

SHORT COMMUNICATION

THE STATUS OF *Bactrocera dorsalis* AS AN EMERGING PREDOMINANT PEST IN THE COMMERCIAL FRUIT INDUSTRY IN SRI LANKA

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Received: 01 January 2023, Accepted: 15 February 2023, Published: 31 March 2023

ABSTRACT

Fruit flies (Diptera: Tephritidae) are considered the most serious insect pests in the fruit industry worldwide. However, there are no sufficient studies and information on the pest severity and the dominance levels of fruit flies in the fruit industry in Sri Lanka. Hence, the present study aimed to assess the abundance, dominance status, and potential risk of fruit flies in the local fruit market in Sri Lanka. The study was carried out using randomly selected eight (08) fruit stalls (in Galle, Matara, Wellawaya, Monaragala, Ambilipitiya, Kakirawa, Hambanthota, Lunugamwehera) as two stalls in each bio-climatic zone. Adult fruit flies were collected using methyl-eugenol field traps. Trapped flies were identified using standard taxonomic keys. Simpson Population Dominance Index and the Abundance Index for recorded fruit flies were calculated. Four *Bactrocera* species; *B. dorsalis*, *B. kandiansis*, *B. correcta* and *B. latifrons* were recorded. Among them, *B. dorsalis* showed the highest percentage abundance in all selected fruit stalls and in all bio-climatic zones ($P < 0.05$). Out of the four species, *B. dorsalis* recorded the highest dominance index value (0.61) as the high-dominant fruit fly species. As such, there is an emerging pest risk of *B. dorsalis* as the predominant fruit fly in the commercial fruit industry in Sri Lanka. These findings will be helpful for fruit exporters, local sellers, cultivators and agriculture authorities in implementing control measures to secure the commercial fruit industry in Sri Lanka.

Keywords: Abundance, Dominance, Fruit flies, Fruit industry, Pest risk, Sri Lanka

INTRODUCTION

Sri Lanka is a tropical island and it is divided into four major climatic zones; wet, intermediate, dry, and arid based on the rainfall and temperature. These climatic zones support the rich ecological diversity with tropical, subtropical, and temperate cultivated fruit crops in Sri Lanka (Peris 2016). Mango, banana, pineapple, guava, papaya and watermelon are several widely cultivated fruits in Sri Lanka especially for commercial purposes. Annually, Sri Lanka loses about 25-30% of its fruit crops due to the damage of insect pests (Raveendranath 1999). The fruit production of Sri Lanka is mainly threatened by

insect pests such as fruit flies, leafhoppers and seed weevils. Among them, fruit flies have a highest attention as a serious pest in the fruit industry and their damage is estimated as more than half of the fruit production in Sri Lanka (MSTR 2016). In 2014, the exporting of fruits from Sri Lanka to European countries was banned and after following the revised procedures and instructions it was lifted.

Bactrocera dorsalis Hendel (Diptera: Tephritidae) is well-known as the most virulent pest species in the predominant genus *Bactrocera* Macquart (Clarke 2005). In Sri Lanka, there are records of 24 species of fruit flies in the genus *Bactrocera* (Drew and Romig 2013, 2016; Leblanc *et al.* 2018).

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There are several past studies on the diversity and control measures of fruit flies in Sri Lanka. The applications of control measures for fruit flies in Sri Lanka were reported by Dhanapala 1996; Karunarathna and Karunarathna 2012. The fruit fly infestation in banana cultivation in Sri Lanka was recorded by Ekanayake *et al.* 2002. Ranaweera *et al.* (2017) reported the abundance and species richness of fruit flies in cucurbit growing areas in Anuradhapura, Kurunegala and Kandy Districts in Sri Lanka. Diets variability and management of *B. cucurbitae* were reported by Ranaweera *et al.* (2016) and Bandara *et al.* (2006). A study was conducted on the diversity of fruit flies in the dry zone by Heshani and Sirisena (2017), highlighting *B. correcta* was the dominant fruit fly than *B. dorsalis* at all sites surveyed. Marasinghe *et al.* (2018) also reported that the *B. correcta* was the dominant fruit fly than *B. kandiensis* and *B. dorsalis* in the survey at Kandy District, Sri Lanka. In terms of recent studies on fruit flies in Sri Lanka, Wijekoon *et al.* (2021, 2022) reported the infestation variation of *B. dorsalis* on mango cultivations in different bio-climatic zones of Sri Lanka and the oviposition variation of *B. dorsalis* on 'Willard' mango variety in Sri Lanka. Furthermore, in the diversity of Dacine fruit flies in selected mango cultivations in Southern Province, Sri Lanka was recorded by Wijekoon *et al.* (2022) and that study indicated *B. dorsalis* as the highest abundant fruit fly species.

