



Survey for incidence of coffee white stem borer, *Xylotrechus quadripes* (Chevrollet) on robusta coffee (*Coffea canephora* Pierre ex A. Froehner) plantations at Kodagu region of Karnataka state, India

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Abstract

Coffee is an important commercial crop attacked by various insect pests. Among them, coffee white stem borer (CWSB), *Xylotrechus quadripes* (Coleoptera: Cerambycidae), is the most serious and economically important pest of arabica coffee. The incidence of CWSB has been noticed in arabica coffee, whereas the other commercial variety, viz., robusta, has been tolerant against this pest so far. Of late, the incidence of CWSB is reported regularly in robusta plantations in the Kodagu region of Karnataka State, India. To understand the extent of CWSB incidence in robusta coffee, a systematic survey was conducted in 40 estates of Polibetta and Siddapura liaison Zones during the year 2019. CWSB infestation and the details on the percentage of CWSB, cultivar types, and age of the plants were recorded. The results of the survey revealed that the incidence was more in aged plants of Old Peridenia and S.274 (>50 years) compared to young plants and C × R hybrid (*Coffea congensis* × *Coffea canephora*). Data on the percentage infestation was found more in Old Peridenia (16.81%), followed by S.274 (4.8%) and C × R (0.88%). The infested plants of Old Peridenia and S.274 showed typical symptoms as in the case of arabica plants like ridge formation, drooping and yellowing of leaves, wilting, defoliation, exit holes and death of branches and whole plants. Hence, Indian coffee farmers are shifting slowly from arabica to robusta coffee because of CWSB infestation. This survey emphasized that a complete shift from arabica to robusta cultivation may face a similar infestation problem unless management practices are followed promptly.

Keywords: Coffee, incidence, robusta, white stem borer, *Xylotrechus quadripes*

Introduction

Coffee (*Coffea* sp.), a native of the South-West region of Ethiopia (Abyssinia), is a popular beverage crop worldwide. India is the seventh largest producer of coffee, growing two varieties, *Coffea arabica* (arabica) and *Coffea canephora* (robusta). Indian coffee is known for its shade-grown nature compared to other coffee grown worldwide. In India, 11 per cent of the population consumes coffee, and the beverage ranks fourth after carbonated soft drinks (28%), milk (28%) and fruit juices (26%). India earns \$836 million annually by exporting

coffee to other countries (The Coffee Board of India, 2019). In India, 2.5 lakh farmers grow coffee in different states; among them, 98 per cent are small-scale farmers (Lee and Lee, 2007). In India, the coffee plantation area has increased by 56 per cent in the past 25 years, replacing arabica with robusta coffee due to severe damage caused by coffee white stem borer (CWSB), which has increased by 25 to 80 per cent from 1950 to 2019 (The Coffee Board of India, 2020).

Coffee plantations follow a complex cropping system with different degrees of shade management

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(Tschardt et al., 2011) using native and exotic primary and secondary shade trees (Suresh Kumar et al., 1992). Several studies have shown that coffee agro-forests could benefit wildlife and provide avenues for conservation strategies as compared to monocultures (Robbins et al., 2015; Karanth et al., 2016; Chang et al., 2018). However, this conversion of the forest to coffee plantations has also created a habitat for *Xylotrechus quadripes*, a species of longhorn beetle belonging to the family of Cerambycidae and Order Coleoptera commonly known as CWSB (Robert, 2017). The first incidence of CWSB attacking coffee plants was reported in early 1838 (Le Pelley, 1968). It is India's most destructive insect pest on arabica coffee plants (Coffee Guide, 2014; Venkatesha and Dinesh, 2012). It is distributed in other Asian countries such as Bangladesh, Myanmar, Nepal, China, Thailand, Vietnam, Indonesia, and Sri Lanka (Rhainds et al., 2002; Lan and Wintgens, 2004). The CWSB beetles lay eggs in cracks and crevices on the bark of woody stems, the larvae feeding inside the bark, which leads to the death of the plants (Seetharama et al., 2005; Venkatesha and Dinesh, 2012). The losses caused by damages due to CWSB varied from 2.30 to 12.50 per cent in well-maintained estates compared to 17.8 to 20.0 per cent in neglected estates (Subramaniam, 1941). The incidence level of CWSB is dependent on the age of the plants and the management practices adopted. The maximum infestation was observed as 8.3 per cent in old plants and 0.7 per cent in young plants in India (Shylesha and Veeresh, 1995). CWSB causes 2 to 20 per cent of damage in India. Although the loss percentage appears to be small, the cumulative effect over several years leads to the complete replanting of large portions. The annual money loss due to the destruction of good-bearing coffee bushes of CWSB accounted for US\$ 40 million in 2006 (Hall et al., 2006) and US\$ 26 million in 2010 (Venkatesha, 2010).

