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Scientific Note

Absence of *Anastrepha grandis* (Macquart, 1846) (Diptera: Tephritidae) in the coastal plain of Piauí, Brazil

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Abstract. Brazil is a large producer of cucurbits; despite the productive advantage, the country still has a low insertion in the international market due to the quarantine restrictions imposed by the *Anastrepha grandis* (Macquart, 1846) (Diptera: Tephritidae) presence. In this context, we conducted a study using McPhail traps and fruit sampling for three consecutive harvests to investigate the presence of A. grandis in commercial watermelon cultivation located in the Irrigation District of the Coastal Plateau of Piauí, Northeast Brazil. *Anastrepha grandis* was not registered in the coastal plain of Piauí, demonstrating the potential to establish a Pest Free Area. For this purpose, developing a pilot project on a larger time scale covering several properties and municipalities in Piauí is necessary.

Keywords: Fruit fly, Quarantine pests, Pest Free Area.

More than 10 fruit flies (Diptera: Tephritidae) species are known to infest cucurbits, particularly species of the genus *Anastrepha* Schiner, 1868 (Bolzan et al. 2017), *Bactrocera* Macquart, 1835 (Dominiak & Worsley 2018) and *Zeugodacus* Hendel, 1927 (Meyer et al. 2015). The only species that infests Cucurbitaceae in America is the South American cucurbit fruit fly (SACFF), *Anastrepha grandis* (Macquart, 1846); its geographic distribution includes countries such as Brazil, Paraguay, the Andean Mountain Chain from Bolivia to Venezuela, and Panamá (Silva et al. 2019a; 2019b). Despite the direct damage to fruit, the major importance of this pest is associated with economic embargoes imposed by importing countries free of the pest (Silva et al. 2019a; 2019b).

Brazil became a large producer and exporter of Cucurbitaceae through the establishment of the SACFF fruit fly Pest Free Area (SACFF PFA) and the use of the Systems Approach for SACFF risk management (Rabelo et al. 2013; Silva et al. 2019a; 2019b). Productivity has increased exponentially due to the increase in technological level and the intensification of activity, which is based mainly to the significant rise on irrigated production systems (Silva et al. 2019b). The opening of new markets was only possible in the 1990s, when the absence of the pest (SACFF PFA) was officially recognized in the Rio Grande do Norte and Ceará States (Silva et al. 2019b), followed by the implementation of a SACFF Systems Approach in areas where the SACFF is present at low prevalence in 38 municipalities distributed in Bahia, Goiás, Minas Gerais, São Paulo, Paraná, Rio Grande do Norte and Rio Grande do Sul (Silva et al. 2019b).

The establishment, maintenance, and expansion of the SACFF PFA and SACFF Systems Approach are indispensable conditions for maintaining Brazil's status as one of the main world producers and exporters of melons, watermelon, and other cucurbits. The presence or absence of the SACFF is only monitored in the officially inserted municipalities in the SACFF PFA and SACFF Systems Approach. Rare scientific studies have investigated the presence and ecology of SACFF in the field, except for the study of Rabelo et al. (2013) in the Brazilian Central region and Raga et al. (2006) in the Brazilian Southeast region. This finding is highly important for supporting the expansion of the SACFF PFA in Brazil. Here, we conducted a study using traps and fruit sampling for three consecutive harvests to record the presence or absence of *A. grandis* in cucurbit production in the coastal plain of Piauí, Northeast Brazil.

The SACFF survey was developed on a rural property that historically cultivated approximately 100 ha of watermelon (*Citrullus lanatus* (Thunb.) Matsum & Naka) per agricultural year. The watermelon is sustained in the field by consecutive and concomitant harvests during the entire agricultural year due to dividing the property area into irrigated plots. The rural property is in the Irrigation District of the Coastal Plateau of Piauí (3°01'32.5"S 41°44'02.0" W), which is in the Parnaíba municipality, northern region of Piauí state, Brazil. The confluence of biomes, transition areas or interaction between coastal vegetation, Caatinga, Cerrado, and Amazon Forest marks the local landscape. The region is characterized by climatic stability, minimal seasonal variation, and periods of high temperatures interspersed with rainy and dry seasons.

The National System for the Management of Genetic Heritage and Associated Traditional Knowledge (SISGEN) supported the sampling, authorization number A3B7F42. Each harvest (planting) of watermelon represents a plot of 5 ha, with 15 ha of watermelon being monitored during three consecutive harvests. The watermelon was cultivated at a spacing of 1 x 2.05 m and was used for the Top Gun, Hollar, and Magnun cultivars. From February to August 2020, the insects were monitored using five McPhail-type traps, supplied with 500 mL of the attraction (hydrolyzed corn protein - Biofruit®) diluted in 5% water and distributed around edges and in the central part of the watermelon production area. The removal and exchange of the attraction were performed weekly. The captured insects were packed in glass flasks and sent to the Entomology Laboratory of Piauí State University for screening. The incidence of the fruit flies studied was quantified by determining the capture index according to the FTD index (FTD = M / A x D). Where M = Number of flies captured, A = Number of traps, and D = Number of days trap exposure. From June to August 2020, the watermelon fruits (100 units) without signs of larval exit holes were randomly sampled to check for *A. grandis* larvae infestation. The fruits

were collected and transported to the Entomology Laboratory, where were individualized and opened to check for tephritid larvae.

