Volume-7
Issue-I
June- 2022
Rajarata University Journal
ISSN: 2362-0080
www.ruj.ac.lk/journals/

Category: Research Article

Temporal Variation of Phytophagous Insects of *Calotropis gigantea* (L.) in Southern Province of Sri Lanka

*[1]Wijeweera WPSN, [1]de Silva MPKSK, [2]Dhileepan K & [2]Senaratne KADW

[1] *Department of Zoology, University of Ruhuna, Matara, Sri Lanka*

[2] *Biosecurity Queensland, Department of Agriculture and Fisheries, Ecosciences Sciences Precinct, Dutton Park, Queensland, Australia*

ARTICLE DETAILS

Article History

Published Online: 30/June, 2022

Keywords

Calotropis gigantea, phytophagous insect, temporal variation

***Corresponding Author**

Email: surendi87nisha@gmil.com

ABSTRACT

Calotropis gigantea is a native plant to Sri Lanka having an ayurvedic medicinal value. People use the plant to gain fodder, fiber, and fertilizer. Despite its benefits, the plant is considered as an invasive species in Australia, the USA, etc. As the plant is medicinally, agriculturally, and ecologically valuable, the study was designed to investigate phytophagous insects of *C. gigantea* and their temporal variation. The field visits were conducted fortnightly from August 2015 to August 2016 in eleven sites in Southern Province (SP). During sampling, the number of insect species, their abundance, and the number of *Calotropis* fruits were recorded in selected trees. Twenty-nine insect species were recorded from *C. gigantea* and among them twelve species were phytophagous. *Dacus persicus* and *Paramecops farinosa* were destructive phytophagous insects. *D. persicus* was recorded in all three districts of SP throughout the year and the mean abundance varies significantly (p= 0.002) among districts. *P. farinosa* was only recorded from Hambantota district. *Sphaeroderma* sp. was the most abundant phytophagous insect and varied widely across (p = 0.000) districts of Southern Province. *Danaus chrysippus* larva was observed in all selected sites of SP. None of the insect abundance correlated with *Calotropis* fruit density, month of year and monthly rainfall.

1. Introduction

The behavior and biology f insect species that live in different parts of the world vary as a response to biotic and abiotic factors and are reflected as temporal variation [1]. Temporal variation is a function of time [2] and it shows the insect response (abundance/ behavior) over a period of time. The temporal variation of tropical insects is more complicated and less studied [3]. They show temporal variation as a response to rainfall and other biotic and abiotic parameters. As a result, insects in tropical regions show significant temporal variation with respect to the local climate, altitude, phenology of the host plants, etc. [3].

Calotropis spp. are tropical plants that are home to numerous insects. These insects are generally classified as pollinators [4], pests [5], occasional visitors, and predators [6]. According to a study from Saudi Arabia [7], insects associated with *Calotropis procera* are classified as pests, neutral insects, scavengers, parasitoids, floral visitors, and predators. Among them, pests play a major role as they feed on plant parts.

Insect pests and their damage to *Calotropis* spp. are well documented [8]. When considering the information on insect fauna associated with *Calotropis* spp., most of the records are from India while very few records are available in Sri Lanka. Few species of bees including *Amegilla comberi*, *Amegilla fallax, Amegilla violacea*, *Xylocopa fenestrate* and *Xylocopa tenuiscapa* were reported as pollinators of *Calotropis gigantea* in Sri Lanka [9]. In addition, Butterfly larvae of *Danaus chrysippus chrysippus* were recorded as feeders on *Calotropis* leaves and flowers [10,11].

However, temporal variation of insects associated with *Calotropis* spp. are less studied in the entire world except for a few studies from India. In India, insect pests associated with *Calotropis* spp. were recorded throughout the year. The highest abundance of insect pests has been recorded during the summer season and the least abundance has been recorded in the winter season [5].

All parts of the *C. gigantea* plant are used in Ayurveda medicine of Sri Lanka. It is used for treating blood clotting, wound healing, bronchitis, dysentery, inflammation, asthma, snake bite, and scorpion poisoning [12-15]. In addition, Sri Lankan farmers use latex of the plant for sticky traps. Alpha and Beta calotropeol and Beta amyrin in latex act as an excellent chemical mixture to use in pest control of crops [16]. Especially sugarcane farmers use plant latex to control termite attacks in crop fields [17]. Furthermore, under laboratory conditions, it has been proved that extraction of *C. gigantea* plants is effective in controlling cotton mealy bug [18]. Despite its benefits, *C. gigantea* is an emerging problem in the USA, Mexico, Australia, Caribbean Islands, etc. where the plant is considered as an invasive species [8]. As the plant has medicinal, agricultural and ecological value in Sri Lanka, it is important to study insects associated with the plant and their temporal variation as they have a close association with the production/reproductive output of the plant.

