein captured a larger number of females than males, while for grape juice there were no differences in the number of flies captured. These authors comment that it is important that a food lure captures a larger number of females, since they are responsible for laying eggs and, consequently, for damaging the fruit. This greater capture of females by CeraTrap® is important when using a large amount of traps in the orchard (mass trapping) to control adults. According to Stupp et al. (2021), this technique minimizes the need for insecticide application during the crop season and can assist in managing chemical residue levels in fruit. Bortoli (2014), in a study carried out in citrus orchards, found that CeraTrap®, when compared to BioAnastrepha®, Torula®, grape juice, and corn syrup, captured a higher percentage of *A. fraterculus* immature females, still in the early stages of reproductive development. In addition, the authors demonstrated that CeraTrap® was more constant in

the capture of adults compared to the other food lures, making it possible to detect the presence of South American fruit fly in the initial outbreaks of infestation, thus being more effective in managing this pest.

In the 2014/2015 crop season, the CeraTrap® indicated the need for six applications of insecticide in total area (FTD higher than 0.5 flies/trap/day); BioAnastrepha® presented three control indications; Torula® and grape juice two indications; and Isca Mosca® one control indication. With the Biofruit® there was no control indication (Table 1). In the 2015/2016 crop season, CeraTrap® presented seven control indications, and it was the only food lure that indicated the need for insecticide applications (Table 1).

Table 2. Average number (± standard deviation) of *Anastrepha fraterculus* (Diptera: Tephritidae) males and females captured/trap/week with different food lures in Asian pear orchard, Caçador, SC, Brazil (2014/2015 and 2015/2016 crop seasons).

Food lures	Females	Males
	2014/2015 crop season	
CeraTrap®	10.4 ± 4.11 Aa	5.24 ± 2.546 Ab
BioAnastrepha®	0.84 ± 0.945 Bb	1.75 ± 1.395 Ba
Torula®	0.68 ± 0.639 Ba	0.54 ± 0.609 Ba
Grape juice	0.35 ± 0.178 Ba	0.45 ± 0.271 Ba
Isca Mosca®	0.39 ± 0.263 Ba	0.19 ± 0.063 Ba
BioFruit®	0.04 ± 0.048 Ba	0.05 ± 0.071 Ba
	2015/2016 crop season	
CeraTrap®	2.3 ± 1.83 Aa	1.95 ± 1.18 Aa
BioAnastrepha®	0.1 ± 0.11 Bb	0.45 ± 0.18 Ba
Torula®	0.26 ± 0.11 Ba	0.16 ± 0.15 Ba
Grape juice	0.06 ± 0.09 Ba	0.05 ± 0.04 Ba
Isca Mosca®	0.11 ± 0.07 Ba	0.23 ± 0.21 Ba
BioFruit®	0.02 ± 0.03 Ba	0.06 ± 0.08 Ba

Means followed by the same lowercase letters in a column do not differ from each other by the Tukey's test ($p < 0.05$). Means followed by the same lowercase letter in rows do not differ from each other by the t-test ($p < 0.05$). Comparison performed in transformed scale.

There were significant captures using CeraTrap® during the pear trees' maturing time, a critical period of high susceptibility to *A. fraterculus* attacks. Therefore, in this period, control failures might have affected production adversely, because in January the fruits of Shinsui, Shinseiki, Kousui, Housui, Suisei, and Kikusui cultivars were already maturing and in mid-February, the fruits of Okusankichi, Nijisseiki, Niitaka, Hakucho, Choujuurou, Hakkou, and Ya-li cultivars began maturing.

With respect to the food lures' evaporation, it was found that CeraTrap® presented a lower rate of evaporation compared to the Biofruit®, BioAnastrepha®, and grape juice (Table 3). Hypothetically, this fact occurred because it is a concentrated substance that does not require water dilution. Corroborating this, Lasa and Cruz (2014) found that CeraTrap® indicated field stability, a durability up to three months, and high capture efficacy, as well as high selectivity for non-targeted organisms. Bortoli et al. (2016) found that there was no need to replace or change CeraTrap® for a period of up to 60 days in citrus orchards, it only being necessary to replace the evaporated volume. Botton et al. (2016) also recorded similar results in grapevines. Therefore, CeraTrap® allows for less sampling effort on the part of trap monitors, as it does not require periodic changes made every 7 or 15 days like other food lures available on the market. In addition, the capture efficiency allows this food lure to be used in mass trapping in different cropping systems, including in organic production.