However, information on the diversity, distribution, and pest status of fruit flies in terms of different climatic regions in Sri Lanka is still insufficient due to the lack of recent systematic studies performed on this important insect group. Besides, any aforementioned past studies had not been focused to assess the dominance status and risk level of common fruit flies in the fruit industry in Sri Lanka. Since there is a long-felt need for a study on the emergence and behavior patterns of fruit flies in Sri Lanka, the present study is vital to understand the basics of the dominant status of fruit flies and their emerging risk.

Hence, the present study aimed to assess the abundance, dominance status and the potential risk of fruit flies in fruit stalls selected from

four main bio-climatic zones in Sri Lanka. Based on the findings of this cross-sectional study, we further attempted to emphasize the emerging pest risk of *B. dorsalis* than other recorded fruit fly species.

MATERIALS AND METHODS

Sites selection

The study was carried out in randomly selected eight small-scale fruit stalls from four main bio-climatic zones (wet zone, dry zone, intermediate zone, and arid zone) of Sri Lanka. The eight (08) small-scale fruit stoles were selected as two fruit stalls from each main bio-climatic zone for this study. The locations and descriptions of the selected eight fruit stalls are shown in Table 01 and Figure 01.

Sampling procedure

The study was conducted from August to December 2020 as a baseline study of a long-term survey. A methyl-eugenol (ME) field trap [5 cm diameter and 10 cm height with two circular opening-(each, 0.5cm×0.5cm), and with a ME coated sponge (3cm×3cm)] was provided to the owner of each fruit stall. The provided trap was hung by the owner (1.5 - 4 m above the ground level) inside the fruit stall for collecting fruit flies. All ME coated sponges were replaced by a new one in each sampling round. All trapped flies in the trap were collected in polythene bags once a month and brought to the laboratory in the Department of Zoology, University of Ruhuna for further identification and confirmation.

Identification of specimens

Collected fruit flies were identified morphologically using standard identification keys for fruit flies in South Asia and Australia (Leblanc *et al.* 2021; Schutze 2012; Prabhakar *et al.* 2012; Choudhary *et al.* 2014; Plant Health Australia 2018; Daud *et al.* 2020). Fruit fly specimens were examined using the Light microscope (Nikon-ECLIPSE-E100) (10×4) to confirm the major discriminating morphological and taxonomical features. Samples of identified species were deposited at the Department of Zoology, University of Ruhuna, Sri Lanka.

