Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(5): 446-450

Received: 06-07-2021
Accepted: 18-08-2021

Apurva Laxmi
Post Graduate Student, College of Agriculture, Vijayapura-586 101, University of Agricultural Sciences, Dharwad, Karnataka, India

Sunitha ND
Professor, Agricultural Entomology, College of Agriculture, Vijayapura-586 101, University of Agricultural Sciences, Dharwad, Karnataka, India

Chavan SS
Professor, Agricultural Entomology, College of Agriculture, Vijayapura-586 101, University of Agricultural Sciences, Dharwad, Karnataka, India

Kushal
Assistant professor, Horticulture, College of Agriculture, Vijayapura-586 101, University of Agricultural Sciences, Dharwad, Karnataka, India

Corresponding Author:
Apurva Laxmi
Post Graduate Student, College of Agriculture, Vijayapura-586 101, University of Agricultural Sciences, Dharwad, Karnataka, India

Management of cerambycid wood borer, *Celosterna scabrator* Fab. In grape vines

Apurva Laxmi, Sunitha ND, Chavan SS and Kushal

Abstract
Experiment was conducted in the grape orchard of Vijayapura district to evaluate the effect of different insecticides for the management of Cerambycid wood borer, *Celosterna scabrator* Fab. (Coleoptera). The treatments included soil application of chlorantraniliprole 0.4 G @ 15.00 g/vine and fipronil 80 WG @ 15.00 g/vine, stem injection of aluminium phosphide @ 2.00 g/vine, dichlorovas 76 EC @ 80 ml/lt and *Metarhizium anisopliae* ($1x10^9$ cfu/ml) @ 2.00 ml/lit and soil drenching of thiamethoxam 25 WG @ 1.5 g/lt + cartap hydrochloride 4 G @ 1.5 g/lt. Among the treatments imposed, stem injection with dichlorovas 76 EC @ 80 ml/lt and aluminium phosphide @ 2 g/vine were found significantly superior with 100 per cent and 93.33 per cent reduction in *C. scabrator* live tunnels. Highest C:B ratio was recorded in stem injection of aluminium phosphide @ 2 g/vine (1:3.70) followed by soil application of chlorantraniliprole 0.4 G @15.00 g/vine (1:3.30).

Keywords: Grape, *Celosterna scabrator* Fab, Management, C:B ratio

Introduction
Grapes (*Vitis vinifera*, Linnaeus), a non-climacteric fruit of the family Vitaceae is a berry fruit with a juicy, smooth skin that grows on woody perennial vines (Todkari, 2012) [1]. It is one of the most widely consumed fruits with numerous nutritional and medicinal benefits. Grapes are grown in two agroclimatic regions in Karnataka which include North Interior Karnataka and South Interior Karnataka. In Karnataka, Vijayapura district ranked first with an area and production of 10,652 ha and 211.64 MT respectively (Anon, 2019) [2].
Intensive and extensive cultivation of grape leads to severe pest problem in vineyards. In India, grape is known to infest with more than 100 pests and as high as 80 per cent yield is lost due to insect pests (Mani *et al.*, 2014) [3]. Among the insect pests, the Cerambycid wood borer, *Celosterna scabrator* Fab (Cerambycidae: Coleoprtera) is appearing as the most abundant and dominant pest in Vijayapura grape orchards.
Both adult and grubs of *C. scabrator* cause damage to grape vines. Adults scrape the tender twigs and shoots resulting in wilting and females make ovipositional slit below the bark. Adults cut circular exit hole within the plant. Grubs cause extensive tunneling from the point of entry hole in the vines and one can observe the presence of frass in and around the entry hole along with the oozing of gummy substances from the live holes. Lot of frass is seen on the ground just below the stem borer affected vines. Total yield loss of 3475.75 kg per acre was observed in borer infested vine (Sunitha, 2018) [4].
Management is essential to keep the pest below economic injury level. The difficulty in studying borer pest because of their inaccessibility in woody host has resulted in few effective control programs that prevents serious economic class from developing (Neilson, 1981) [5]. Accurate delivery of selected materials to the crop canopy is very essential for effective use of pesticides in an integrated pest management (McArtney and Obermiller, 2008) [6]. Even though some insecticides are claimed effective against *C. scabrator*, there is a need to evaluate the potential of few more insecticide formulations for the effective management of the borer and also owing to the serious hazards of insecticides to the environment, there is also a need to develop safe delivery method of insecticide to tackle a pest. Considering these points, the present study is planned to evaluate different management practices of Cerambycid wood borer, *C. scabrator* through different delivery methods.

