Management of Cut and Dry Bamboo Borer - *Chlorophorus annularis* Fab. (Coleoptera: Cerambycidae) by Using Systemic and Contact Insecticides

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Received: Aug 03, 2021; Accepted: Sep 28, 2021

CITATION: Singh KP, Sharma M. Management of Cut and Dry Bamboo Borer - *Chlorophorus annularis* Fab. (Coleoptera: Cerambycidae) by Using Systemic and Contact Insecticides. Recent Adv Biol Med. 2021;7(3):9800016. https://doi.org/10.18639/RABM.2021.9800016

ABSTRACT
Chlorophorus annularis Fab. (Coleoptera: Cerambycidae) damages cut and dry bamboo. Chlorpyriphos 0.04% yielded 39.13 per cent for the control of bamboo borer followed by chlorpyriphos 0.02%, which controlled 34.78% of borer attacks while cypermethrin and deltamethrin were found least effective. Among the systemic insecticides, imidacloprid 0.04% gave 26.32 per cent control of borer attack.

KEYWORDS: Bamboo; *Chlorophorus annularis*; Systemic Insecticides; Contact Insecticides.

1. INTRODUCTION

Bamboos belong to the grass family Poaceae comprising 75 genera and 1250 species [1]. Bamboos in India suffer from insect damage, in varying degrees, right from the seed to the finished products, and have a quite rich spectrum of insect fauna including borers, defoliators, culm and shoot borers and sap-suckers. The insect fauna of bamboos has been grouped into seed insects (2 species), nursery pests (5 species), defoliators (48 species), sapsuckers (90 species), culm and shoot borers (12 species), borers of felled and dried bamboos (44 species) and termites (13 species) belonging to insect orders Coleoptera, Homoptera, Isoptera, Lepidoptera and Orthoptera. Above all, *Chlorophorus annularis* Fab. (Coleoptera: Cerambycidae), Syn. - *Callidium annulare* Fab. [2], *Caloclytus annulare* [2], common name - Bamboo tiger longicorn [3] and Bamboo longhorn [4] has been found as one of the most deteriorating insects of cut and dry bamboo. *C. annularis* is a primary borer of Cut and Dry Bamboo [5]. During the field survey, *C. annularis* was found damaging on cut and dry bamboo in natural stands. No information is available on chemical control of *C. annularis,* therefore, the present work was taken up to find out suitable insecticides and dosages for the control of the cut and dry bamboo borer.

2. METHOD(S)

During the study period 2017-2019, intensive surveys of various localities were carried out. The forest areas visited were Soil Conservation Forest Division, Kalsi, Timli, and Langha Ranges, Dehradun Forest Division, Thano Range, Bamboo setum, FRI – Uttarakhand; Saharanpur, Uttar Pradesh and Kalesar, Haryana. The infested bamboo culms along with the insect were collected from the field and brought from the sites for rearing in the Insectary of Forest Entomology Discipline of Forest Protection Division, Forest Research Institute, Dehradun. The rearing of borer was done in the chimney, metallic zinc and outdoor cages for laying down the experiments**.**

2.1. CONTROL EXPERIMENT USING SYSTEMIC INSECTICIDES

In April 2018, a trial for the control of bamboo borer - *C. annularis* on dry bamboo - *Bambusa balcoa* in outdoor cages in Insectary, Forest Entomology discipline, FRI, Dehradun was laid down to test their effectiveness and to optimize suitable dose. Three systemic insecticides - dimethoate, monocrotophos, and imidacloprid at 0.01, 0.02 and 0.04 per cent concentration with three replications were applied through hand sprayer along with sticker on the dry bamboo. Three bamboo pieces each having two internodes were taken for each treatment of 0.01, 0.02 and 0.04% concentration and sprayed thoroughly. Dimethoate was put in T1, T2 and T3 at respective concentration. Monocrotophos was introduced in T4, T5 and T6 and imidacloprid was put in T7, T8, and T9. T10 was kept under observation as a control experiment without applying insecticide. Pre-treatment observations were recorded before applying insecticides and no borer attack was recorded in the bamboo pieces used for the experiment. Post-treatment observations were recorded after one year.