However, there are no recordings of the temporal variation of insects on the plant within Sri Lanka or any other part of the World. In addition, knowledge on temporal variation is essential for forecasting future changes in community structure and ecosystem function [3]. Thus, studies on temporal variation in communities remains an important and interesting challenge in ecology [3]. Therefore, this study was conducted with the objective of examining the temporal variation of phytophagous insects associated with *C. gigantea* plants in selected sites in the Southern Province of Sri Lanka.

2. Material and Methods

Study sites

To study the temporal variations in phytophagous insects of *C. gigantea*, eleven sites from Southern province having easy access from University of Ruhuna (19) were selected (Table 1). The sites were selected randomly, and the sites were located more than 3 km from each other including both inland and coastal regions. Sites within hundred meters towards the seashore are considered as coastal sites while rest of the sites are considered as inland sites [19]. The study sites contained a minimum of six mature *C. gigantea* plants and all of them were approximately similar in size assuming similar size *C. gigantea* plants belong to the same age. The stems of the selected plants were numbered with white paint.

All the plants in each site were sampled at two weeks' time intervals from August 2015 to August 2016. Insects on selected *C. gigantea* plants were closely observed using a hand lens and photographed while spending approximately 3 hours in a site, allocating a minimum of 20-30 minutes per plant [20]. During sampling, the number of phytophagous insects on *C. gigantea*, the number of individuals of each phytophagous insect species landing on *C. gigantea,* their interactions with the plant and the number of fruits in each plant were recorded.

Table 1: Details of study sites

District	Site	Location
Matara	Kamburugamuwa	5^0 56’ N; 80^0 29’ E
	Devinuwara	50 56’ N; 80^0 34’ E
	Palena	5^0 56’ N; 80^0 29’ E
Galle	Dadalla	6^0 02’ N; 80^0 11’ E
	Thalpe	5^0 59’ N; 80^0 16’ E
	Habaraduwa	5^0 59’ N; 80^0 18’ E
	Kathaluwa	5^0 58’ N; 80^0 20’ E
Hambantota	Kalametiya	6^0 06’ N; 80^0 55’ E
	Medilla	6^0 02’ N; 80^0 48’ E
	Tangalle	6^0 01’ N; 80^0 47’ E
	Nalagama	6^0 04’ N; 80^0 47’ E

Preservation and identification of phytophagous insects

Live insect samples were collected using sweep nets into small vials. Insects were directly collected from various parts of the plant (leaves, flowers, stems, fruits) by hand nets. The specimens were transported to the University of Ruhuna and preserved, pinned at the laboratory of the Department of Zoology. Specimens were identified by taxonomic expertise of Entomologists of Entomology Division, The Horticultural Crop Research and Development Institute (HORDI), Gannoruwa, Sri Lanka. Unidentified specimens were sent to taxonomists in Australia and India for identification.

Statistical analysis

Monthly rainfall data related to Southern Province (during sampling period) were obtained from Sri Lanka Meteorological Department (http://www.meteo.gov.lk). Statistical analysis was done using environmental data by developing correlations with the mean abundance of selected insect species. The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the mean abundance of selected phytophagous insects among sites of three districts of Southern Province. The statistical analysis was done using Minitab 16 Statistical Software [20].

3. Results and discussion

Table 2: Phytophagous insects associated with *Calotropis gigantea* in Southern Province

Order	Family	Scientific name
Coleoptera	Chrysomelidae	*Sphaeroderma* sp.
	Curculionidae	*Paramecops farinosa* Schoenherr
	Cerambycidae	*Phelipara moringae* Aurivillius
		Sybra praeusta Pascoe
Hemiptera	Lygaeidae	*Graptostethus servus* Fabricius
		Spilostethus hospes (Scopoli)
		Spilostethus pandurus Militaris
	Cercopidae	*Abidma refula*
	Membracidae	*Leptocentrus* sp.
	Aphidae	*Aphis nerri* Boyer de Fonscolombe
Diptera	Tephritidae	*Dacus persicus* Hendel
Lepidoptera	Papilionidae	*Danaus chrysippus* L..