Material and Methods
The experiment was carried out at Tikota village of Vijayapura taluk ($16^0$84'N $75^0$52'E) in

Randomized Complete Block Design (RCBD) with 7 treatments replicated thrice having 5 grape vines with live tunnels for each replication. The live tunnels were diagnosed by adopting frass indexing method (Goodwin *et al.*, 1994) [7]. The orchard with Thompson seedless variety with spacing of 10 feet between rows and 5 feet between the plants under unprotected condition for *C. scabrator* was selected for the experiment.
The treatment details are represented in the table 1. The two insecticides *viz.*, chlorantraniliprole 0.4 G and fipronil 80 WG were applied into the soil near active root zone around the trunk to the depth of 5-10cms which was followed by irrigation. Dichlorovas 76 EC and *M. anisopliae* were applied through stem injection with the aid of squeeze bottle into the live tunnel. After injecting into the tunnels, bored holes were plugged with the wet mud. Aluminium phosphide was inserted to the live hole in vine. Soil drenching of thiamethoxam 25 WG @ 1.5 g/lt + cartap hydrochloride 4 G @ 1.5 g/lit was done near the plant root. Insecticide solution was poured into the soil around the vine basins near the active root zone surrounding to trunk region to a depth of 5-10 cm with a peripheral distance of 1-1.5 ft from the main trunk where feeder roots were present.

Table 1: Treatment details for management of *Celosterna scabrator* Fab.

Treatments	Treatment details	Application method
T1	Chlorantraniliprole 0.4 G @ 15.00g/vine	Soil application
T2	Fipronil 80 WG @ 15.00g/vine	Soil application
T3	Aluminium phosphide @ 2.00 g/vine	Stem injection
T4	Dichlorovos 76 EC @ 80ml/lit	Stem injection
T5	*Metarhizium anisopliae* ($1x10^9$ cfu/ml) @ 2.00ml/lit	Stem injection
T6	Thiamethoxam 25 WG @ 1.5 g/lit + Cartap hydrochloride 4 G @ 1.5 g/lt g/lit	Soil drenching
T7	Control	-

Observations were recorded on number of live tunnels at 7, 14, 21, 28 and 35 days after the treatments and finally per cent reduction in live tunnels was calculated. The data was converted to arc sin values before statistical analysis and subjected to statistical analysis under a randomized complete block design. Yield data on grape fruits was collected from 15 vines from each treatment and finally converted to yield /acre. The C: B ratio was calculated for each treatment in field experiments in order to identify cost effective and feasible treatments after estimating the cost of production of grape in Vijayapura region of Karnataka.

Results and Discussion

Evaluation of management practices for *Celosterna scabrator* Fab.