2.2. CONTROL EXPERIMENT USING CONTACT INSECTICIDES

Another experiment in April 2018 using contact insecticides on *B. balcoa* was also laid down. The insecticides used were deltamethrin, cypermethrin, and Chlorpyriphos at 0.01, 0.02, and 0.04 % concentration in three replications. Each concentration was taken as one treatment as in the case of systemic insecticides. Deltamethrin was used in T1, T2, and T3; cypermethrin was used in T4, T5, and T6; Chlorpyriphos was applied in T7, T8, and T9. T10 was kept under observation as a control experiment without introducing insecticide. The control of borer attack was calculated by counting the number of galleries and compared with control. The control of borer attack was calculated by counting the number of galleries and compared with control. Pre-treatment observations were recorded before applying insecticides and no borer attack was recorded in the bamboo pieces used for the experiment. Post-treatment observations were recorded after one year.

3. RESULTS AND DISCUSSION

3.1. CONTROL EXPERIMENT USING CONTACT INSECTICIDES

On the basis of pre and post-treatment observations presented in Table 1, after applying chlorpyriphos 0.01% (T1) the number of borer galleries (per piece of bamboo) in R1, R2 and R3 were 18.00, 18.00, and 17.00 respectively with an average of 17.67 galleries per piece. The borer attack was reduced to 78.83% in comparison to the control treatment. The per cent control of borer attack was 23.17. After applying chlorpyriphos 0.02% (T2), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 15.00, 16.00, and 14.00 respectively with an average of 15.00 galleries (per piece). The borer attack was reduced to 65.22% in comparison to the control treatment. The per cent control of borer attack was 34.78. Chlorpyriphos 0.04% (T3), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 14.00, 13.00, and 15.00 respectively with an average of 14.00 galleries per piece. The borer attack was reduced to 60.87% in comparison to the control treatment. The per cent control of borer attack was 39.13.

After applying cypermethrin 0.01% concentration in T4, the number of borer galleries per piece of bamboo in R1, R2, and R3 were 19.00, 19.00, and 20.00 respectively with an average of 19.33 galleries per piece. The borer attack was reduced to 84.04% in comparison to the control treatment. The per cent control of borer attack was 15.96. After applying cypermethrin 0.02% (T5), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 18.00, 17.00, and 19.00 respectively with an average number of 18.00 galleries per piece. The borer attack was reduced to 78.26% in comparison to the control treatment. The per cent control of borer attack was 21.74. After applying cypermethrin 0.04% (T6), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 16.00, 17.00, and 15.00 respectively with an average number of 16.00 galleries per piece. The borer attack was reduced to 69.57% in comparison to the control treatment. The per cent control of borer attack was 30.43.

After applying deltamethrin 0.01% concentration in T7, the number of borer galleries per piece of bamboo in R1, R2, and R3 were 20.00, 19.00, and 20.00 respectively with an average number of 19.66 galleries per piece. The borer attack was reduced to 85.48% in comparison to the control treatment. The per cent control of borer attack was 14.52. After applying deltamethrin 0.02% (T8), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 18.00, 18.00, and 19.00 respectively with an average number of 18.33 galleries per piece. The borer attack was reduced to 79.70% in comparison to the control treatment. The per cent control of borer attack was 20.30. After applying deltamethrin 0.04% (T9), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 16.00, 16.00, and 17.00 respectively with an average number of 16.33 galleries per piece. The borer attack was reduced to 71.00% in comparison to the control treatment. The per cent control of borer attack was 29.00. On the qualitative observation records of these contact insecticides, it was observed that chlorpyriphos 0.04% yielded (39.13%) for the control of bamboo borer - *C. annularis* followed by chlorpyriphos 0.02%, which controlled 34.78% of borer attacks while cypermethrin and deltamethrin were found least effective. Regarding the control treatment (T10), the post-treatment observations showed that the numbers of galleries (R1, R2, and R3) were 24.00, 22.00, and 23.00 respectively with an average of 23.00 galleries per piece of bamboo and taken as 100% of borer attack (Table 1).

