International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 1998-2001

Received: 04-11-2020
Accepted: 14-12-2020

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Management of shoot and capsule borer of small cardamom through insecticides and bio-pesticides

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DOI: https://doi.org/10.22271/chemi.2021.v9.i1ab.11517

Abstract
Conogethes punctiferalis Guenee (Lepidoptera: Crambidae) is considered to be an important pest causing damage to the cardamom suckers as well as capsules. Among the evaluated insecticides and bio-pesticides, Flubendiamide 480 SC showed the maximum reduction of shoot damage (13.00% incidence) after spray followed by Carbosulfan 25 EC (15.80% incidence). The untreated control showed 30.00 per cent of shoot damage. Similarly, Acetamiprid 20 SP SC showed the maximum reduction of capsule damage (15.15% incidence) after spray followed by Flubendiamide 480 SC and Thiamethoxam 70 WS (16.00% incidence) which were on par with each other. The untreated control showed 22.22 per cent of capsule damage. The bio-pesticides, Poneem and Econeem plus showed minimum shoot damage (22.00 and 21.40%) compared to control. Similarly, Poneem and Econeem plus showed minimum capsule damage (17.40 and 16.45%) which were on par with other treatments and superior over untreated control. Maximum benefit cost ratio was noticed in Flubendiamide (1:4.05) followed by Carbosulfan (1:3.87) and Acetamiprid (1:3.60).

Keywords: Insecticides, bio-pesticides, borer, cardamom, shoot and capsule damage

Introduction

Cardamom (*Elettaria cardamomum* Maton) has been certainly found growing in a wild state in evergreen forests of Western Ghats of South India. South India and parts of Sri Lanka are believed to be the place of origin of cardamom (Anonymous, 1952; Abraham, 1965) [2, 1]. The cultivation of cardamom requires an annual rainfall of 1500-5000 mm, temperature of 10-35^0 C medium altitude, moderate shade and protection. Cardamom is cultivated in 12 countries of the world *viz.*, India, Guatemala, Tanzania, Vietnam, Thailand, Laos, Costa-Rica, Elsalvadar, Indonesia, Malaysia, Srilanka and Papua New Guinea. Cardamom *(Conogethes punctiferalis*) is a polyphagous crop and fruit pest found to infest 30 crop plants belonging to 23 families in India. Cardamom is the most preferred plant.

Conogethes punctiferalis Guenee (Lepidoptera: Crambidae) is considered to be an important pest causing damage to the cardamom suckers as well as capsules. The estimated loss may up to 35-40% (Anonymous, 2010) [3]. Shoot and capsule borer occurs throughout the year on cardamom in Western Ghats of South India. Usually two peaks in the population were noticed in a year, i.e. one during April – May and the other during November- December. The population coincides with the period of less or no rainfall, i.e. during pre and post monsoon periods (Thyagaraj, 2003) [10]. The changing environmental conditions increase the activity of borers soon after the emergence and reaches peak during flower set and tender capsule formation and cause heavy crop loss. In order to suit the changed weather conditions and pest behavior, the existing management schedule has to be modified correspondingly. The farmers will take up untimely sprays with conventional insecticides available in the market, those results in higher cost and low quality produce. Hence an experiment was carried out to find out safe alternative sprays schedules under hill zone of Karnataka.

Material and Methods

Evaluation of bio-efficacy of insecticide and bio-pesticide molecules against cardamom shoot and capsule borer

Seven years old cardamom clumps of M-2 variety were selected for the study. Randomized Block Design (RBD) was used for the experiment with ten treatments and replicated thrice.

The treatment was done twice, the first treatment was done in March and the second treatment was taken up after 30 days after the first spray. The details of treatments employed in the present investigation were given in tabular form.