The results of the experiment are presented in table 2. Significant differences were found among different treatments with respect to per cent reduction of live tunnels at different intervals of observations. At 7DAT, stem injection of dichlorovos 76 EC @ 80 ml/lt was found significantly superior with 80.00 per cent reduction over control in live tunnels. Soil application of chlorantraniliprole 0.4 G @ 15.00 g/vine was found to be next best treatment by recording 60.00 per cent reduction in live tunnels. Soil application of fipronil 80 WG @ 15.00 g/vine, stem injection of aluminium phosphide @ 2.00 g/vine and *M. anisopliae* ($1x10^9$ cfu/ml) @ 2.00 ml/lt were on par with each other with 46.67 per cent reduction in live tunnels followed by soil drenching of thiamethoxam 25 WG @ 1.5 g/lt + cartap hydrochloride 4 G @ 1.5 g/lt with 33.33 per cent reduction in live tunnel.
At 14 DAT, stem injection of dichlorovos 76 EC @ 80 ml/lt was found to be significantly superior with a reduction in live tunnels of 86.67 per cent (CD=12.40). Stem injection of aluminium phosphide @ 2.00 g/vine and *M. anisopliae* ($1x10^9$ cfu/ml) @ 2.00 ml/lt and soil application of chlorantraniliprole 0.4 G @15.00 g/vine were found next best with 66.67 per cent, 60.00 per cent and 60.00 per cent reduction in live tunnels respectively. Other two treatments, *i.e.*, soil application of fipronil 80 WG @ 15.00 g/vine and soil drenching of thiamethoxam 25 WG @ 1.5 g/lt + cartap hydrochloride 4 G @ 1.50 g/lt differed significantly with 53.33 and 40.00 per cent reduction in live tunnels.
At 21 DAT, two treatments, stem injection of dichlorovos 76 EC @ 80 ml/lt (86.67%) and aluminium phosphide @ 2.00 g/vine (80.00%) were found significantly superior and are on par with each other (CD=11.26) followed by soil application of chlorantraniliprole 0.4 G @15.00 g/vine (73.33%) and soil application of fipronil 80 WG @ 15.00 g/vine (66.67%) which was found on par with each other and differed significantly from stem injection of *M. anisopliae* ($1x10^9$ cfu/ml) @ 2.00 ml/lt (66.67%) and soil drenching of thiamethoxam 25 WG @ 1.5 g/lt + cartap hydrochloride 4 G @ 1.5 g/lt (53.33%).
At 28DAT and at 35DAT, stem injection of dichlorovos 76 EC @ 80 ml/lt and aluminium phosphide @ 2.00 g/vine were found significantly superior with 100 per cent and 93.33 per cent reduction in live tunnels respectively and all other treatments were on par with each other *viz.*, soil application of chlorantraniliprole 0.4 G @15.00 g/vine (73.33%) and fipronil 80 WG @ 15.00 g/vine (66.67%), stem injection of *M. anisopliae* ($1x10^9$ cfu/ml) @ 2.00 ml/lt (66.67%) and soil drenching of thiamethoxam 25 WG @ 1.5 g/lt + cartap hydrochloride 4 G @ 1.5 g/lt (66.67%).

Table 2: Effect of different treatments on the management of *Celosterna scabrator* Fab.

Treatment No.	Treatments	Per cent reduction in live tunnels				
		7 DAT	14 DAT	21 DAT	28 DAT	35 DAT
T1	Chlorantraniliprole 0.4 G @ 15.00 g/vine	60.00^b (50.77)	60.00^b (50.77)	73.33b (58.91)	73.33^b (58.91)	73.33^b (58.91)
T2	Fipronil 80 WG @ 15.00 g/vine	46.67^c (43.09)	53.33^c (46.91)	66.67^b (54.74)	66.67^b (54.74)	66.67^b (54.74)
T3	Aluminium phosphide @ 2.00 g/vine	46.67^c (43.09)	66.67^b (54.74)	80.00^a (63.43)	93.33^a (75.04)	93.33^a (75.04)
T4	Dichlorovos 76 EC @ 80ml/lt	80.00^a (63.43)	86.67^a (68.58)	86.67^a (68.58)	100^a (90.00)	100^a (90.00)

T5	*Metarhizium anisopliae* (1x10^9 cfu/ml) @ 2.00 ml/lt	46.67^c (43.09)	60.00^b (50.77)	60.00^c (50.77)	66.67^b (54.74)	66.67^b (54.74)
T6	Thiamethoxam 25 WG @ 1.50 g/lt + Cartap hydrochloride 4 G @ 1.50 g/lt	33.33^d (35.26)	40.00^d (39.23)	53.33^c (46.91)	66.67^b (54.74)	66.67^b (54.74)
T7	Control	0.1^e (1.81)	0.1^e (1.81)	0.1^d (1.81)	0.1^c (1.81)	0.1^c (1.81)
	S.Em ±	3.02	4.02	3.65	3.62	3.62
	CD @ 5%	9.29	12.40	11.26	11.16	11.16
	CV (%)	13.04	15.41	12.67	11.06	11.06

Figures in the parentheses are arc sine transformed values. DAT=days after treatment, n=5
T1, T2= Soil application, T3, T4, T5= Stem injection, T6= Soil drenching

The higher efficiency of dichlorovas 76 EC and aluminium phosphide can be attributed to the fumigant action of these insecticides and chlorantriniliprole due to the quick translocation of insecticide in the xylem tissue.

Yield and C:B ratio under different treatments of management of *Celosterna scabrator* Fab.

Grape yield was recorded from 5 vines from each replication and later converted to yield per acre from different treatments are presented in table 3.