3.2. CONTROL EXPERIMENT USING SYSTEMIC INSECTICIDES

On the basis of pre and post-treatment observations presented in Table 2, after applying dimethoate 0.01% (T1), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 16.00, 17.00, and 15.00 respectively with an average of 16.00 galleries per piece. The borer attack was reduced to 84.21% in comparison to the control treatment. The per cent control of borer attack was 15.79. After applying dimethoate 0.02% (T2), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 15.00, 15.00, and 14.00 respectively with an average number of 14.66 galleries per piece. The borer attack was reduced to 77.16% in comparison to the control treatment. The per cent control of borer attack was 22.84. After applying dimethoate 0.04% (T3), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 15.00, 14.00, and 14.00 respectively with an average number of 14.33 galleries per piece. The borer attack was reduced to 75.42% in comparison to the control treatment. The per cent control of borer attack was 24.59.

After applying monocrotophos 0.01% concentration in T4, the number of borer galleries per piece of bamboo in R1, R2, and R3 were 17.00, 17.00, and 16.00 respectively with an average number of 16.66 galleries per piece. The borer attack was reduced to 87.68% in comparison to the control treatment. The per cent control of borer attack was 12.32. After applying monocrotophos 0.02% (T5), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 17.00, 16.00, and 15.00 respectively with an average of 16.00 galleries per piece. The borer attack was reduced to 84.21% in comparison to the control treatment. The per cent control of borer attack was 15.79. After applying monocrotophos 0.04% (T6), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 16.00, 15.00, and 14.00 respectively with an average of 15.00 galleries per piece. The borer attack was reduced to 78.95% in comparison to the control treatment. The per cent control of borer attack was 21.05.

After applying imidacloprid 0.01% concentration in T7, the number of borer galleries per piece of bamboo in R1, R2, and R3 were 16.00, 16.00, and 16.00 respectively with an average of 16.00 galleries per piece. The borer attack was reduced to 84.21% in comparison to the control treatment. The per cent control of borer attack was 15.79. After applying imidacloprid 0.02% (T8), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 15.00, 15.00, and 14.00 respectively with an average of 14.66 galleries per piece. The borer attack was reduced to 77.16% in comparison to the control treatment. The per cent control of borer attack was 22.84. After applying imidacloprid 0.04% (T9), the number of borer galleries per piece of bamboo in R1, R2, and R3 were 14.00, 14.00, and 14.00 respectively with an average number of 14.00 galleries per piece. The borer attack was reduced to 73.68% in comparison to the control treatment. The per cent control of borer attack was 26.32. The post-treatment observations revealed that among the systemic insecticides, imidacloprid 0.04% gave only 26.32% control of borer attack. Therefore, it is concluded that systemic insecticides were found not effective for the control of borer attacks. Regarding the control treatment (T10), the post-treatment observations showed that the number of galleries (R1, R2, and R3) were 18.00, 19.00, and 20.00 respectively with an average of 19.00 galleries per piece of bamboo and taken as 100% of borer attack (Table 2). Duffy [6] and EPPO [7] stated that chemical control treatment of the larvae and adults is a possibility. However, fumigation is costly and chemical treatment may be of little or no value because of the expense. Barak *et al.* [8] reported that Methyl bromide is a quarantine treatment for *C. annularis* in raw bamboo poles. Yu *et al.* [9] reported that as a fumigant, sulfuryl fluoride (SF) would be a practical alternative to methyl bromide (MeBr) fumigation. Singh and Bhandari [10] reported that *Phloeobius crassicollis* Jorden (Coleoptera: Anthribidae) damages felled as well as green standing bamboos, chlorpyriphos (0.04%) provided damage control of borers 78.16% followed by 69.47 and 64.43% with the application of endosulphan (0.04%) and Imidacloprid (0.04%) respectively. Monocrotophos, deltamethrin, dimethoate, and cypermethrin were found not effective for the control of borer.

4. CONCLUSION

Chlorophorus annularis Fab. (Coleoptera: Cerambycidae) damages cut and dry bamboo including – *Bambusa polymorpha, Bambusa balcoa, Bambusa giganteus, Bambusa multiplex, Bambusa tulda, Dendrocalamus strictus, Bambusa vulgaris,* and *Bambusa spinosa.* Insecticidal control experiments were carried out by applying systemic and contact insecticides. On the qualitative observation records of contact insecticides, it was observed that chlorpyriphos 0.04% yielded 39.13% of borer control followed by chlorpyriphos 0.02%, which controlled 34.78% of borer attacks while cypermethrin and deltamethrin were found least effective. Among the systemic insecticides, imidacloprid 0.04% gave 26.32% control of borer attack.