Twenty-nine insect species were observed on *C. gigantea* during the study. Among them, twelve species of phytophagous insects belonging to nine families were recorded (Table 2). *Sphaeroderma* sp.; was the most common (67.50%) insect pest associated with *C. gigantea* in the Southern province of Sri Lanka. *Paramecops farinosa* and *Dacus persicus* were identified as highly destructive monophagous insects [8]. They feed on 100% seeds while destroying the whole fruit and directly influence the reproductive output of the plant [8,19, 20,21].

Out of twelve phytophagous insects, six species namely *D. persicus*, *P. farinosa*, *Sphaeroderma* sp., *Spilostethus* sp., *A. nerri* and *D. chrysippus* larvae were abundant and act as major or moderately damaging pests which directly influence on reproductive output/growth of the plant. Other species were uncommon, and they cause negligeable/minor damage to the plant. Therefore, temporal variation was only studied on above phytophagous insects. Monthly variation of mean abundance of them in three districts of Sothern province are given in Figures 1, 2, 3, 4, 5 and 6.

Comparative study of phytophagous insects across districts of Southern province

Dacus persicus was recorded in all three districts of Southern province. However, there was a significant difference in the mean abundances of *D. persicus* ($p = 0.002$, $F= 7.4$) at least in two districts. Comparatively higher abundance of *D. persicus* was recorded in Galle district (12.18± 4.11) while lower abundance was in Hambantota district (0.60± 0.30) (Figure 1).

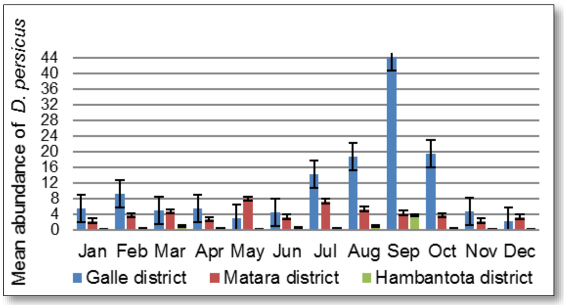

Figure 1: Monthly variation of mean abundance of *D. persicus* in districts of Southern Province (bars represent standard deviation).

Female *D. persicus* is attracted to *Calotropis* fruits for oviposition. Male *D. persicus* were common on *Calotropis* fruits to get a chance for mating. Therefore, we studied whether the abundance of *D. persicus* link with *Calotropis* fruit abundance. However, statistically, there was no correlation ($r = 0.252$, $p= 0.139$) between them. Similarly, the monthly rainfall of the Southern province had no influence ($r = -0.237$, $p= 0.164$) on *D. persicus* abundance.

P. farinosa was recorded only from the Hambantota district (Figure 2).

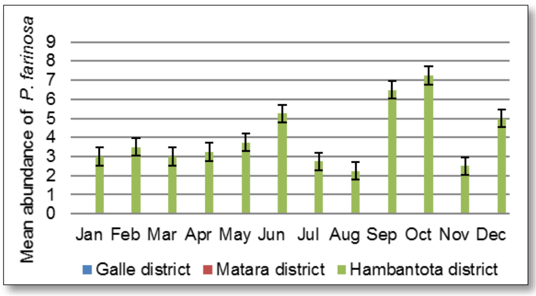

Figure 2: Monthly variation of mean abundance of *P. farinosa* in districts of Southern Province (Bars represent standard deviation).

Graphically, there were fluctuations in mean abundance of P. farinosa (Figure 2). In India, [23], *P. farinosa* is active throughout the year but is least abundant during the winter season (December to February). As there is no winter season in Sri Lanka, similar observations were not recorded. Even though *P. farinosa* oviposit in *Calotropis* fruits, no correlation was obtained ($r = - 0.268$, $p = 0.115$) between the mean abundance of *Calotropis* fruits and the mean abundance of *P. farinosa*. Similarly, their abundance was not correlated with rainfall.

Sphaeroderma sp. was observed throughout the Southern province and their abundance also significantly varied (p = 0.000, F= 15.68) among districts. However, their mean abundances not significantly change according to time (month) as well as monthly rainfall.