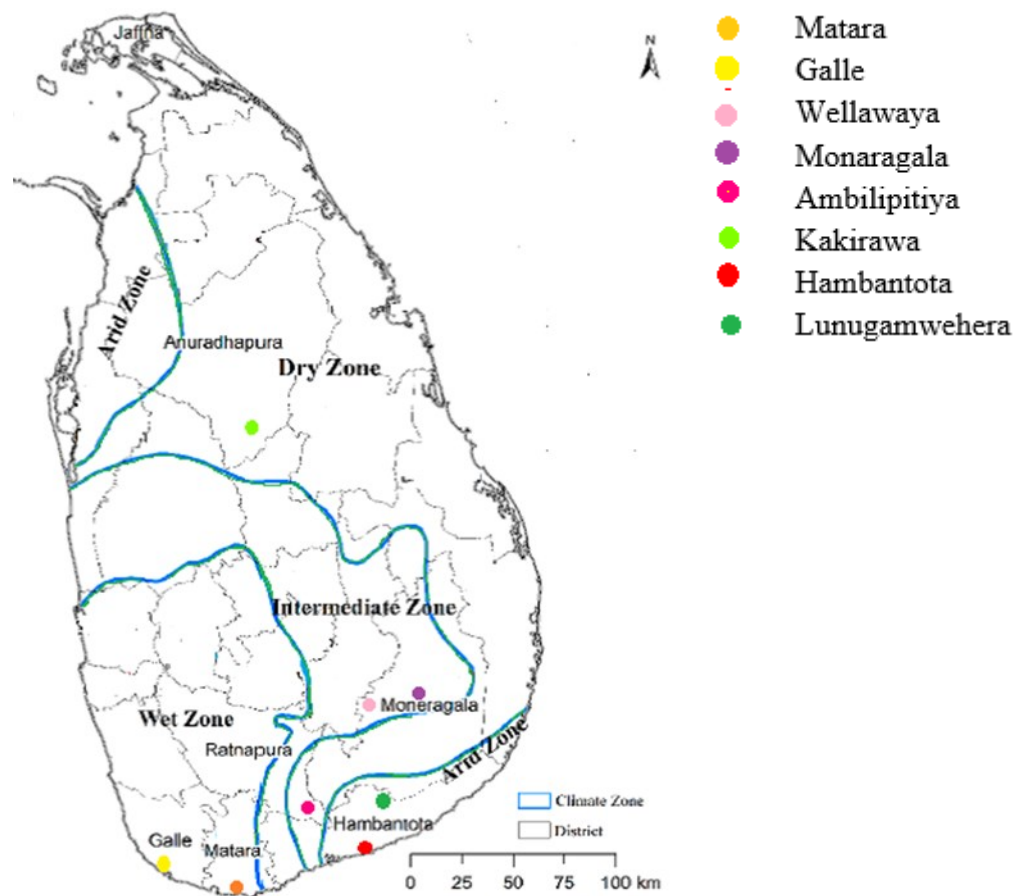


Figure 01: Selected study sites in four each bio-climatic zones of Sri Lanka (Modified the basic map derived from Alahacoon and Edirisinghe 2021)

Table 01: The description of study sites

Bio-climatic zone	Location of the fruit stalls	Gps location	Description of fruit stalls
Wet	Matara	5° 57' 17" N, 80° 33' 17" E	mango + water melon+ Papaya+ guava
	Galle	6°04'14"N, 80°15'12"E	mango +banana+ water melon
Intermediate	Wellawayaya	6° 43' 17" N 81° 7' 13" E	Mango+ banana+ water melon+ guava
	Monaragala	6°46'11"N, 81°16'12"E	mango+ water melon
Dry	Ambilipitiya	6°21'24" N, 80°52'34" E	mango+ banana+ guava
	Kakirawa	8°3'32.45"N, 80°33'36.1"E	mango+ water melon+ guava
Arid	Hambantota	6° 8' 26" N, 81° 7' 5" E	mango+ water melon
	Lunugamwehera	6°18'62"N,81°12'62"E	mango+ guava+ water melon

Data analysis

The fruit fly abundance and dominance were calculated using the recorded number of trapped flies of each species in each trap.

- a) **Population Dominance:** The dominance index for each fruit fly species was calculated using the following formula (Ludwig and Reynold 1988):

$$D = \frac{1}{\sum_{i=1}^s \left[\frac{n_i}{N} \right]^2} \dots\dots\dots\text{Eqn 01}$$

D = Simpson Dominance index
 S = the total number of species
 ni = the total number of organism of species –i
 N = the total number of organisms of all species
 Pi = ni/N = proportion of total abundance represented by species –i

The degree of dominance is divided into 3 categories (Maesyorah *et al.* 2018):

- 0.01–0.30 = low dominance;
- 0.31–0.60 = moderate dominance;
- 0.61–1.00 = high dominance

b) Population Abundance:

Fruit fly abundance was calculated using the following formula (Brown *et al.* 1998):

$$A = \frac{a}{b} \times 100\% \dots\dots\dots\text{Eqn 02}$$

A = abundance
 a = number of i species in location X
 b = total population of all species observed in location X

Statistical analysis

Data were entered into a database in MS excel (2010 version) and transferred to the Statistical Package for the Social Sciences (IBM SPSS, 20.0 version) software. The normality of the data set was tested using the Anderson-darling test. The mean, standard error and percentages were calculated. The significance levels in the variations of species abundance among species and bio-climatic zones were compared using the one-way ANOVA test.

RESULTS AND DISCUSSION

a) Recorded species

A total of 849 fruit fly specimens were examined. These all specimens belonged to four (04) species of the genus, *Bactrocera*; *B. dorsalis* (Hendel), *B. kandiansis* (Drew and Hancock), *B. correcta* (Bezzi) and *B. latifrons* (Hendel) (Figure 02).