Yield obtained from all the treatments was significantly higher than control and significant difference was found among the various treatments. Stem injection of dichlorovos 76 EC @ 80 ml/lt and aluminium phosphide @ 2.00 g/vine were found at par and significantly superior to other treatments with 7934.40 kg and 7847.40 kg berry yield respectively. The next higher yield of 6890.40 kg was obtained in soil application of chlorantraniliprole 0.4 G @15.00 g/vine which was significantly superior over other treatments. Soil application of fipronil 80 WG @ 15.00 g/vine (6237.90 kg) and soil drenching of thiamethoxam 25 WG @ 1.5 g/lt + cartap hydrochloride 4 G @ 1.5 g/lt (6124.80 kg) are found on par with each other followed by stem injection of *M. anisopliae* (1x10^9 cfu/ml) @ 2.00 ml/lt which recorded 4868.52 kg respectively which differed significantly from control (2053.20 kg).

Table 3: Yield of grapes under different treatments for management of *Celosterna scabrator* Fab.

Treatment No.	Treatments	Yield/5 vines (Kg)	Yield (Kg/ac)
T1	Chlorantraniliprole 0.4 G @ 15.00 g/vine	39.60^b	6890.40^b
T2	Fipronil 80 WG @ 15.00 g/vine	35.85^c	6237.90^c
T3	Aluminium phosphide @ 2.00 g/vine	45.10^a	7847.40^a
T4	Dichlorovos 76 EC @ 80 ml/lt	45.60^a	7934.40^a
T5	*Metarhizium anisopliae* (1x10^9 cfu/ml) @ 2.00 ml/lt	27.98^d	4868.52^d
T6	Thiamethoxam 25 WG @1.5 g/lt+ Cartap hydrochloride 4 G @ 1.5 g/lt	35.20^c	6124.80^c
T7	Control	11.80^e	2053.20^e
	S.Em ±	1.21	210.41
	CD @ 5%	3.73	648.33
	CV (%)	6.08	6.08

n=15, T1, T2= Soil application, T3, T4, T5= Stem injection, T6= Soil drenching

The cost benefit ratio of the management practices is presented in table 4. Highest cost benefit ratio was observed in stem injection of aluminium phosphide @ 2.00 g/vine (1:3.70) followed by soil application of chlorantraniliprole 0.4 G @ 15.00 g/vine (1:3.30), stem injection of of dichlorovos 76 EC @ 80 ml/lt (1:3.26), soil drenching of thiamethoxam 25 WG @ 1.5 g/lt + cartap hydrochloride 4 G @ 1.5 g/lt (1:2.85) and *M. anisopliae* (1x10^9 cfu/ml) @ 2.00 ml/lt (1:2.39). Lowest C:B ratio was observed in soil application of fipronil 80 WG (1:1.36), however it was found to be superior over control.

Table 4: Cost benefit ratio of different treatments against C*elosterna scabrator* (Fab.)

Treatment No.	Treatments	Yield/ acre (kg)	Gross returns/ acre (Rs)	Cost of Pest management/ acre (Rs)	Net Returns/ acre (Rs)	C:B ratio
T1	Chlorantraniliprole 0.4 G @ 15.00g/vine	6890.40	241164	3154.84	168009.16	3.30
T2	Fipronil 80 WG @ 15.00g/vine	6237.90	218326.50	91000	57326.50	1.36
T3	Aluminium phosphide @ 2.00 g/vine	7847.40	274659	4350	200309	3.70
T4	Dichlorovos 76 EC @ 80ml/lt	7934.40	277704	15138	192566	3.26
T5	*Metarhizium anisopliae* (1x10^9 cfu/ml) @ 2.00ml/lt	4868.52	170398.20	1252.80	99145.40	2.39
T6	Thiamethoxam 25 WG @ 1.5g/lt + Cartap hydrochloride 4 G @ 1.50 g/lt	6124.80	214368	5190.75	139177.25	2.85
T7	Control	2053.20	71826		1862	1.03

Market price of grape fruits= Rs 35.00/Kg. Orchard management cost excluding pest management = Rs 70,000/acre T1, T2= Soil application, T3, T4, T5= Stem injection, T6= Soil drenching

