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Emergence Pattern of Coffee White Stem Borer, *Xylotrechus quadripes* Chevrolat (Coleoptera: Cerambycidae) Across Age Groups and Estimation of Base Line Population

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ABSTRACT

In order to achieve successful management of coffee white stem borer in a plantation with heterogenous age group, understanding the emergence pattern of the CWSB across age groups and knowing the intensity of infestation in terms of baseline population is a prerequisite. Thus, emergence pattern of CWSB across age groups in a severely infested arabica coffee plantation with mixed aged plants was studied during winter emergence in 2020. The results revealed that, there is no significant variation in the emergence of CWSB adults across 8 age groups studied. However, amongst the 8 age groups studied, highest mean emergence per sleeved plant was observed in 7-8 year old plants in the winter emergence of 2020 (0.48 CWSB adults/infested plants). Our investigation also showed that, there is a significant difference in the emergence of beetle across months in the winter emergence of 2020. The data showed that, significantly maximum beetles per infested plant emerged in the month October (0.85 beetles/infested plant), followed by November (0.34 beetles/infested plants). Further, a total of 126 CWSB adults were observed emerging from a total of 80 sleeved infested arabica plants belonging to 8 different age groups studied. Out of all the age groups studied, highest total number of CWSB adults was seen emerging from the age group 7-8 years (19 CWSB adults or 1.9 CWSB adults/plant/emergence season).With the results and data acquired in the preceding experiment, base line population of CWSB adults in one acre area of a new experimental plot was estimated. The data showed that, a total of 203 infested arabica plants were located and labeled across different age groups out of an over 1000 plants subjected for survey in one acre area. Further, based on the data on mean number of CWSB adults emerging from different age category plants from previous experiment, the expected baseline population of the pest in one acre area was predicted to be 318.1 CWSB adults/acre.

Keywords Coffee white stem borer, *Xylotrechus quadripes,* Baseline population, CWSB.

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INTRODUCTION

There are more than 850 insect species which feed on coffee and the prevalence of these insect pests is posing a substantial threat to coffee cultivation globally (LePelly1973). In addition, Coffee insect pests have been estimated to cause economic loss to the tune of 13% (Bardner 1978) and adversely hit the coffee markets of Asia in particular. Coffee white stem borer (CWSB), *Xylotrechus quadripes* Chevrolat (Coleoptera: Cerambycidae) is a devastating pest of arabica coffee. Consequently, over the decades, the management of coffee white stem borer has gained a lot of importance in entomological research. The economic importance of the coffee white stem borer is highest in traditional belt of India as it is a major producer of arabica coffee in Asia. A majority of coffee planters consider the coffee white stem borer as a major threat to arabica coffee because crop losses can pile up to devastating levels in some plantations when timely management is not taken up (Venkatesh and Dinesh 2012). The recommended practices for management of *X. quadripes* are difficult to practice by the large-scale arabica coffee land holders because the strategies are cumbersome, laborious and less satisfactory. In addition, CWSB seems to be gambling with our existing management strategies due to its strong ecological adaptations. As a result, the anomalies with respect to pattern of emergence and flight period of CWSB have made the control measures less satisfactory. Hence, it is a prerequisite to have a better comprehension about the behavior, ecological adaptations and niche areas of the pest in order to effectively manage them. Further the activity of adult beetles is highly seasonal and it is influenced by the plant physiology and environmental factors as well. In the present investigations, efforts were made to figure out a simple procedure for identification of the baseline population of CWSB. This investigation would let us comprehend the ferocity at which the infestation is piling up and eventually this could help us anticipate the best management strategy by focusing at infestation severity and probable base line population.

MATERIALS AND METHODS

Influence of age of the plant and seasonality for beetle emergence

This investigation was done at a severely infested plantation with heterogeneous aged plants. The heterogeneity is a common scenario in most large estates because of the practice of replanting being followed by the coffee planters in order to get rid of the infested plant. In this experiment, 10 infested plants representing varied ages (predicted on the basis of height and girth of plants) was individually sleeved with nylon meshes to record number of CWSB adults emerge from each sleeved plant. The sleeves used in the investigation to wrap the plants were prepared using standard quality nylon material. The nylon meshes were 1 x 0.3 meter in size and were stitched with velcro band to achieve firm covering. This investigation was conducted by following two factorial design. Age of the sleeved arabica coffee plant was factor A with 8 levels i.e., each level represented different age group. Further, month was factor B with 4 levels. i.e., months representing winter emergence of CWSB viz., September, October, November and December was taken into consideration. The principle motive of this investigation was to comprehend the influence of age of the plant and seasonality for emergence of adult CWSB.