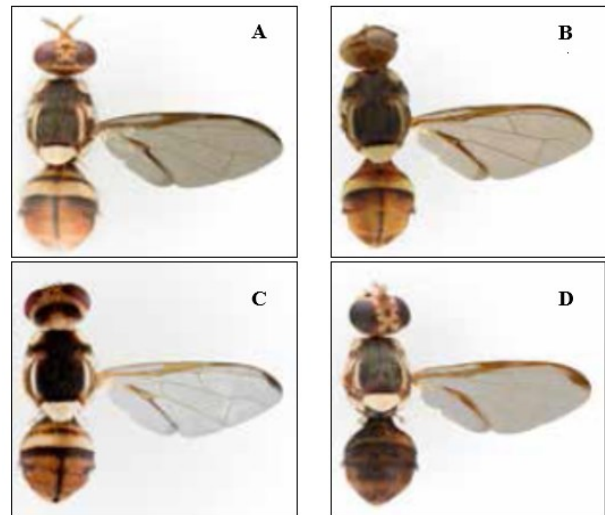


Figure 02: Dorsal view of (a) *B. dorsalis*, (b) *B. kandiansis*, and (c) *B. correcta* (d) *B. latifrons* (Photos@ Plant Health Australia 2018)

b) Percentage abundance

Among the four species recorded, *B. dorsalis* (77.85±1.86) showed a significantly high abundance in fruit stalls (P<0.05) than other recorded fruit fly species. The lowest abundance was recorded for *B. latifrons* (2.23±1.04) and *B. kandiansis* showed a moderate abundance (14.13±0.93) in all studied sites (Fig. 03). The findings of Duyck *et al.* (2006) and Vargas *et al.* (2015) supported our results, that *B. dorsalis* shows a highly competitive behavior to establish quickly in their habitat by becoming the dominant pest species.

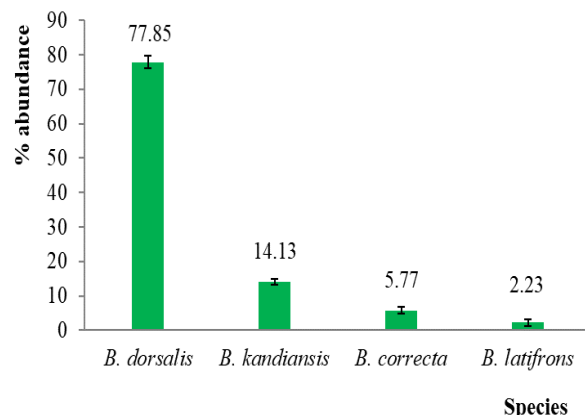


Figure 3: The variation of percentage abundance of four fruit fly species recorded

Among the four species, *B. dorsalis* recorded as the dominant species in all four bio-climatic zones. Comparatively, *B. correcta*

and *B. latifrons* showed a very low abundance in all bio-climatic zones (Figure 04).

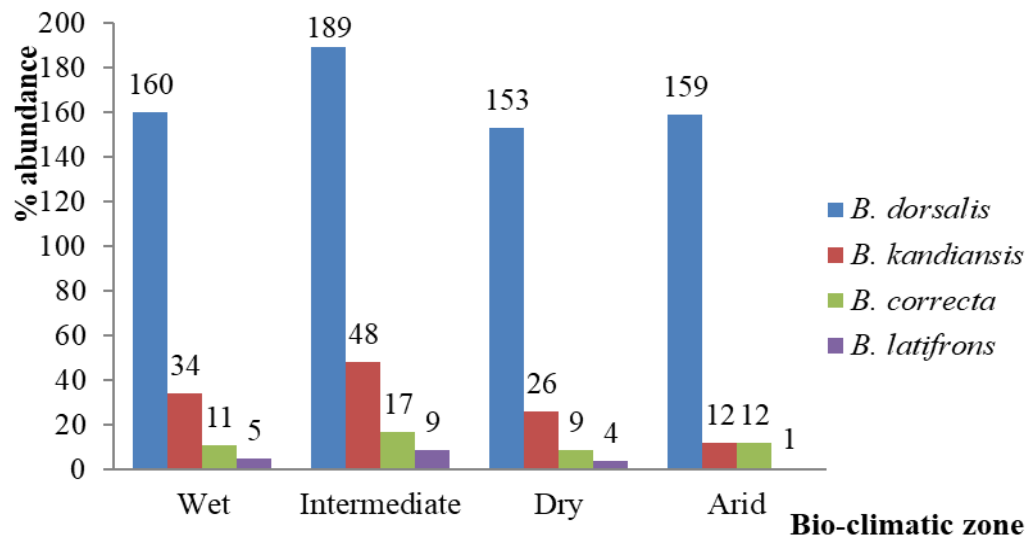


Figure 4: The variation of percentage abundance of fruit flies among four main bio-climatic zones