Sl. No	Treatments	Dosage (g /L)
T_1	Thiamethoxam 70WS	0.50 g
T_2	Acetamiprid 20SP	0.20 g
T_3	Flubendiamide 480 SC	0.25 ml
T_4	Poneem (1:1)	4.00 ml
T_5	Econeemplus 10000ppm	2.50 ml
T_6	Carbosulfan 25 EC	2.00 ml
T_7	Control	Water spray

All the treatments were applied using knap sack high volume sprayer during morning hours. Spray application was made up of 800 litres spray fluid per hectare. Sprays were similar for both first and second spray. Only water spray was given to the control plots. One day prior to spray, all the damaged capsules were counted and removed. Then freshly damaged capsules were counted after spray at fortnight intervals. Observations on the incidence of bored holes and number of larvae were recorded from 10 plants per each plot a day before and 7, 15 and 21 days after each spray. The per cent incidence of capsule borer was assessed by counting the affected capsules using following formula.

Per cent bored capsules = (Total no. of bored capsules / Total no. of capsules) X 100

Yields were recorded separately from net plot area of each treatment after harvesting the crop. The data obtained from all the observations were subjected to ANOVA after suitable transformations as per RCBD.

Cost economics

The incremental cost benefit ratio (ICBR) was calculated by considering the cost of various treatments, cost incurred for labour, other expenditure (irrigation charges, watch and ward) and market price of cardamom capsules. Cost effectiveness of each treatment was assessed based on net returns. Total cost of production included both cultivation as well as plant protection charges.

Gross return = Marketable yield x Market price
Net return = Grass return – Total cost
Benefit: Cost Ratio = Net return / Total cost

Statistical analysis

The experimental data recorded on various parameters during the investigation were analyzed statistically by adopting Fischer's method of analysis of variance as outlined by Gomez and Gomez (1976). The interpretation of data was done by using the critical difference value calculated at 0.05 probability level. The level of significance was expressed at 0.05 probability. The transformation of data was done as given by Gomez and Gomez, (1976). Simple correlation of the data was obtained using Microsoft Office Excel 2007.

Result and Discussion

The neonites of cardamom shoot and capsule borer bored into the tender shoots and webbed the capsules together and feed on the contents of capsules by remaining inside. The infested capsules when opened revealed the presence of caterpillars. The infested capsules were filled with the excretory pellets. The shift of borer from shoot to capsule was observed during later stages of the crop. This may be due to ageing of shoots which becomes more harder & not congenial for shoot borer, but the capsules will be in small fruit stage which is more preferential hence damage is observed on capsules at later age of crop, Capsule is a preferred host for *Conogethes punctiferalis.*

The results of the bio-efficacy of insecticides are presented in Table 1. The pre-treatment counts, indicated, uniformity in borer population. On an average the borer infestation ranged from 26.60 to 28.00 percent. The post treatment observations on the borer population at the 7, 15, and 21 days after spray showed that all the chemical treatments were at par with each other. However, all the treatments were significantly superior over control.

A comparison of data at 15 days observation on population of borer indicated that all the treatments were found significantly superior over control in managing borer population. Among the treatments flubendiamide found less effective (10.00%) in reducing borer population when compared to other treatments and which is at par with standard check carbosulfan (12.00%) followed by acetamiprid (15.20%) thiamethoxam (16.00%), econeemplus (17.00%), ponneem (17.40%). 15 days after spray, lowest percent shoot damage was recorded in flubendiamide (12.40%) followed by carbosulfan (14.60%). The next best treatment were acetamiprid (19.20%) followed by Thiamethoxam (18.00%), Econeem (19.40%) and poonneem plus (20.00%). The highest percent damage (29.60%) was recorded in control. Observations on the population of borer indicated that the treatments were found significantly superior over untreated control. Among the treatments flubendiamide (13.00%) found effective in reducing borer population when compared to other treatments if less is on par with standard check Carbosulfan (15.80%). Followed by acetamiprid (24.20%), Thiamethoxam (21.00%), Econeem (21.40%) and Poneem plus (22.00%) (Table 1). Similarly, Saroja *et al.* (1973) [9], He (1997) [4] and Xie *et al.* (2002) [12] reported that, Fenitrothion to be effective against *C. punctiferalis* on castor, peach and chestnut, respectively. Kumaresan *et al.* (1978) [5] obtained maximum control of *C. punctiferalis* on cardamom by monocrotophos. The efficacy of Fenthion and methyl parathion was proved by Mogal *et al*. (1980) [6] who reported that, there was 90 per cent mortality of larvae.