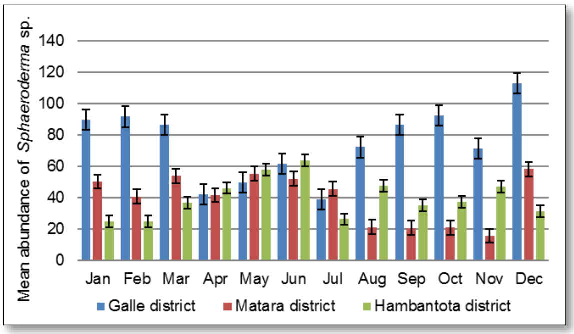

Figure 3: Monthly variation of mean abundance of Sphaeroderma sp. in districts of Southern Province (Bars represent standard deviation)

Spilostethus spp. were collected in all districts of Southern province throughout the year and similar observation was recorded from India as well [5]. Their abundance was comparatively higher in June and July (Figure 4). Even though, there was no correlation (r = 0.437, p = 0.008) between *Calotropis* fruit abundance and abundance of *Spilostethus* spp., field observations revealed that, a large number of nymphs and adults associated with ruptured/ mature fruits as they feed on seed sap. According to studies in India, *Spilostethus* sp. abundance was highly correlated with the environmental factors while the maximum temperature act as a limiting factor of population [5]. Similarly, in India, higher abundance of their population was observed from September to May with the onset of rain [5].

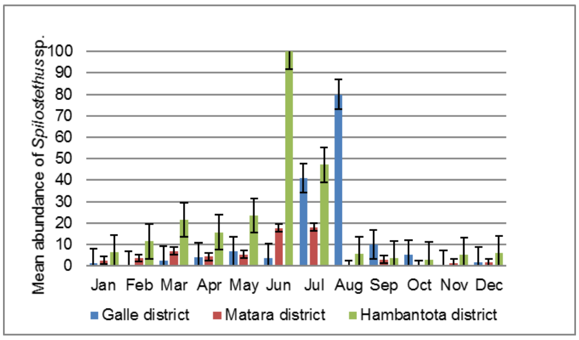

Figure 4: Monthly variation of mean abundance of *Spilostethus* spp. in districts of Southern Province (bars represent standard deviation)

Peak aphid infestation (mean-15.33) was recorded during January in Hambantota as well as during October (mean- 18.13) in Matara district. The lowest abundance of the aphid was recorded during August in three districts of Southern Province (Figure 5). However, no significant difference in the mean abundances of aphid colonies at least in two districts during 12 months of study period (p= 0.191, F= 1.74) indicating no notable mean differences in abundances of aphid colonies among districts.

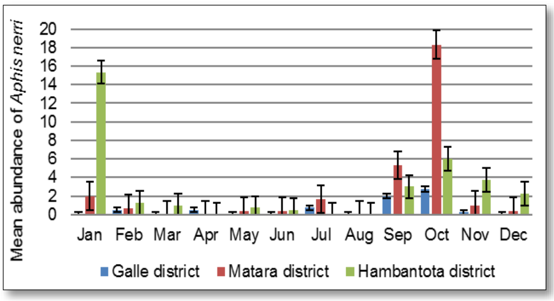

Figure 5: Monthly variation of mean abundance of *Aphis nerri* colonies in districts of Southern Province (bars represent standard deviation).

Comparatively higher mean abundance of *Danaus chrysippus* larvae was recorded in Hambantota (1.542± 0.39) and Matara district (0.859 ± 0.28) than in Galle (0.416± 0.09) district (Figure 6) which are less urbanized districts.

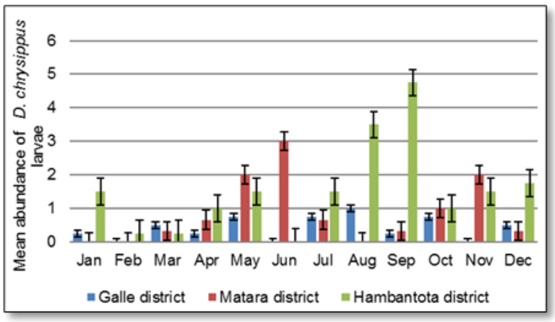

Figure 6: Monthly variation of mean abundance of *Danaus chrysippus* larvae in districts of Southern Province (bars represent standard deviation).

Monthly variation of phytophagous insects across the sites of Galle, Matara and Hambantota

D. persicus was recorded in all sites except Kathaluwa (Galle district) and Devinuwara (Matara district). Dadalla was the only site, where *D. persicus* was recorded throughout the year with high abundance (Table 3). It might be due to resource availability around the sampling area. In Hambantota district, *D. persicus* was recorded in all sites. It might be due to climate suitability of the district for survival of *D. persicus*. According to the present study, *D. persicus* covered a wider range of distribution than *P. farinosa*. It might be due to vigorous flying ability of *D. persicus*. Similar observations were recorded from India also [20].

