GUAVA *PSIDIUM GUAJAVA* (L.) MAY HAVE THE POTENTIAL TO BE A GOOD HOST FOR MANY TEPHRITIDS

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Summary

Guava (*Psidium guajava*) is grown throughout the world and particularly in the tropics and subtropics. Fruit and other plant parts are used in folk and traditional medicine to treat a wide range of medical aliments. Guava is attractive to tephritids and a high percentage of crops are infested. I conducted a literature review to identify the host suitability index of ten tephritids. Most tephritids were reported in the highest category of "very good", supporting >100 adults per kg of fruit. More research is required to further assess if guava is a very good host for other tephritids.

Keywords: suitability, index, fruit fly, infestation

INTRODUCTION – GUAVA PLANTS

Guava (*Psidium guajava* L.) is one of the most ubiquitous tropical fruits of the Myrtaceae family and is commonly used as a food throughout the world (Sarwar *et al.* 2014). The plant can be found in all tropical and subtropical regions on America (Junior *et al*. 2013). Guava is frequently grown in orchards or harvested from the wild. Extracts of root, bark and leaves of guava are used in folk medicine to treat gastroenteritis, vomiting, diarrhoea, wounds, ulcers, toothache, coughs, sore throat, inflamed gums and many other conditions (Sarwar *et al.* 2014). Additionally, guava has been widely used in traditional medicine to treat hypertension, inflammation, pain and diabetes (Diaz-de-Cerio *et al.* 2017).

Guava is sometimes included in the super foods because it is rich in dietary fibre, vitamins A and C, folic acid, dietary minerals, potassium, copper and manganese. Additionally, guavas have a low-calorie profile and are a source of antioxidants, carotenoids and polyphenols (Sarwar *et al.* 2014). Brazil is one of the world's largest producers of guava with a production of 328,000 tonnes in 2009. Similarly, Mexico, has a long history of local consumption and guava export potential (Birke and Alija 2011). In Africa, guava is the third most important fruit grown in terms of area in Eritrea (Hussain *et al.* 2015). However, fruit flies are a major obstruction to guava commercialisation (Junior *et al.* 2013).

GUAVA AS HOST PLANTS FOR FRUIT FLIES

When ripe, guava fruit emit a pungent, musky or sweet-smelling odour that attracts fruit flies (Sarwar *et al.* 2014). Guava fruit may have some properties that promote or improve reproductive potential in the fruit fly life cycle. Carambola fruit fly, *Bactrocera carambolae* (Drew & Hancock), emerged from guava weighed 12.24 mg but only 8.16 mg when emerging from carambola (*Averrhoa carambola* L.) (Castilho *et al.* 2019). In a laboratory assessment with the choice of six host fruit, peach fruit fly (*Bactrocera zonata* (Saunders)) developed 318 pupae per guava fruit with an 88.6% emergence. This compared to banana, the second most preferred fruit, with 266 pupae per fruit with a 36.8% emergence (Rauf *et al.* 2013). Guava could support >1,000 pupae per kg when co-infested with *Anastrepha fraterculus* (Bezzi), *A. striata* (Schiner) and *B. carambolae* (Deus *et al.* 2016).

Guava is a preferred and frequently damaged host fruit (Sarwar *et al.* 2014). In Africa, Hussain *et al.* (2015) found 31% of guava fruit were infested with *Bactrocera dorsalis* (Hendel) or *Ceratitis capitata* (Wiedemann) in Eritrea. Mwatawala *et al.* (2006) found *Bactrocera invadens* (Drew, Tsuruta & White) (syn. *B. dorsalis*, (Schutze et al. 2014)) infested 37.5% of fruit in Tanzania. Similarly, Rwomushana *et al.* (2008) reported 32.9 % of fruit was infested by *B. invadens* in Kenya. Additionally, *Bactrocera invadens* caused up to 92.5% infestation in Mozambique (Jose *et al.* 2013). Levels of infestation can be affected by country, season, altitude, climate and other factors (Mwatawala *et al.* 2006, Rwomushana *et al.* 2008, Follett *et al.* 2021).

Where no pest management is practiced, the entire guava crop is damaged (Quresh and Hussain 1993). In Pakistan, *B. zonata* infested up to 18.6% of guavas (Sarwar *et al.* 2014). In West Pakistan, *B. zonata* damaged 25-50% of fruit (Syed *et al.* 1970). High levels of infestation of guava resulted in abandoning production in Southern Pakistan (Sarwar *et al.* 2014). In India, *B. correcta* (Bezzi), guava fruit fly, caused fruit damage ranging from 60 to 80% (Jalaluddin *et al*. 1999).

In the Americas, similar issues are reported. *Anastrepha sorocula* (Zucchi) and *A. zenildae* (Zucchi) were bred from guava fruit however infestation rates were not recorded but samples were dominated by *A. striata* (Maciel *et al.* 2017). Regarding *A. fraterculus*, guava cultivars with the highest infestation rates were correlated with the highest soluble solids content and colour, with yellow fruit being more attractive (de Oliveira *et al.* 2014). In Costa Rica, *A. striata* was detected in 97.8% of all guava fruits (Junior *et al.* 2013). *Anastrepha striata* infested 70.8% of examined fruit in Ecuador (Junior *et al.* 2013) and 65.6% in eastern Amazon (Deus *et al.* 2016).