Figure 1-3: Showing chemical control treatment.

Table 1: Chemical control using contact insecticides against *C. annularis* Fab.

Insecticides	Doses %	Treatment/ Replication	Lot No.	No. of pieces	Pre-treatment observation		Post-treatment observation		%age of borer attack	% control of borer attack
					No. of attacked pieces	% of attack	No. of galleries/ piece	Mean no. of gallery		
Chlorpyriphos 50 EC	0.01	R1 T1 R2 R3	25 16 07	03 03 03	Nil	Nil	18 18 17	17.67	78.83	23.17
	0.02	R1 T2 R2 R3	23 04 14	03 03 03	Nil	Nil	15 16 14	15.00	65.22	34.78
	0.04	R1 T3 R2 R3	05 15 24	03 03 03	Nil	Nil	14 13 15	14.00	60.87	39.13
Cypermethrin	0.01	R1 T4 R2 R3	22 03 13	03 03 03	Nil	Nil	19 19 20	19.33	84.04	15.96
	0.02	R1 T5 R2 R3	11 20 01	03 03 03	Nil	Nil	18 17 19	18.00	78.26	21.74
	0.04	R1 T6 R2 R3	19 10 18	03 03 03	Nil	Nil	16 17 15	16.00	69.57	30.43
Deltamethrin	0.01	R1 T7 R2 R3	26 28 31	03 03 03	Nil	Nil	20 19 20	19.66	85.48	14.52
	0.02	R1 T8 R2 R3	09 17 08	03 03 03	Nil	Nil	18 18 19	18.33	79.70	20.30
	0.04	R1 T9 R2 R3	27 30 29	03 03 03	Nil	Nil	16 16 17	16.33	71.00	29.00
*Control	-	R1 T10 R2 R3	21 02 12	03 03 03	Nil	Nil	24 22 23	23.00	100.00	Nil

*In control treatment the mean number of gallery = 100% of borer attack
% control of borer attack in other treatments was calculated in comparison to control treatment
Pieces used in trail were attack free from borer

Table 2: Chemical control using systemic insecticides against *C. annularis* Fab.

Insecticides	Doses %	Treatment/ Replication	Lot No.	No. of pieces	Pre-treatment observation		Post-treatment observation			% control of borer attack
					No. of attacked pieces	% of attack	No. of galleries/ piece	Mean no. of gallery	%age of borer attack	
Dimethoate	0.01	R1 T1 R2 R3	03 05 06	03 03 03	Nil	Nil	16 17 15	16.00	84.21	15.79
	0.02	R1 T2 R2 R3	08 11 02	03 03 03	Nil	Nil	15 15 14	14.66	77.16	22.84
	0.04	R1 T3 R2 R3	12 14 07	03 03 03	Nil	Nil	15 14 14	14.33	75.42	24.59
Monocrotophos	0.01	R1 T4 R2 R3	15 18 20	03 03 03	Nil	Nil	17 17 16	16.66	87.68	12.32
	0.02	R1 T5 R2 R3	22 24 27	03 03 03	Nil	Nil	17 16 15	16.00	84.21	15.79
	0.04	R1 T6 R2 R3	29 30 26	03 03 03	Nil	Nil	16 15 14	15.00	78.95	21.05
Imidacloprid	0.01	R1 T7 R2 R3	21 01 04	03 03 03	Nil	Nil	16 16 16	16.00	84.21	15.79
	0.02	R1 T8 R2 R3	09 13 19	03 03 03	Nil	Nil	15 15 14	14.66	77.16	22.84
	0.04	R1 T9 R2 R3	16 17 10	03 03 03	Nil	Nil	14 14 14	14.00	73.68	26.32
*Control	-	R1 T10 R2 R3	28 23 25	03 03 03	Nil	Nil	18 19 20	19.00	100	Nil

*In control treatment the mean number of gallery = 100% of borer attack
% control of borer attack in other treatments was calculated in comparison to control treatment
Pieces used in trail were attack free from borer

CONFLICT OF INTEREST
None.

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