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# Emergence period of coffee white stem borer, *Xylotrechus quadripes* (Chevrolat) (Coleoptera: Cerambycidae) on robusta coffee (*Coffea canephora* Pierre ex A. Froehner) at Kodagu region, Karnataka

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**Abstract**

Coffee is an economically important commercial crop that is severely harmed by the coffee white stem borer (CWSB), *Xylotrechus quadripes* (Chevrolat). CWSB has several alternate hosts, arabica coffee was the most preferred hosts in all coffee growing regions. A severe outbreak has recently occurred during 2019 in few robusta estates of Polibetta liaison zone in Kodagu district, Karnataka. Hence, studying the emergence period of CWSB is necessary to understand their infestation in robusta coffee plantations. The monthly mean data was recorded for the CWSB adult emergence from the cages during 2019-2021, where the infested stems were collected and kept inside. The peak emergence was observed in the month of May and during November and December in every year. The average number of beetles emerged per stem ranged from 0.30, 0.38 and 0.38 during 2019-2021 respectively. The total number of beetles (92, 112 and 114) emerged from 300 stems and the sex ratio (1:1.5, 1:1.6 and 1:1.4) were recorded during 2019-2021, respectively. Correlation of CWSB beetle emergence and weather parameters exhibited a significant positive correlation with maximum temperature (0.480, 0.558 and 0.722) and negatively correlated with rainfall (-0.471, -0.525 and -0.485) during 2019-2021 respectively. The multiple regression analysis showed that the weather parameters influence the adult emergence to the extent of 46%, 53% and 76% ($R^2$ values) during the year 2019-2021.

**Keywords:** abiotic factors, emergence period, robusta coffee, *Xylotrechus quadripes*.

## Introduction

Coffee is a most popular beverage consumed all over the world, it provides mild stimulation due to presence of caffeine. It also provides aroma, flavour and taste to the consumers that makes up the quality (Leroy *et al*., 2006) [5]. India is the seventh largest producer of coffee, derived from two species *viz*., *Coffea arabica* (arabica) and *Coffea canephora* (robusta) (Dastagiri, 2017) [2]. India is known for its shade grown coffee while the rest of the world generally grows coffee as a monocrop. In India, coffee is cultivated in 4,71,656 ha with 84.5 per cent of the area in three states (Karnataka: 56.1 %, Kerala: 20.7 % and Tamil Nadu: 7.7 %) and remaining 15.5 % in Non-traditional States like, Andhra Pradesh, Orissa and North-Eastern States. Robusta is the more popular variety occupies more than 70% of India's coffee crop. Total production of 3.93 lakh metric tonnes of coffee which account to 5.2 percent of the world production and export earnings US$ 735 million (Coffee Board, 2021) [1].

The coffee white stem borer (CWSB), *Xylotrechus quadripes* is a major pest in commercial arabica coffee plantations in South Africa, India, Thailand, Sri Lanka, Vietnam and China (Rhainds *et al*., 2001) [13]. Coffee cultivation was threatened due to the problem of coffee rust and white stem borer during 1868, results in abandoning of coffee cultivation in Sri Lanka. CWSB was noticed in India as early as 1838 and the borer affected plants normally show drooping of leaves, yellowing, wilting symptoms and presence of emergence holes on the main stem or reduction of fruit set or complete death of coffee plants (Veeresh, 1995; Sreedevi *et al*., 2016; Rajus *et al*., 2021) [17, 15, 9]. The emergence period of CWSB varies in different countries, probably because of different climatic conditions (Seetharama *et al*, 2005) [14]. CWSB has two flight periods in India, pre-monsoon and post-monsoon flight period. The activity of the insect is influenced to a great extant by weather conditions, during cloudy and moist days, the beetles do not emerge but on bright sunny days they alight on the leaves exposed to sun and become active in the afternoon hours (Venkatesha and Dinesh, 2013) [18]. The infestation of the pest seems to be severe in open conditions than in shady areas as revealed by their emergence, which is half of that in sunny conditions (Prashant, 2014) [8]. Stray occurrence of white stem borer on robusta from Coorg (Polibetta) was reported by Veeresh (1993) [16]. Kurian and Surekha (2000) [4] reported severe incidence of CWSB in robusta plantations on few neglected estates in Polibetta and Siddapura, Kodagu district, Karnataka.