The result of the bio-efficacy of insecticides are presented in the Table 2. The observation recorded at first harvest indicated that all treatments found significantly superior over untreated control. The treatment with thiamethoxam recorded lowest capsule damage (9.88%) compared to control (21.00%). Whereas, the treatments Acetamiprid, Flubendamide and Carbosulfon were on par with other recording a capsule damage of (14.00%), (10.00%) & (14.50%), respectively. While, the treatments with biopesticides Poneem and econeem plus also showed lesser capsule damage which are on par with pesticides i.e (16.40%) & (15.96%), respectively. Observation on per cent bored capsules indicated that treatments that found superior over untreated control (Table 2).

Similar results were observed during both second and third harvest. Where thiamethoxam showed lower capsule damage of (12.40%) & (16.00%) compared to control which recorded maximum capsule damage of (20.14%) & (22.00%). Whereas, the treatments with pesticides Acetamiprid, Flubendamide & Carbosulfan recorded capsule damage which are on par with each other with (15.50%), (12.20%) &

(15.60%) respectively. Observation on per cent bored capsule indicated that treatments that found superior over untreated control. Whereas, the treatment with pesticides Acetamiprid, Flubendamide & Carbosulfan recorded capsule damage which are on par with each other with (15.15%), (16.00%) & (16.85%), respectively. The treatments with biopesticides i.e poneem & econeem plus proved to be better with lower capsule damage of (17.00%) & (16.90%) (II harvest) & (17.40%) & (16.45%) (III harvest) compared to treatments i.e. Acetamiprid, Flubendamide & carbosulfan, respectively (Table 2). Similarly, efficacy of monocrotophos and Quinalphos followed by carbaryl and NSKE were appreciated in cardamom ecosystem by Patel *et al*. (2002) [8] for management of *C. punctiferalis*. Dimethoate was found effective in controlling *C. punctiferalis* and neem oil is the least effective (Virender Kaul Kesar, 2004). However as per the reports of Naik *et al*. (2006) [7], there was least number of capsules borer population in plots sprayed with neem oil. Despite, the insecticidal spray at fortnight interval there was increase in capsule damage may be due to heavy rain which comes during flowering time and also may be borer preference on capsules compare to shoot at later age of crop. Here, only 2 sprays were given so that percent capsule damage was increased at III harvest.

The lowest cost of protection was revealed in the treatment T_4 Poneem (825 Rs/ ha) followed by T_5 Econeem (900 Rs/ ha), T_2 Acetamiprid (960 Rs/ ha), T_3 Flubendiamide (1001Rs/ ha), and Further, the highest cost of protection was recorded in T_1 Thiamethoxam (1960 Rs/ ha), T_6 Carbosulfan (1200 Rs/ha) (Table 3). In comparison with treatments, higher gross return was obtained in T_3 Flubendiamide (2, 24,000 Rs/ ha), followed by T_6 Carbosulfan (2, 17,000 Rs/ ha), T_2 Acetamiprid (2, 04,169 Rs/ ha), followed by T_1 Thiamethoxam (2,000,25) and T_4 Poneem (2,000,25), further, the lowest gross return was obtained in T_5 Econeem (1, 96,574 Rs/ ha). However, untreated control, T_7 (1, 34,575 Rs/ ha) obtained lowest gross return than rest of the treatments (Table 3). In comparison with the treatments, highest net return was obtained in T_3 Flubendiamide (1,79,649 Rs/ ha), followed by T_6 Carbosulfan (1,72,450 Rs/ ha).T_2 Acetamiprid (1,59,859 Rs/ ha). Further, the lowest net return was obtained in T_5 Econeem (1, 52,324 Rs/ ha), T_1 Thiamethoxam, (1,54,715 Rs/ ha) and T_4 Poneem (1,55,850 Rs/ ha) However, untreated control, T_7 (92,575 Rs/ ha) obtained lowest net return. Finally, the benefit cost ratio was higher in T_3 Flubendiamide (1:4.05) followed by T_6 Carbosulfan (1:3.87) and T_2 Acetamiprid (1:3.60). However, lowest C: B ratio were obtained in T_4 Poneem (1:3.52), T_1 Thiamethoxam (1:3.4) and T_5 Econeem (1:3.44). However, lowest C: B ratio recorded in untreated control, T_7 (1:2.20) (Table 3). From the above discussion it could be inferred that, no botanical insecticides available are effective against cardamom pest as they are having only contact nature of mode of action or as repellent to some extent, but the internal borer and sucking type of feeding on the cardamom by major pests only a systemic nature of mode of action could control the pests. Hence, the botanicals insecticides are of no little use in pest management programme in cardamom ecosystems