c) Dominance index

Bactrocera dorsalis showed a high dominance index (0.61) belonging to the 'High dominant' category. As such, *B. dorsalis* was reported as the high-dominance fruit fly species in all stalls surveyed in all bioclimatic zones of Sri Lanka during the study period (Table 02). Evidently, there is a high possibility of fruit flies to become a dominant species when the decreasing the number of species in a particular site (Riastiwi *et al.* 2021). The study results significantly indicate the predominance of *B. dorsalis* over other recorded three species, and these findings could be linked with the previous records of *B. dorsalis* because this species have been recorded as the predominant fruit fly species in several other countries like China (Li 2016) and Indonesia

(Zulida and Tati 2016; Kartika and Tati 2016). *Bactrocera dorsalis* (mango fruit fly) is well known to cause a severe damage on mango industry worldwide (Drew and Hancock 1994; Kapoor 2006) and especially in South Asia (Wan *et al.* 2012).

The study findings further indicated the status of *B. kandiansis* as a moderate dominant fruit fly species belonging to the 'Low' dominance category. Both *B. correcta* and *B. latifrons* showed a very low abundance and a lowest dominance index values. As such, they belonged to the 'Non dominance' category (Table 02). Ricklefs, (1978) reported that the non-dominant fruit fly species are rarely found and they showed a less abundance.

Table 02: The dominance index and criteria of recorded fruit flies

Recorded species	Total No.	Dominance Index	Dominance category
<i>B. dorsalis</i> *	661	0.61	High
<i>B. kandiansis</i>	120	0.02	Low
<i>B. correcta</i>	49	0.003	Non dominance
<i>B. latifrons</i>	19	0.0005	Non dominance

*The mean difference is significant at the 0.05 level

When comparing the present findings on the predominance of *B. dorsalis* with the past two studies by Heshani and Sirisena (2017) and by Marasinghe *et al.* (2018), they have been recorded *B. correcta* as the dominant fruit fly than *B. dorsalis*. Whereas several recent findings of fruit flies (Wijekoon *et al.* 2021, 2022) have recorded a high abundance of *B. dorsalis* than other *Bactrocera* fruit flies in different climatic regions in Sri Lanka. These findings further support to strength the present study results on the predominance of *B. dorsalis* than *B. kandiansis*, *B. correcta* and *B. latifrons* in main bioclimatic zones of Sri Lanka. Further in our study showed a notably low abundance of *B. correcta* in all studied sites, compared to *B. dorsalis*. Hence it is clear that *B. dorsalis* has emerged very recently as a highly dominant fruit fly species in all bioclimatic zones of Sri Lanka. As such it is very crucial to estimate and understand the possible alarming future risk of *B. dorsalis* as a serious pest in the local fruit market in Sri Lanka. Future studies are recommended to get an overall picture of the Island wide distribution of *B. dorsalis* and then to develop efficient management systems to enhance the income of fruit deals by minimizing fruit fly damage-related fruit wastes.

CONCLUSIONS

Bactrocera dorsalis is an emerging serious pest in the commercial fruit industry of Sri Lanka. It is the predominant fruit fly compared to the other *Bactrocera* species recorded in all sites studied in the main bio-climatic zones of Sri Lanka. The presence of the high population and the dominance of *B. dorsalis* over all bioclimatic zones reveal the severity of their future alarming threat on the commercial fruit industry in Sri Lanka. Hence the present findings are vital to plan future control measures and management programs for *B. dorsalis* to strengthen the commercial local fruit market in Sri Lanka.

CONFLICTS OF INTEREST

The authors would like to declare that there are no conflicts of interest in undertaking this research.

AUTHOR'S CONTRIBUTION

WMCDW conducted field surveys, data collection, data entering, data analysis and writing the manuscript, GASMG, HCEW and SPV supervised the research and reviewed the manuscript.

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