The incidence of CWSB has been noticed in arabica coffee only. Robusta, the other commercial variety, has shown tolerance against this pest. However, the incidence of *X. quadripes* was reported on robusta as early as 1915 by Duport in Vietnam. Beeson (1941) reported the incidence of CWSB on robusta coffee from India. Stray incidences of CWSB attacking *Olea dioica* and *Tectona grandis* were reported by Subramaniam

(1941). Kung (1977) reported *Wendlandia myriantha* (Menispermaceae) and *Randia spinosa* (Rubiaceae) as alternate hosts for *X. quadripes*. The occurrence of CWSB on robusta coffee from Coorg (Polibetta) was reported by Veeresh (1995). Raphael and Sureakha (2000) reported a severe incidence of CWSB on a few neglected estates in Polibetta and Siddapura. Of late, the incidence of CWSB is regularly reported in the robusta plantations, especially in the Kodagu region of Karnataka. Hence, a systematic survey was conducted during 2019-20 to record the incidence of CWSB on robusta coffee in the Kodagu region of Karnataka, India.

Materials and methods

An extensive survey was conducted to know the level of incidence of CWSB in 40 robusta coffee growing estates of Polibetta/Siddapura liaison zones of Kodagu district, Karnataka, India, during 2019-21. During the survey, the per cent incidence of CWSB and the number of infested plants, information on cultivar types and age of the plants and spacing were recorded. The coffee plants were cultivated under the medium shade with a spacing of 2.7 x 2.7 m, 3.0 x 3.0 m and 3.7 x 3.7 m with different cultivars like C X R, S.274 and Old Peridenia. The number of coffee plants varied from 746 to 1329 per hectare, depending on the spacing. The average age of the plants varied from 5 to 55 years with different cultivars.

The number of infested coffee plants in each estate of a study area was recorded for three years during flight periods (April-May and October-December), and the percentage damage was worked out in groups of five consecutive coffee plants from a total of 50 plants sampled at each estate (Table 1). The CWSB incidence was assessed with ridges formation on the stem, plants showing yellowing of the leaves and stunted. The per cent damage of CWSB was assessed in each estate based on the number of healthy coffee plants and the number of infested plants per hectare. The infested stems were cut open and observed for the presence of CWSB grubs (Reddy, 2011).

Results and discussion

Forty estates in the Kodagu region of Polibetta and Siddapura zones with robusta coffee plantations were surveyed for the incidence of CWSB.