From this study, we concluded that the CeraTrap® was the most effective food lure in the capture and population monitoring of *A. fraterculus* in Asian pear tree crop. Thus, population monitoring with CeraTrap® can minimize losses caused by this tephritid in Asian pear crops due to its high accuracy in detecting the pest, which will facilitate the decision making for control. We suggest that feasibility studies on the use of toxic bait and mass capture in Brazil be resumed, because the demonstrated efficacy of this food lure compared to other formulations assessed makes this product a promising tool for an integrated pest management (IPM) strategy for fruit fly.

Table 3. Mean weekly evaporation in mL (± standard deviation) of different food lures used for capture and population monitoring of fruit flies in Asian pear orchard, Caçador, SC, Brazil (November 2015 to March 2016).

Food lures (formulation)	Weekly evaporation (mL)
CeraTrap® (undiluted)	46.2 ± 4.95 a
Torula® (18 g diluted in 1 L of water)	64.5 ± 9.39 ab
Isca Mosca® (diluted in 5% water)	66.3 ± 6.08 ab
BioFruit® (diluted in 5% water)	73.2 ± 7.67 bc
BioAnastrepha® (diluted in 5% water)	82.7 ± 15.94 bc
Grape juice (diluted in 25% water)	93.6 ± 13.12 c

Means followed by the same letter do not differ from each other by the Tukey's test at 5% probability of error. Comparison performed in transformed scale.

CONCLUSIONS

CeraTrap® food lure is more effective in capture and population monitoring of *A. fraterculus*, captures greater numbers of females and males, and has a higher number of control indications when compared to the other food lures evaluated, while the grape juice (the standard food lure used in Southern Brazil) has lower effectiveness compared to CeraTrap®, including the evaporation parameter.

REFERENCES

ALUJA, M. et al. Understanding long-term fruit fly (Diptera: Tephritidae) population dynamics: implications for area wide management. **Journal of Economic Entomology**, 105: 823-836, 2012.

BORTOLI, L. C. **Interações tritróficas entre moscas-das-frutas (Diptera: Tephritidae), seus hospedeiros e inimigos naturais (Hymenoptera) e avaliação de atrativos alimentares para o monitoramento na Região da Serra Gaúcha, RS**. 2014. 90 f. Dissertação (Mestrado em Fitossanidade: Área de Concentração em Entomologia) – Universidade Federal de Pelotas, Pelotas, 2014.

BORTOLI, L. C. et al. Evaluation of food lures for fruit flies (Diptera: Tephritidae) captured in a citrus orchard of the Serra Gaúcha. **Florida Entomologist**, 99: 381-384, 2016.

BOTTON, M. et al. Ceratrap – Monitoramento e supressão populacional de moscas-das-frutas. **Revista Campo & Negócios Hortifrúti**, 129: 84-86, 2016.

GARCIA, F. R. M.; CAMPOS, J. V.; CORSEUIL, E. Flutuação populacional de *Anastrepha fraterculus* (Wiedemann, 1830) (Diptera, Tephritidae) na região Oeste de Santa Catarina, Brasil. **Revista Brasileira de Entomologia**, 47: 415-420, 2003.

GARCIA, F. R. M.; NORRBOM, A. L. Tephritoid flies (Diptera, Tephritoidea) and their plant hosts from state of Santa Catarina in Southern Brazil. **Florida Entomologist**, 94: 151-157, 2011.

IBGE – Instituto Brasileiro de Geografia e Estatística. **Banco de Dados Agregados, Sistema IBGE de Recuperação Automática** - SIDRA. 2015. Disponível em: <http://www.cidades.ibge.gov.br/xtras/home.php>. Acesso em: 05 fev. 2020.

JAHNKE, S. M.; REYES, C. P.; REDAELLI, L. R. Influência da fase de maturação de pêssegos e goiabas na atratividade de iscas para *Anastrepha fraterculus*. **Científica**, 42: 134-142, 2014.