During the experiment, there was no register of *A. grandis* in any of the traps and fruits (Tab. 1). Furthermore, no Tephritidae species were registered in traps and fruits (Tab. 1). On the other hand, lacewings and bees were captured in the traps (Tab. 1). Lacewings are important natural enemies of cucurbit pests (Bezerra et al. 2010). Bees are the main pollinators of several plants, including watermelons (Souza & Malerbo-Souza 2005). The grower remained ten *Apis mellifera* Linnaeus, 1758 (Hymenoptera: Apidae) hives for watermelon pollination in the production area under study.

SACFF has a South-Central distribution, being recorded in at least 62 municipalities in 10 Brazilian states (Tab. 2). Studies usually collect SACFF in non-host fruit production areas (Tab. 2). Here, we sought to investigate the SACFF presence in cucurbit production areas with consecutive watermelon harvests. However, SACFF was not captured in the traps nor recorded as infesting watermelon fruits. Similar results were reported by Araújo et al. (2009) in Ceará state in Northeast Brazil, where no fruit fly was found in melon cultivation in the municipalities of Aracati, Icapuí, and Itaçaba. In addition, studies in cucurbit production areas have revealed the presence of SACFF in low populations in the states of Goiás (Veloso et al. 2012; Rabelo et al. 2013), São Paulo (Lampert et al. 2020), Santa Catarina (Garcia & Norrbom 2011) and Paraná (Savaris et al. 2021) in Brazil.

Piauí began investigating fruit flies relatively recently, which resulted in a significant delay in obtaining information compared to other producing states (Silva et al. 2023). Currently, *Ceratitis capitata* (Wiedemann, 1824) and 21 species belonging to the genera *Anastrepha* have been cataloged and 17 fruit hosts are known, which are infested by 12 fruit fly's species (Silva et al. 2023). During approximately 30 years of sampling efforts, no specimens of SACFF were recorded in Piauí (Silva et al. 2023). However, our study did not aim to record and monitor the SACFF in areas where cucurbits are produced (Silva et al. 2023). The only exception concerns monitoring in a melon production area carried out by Biofábrica Moscamed Brasil at the farm Itaueira Agropecuária S.A. in Canto do Buriti municipality, where *Anastrepha dissimilis* Stone, 1942; *Anastrepha distincta* (Greene, 1934); *Anastrepha montei* Lima, 1934 and *Anastrepha zenildae* Zucchi, 1979 were collected in McPhail traps (Silva et al. 2023). In the coastal plain of Piauí, the species *Anastrepha pickeli* Lima, 1934; *Anastrepha fraterculus* (Wiedemann, 1830), *Anastrepha sororcula* Zucchi, 1979; *A. zenildae*, and *C. capitata* have already been recorded (Silva et al. 2023). Here, no Tephritidae fruit fly was recorded.

The farm grows watermelon continuously and has uninterrupted availability of host fruits at different degrees of maturation. During the study, the presence of discarded and abandoned mature fruits was regularly observed. However, the presence of SACFF was not verified, not even at the peak of the watermelon harvest. The period of greater concentration of ripe fruits in the field typically contrasts with the period of greater fruit fly population (Nascimento & Carvalho 2000).

The absence of adult and immature SACFF reinforces the hypothesis that the coastal plain of Piauí has the potential to install an area free of SACFF PFA. The climate is hot and dry in coastal plains, and the soil is sandy with low water availability. Recent studies indicate that the SACFF is unlikely to be established in regions with these characteristics (Mesquita Filho et al. 2021). Furthermore, it is important to emphasize that the coastal plain of Piauí is geographically close to the SACFF PFA and has similar geoclimatic characteristics.

In summary, this study reports that the species *A. grandis* was not recorded in an area of commercial watermelon production in the

Table 1. Number of insects trapped in MacPhail trap and pupae collected in watermelon fruits from February to August 2020 in Parnaíba, Piauí.