Table 1. Incidence of *X. quadripes* in robusta coffee plantations in Kodagu region

Sl. No.	Estates	Robusta area (ha)	Variety	Crop age (years)	Total no. of plants in the area (ha)	No. of CWSB infested plants	Per cent Incidence
1.	Estate 1	24.3	C×R	5	5316	0	0
			S.274	35	4300	0	0
			Old Peridenia	40	29840	10	0.04
2.	Estate 2	10.4	C×R	10	9701	0	0
			Old Peridenia	40	5595	0	0
3.	Estate 3	5.3	Old Peridenia	40	3954	27	0.69
4.	Estate 4	12.2	Old Peridenia	80	9102	31	0.34
5.	Estate 5	28.4	C×R	10	7974	0	0
			S.274	30	8600	2	0.03
			Old Peridenia	40	10594	9	0.09
6.	Estate 6	3.3	Old Peridenia	30	2462	0	0
7.	Estate 7	5.7	C×R	5	2658	0	0
			Old Peridenia	40	2761	0	0
8.	Estate 8	28.4	C×R	10	3230	3	0.10
			S.274	30	10535	0	0
			Old Peridenia	40	15144	12	0.08
9.	Estate 9	6.0	Old Peridenia	40	1269	0	0
10.	Estate 10	6.5	C×R	10	1728	2	0.12
			S.274	30	1398	22	1.58
			Old Peridenia	80	2119	41	1.94
11.	Estate 11	24.3	C×R	10	5316	0	0
			S.274	35	4300	5	0.12
			Old Peridenia	40	12085	24	0.20
12.	Estate 12	28.4	C×R	10	13024	0	0
			S.274	35	7418	0	0
			Old Peridenia	40	8803	0	0
13.	Estate 13	6.0	S.274	35	2150	0	0
			Old Peridenia	40	2984	18	0.60
14.	Estate 14	16.0	C×R	10	5316	0	0
			S.274	35	6450	0	0
			Old Peridenia	80	4476	41	0.20
15.	Estate 15	6.0	C×R	10	4386	7	0.16
			Old Peridenia	40	1865	13	0.70
16.	Estate 16	1.7	Old Peridenia	80	1269	4	0.32
17.	Estate 17	28.4	S.274	35	8600	11	0.13
			Old Peridenia	80	15144	39	0.26
18.	Estate 18	32.4	C×R	10	10752	0	0
			Old Peridenia	40	18128	6	0.04
19.	Estate 19	16.0	C×R	10	5316	0	0
			S.274	30	4300	0	0
			Old Peridenia	40	5968	0	0

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20.	Estate 20	20.3	C×R	5	5316	0	0
			Old Peridenia	80	11936	43	0.36
21.	Estate 21	7.7	C×R	10	2658	3	0.12
			S.274	35	4300	21	0.49
			Old Peridenia	80	2984	44	1.48
22.	Estate 22	16.0	C×R	10	8067	2	0.03
			Old Peridenia	85	7609	12	0.16
			S.274	35	2150	16	0.75
			Old Peridenia	40	7609	44	0.58
24.	Estate 24	6.5	C×R	5	2658	0	0
			S.274	35	1828	26	1.43
			Old Peridenia	80	1865	53	2.85
25.	Estate 25	24.3	C×R	10	5316	0	0
			S.274	35	6450	0	0
			Old Peridenia	40	10594	20	0.19
26.	Estate 26	24.3	Old Peridenia	80	18128	44	0.25
27.	Estate 27	24.3	C×R	10	13556	0	0
			Old Peridenia	40	10594	0	0
28.	Estate 28	8.0	Old Peridenia	40	5968	16	0.27
29.	Estate 29	4.9	C×R	5	2260	0	0
			Old Peridenia	40	2462	0	0
30.	Estate 30	28.4	C×R	10	13556	0	0
			Old Peridenia	40	13652	0	0
31.	Estate 31	2.0	C×R	10	2658	0	0
32.	Estate 32	12.2	Old Peridenia	80	9102	57	0.63
33.	Estate 33	12.2	Old Peridenia	80	9102	30	0.33
34.	Estate 34	14.2	C×R	5	7974	0	0
			Old Peridenia	40	5968	26	0.44
35.	Estate 35	6.0	Old Peridenia	80	4476	28	0.63
36.	Estate 36	12.2	C×R	5	2658	0	0
			Old Peridenia	40	7610	23	0.30
37.	Estate 37	6.0	Old Peridenia	80	4476	29	0.65
38.	Estate 38	24.3	C×R	10	7974	4	0.06
			S.274	35	6450	17	0.27
			Old Peridenia	40	9102	12	0.14
39.	Estate 39	4.0	Old Peridenia	80	2984	15	0.50
40.	Estate 40	2.0	C×R	5	1728	5	0.29
			Old Peridenia	40	1552	24	1.55
Total		561.7	C×R				0.88
			S.274				4.8
			Old Peridenia				16.81