P. farinosa was recorded in the Hambantota district only. When compared to Matara and Galle, the Hambantota district was less urbanized. *P. farinosa* were highly sensitive to urbanization [22] and as a result, they might be restricted to the Hambantota; a district with more rural areas. Even in Hambantota district, *P. farinosa* was not found in the highly urbanized Tangalle site. The site was closer to the main road which was highly polluted by the smoke of vehicles and dust. The polluted and urbanized nature of the site might be the possible reason for the absence of *P. farinosa* in the Tangalle site. The lethargic, slow-moving nature of P. *farinosa* [8] and the patchy distribution of *C. gigantea* plants through the land also limit the distribution of *P. farinosa* [21, 23].

Sphaeroderma sp. was recorded in all sites and their abundances were fluctuating throughout the year. The remarkable abundance of *Spilostethus* sp. was also recorded in the Thalpe site (Table 2) and their highest abundance was observed during March, June, July, and August. *A. nerri* were recorded in all sites except Dadalla, Habaraduwa (Galle district) and Medilla (Matara district) sites. *Danaus chrysippus* larvae were recorded from all surveyed sites (Table 3).

Table 3: Monthly variation of mean abundance (± S.D) of pests across the sites of Galle, Matara and Hambantota districts

District	Site	Mean insect abundance (± S.D)					
		D. chrysippus larvae	*Aphis nerri*	*Spilostethus* spp.	*Sphaeroderma* sp.	*P. farinosa*	*D. persicus*
Matara	Devinuwara	0.05± 0.2	0.45± 1.6	0.37± 1.1	4.88± 5.6	0.00± 0.0	0.00± 0.0
	Kamburugamuwa	0.14± 0.5	0.17± 0.8	0.20± 0.8	4.50± 5.0	0.00± 0.0	0.86± 1.3
	Palena	0.15± 0.5	1.18± 8.3	1.71± 4.7	7.62± 9.8	0.00± 0.0	0.85± 1.8
Hambantota	Kalametiya	0.21±0.6	0.77± 4.1	5.70± 23.5	7.25± 6.9	0.80± 1.3	0.02± 0.1
	Medilla	0.05± 0.2	0.00±0.0	1.72± 3.4	7.20±10.3	1.30± 1.8	0.23± 1.0
	Nalagama	0.17± 0.9	0.62± 2.2	0.36± 1.2	1.24± 2.5	0.66±1.9	0.02± 0.2
	Tangalle	0.47± 1.3	0.32± 1.4	6.86±23.2	10.82±11.1	0.00± 0.0	0.10± 0.5
Galle	Thalpe	0.03±0.2	0.05±0.3	10.9±34.8	21.89±18.4	0.00± 0.0	1.40 ±4.5
	Habaraduwa	0.08 ±0.3	0.00± 0.0	0.21 ±0.8	5.77 ± 4.9	0.00± 0.0	0.16±0.7
	Kathaluwa	0.04±0.2	0.23±0.8	0.22 ±0.7	6.02 ± 6.9	0.00± 0.0	0.00± 0.0
	Dadalla	0.06±0.3	0.00±0.0	0.14±0.5	14.91±12.7	0.00± 0.0	6.06± 8.5

4. Conclusion

Twelve insects associated with *C. gigantea* was identified as phytophagous insects. Among them, *D. persicus* and *P. farinosa* were prominent phytophagous insects. Mean abundances of *D. persicus* varied significantly (p= 0.002) among districts. Similar observation (p= 0.000) was recorded for the most abundant insect pest; *Sphaeroderma* sp. *P. farinosa* was only recorded from Hambantota district of the southern province. However, the abundance of all studied pests was not varied according to the *Calotropis* fruits density, month of the year and monthly rainfall.

5. References

1. Danks HV. The elements of seasonal adaptations in insects. Entomological Society of Canada. 2007;139: 1-44.
2. White PS, Walker JL. Approximating nature's variation: Selecting and using reference Information in restoration ecology. Restoration Ecology. 1997; 5 (4): 338-349.
3. Park Y, Jang T, Kim J, Kim SK, Kim IK, Kim CJ, Takami Y. Temporal Variation Dominates in Local Carabid Beetle Communities in Korean Mountains. Insects. 2021; 12(11): 1019. https://doi.org/10.3390/insects12111019
4. Borders B, Mader EL. Milkweeds: A Conservation Pratitioner’s Guide. Portland: The Xerces Society for Invertebrate Conservation; 2014; 2: 11-16.
5. Sudan M. Survey, bio- ecology and management of insect pest of *Calotropis procera* (Ait.) R.Br., a medicinal plant in Jammu division J & K State. Ph.D. Jammu: University of Jammu; 2013.