Calculation of base line population of X. quadripes in an infested arabica plot

The number of adult CWSB emerging per sleeved plant under respective age groups was observed on regular basis. Later, this data was categorically summed up to predict the combined baseline population of CWSB beetles across different age category per known number of infested plant samples in the experimental area. This data was eventually used to estimate the baseline population of CWSB in a new large experimental area by taking total number of infested plants, their respective age groups and mean beetle emergence from each age group into account. This prediction will help us to plan the management strategy based on the intensity and severity of the CWSB and their populations build up

RESULTS AND DISCUSSIONS

Influence of age of the plant and seasonality for beetle emergence

The results depicted in Table 1 showed that there is

Table 1. Influence of age of the plant and seasonality for beetle emergence.

Age groups/ month	September	October	November	December	Grand mean
3-4	0.20	1.00	0.30	0.00	0.38 a
5-6	0.30	0.80	0.40	0.00	0.38 a
7-8	0.20	0.80	0.50	0.40	0.48 a
9-10	0.10	0.90	0.10	0.20	0.33 a
11-12	0.20	0.70	0.40	0.30	0.4 a
13-14	0.30	0.90	0.30	0.30	0.45 a
15-16	0.10	0.90	0.30	0.10	0.35 a
17-18	0.20	0.80	0.40	0.20	0.4 a
Mean	0.2 b	0.85 a	0.34 b	0.19 b	
Factor A CD @ 5%	0.25				
Factor B CD @ 5%	0.17				
Factor A X B CD @ 5%	0.50				

no significant difference in the emergence of CWSB across age groups. However, amongst the age groups studied, highest mean emergence per sleeved plant was observed in 7-8 year old plants (0.48 CWSB adults/infested plants), followed by older aged plants (Table 1). The possible justification for this tendency could be strong vigor of the plant to sustain the pest load and sufficient accumulation of dry matter. Our results are in line with Rhainds *et al*. (2002) who reported pest incidence, severity of infestation and symptomology by 3 Coffee Stem Borers (Coleoptera: Cerambycidae). The results of their experiment proved that, plants belonging to age group 5-7 year were 10 folds more heavily attacked with *X. quadripes* than younger aged plants. Further, as documented by Smith *et al*. (2004). The CWSB adults are very well likely that they display certain range of spatial dependability and host preference even in most fragmented landscapes. As far as the population dynamics of the CWSB is regarded, the beetles are often highly selective about the environmental factors and conditions of the host plant chosen for survival. Further, not clinging to such necessary conditions could lower their fitness (Hanks 1999).

Our investigation also showed that, there is a significant difference in the emergence of beetle across months. The data showed that, significantly maximum beetles per infested plant emerged in the month October (0.85 beetles/infested plant), followed by November (0.34 beetles/infested plants) (Table 1).Our findings are in agreement with Venkatesha *et al*. (2012) and Venkatesha (2010) who documented that, maximum infestation of CWSB occurs during the October – November flight period in India where in October remains the predominant month. Similar inspections were also made by Le Pelley (1973) who reported that October month is more likely to see maximum activity and emergence of CWSB during winter emergence.

Table 2. Beetle population of *X. quadripes* across age groups captured using sleeve traps. n=80 (10 sleeved plants under each age group)

Age category /Plant number	1	2	3	4	5	6	7	8	9	10	Total	Mean	Range	SD ±
3-4	2	3	3	0	0	3	3	0	1	0	15	1.5	0-3	1.4
5-6	2	0	2	3	2	2	2	2	0	0	15	1.5	0-3	1.1
7-8	0	2	3	1	0	4	3	1	2	3	19	1.9	0-4	1.4
9-10	0	3	1	0	4	2	3	0	0	0	13	1.3	0-4	1.6
11-12	3	0	0	0	1	0	3	3	2	4	16	1.6	0-4	1.6
13-14	0	4	4	3	1	2	1	0	3	0	18	1.8	0-4	1.6
15-16	2	2	2	0	2	2	2	2	0	0	14	1.4	0-2	1.0
17-18	2	0	3	4	2	3	1	1	0	0	16	1.6	0-4	1.4
Grand Total											126			

n=80 (10 sleeved plants under each age group)

Calculation of base line population of X. quadripes in an infested arabica plot

The results of this investigations revealed that (Table 2) a total of 126 adult CWSB were seen emerging from a total of 80 sleeved infested arabica plants belonging to 8 different age groups. Out of all the age groups studied, highest number of CWSB adults was seen emerging in the age group 7-8 years (19 CWSB adults or 1.9 CWSB adults/plant/emergence season). As far as the range is concerned, highest range of CWSB adult emergence was observed in the same age group of 7-8 years and 9-10, 11-12 and 13-14 years (0 to 4 CWSB adults/plant/emergence season). The mean number and range observed in the younger age group plants of age 3-4 and 5-6 years is 1.5 CWSB adults/plant/emergence and 0-3 CWSB adults/plant/emergence season respectively.