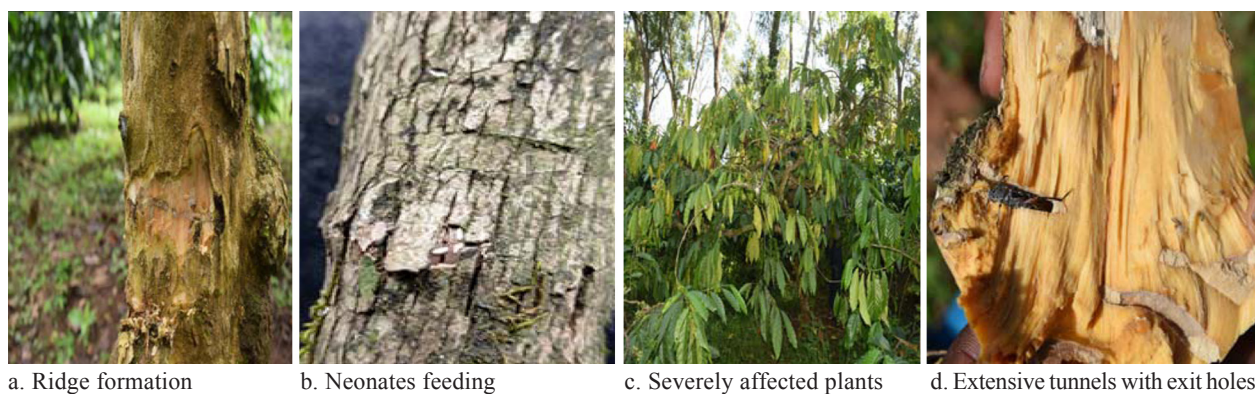


Fig. 1. Nature of coffee white stem borer damage observed in robusta plantations in Kodagu region of Karnataka state

The survey results revealed that a total of 5,15,819 plants were present in 561.8 ha, and the results are furnished in Table 1. Of this, 921 plants were infested with CWSB in three different cultivars. This accounted for 26 plants of C×R (0.88%) infestation, followed by 120 plants in S.274 (4.8%) and 775 plants of Old Peridenia (16.81%) infested with CWSB.

The incidence of CWSB recorded was 0.29 per cent in 5-year-old C×R compared to 0.59 per cent in 10-year-old plants. In S.274, 1.61 per cent of CWSB incidence was recorded in the 30-year-old plants, while a comparatively higher 3.19 per cent was recorded in the 35-year-old plants. Forty-year-old Old Peridenia plants recorded 5.91 per cent CWSB incidence, which was less than 80-year-old plants, which showed the highest CWSB incidence, *viz.*, 10.9 per cent. The symptoms included prominent ridges on the main stem and thick primaries, and severely infested plants showed yellowing symptoms, leading to the death of the plants. In contrast, in young plants of C×R selection, CWSB could not complete its life cycle as only ridges were noticed without any other symptoms and exit holes. Also, larval mortality was observed after initial feeding on the green tissue. However, the infested plants of Old Peridenia and S.274 showed symptoms like ridge formation, drooping and yellowing of leaves, wilting, defoliation, exit holes and death of primary branches and whole plants.