In Australia, guava is not grown commercially but is frequently found in urban backyards (Dominiak *et al.* 2020; Lloyd *et al.* 2013). Regarding *Bactrocera tryoni* (Froggatt), Lloyd *et al.* (2013) found guava was more heavily infested (318 adults/kg) in the sub-tropical Queensland compared with the temperate New South Wales (92 adults/kg) (Dominiak *et al.* 2020) (Table 1.). In Western Australia, Woods *et al.* (2005) found guava heavily infested (160 adults/kg) by *C. capitata*.

Table 1. Guava host suitability based on the number of pupae or adults detected in one kg of guava fruit. Host suitability index (HSI) based on Follett et al (2021).

Species	Pupae per kg of fruit and HIS	Adults per kg of fruit and HSI	Reference
*Anastrepha spp.**	231 (VG)		Maciel *et al*. (2017).
Anastrepha fraterculus (Wiedemann)	261 (VG)		Ovruski *et al.* (2003).
Anastrepha striata (Schiner)	86 (G)		Junior *et al.* (2013).
Bactrocera dorsalis (Hendel)	217 (VG)	142 (VG)	Jose *et al.* (2013).
Bactrocera frauenfeldi (Schiner)	174-580 (VG)		Leblanc and Allwood (1996)
Bactrocera tryoni (Froggatt)		92 (G)	Dominiak *et al.* (2020).
		318 (VG)	Lloyd *et al*. (2013).
Ceratitis anonae (Graham)		133 (VG)	Copeland *et al.* (2006)
Ceratitis capitata (Wiedemann)		160 (VG)	Woods *et al*. (2005).
Ceratitis cosyra (Walker)		948 (VG)	de Graaf (2009)
Ceratitis fascivenytris (Bezzi)		182 (VG)	Copeland *et al.* (2006)
Ceratitis rosa (Karsch)		1072 (VG)	de Graaf (2009)

* Sample was dominated by *A. striata* with 258 of the 273 *Anastrepha* spp (5 species) detected in guava fruit.
VG = very good (>100 adults/kg of host fruit from Follett *et al.* (2021))
G = good (10-100 adults/kg of host fruit from Follett *et al*. (2021))

INDEX FOR REPORTING INFESTATION

I used a literature review to gather data on tephritid infestation of guava fruit. Unfortunately, many papers report tephritid infestations in several formats and this makes comparison between host fruit or countries difficult. There is merit in reporting infestation in a standard format. Follett *et al.* (2021) proposed a host suitability index based on the capacity of different host fruit to support a complete life cycle of fruit flies. The index is based on the number of fruit flies that could complete their life cycle per kg of fruit. Ideally, data gathered from field infestations is more likely to reflect genuine capacity, compared with laboratory generated data (Cowley *et al.* 1992, Follett *et al.* 2021). In my review, some authors focused on detections of pupae per kg of fruit. This pupal data does not fully reflect the host's capacity to support the full life cycle (see *B. dorsalis* in Table 1), but it does serve as a guide in the absence of adult survival per kg of fruit.

Unfortunately, there is less data published on guava compared to some worldwide commercially grown fruit. The available data is presented in Table 1. Most impressively, *Ceratitis rosa* (Karsch) produced 1072 adults per kg (de Graaf 2009) and was the most efficient user of guava fruit flesh requiring only 0.93 g to complete their life cycle. This is compared to *C. capitata* (Wiedemann), much more widely distributed internationally, which used 6.25 g per adult (Woods *et al.* 2005). Generally, guava fruit fall into the highest category of suitability; this is a "very good" host supporting more than 100 adults per kg of fruit. This "very good" suitability compares with the suitability of fruit such as oranges (*Citrus sinensis* (L.) Osbeck) which supports a range of infestations such as 2 pupae/kg (*B. latifrons* Hendel), 85 pupae/kg (*Zeudacus cucurbitae* Coquillett), 7 adults/kg (*C. capitata*), 11 adults/kg (*B. dorsalis* Hendel), and 142 adults/kg (*B. tryoni*) (Ovruski *et al.* 2003, Mwatawala *et al.* 2006, McQuate *et al.* 2015; Dominiak *et al*. 2020).

For commercial guava producers, this high suitability means that fruit fly management must be at a very high level to prevent fruit damage. In situations such as Australia, guava trees should be used in surveillance due to their attractiveness. Guava plants could be used to identify range extensions due to climate change (Simpson *et al.* 2020). Similarly, apples were reported as a preferred surveillance host tree for *B. tryoni* (Mo *et al.* 2014). More research is required to verify if guava is similarly very suitable for other tephritids. This literature review found data on only ten tephritid species (Table 1).

This knowledge can be used for informed decisions in areas where fruit flies need to be managed, particularly for domestic or international trade. Deus *et al*. (2016) summarized multiple cases of tephritid exotic incursions in many countries. In surveillance, guava plants could be used a sentinel plants for the early detection of exotic fruit fly incursions or range extensions of endemic species. Additionally, this host suitability information could be used to assess the biosecurity risks due to the possible importation of guava fruit from other countries.

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