Highest C:B ratio for stem injection of aluminium phosphide @ 2 g/vine and soil application of chlorantraniliprole 0.4 G @ 15.00 g/vine is due to low cost of pest management when compared with stem injection of dichlorovas 76 EC @ 80ml/lit. Lowest C:B ratio of fipronil 80WG is due to high cost of pest management. The current findings are in full conformity with Jagginavar *et al.* (2008) [8] who demonstrated that stem injection with 8.00 per cent dichlorvos 76 EC resulted in a 100 per cent reduction of live *C. scabrator* tunnels because the destructive stage of the pest is not always susceptible to direct application of pesticides. Similarly, Sawant *et al.* (2007) [9] reported injecting vines with 2 ml of dichlorvos 76 per cent EC with a syringe 60-75 days after pruning to kill the larval stage of stem borer is a good practice for managing C. *scabrator*. The current findings are also in consistent with those of Mani *et al.* (2014) [10] who found that dichlorvos injection at 5 ml/hole is effective in killing stem borer larvae and Kumari and Vijaya (2015) [11] who discovered that dichlorvos injection at 76 per cent EC @ 80 ml/live hole resulted in a 100 per cent reduction in live tunnels. Similarly Kambrekar *et al*. (2017) [12] confirmed stem injection with dichlorvos 76 EC @ 80 ml/l resulted in a 100 per cent reduction in live tunnels 35 days following treatment with no frass retrieved from live tunnels at 5 days and Sunitha (2018) [13] reported that stem injection with DDVP 76% EC @ 8.00 per cent was very effective in grub management by recording 100 per cent reduction in live tunnels at 45 DAT. This may be due to the fumigant action of the insecticide.

The results on the effect of stem injection of aluminium phosphide are in agreement with Kumari and Vijaya (2015) [14] who reported that mean mortality of *C. scabrator* grubs was 100 per cent in stem injection of aluminium phosphide @ 1 g/live hole.

The results on the adequacy of chlorantraniliprole 0.4 G are supported by Kambrekar *et al.* (2017) [15] who analysed different doses of the chemical and reported that chlorantraniliprole (Ferterra 0.4 GR) @ 15.00 g/vine can be an effectual way of managing the stem borer *C. scabrator*, lessening plant protection costs while increasing returns. As a soil applicant, chlorantraniliprole is taken up through plant roots and translocated throughout the different growing parts of the plant by providing protection against insect pests. The results are also consistent with Sunitha (2018) [16] who reported soil application of chlorantraniliprole 0.4 G at 15 g/vine gives 70.83 per cent reduction in live *C. scabrator* tunnels.

The current findings on fipronil efficacy are consistent with those of Goodwin (2005) [17] , who found that fipronil 200 SC @ 100 ml/100 lt of water effectively inhibited emerging adults and young of the stem borer *A. vastator* (Cerambycidae: Coleoptera). Similarly, the findings of investigation on management of *C. scabrator* by soil application of fipronil 80 WG @ 15.00 g/vine are in agreement with Sunitha (2018) [18] who mentioned 66.66 per cent reduction in live tunnels.

The results on efficacy of *Metarhizium anisopliae* ($1x10^9$ cfu/ml) @ 2.00 ml/lit is supported by Chauhan *et al.* (2013) [19] who reported 66.7 per cent mortality of apple stem borer *Aeolesthes* sp by stem injection of *M. anisopliae* at 5 x 107 conidia/gallery. Similarly the results are in agreement with Sahu and Sharma (2008) [20] who conducted bio-control measures for management of cashew stem and root borer, *P. ferrugineus* and reported that the most effective treatment with the least affected trees (7.40%) was application of *M. anisopliae* spawn 250 g/tree in combination with 63.63 per cent reduction in CSRB infestation.

The result on the C:B ratio is in agreement with Sunitha (2018) [21] who reported the cost benefit ratio of pest management practices indicated highest cost benefit ratio in soil application of chlorantraniliprole 0.4 G @ 20.00 g (1:2.83) followed by stem injection of DDVP 76 EC (1: 2.77), fipronil 80% WG @ 20.00 g (1: 2.74) , fipronil 80% WG @15.00 g (1:2.67) and chlorantraniliprole 0.4% @ 15.00 g (1:2.55).

Conclusion

Cerambycid wood borer, *Celosterna scabrator* Fab (Cerambycidae: Coleoprtera) is the abundant pest of grape vine in Vjayapura district and cause severe loss in grape vine. In the view of management, stem injection with dichlorovas 76 EC @ 80 ml/lt and aluminium phosphide @ 2 g/vine were found effective and highest C:B ratio was recorded in stem injection of aluminium phosphide @ 2 g/vine (1:3.70) followed by soil application of chlorantraniliprole 0.4 G @ 15.00 g/vine (1:3.30). Since dichlorovas 7 EC has banned recently and aluminium phosphide have restricted usage, soil application of chlorantraniliprole 0.4 G @ 15.00 g/vine can be recommended for *C. scabrator* control.