Week	Date	Trap					FTD	Other insects			Fruits	
		1	2	3	4	5		Tephritidae	Chrysopidae	Apidae	Amount	Pupae
1	02/25	0	0	0	0	0	0	0	1	0	-	-
2	03/03	0	0	0	0	0	0	0	0	1	-	-
3	03/10	0	0	0	0	0	0	0	0	0	-	-
4	03/17	0	0	0	0	0	0	0	0	10	-	-
5	03/24	0	0	0	0	0	0	0	1	3	-	-
6	03/31	0	0	0	0	0	0	0	3	1	-	-
7	04/07	0	0	0	0	0	0	0	3	2	-	-
8	04/14	0	0	0	0	0	0	0	0	0	-	-
9	04/21	0	0	0	0	0	0	0	0	0	-	-
10	04/28	0	0	0	0	0	0	0	0	0	-	-
11	05/05	0	0	0	0	0	0	0	0	6	-	-
12	05/12	0	0	0	0	0	0	0	0	0	-	-
13	05/19	0	0	0	0	0	0	0	0	0	-	-
14	05/26	0	0	0	0	0	0	0	0	0	-	-
15	06/02	0	0	0	0	0	0	0	2	0	-	-
16	06/09	0	0	0	0	0	0	0	0	0	13	0
17	06/16	0	0	0	0	0	0	0	0	0	13	0
18	06/23	0	0	0	0	0	0	0	2	0	13	0
19	06/30	0	0	0	0	0	0	0	10	0	13	0
20	07/07	0	0	0	0	0	0	0	8	2	10	0
21	07/14	0	0	0	0	0	0	0	0	5	4	0
22	07/21	0	0	0	0	0	0	0	1	6	-	-
23	07/28	0	0	0	0	0	0	0	0	2	-	-
24	08/04	0	0	0	0	0	0	0	6	37	-	-
25	08/11	0	0	0	0	0	0	0	0	22	12	0
26	08/18	0	0	0	0	0	0	0	0	19	12	0
27	08/25	0	0	0	0	0	0	0	0	0	10	0

Table 2. New synthesis of the *Anastrepha grandis* distribution in Brazil.

State	Municipality (references)
Bahia	Ilhéus e Wenceslau Guimarães (1)
Distrito Federal	Brasília (2)
Goiás	Aparecida de Goiânia, Goiânia, Hidrolândia, São Miguel do Passa Quatro, Silvânia, Vianópolis, Orizona e Turvânia (3); Cristalina, Ipameri, Rio Verde e Goianésia (4); Jaraguá e Uruana (4,5)
Mato Grosso do Sul	Aquidauana e Rochedo (6); Terenos (7)
Minas Gerais	Caldas (8); Viçosa (9)
Rio de Janeiro	Bom Jesus do Itabapoana e Natividade (10); Campos dos Goytacazes (11); Itaocara (11; 12)
São Paulo	Piracicaba (13, 14, 15); Serra Negra (16); Monte Alegre do Sul (16, 17, 18); Campinas, Socorro, Bauru, Caconde, Ituverava, Canas, Guaratinguetá, Registro, Pindorama, São Bento do Sapucaí, Pirapozinho, Presidente Epitácio, Regente Feijó, Presidente Prudente, Presidente Bernardes, Presidente Venceslau e Lucélia (18)
Paraná	Coronel Vivida (14); Cerro Azul, Lapa, Pinhais e Porto Amazonas (19)
Santa Catarina	Iraceminha (20); Xanxerê (21); Chapecó (21; 22); Dionísio Cerqueira (23); Cunha Porã e São Carlos (24)
Rio Grande do Sul	Montenegro e Pareci novo (25); Pinto Bandeira (26); Porto Alegre (27)

[1]Melo et al. (2016); [2]Viana et al. (2019); [3]Veloso et al. (2005) *apud* Veloso et al. (2012); [4]Veloso et al. (2012); [5]Rabelo et al. (2013); [6]Uchôa-Fernandes et al. (2002); [7]Uchôa-Fernandes et al. (2003); [8]Rossi et al. (1988); [9]Pirovani et al. (2010); [10]Ferrara et al. (2005); [11]Leal et al. (2009); [12]Aguiar-Menezes et al. (2008); [13]Uramoto et al. (2003); [14]Savaris et al. (2021); [15]Soares et al. (2024); [16]Baldo et al. (2017); [17]Lemos et al. (2015); [18]Mesquita Filho et al. (2021); [19]Monteiro et al. (2018); [20]Alberti et al. (2012); [21]Garcia et al. (2003); [22]Zilli & Garcia (2010); [23]Garcia & Lara (2006); [24]Garcia et al. (2003); [25]Silva et al. (2006); [26]Bortoli et al. (2016); [27]Garcia & Corseuil (1998).

Irrigation District of the Coastal Plateau of Piauí. It reveals that the coastal plain of Piauí has the potential to establish an area free of A. grandis in Brazil. For this purpose, a pilot project on a larger scale covering several properties and municipalities in northern Piauí is necessary.

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Author's Contributions

MAS: Funding acquisition, Conceptualization, Project administration, Supervision, Taxonomic identification, Formal analysis, Writing - original draft, Writing - review & editing; GCDBS: Funding acquisition, Conceptualization, Project administration, Supervision, Taxonomic identification, Formal analysis, Writing - original draft, Writing - review & editing; MESV: Funding acquisition, Conceptualization, Taxonomic identification, Formal analysis, Writing - original draft, Writing - review & editing; LLGOR: Investigation, Writing - original draft, Writing - review & editing.

Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

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