KOVALESKI, A. Pragas. In: KOVALESKI, A. (Ed.). **Maçã: Fitossanidade**. Bento Gonçalves, RS: Embrapa Uva e Vinho; Brasília, DF: Embrapa Informação Tecnológica, 2004. v. 1, cap. 2, p. 10-33.

LASA, R.; CRUZ, A. Efficacy of new commercial traps and the lure Ceratrap® against *Anastrepha obliqua* (Diptera: Tephritidae). **Florida Entomologist**, 97: 1369-1377, 2014.

MONTEIRO, L. B. et al. Avaliação de atrativos alimentares utilizados no monitoramento de mosca-das-frutas em pessegueiro na Lapa-PR. **Revista Brasileira de Fruticultura**, 29: 72-74, 2007.

MONTES, S. M .N. M.; RAGA, A. Eficácia de atrativos para monitoramento de *Ceratitis capitata* (Diptera: Tephritidae) em pomar de citros. **Arquivos do Instituto Biológico**, 73: 317-323, 2006.

NAVA, D. E.; BOTTON, M. **Bioecologia e controle**

de *Anastrepha fraterculus* e *Ceratitis capitata* em pessegueiro. 1. ed. Pelotas, RS: Embrapa Clima Temperado, 2010. 29 p. (Documento 315).

NORA, I.; SUGIURA, T. Pragas da pereira. In: EPAGRI (Ed.). **Nashi, a pêra japonesa**. Florianópolis, SC: Epagri/Jica, 2001. v. 1, cap. 11, p. 261-321.

NUNES, M. Z. et al. Avaliação de atrativos alimentares na captura de *Anastrepha fraterculus* (Wiedemann, 1830) (Diptera: Tephritidae) em pomar de macieira. **Revista de la Facultad de Agronomia**, 112: 91-96, 2013.

RAGA, A. et al. Eficácia de atrativos alimentares na captura de mosca-das-frutas em pomar de citros. **Bragantia**, 65: 337-345, 2006.

RIBEIRO, L. G. Manejo das principais pragas da macieira no Brasil. **Agropecuária Catarinense**, 23: 149-157, 2010.

RIBEIRO, L. G. Flutuação populacional da mosca-das-frutas na cultura da pereira na região de São Joaquim. **Agropecuária Catarinense**, 25: 126, 2012.

ROSA, J. M. et al. Andiroba oil (*Carapa guianenses* Aubl) in the capture of the fruit fly (*Anastrepha fraterculus* Wiedemann) in feijoa (*Acca sellowiana* (Berg) Burret). **Idesia**, 31: 97-101, 2013.

ROSA, J. M. et al. Evaluation of food lures for capture and monitoring of *Anastrepha fraterculus* (Diptera: Tephritidae) on temperate fruit trees. **Journal of Economic Entomology**, 110: 995-1001, 2017.

SANTOS, J. P. et al. Flutuação populacional e estimativa do número de gerações de *Anastrepha fraterculus* (Diptera: Tephritidae) em pomar de macieira em Caçador, Santa Catarina, Brasil. **Arquivos do Instituto Biológico**, 84: 1-7, 2017.

STUPP, P. et al. Mass trapping is a viable alternative to insecticides for management of *Anastrepha fraterculus* (Diptera: Tephritidae) in apple orchards in Brazil. **Crop Protection**, 139: 1-6, 2021.

TAUFER, M. et al. Efeito da temperatura na maturação ovariana e longevidade de *Anastrepha fraterculus* (Wied) (Diptera: Tephritidae**). Anais da Sociedade Entomológica do Brasil**, 29: 639-648, 2000.

TEIXEIRA, R. et al. Atratividade de iscas alimentares comerciais para mosca-das-frutas em pomares de macieira. **Agropecuária Catarinense**, 23: 84-88, 2010.

ZUANAZZI, J. V. Mosca das frutas, em curto prazo um panorama sombrio. **Jornal da Fruta**, 256: 20-20, 2012.

ZUCCHI, R. A. Taxonomia. In: MALAVASI, A; ZUCCHI, R.A. (Ed.). **Moscas-das-frutas de importância econômica no Brasil: conhecimento básico e aplicado**. Ribeirão Preto: Holos, 2000. cap. 1, p. 13-24.