Acknowledgement

The authors are thankful to the grape growers for giving feedback at the right time and providing experimental area.

References

1. Todkari GU. Origin and distribution of grape orchards in India: A geographical analysis. World Resouce Journal of Geoinformatics 2012;1(1):14-16.
2. Anonymous. Agricultural Statistics at a glance. Agricultural Statistics Division, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi 2018.
3. Mani M, Shivaraju C, Kulkarni NS. The grape entomology. Springer, India 2014, 1-164
4. Sunitha ND. Studies on population dynamics, hostage preference and management of grape stem borer *Celosterna scabrator* Fab. (Cerambycidae: Coleoptera). Ph. D Thesis. UAS, GKVK Bengaluru 2018.
5. Neilson DG. Studying biology and control of borers attacking woody plants 1981
6. McArtney SJ, Obermiller JD. Comparative performance of insecticides and conventional nozzles on an axialfan sprayer in medium density apple orchards. Horticultural Technology 2008;18:365-371.
7. Goodwin S, Pettit MA, Spohr LJ. *Acalolepta vastator* (Newman) (Coleoptera: Cerambycidae) infesting grapevines in the Hunter Valley, New South Wales.1. Distribution and Dispersion. Journal of Australian Entomology Society 1994;33:385-390.
8. Jagginavar SB, Sunitha ND, Patil DR. Management strategies for grape stem borer, *Celosterna scrabrator* Fab. (Coleoptera:Cerambycidae). Indian Journal of Agricultural Resources 2008;42(4):307-309.
9. Sawant SD, Kulkarnin S, Indu S, Mani M. Package of practices for managing major diseases and insect pests on grape. Technical Bulletin 8, National Research Centre for Grape. Pune. India 2008.
10. Mani M, Shivaraju C, Kulkarni NS. The grape entomology. Springer, India 2014, 1-164
11. Kumari D, Vijaya D. Management of stem borer, *Celosterna scabrator* Fabr. in grapevine. Plant Archives 2015;15(2):1089-1091.
12. Kambrekar DN, Jagginavar SB, Arun J. Status and management of grape stem borer, *Celosterna scabrator* with soil application of Chlorantraniliprole 0.4G. International Journal Agricultural Biosystematics 2017;11(11):783-787.
13. Sunitha ND. Studies on population dynamics, hostage preference and management of grape stem borer *Celosterna scabrator* Fab. (Cerambycidae: Coleoptera). Ph. D Thesis. UAS, GKVK Bengaluru 2018.
14. Kumari D, Vijaya D. Management of stem borer,

Celosterna scabrator Fabr. in grapevine. Plant Archives 2015;15(2):1089-1091.

15. Kambrekar DN, Jagginavar SB, Arun J. Status and management of grape stem borer, *Celosterna scabrator* with soil application of Chlorantraniliprole 0.4G. International Journal Agricultural Biosystematics 2017;11(11):783-787.
16. Sunitha ND. Studies on population dynamics, hostage preference and management of grape stem borer *Celosterna scabrator* Fab. (Cerambycidae: Coleoptera). Ph. D Thesis. UAS, GKVK Bengaluru 2018.
17. Goodwin S. Chemical control of fig longicorn, *Acalolepta vastator* (Newman) (Coleoptera: Cerambycidae), infesting grapevines. Journal of Australian Entomological Society 2005;44:71-76.
18. Sunitha ND. Studies on population dynamics, hostage preference and management of grape stem borer *Celosterna scabrator* Fab. (Cerambycidae: Coleoptera). Ph.D. Thesis. UAS, GKVK Bengaluru 2018.
19. Chauhan U, Sharma PL, Gupta PR, Sharma KC, Verma SP. Evaluation of some microbial pesticides against apple stem borer, *Aeolesthes* sp. in Himachal Pradesh. Journal of Biological Control 2013;27(3):211-213.
20. Sahu KR, Sharma D. Management of cashew stem borer, *Plocaederus ferrugenius* L. by microbial and plant products. Journal of Biopesticides 2008;1(2):121-123.
21. Sunitha ND. Studies on population dynamics, hostage preference and management of grape stem borer *Celosterna scabrator* Fab. (Cerambycidae: Coleoptera). Ph. D Thesis. UAS, GKVK Bengaluru 2018. Japan, in, which affected more than 50,000 people with brain damage, paralysis 1956.