6. Saikia, CH, Das, BK, Kalita J. Studies on the Insects associated with *Calotropis gigantea* in Guwahati city of Assam, India. The Journal of Zoology Studies. 2015; 2 (3): 06-13.

7. Al Dhafer HM, Aldryhim YN, Elgharbawy AA and Fadl HH. Insects associated with milkweed *Calotropis procera* (Ait.) Ait. in the Ibex reserve in the central region of the kingdom of Saudi Arabia. Entomological News. 2011; 122(3): 233-235.

8. Dhileepan K. Prospects for the classical biological control of *Calotropis procera* (Apocynaceae) using coevolved insects. Biocontrol Science and Technology. 2014; 24(9): 977-998.

9. Karunaratne WAIP, Edirisinghe JP, Gunatilleke CVS. Floral relationships of bees in selected areas of Sri Lanka. Ceylon journal of Science (Biological Science). 2005; 34: 27-45.

10. Jayasinghe HD, Rajapaksha SS, de Alwis CA compilation and analysis of food plants utilization of Sri Lankan butterfly larvae (Papilionoidea). Taprobanica. 2013; 6 (2):110-131.

11. Perera N, Wickremasinghe H. Butterfly Conservation Action Plan of Sri Lanka. 2nd ed. Battaramulla, Sri Lanka: Biodiversity Secretariat, Ministry of Environment & Renewable Energy; 2014.

12. Gunaratna TANR, Samarathunga DK, Liyanage JA. Medicinal values of plants that are habitat to coastal areas of Sri Lanka: A literary study. Journal of Social Sciences – Sri Lanka. 2015; 7 (3): 157-165.

13. Herath HMDR. Mangrove associated vegetation in Sri Lanka and their ethno-botanical values. Publication of Seacology-Sudeesa Mangrove Museum. 2017; 1(1): 3-8.

14. Shukla D, Wijayapala S, Vankar PS. Pain and inflammation relieving herbs from Sri Lanka. International journal of pain and relief. 2018; 2(1): 1-5.

15. Ediriweera ERHSS, Ratnasooriya WD. and Kamathewatta KWMD. Ethnomedicinal uses in scorpion poisoning (Gonusu Visha) in Sri Lankan traditional medicine. International journal of Ayurveda and pharma research. 2018; 6 (7): 29-43.

16. Widanapathirana CU, Dassanayake DLALA. The use of plant parts in pest control activities in traditional Sri Lankan agricultural systems. International journal of scientific & technology research. 2013; 2 (6): 150-152.

17. Wanasinghe VKASM, Chanchala KMG, Kumarasinghe, NC. An assessment of major pests of sugarcane in Sri Lanka. Major pests of sugarcane in Sri Lanka. 2018; 1: 21-28.

18. Prishanthini M, Vinobaba M. Efficacy of some selected botanical extracts against the Cotton mealybug *Phenacoccus solenopsis* (Tinsley) (Hemiptera: Pseudococcidae). International Journal of Scientific and Research Publications. 2014; 4 (3): 1-5.

19. Wijeweera W.P.S.N., Senaratne K.A.D.W., Dhileepan K. Distribution, development biology and behavior of *Dacus persicus* associated with *Calotropis gigantea* (L.) in Sri Lanka. Ceylon Journal of Science. 2021; 50(3): 219-226.

20. Wijeweera W.P.S.N., Senaratne K.A.D.W., Dhileepan K, de Silva M.P.K.S.K. Insect diversity on Calotropis gigantea (L.) in Sri Lanka. Ceylon Journal of Science. 2022; 51(2): 121-128.

21. Wijeweera W.P.S.N., Senaratne K.A.D.W., Dhileepan K. Studies on the fruit feeding weevil, Paramecops farinosa (Coleoptera Curculionidae) in Sri Lanka as a prospective weed biological control agent of the invasive weed, Calotropis spp., Journal of Biological Control. 2020; 34(4): 241–250.

22. Sharma S, Amriphale D. Effect of urbanization on the population density of Aak weevil. Current Science. 2007; 93 (8): 1130-1134.

23. Sudan M, Tara JS, Sharma B. Bionomics of Aak weevil, *Paramecops farinosa* (Wiedemann) (Coleoptera: Curculionidae), a pest of *Calotropis procera* (Ait.) R. Br. in Jammu division of J & K State (India). Munis Entomology and Zoology Journal. 2013; 8(2): 756-766.