In the recent past, the incidence of CWSB is reported regularly in the robusta plantations especially in Kodagu region of Karnataka and the emergence pattern has changed in recent years due to weather conditions, but there is limited information on the influence of weather factors on CWSB adult emergence from coffee growing tracts in India. In this context, the current study on the emergence pattern of CWSB in relation to weather parameters was carried out in 40 to 80 years old robusta coffee plants in Polibetta zone, Kodagu, Karnataka.

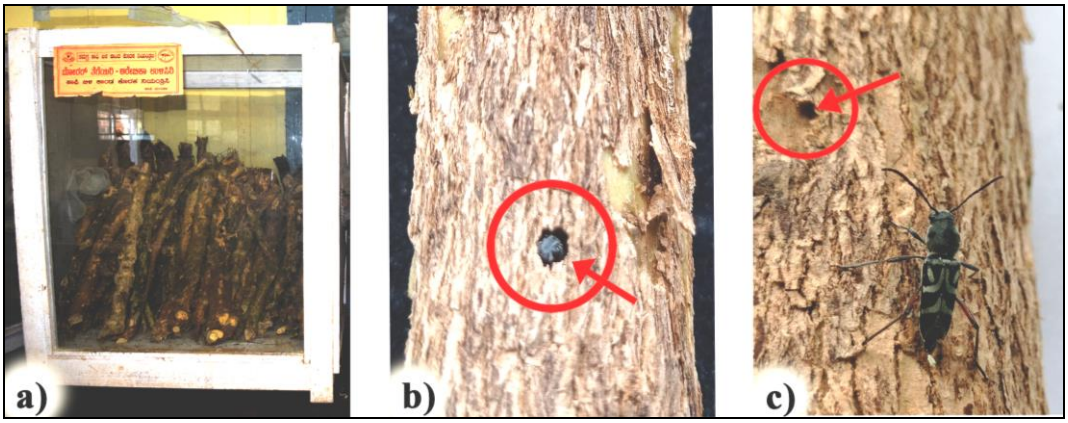


**Fig 1:** Coffee White Stem Borer, *Xylotrechus quadripes* (Chevrolat) a) infested coffee stems confined in cages for emergence; b) emergence of CWSB; c) emergence holes with an adult beetle

## Materials and methods

To monitor the emergence of CWSB adult beetles, 60 to 90 years "Old peridenia"robusta plants infested by CWSB were traced based on the presence of ridges on the main stem and thick primaries were collected prior to emergence periods (April to December) during the year 2019-2021 respectively at Craig More Estate, Polibetta, Karnataka (12.23° N; 75.91° E, 974 m above MSL). The collected stems (30 x 6 cm size; 300 nos.) were kept in 6 cages (90 x 90 x 60 cm) (*i.e.* 50 stems per cage) to record the adult emergence period in the Division of Entomology Laboratory, Coffee Research Sub Station, Chettalli, Kodagu, Karnataka (12.37° N, 75.83° E, 1050 m above MSL). The adult beetles as and when emerged were monitored daily and pooled into monthly mean data. The sex ratio of the beetles and the number of beetles emerged per stem a day was recorded (Reddy *et al*., 2022) [12] (Fig. 1a). The emergence of the beetles was correlated with weather parameters *viz*., the maximum and minimum temperature, relative humidity, rainfall and the total sunshine hours of the day.

The Pearson correlation was used to find the relation between the mean emergence of beetles against weather parameters. Multiple regression analysis was done to predict the emergence pattern of CWSB beetle with the effect of weather parameters. All the analyses were done with R software version 3.6.2 (Mendiburu, 2015) [6].