The present survey on the incidence of *X. quadripes* indicated that the infestation was more pronounced in 40 to 80 years of Old Peridenia and

S.274 robusta plantations than in 5 to 10 years of C×R robusta coffee plantations. Some of the growers had neglected the estates and had not maintained the estates properly by undertaking timely cultural operations. Extensive tunnelling and exit holes leading to the death of the plants were noticed in affected plants (Fig. 1. a-d).

Raphael and Surekha (2000) surveyed 28 estates in the Kodagu region. Among them, 16 estates recorded borer incidence and reported 1 to 20 per cent infestation of CWSB in 80 to 100 years old robusta plantations.

The percentage loss varied from 2.3 to 12.5 in very well-maintained estates, but in neglected estates, the loss went up from 17.8 to 20.0 per cent (Subramaniam, 1941). The level of CWSB incidence was related to the age of the plants, with a maximum infestation of 8.3 per cent observed in old plants and only 0.7 per cent in very young plants (Shylesha and Veeresh, 1995). Veeresh (1995) also reported 2 to 20 per cent yield loss due to CWSB in arabica coffee plantations. A study from 90 randomly selected arabica coffee plantations in India showed 45 per cent of plants infested by CWSB and a mean annual yield loss of 35 per cent (Joy, 2004). Samuel *et al.* (2013) reported 33.2 to 41.6 per cent reduced fruit yield was due to CWSB infested plants compared to healthy plants of arabica selections like Sln. 3 (S.795) and Sln. 12 (Cauvery).

Conclusion

The present survey indicated that the damage caused by CWSB was more pronounced in 40 to 80 years of Old Peridenia followed by S.274 robusta

plantations compared to the 5 to 10 years of C x R robusta plantations. The mean per cent incidence of coffee white stem borer in Old Peridenia and S.274 cultivar was 17.13 and 4.8, respectively. The incidence level has increased recently because Indian coffee farmers are shifting from arabica to robusta coffee plantations. Tracing and destroying the infested plants before flight seasons is emphasized as a part of the recommendation by the Coffee Board of India for the management of CWSB. However, the main reason for the variation in CWSB infestation between different plantations is the lack of awareness of borer tracing, uprooting, burning and timely management.