With the results and data acquired in the preceding experiment, base line population of CWSB adults in 1 acre area of a new experimental area was

Table 3. Baseline population of the *X. quadripes* beetles estimated per acre area of experimental area. n=203 infested plants

Age category	Number of infested plants	Mean beetle population in the age category	Estimated number of beetles
3-4	21	1.5	31.5
5-6	25	1.5	37.5
7-8	27	1.9	51.3
9-10	32	1.3	41.6
11-12	25	1.6	40.0
13-14	29	1.8	52.2
15-16	32	1.4	44.8
17-18	12	1.6	19.2
Total per acre	203	12.6	318.1

estimated (Table 3). The data showed that, a total of 203 infested arabica plants were located and labeled across different age groups out of an over 1000 plants subjected for survey in one acre area. Further, based on the data on mean number of CWSB adults emerging from different age category plants from previous experiment, the expected baseline population of the pest in one acre area was predicted to be 318.1 CWSB adults/acre.

Having said that, the emergence of CWSB adults doesn't solely depend on just age of the plant. In addition, they are considerably impacted by a lot of other parameters as well like altitude, weather, topography and microclimate *et cetera*. However, the influence of age and vigor of the coffee plant cannot be ruled out as it is highly comparative. The estimation of baseline population of a CWSB needs to be contemplated as a fundamental requirement to plan more effective pest management strategies. As a matter of fact, researchers from all nuke and corners of the world have always been vocal about the significance of ecological studies as an essential tool in order to chalk out effective management strategies. Further, unless ecological preferences of the pest and the behavior are studied, the consequences of the counter actions will be apparently dissatisfactory. Thus, our investigation on estimation of base line population of CWSB stands a testimony to many such arguments.

Following are the investigations with more or less similar motives conducted by as they could eventually estimate the richness of pest population and how this knowledge can be potentially exploited in the pest management exercises.

Rhainds *et al.* (2002) studied pest occurrence, symptomology and intensity of infestation by 3 Coffee Stem Borers (Coleoptera: Cerambycidae). During the research, sampling studies were conducted in various coffee estates to predict the aforementioned details by three stem borers: *Xylotrechus quadripes* (Chevrolat), *Acalolepta cervina* (Hope) and *Bacchisa* sp. Out of a 5,690 plants studied in eight plantations, a total of 440 plants were seen to be attacked with *A. cervina,* 63 plants were attacked with *X. quadripes,* and 3 plants were attacked with *B. pallidiventris.* Further, the comparison of severity of infestation and life history traits for the 3 borer species pointed out that, *Xylotrechus quadripes* is the most severely infesting pest of arabica coffee and the data also advocated that population growth trend of *Xylotrechus quadripes* has the extraordinary potential to rapidly increase with time. Ohsawa (2003) experimented on species richness of major cerambycid beetles in larch plantations and natural broad-leaved forests in the central mountainous region of Japan. The experiments were conducted by using Malaise traps. The data on trap catches of target pest was eventually used in envisaging the species abundance of major cerambycids and they were compared among 32 forest stands in the central mountainous region of Japan.

Garcia *et al.* (2000) investigated on the diversity of major cerambycids (Coleoptera) in the Caribbean region of Colombia. The study concentrated on the spatio-temporal variation of the cerambycids diversity in two separate set of tropical dry forest. At each of the experimental locality, 4 squared subplots were demarked and the adult cerambycid beetles were sampled with light traps, fruit traps, manual capture and beating sheets put in the center of the each plots. As a result, 587 specimens representing 128 species were sampled, out of which, tribe *Ectenessini* (Cerambycinae) was observed as the most abundant. Similar experiments were conducted by Fahri *et al*. (2016), who experimented on diversity and abundance of cerambycids in 4 major land use kinds located in Jambi Province of Indonesia. In the due course of research, cerambycid species diversity was estimated in four land types viz., rubber plantations, junglerubber, oil palm plantations and felled jungle rubber. Sampling of cerambycids was done by installing Artocarpus trap prepared by freshly cut *Artocarpus heterophyllus* branches.

CONCLUSION

The data presented on pattern of emergence of CWSB across age groups coupled with data on base line population of CWSB adults in 1 acre area could help us foresee the intensity of damage and it would eventually guide us design an appropriate pest management strategy. To sum up, our results would help us in predicting an appropriate management strategy to be employed against the CWSB in accordance with the baseline population. Knowing the baseline population in a heterogeneous age grouped plantation is an added advantage because the technique could be effective in situations where the population size is higher and sufficient.

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