**Table 1:** Emergence of *X. quadripes* in caged plants at Coffee Research Sub Station, Chettalli, Kodagu.

| Months | Mean no. of beetle emerged over three years | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2019 | | | 2020 | | | 2021 | | |
| | Male | Female | Total* | Male | Female | Total* | Male | Female | Total* |
| January | 0 | 0 | 0 | 2 | 4 | 6 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| April | 7 | 8 | 15 | 3 | 5 | 8 | 4 | 10 | 14 |
| May | 8 | 11 | 19 | 9 | 16 | 25 | 9 | 12 | 21 |
| June | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| July | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| August | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| September | 3 | 5 | 8 | 3 | 7 | 10 | 3 | 4 | 7 |
| October | 5 | 8 | 13 | 8 | 11 | 19 | 1 | 2 | 3 |
| November | 11 | 16 | 27 | 13 | 17 | 30 | 17 | 22 | 39 |
| December | 4 | 6 | 10 | 5 | 9 | 14 | 13 | 17 | 30 |
| Total | 38 | 54 | 92 | 43 | 69 | 112 | 47 | 67 | 114 |
| Sex ratio | 1:1.5 | | | 1:1.6 | | | 1:1.4 | | |
| No. of beetles emerged/stem | 0.30 | | | 0.38 | | | 0.38 | | |

*Total number of male and female beetles emerged from 300 stems

**Table 2:** Correlation of emergence period with weather parameters

| Weather parameters | CWSB, *X. quadripes* | | |
|---|---|---|---|
| **Years** | **2019** | **2020** | **2021** |
| Minimum Temperature ($X_1$) | 0.067 | 0.181 | 0.346 |
| Maximum Temperature ($X_2$) | **0.480*** | **0.558*** | **0.722*** |
| Mean RH (%) ($X_3$) | -0.101 | 0.035 | **-0.546*** |
| Rainfall (mm) ($X_4$) | **-0.471*** | **-0.525*** | **-0.485*** |
| Mean Sunshine Hours ($X_5$) | 0.242 | **0.486*** | **0.523*** |
| Rainy days ($X_6$) | -0.371 | -0.306 | -0.440 |
| Regression equation | $Y= -4.241 - 0.180X_1 + 0.115X_2 + 0.084X_3 - 0.014X_4 + 0.079X_5 - 0.043X_6$ | $Y= -15.95 + 0.096X_1 + 0.141X_2 + 0.132X_3 - 0.001X_4 - 0.032X_5 - 0.124X_6$ | $Y= -2.90 + 0.110X_1 + 0.159X_2 - 0.054X_3 + 0.007X_4 - 0.006X_5 + 0.237X_6$ |
| $R^2$ Values | 0.469 | 0.537 | 0.760 |

*Significant at 5 per cent level.