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References

- Beeson, C.F.C. 1941. *The Ecology and Control of the Forest Insects of India and the Neighbouring Countries*. Vasant Press, Dehra Dun, India, pp. 1007.
- The Coffee Board of India. 2019. Export Information. Abstract on Both Indian and Re-exported coffee. Available online at: https://www.indiacoffee.org/ExportInfo_Archives.aspx (accessed August 16, 2020).
- The Coffee Board of India. 2020. Database on Coffee, January 2020. Available online at: <https://www.indiacoffee.org/database-coffee.html> (accessed August 16, 2020).
- Coffee Guide. 2003. Central Coffee Research Institute, *Coffee Research Department*, Balehonnur, India.
- Chang, C. H., Karanth, K. K., and Robbins, P. 2018. Birds and beans comparing avian richness and endemism in arabica and robusta agroforests in India's Western Ghats. *Scientific Reports* **8**: 3143.
- Hall, D. R., Cork A., Phythian S. J., Chittamuru S., Jayarama B. K., Venkatesha M. G., Sreedharan K., Kumar P. K. V., Seetharama H. G. and Naidu, R., 2006. Identification of components of the male-produced pheromone of coffee white stem borer, *Xylotrechus quadripes*. *Journal of Chemical Ecology* **32**: 195-219.
- Joy, C.V. 2004. Small Coffee Growers of Sulthan Bathery, Wayanad. Discussion Paper No. 83, Kerala Research Programme on Local Level Development Centre for Development Studies Thiruvananthapuram.
- Kung, P.C. 1977. Studies on two long-horned beetles infesting coffee trees in Kwangsi Autonomous Region. *Acta Entomologica Sinica* **20**:49-56.
- Raphael, P. K. and Surekha K., 2000. Survey of coffee white stem borer incidence on robusta in Kodagu. *International Scientific Symposium on Coffee*, pp. 57-62.
- Karanth, K. K., Sankaraman, V., Dalvi, S., Srivathsa, A., Parameshwaran, R., Sharma, S., 2016. Producing diversity agroforests sustain avian richness and abundance in India's Western Ghats. *Frontiers in Ecology and the Environment* **4**:111.
- Le Pelley R. H., 1968. *Pests of Coffee*. Longmans, Green and Co. Ltd, London, pp. 590.
- Lee, H. L., and Lee, C. Y., 2007. Building Supply Chain Excellence in Emerging Economies. *Springer Science & Business Media* Vol. 98.
- Lan, C.C. and Wintgens, J.N. 2004. *Major Pests of Coffee in the Asia-Pacific region*. pp. 459-473.
- Reddy, A., 2011. Studies on behaviour and management of coffee white stem borer, *Xylotrechus quadripes* Chevrolat (Cerambycidae: Coleoptera). *Ph.D. Thesis University of Agricultural Sciences, Bengaluru*.
- Rhainds, M., ChinChiew L., MoLi Z. and Gries G., 2002. Incidence, symptoms, and intensity of damage by three coffee stem borers (Coleoptera: Cerambycidae) in South Yunan, China. *Journal of Economic Entomology* **95**: 106-112.
- Robbins, P., Chhatre, A., and Karanth, K., 2015. Political ecology of commodity agroforests and tropical biodiversity. *Conservation Letters* **8**: 77-85.
- Robert, A. H., 2017. Cerambycid pests in forest and urban trees, In: *Cerambycidae of the World: Biology and Pest Management*, Ed. Qiao Wang, Boca Raton, NY: CRC Press, pp. 305-320.
- Subramaniam, T.V. 1941. The coffee white stem borer. *Bulletin:Department of Agriculture, Mysore State, Entomology Series*. 11pp.
- Suresh Kumar, V. B., Sambamurthy Reddy, A.G. and Ramachandran, M., 1992. A leguminous shade tree for coffee. *Indian Coffee* **56**: 3-9.
- Shylesha, A. N. and Veeresh G. K., 1995. Incidence of coffee white stem borer *Xylotrechus quadripes* Chevrolat in major coffee growing tracts of Karnataka. *Journal of Hill Research* **8**: 239-241.
- Seetharama, H. G., Vasudev V., Kumar P. K. V. and Sreedharan K., 2005. Biology of coffee white stem borer, *Xylotrechus quadripes* Chevrolat. (Coleoptera: Cerambycidae). *Journal of Coffee Research* **33**: 98-107.

- Samuel, S.D., Norman, S.J., and Kumar, P.K.V., 2013. Effect on crop due to coffee white stem borer infestation. *Journal of Coffee Research* **41**(1&2): 40-46.
- Tscharntke, T., Clough, Y., Bhagwat, S. A., Buchori, D., Faust, H. and Hertel, D., 2011. Multifunctional shade-tree management in tropical agroforestry landscapes - A review. *Journal of Applied Ecology* **48**: 619-629.
- Veeresh, G. K., 1995. Bio-ecology and Management of the Coffee White Stem Borer, *Xylotrechus quadripes* Chevrolat. *University of Agricultural Sciences*, Bangalore. Deposited at Cornell University Library, NY, pp. 56.
- Venkatesha, M. G. B., 2010. Sustainable coffee cultivation in India: challenges and management. In: *Proceedings of the 16th Asian Agricultural Symposium and 1st International Symposium on Agricultural Technology* (Bangkok: King Mongkut's Institute of Technology Ladkrabang), pp. 492-495.
- Venkatesha, M. G. and Dinesh, A. S., 2012. The coffee white stem borer *Xylotrechus quadripes* (Coleoptera: Cerambycidae): Bioecology, Status and Management. *International Journal of Tropical Insect Science* **32**: 177-188.