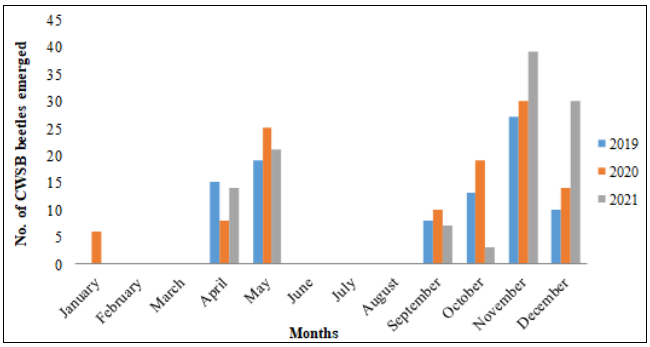


**Fig 2:** Emergence periods of *X. quadripes* during 2019-2021.

## Result and discussion

The results obtained from the experiment carried out for the CWSB emergence period showed that the maximum of 50 beetles (20 ♂ and 30 ♀), 63 (26 ♂ and 37 ♀) and 72 (31 ♂ and 41 ♀) emerged during October-December 2019-2021 respectively. The results are supported by Kurian and Surekha (2000) [4] who observed the emergence of CWSB on robusta with the peak emergence of adult beetle's in the months of November, December and during the months of March, July and August, the emergence was relatively very less due to climatic conditions (Table. 1). The second highest emergence was recorded with 33 beetles (15 ♂ and 19 ♀), 33 (12 ♂ and 21 ♀) and 35 (13 ♂ and 22 ♀) emerged during April-May 2019-2021 respectively and in the months of July and August, the emergence was ceased completely due to climatic conditions like high rainfall and low temperatures. During 2020, a total of six beetles (2 ♂ and 4 ♀) were emerged during January and there was no emergence observed in the month of January during 2019 and 2021. The present study corroborates with the findings of Manikandan *et al.* (2019) [7], that the emergence period of CWSB varies according to climatic conditions and the flight of the CWSB occurs in two periods *i.e.* pre-monsoon flight (April to May) and post-monsoon flight (October to November) (Table. 1). The total number of beetles that emerged, sex ratio and the average number of beetles emerged per stem were 92 (38 ♂ and 54 ♀), 1:1.5 and 0.30; 112 (43 ♂ and 69 ♀), 1:1.5 and 0.38; 14 (47 ♂ and 67 ♀), 1:1.6 and 0.38 during 2019-2021 respectively (Table.1 and Fig. 2).

The present study revealed that CWSB peak emergence in robusta was observed during May, November and December in all the three years *i.e.* 2019-2022. No emergence was observed during the months of March, July and September. According to Reddy *et al.* (2020) [11] and Kumar *et al.* (2022) [3], the maximum number of CWSB adults were observed during October-November months. The above studies are in conformity with the present findings.

The emergence of CSWB beetles was correlated with weather parameters *viz.*, maximum temperature, minimum temperature, rainfall, relative humidity, rainy days and sun shine hours of the day and the results revealed that the emergence of CWSB during the year 2019-2021 exhibited a significant positive correlation with maximum temperature (0.480, 0.558 and 0.722 respectively) and rainfall showed a significant negative correlation with adult emergence (-0.471, -0.525 and -0.485 respectively). Similarly, during the year 2019-2021 sunshine hours showed a positive correlation with adult emergence (0.242, 0.486 and 0.523 respectively) and relative humidity showed a negatively correction with adult emergence (-0.101 and -0.485 respectively) (Table. 2). Reddy (2010) [10] observed that the emergence of CWSB exhibited a significant positive correlation with maximum temperature (r = 0.681) and sunshine hours (r = 0.443) while, there was a significant negative correlation between rainfall (r =-0.421) and relative humidity (r =-0.679). This study was in accordance with the present findings.

The multiple regression analysis also indicated that all the weather parameter together was responsible for the CWSB adult emergence to the extent of 46, 53 and 76 per cent ($R^2$ values) during the year 2019-2021 emergence period. Similar findings were also reported by Reddy *et al.* (2022) [12], that all the weather parameters together influenced the *X. quadripes* adult emergence to the extent of 66 to 72% during the summer and 68 to 92% ($R^2$ values) during the winter season.

## Conclusion

From this study, it is inferred that the emergence period of CWSB beetles were recorded throughout the year but during the months of April to May and November to December reached peak during 2019-2021. The weather factors of the study area had influence on the emergence of CWSB adult beetles, from the results it was noticed that maximum temperature and sunshine hours were correlated with each other while negative correlation was observed with relative humidity and rainfall. However, CWSB's most preferred arabica plants are not found in adequate area, hence the CWSB gradually shift to robusta cultivation in the years to come. Hence, the proper management strategies like borer tracing and uprooting of infested plants before emergence period of beetles are required to manage the CWSB in the robusta coffee plantations.

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