Table 1: Bio efficacy of new insecticides and botanicals against *Conogethes punctiferalis* L. Guenee on per cent shoot damage

Treatments	Dose/ l	Pre-count (% shoot damage)	Shoot damage (%)		
			7 days	15 days	21 days
T_1-Thiamethoxam 70 WS	0.50 g	26.60	16.00 (23.58)	18.00 (25.10)	21.00 (27.18)
T_2-Acetamiprid 20 SP	0.20 g	27.00	15.20 (22.05)	19.20 (25.99)	24.20 (29.47)
T_3-Flubendiamide 480 SC	0.25 ml	28.00	10.00 (18.44)	12.40 (20.62)	13.00 (21.13)
T_4-Poneem 5000 ppm	4.00 ml	26.80	17.40 (24.65)	20.00 (26.56)	22.00 (27.97)
T_5-Econeem plus 10000ppm	2.50 ml	26.80	17.00 (24.35)	19.40 (26.13)	21.40 (24.56)
T_6-Carbosulfan 25 EC	2.00 ml	27.70	12.00 (20.27)	14.60 (22.46)	15.80 (23.42)
T_7-Control	Water spray	27.60	28.00 (31.95)	29.60 (32.96)	30.00 (33.21)
S Em ±		-	1.32	0.51	0.32
CD @ 5%		NS	4.20	1.52	0.98

Note: Figures in the parentheses are angular transformed values

Table 2: Bio efficacy of insecticides and botanicals against *Conogethes punctiferalis* L. Guenee on cardamom capsules

Treatments	Dose/ l	Pre-count (% capsule damage)	Capsule damage (%)		
			I harvest	II harvest	III harvest
T_1-Thiamethoxam 70 WS	0.5 g	16.80	09.88 (18.34)	12.40 (20.62)	16.00 (23.58)
T_2-Acetamiprid 20 SP	0.2 g	17.20	14.00 (21.97)	15.50 (23.19)	15.15 (22.95)
T_3-Flubendiamide 480 SC	0.25 ml	18.00	10.00 (19.27)	12.20 (20.27)	16.00 (23.58)
T_4-Poneem 5000 ppm	4 ml	17.80	16.40 (23.89)	17.00 (24.35)	17.40 (24.65)
T_5-Econeem plus 10000ppm	2.5 ml	17.00	15.96 (23.58)	16.90 (24.97)	16.45 (23.97)
T_6-Carbosulfan 25 EC	2 ml	16.90	14.50 (22.38)	15.60 (23.26)	16.85 (24.27)
T_7-Control	-	18.10	21.00 (26.89)	20.14 (25.96)	22.00 (29.15)
S Em ±		-	1.51	0.61	00.70
CD @ 5%		NS	4.66	1.82	02.00

Note: Figures in the parentheses are angular transformed values

Table 3: Effect of different insecticides molecules on yield and B: C ratio

Sl. No	Treatments	Yield (Kgs/ha)	% yield increase over control	Cost of protection (Rs/ha)	Total cost of production (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	C:B ratio
T_1	Thiamethoxam 70 WS	285.75	127.31	1960	45310	200025	154715	1:3.40
T_2	Acetamiprid 20 SP	291.67	130.06	0960	44310	204169	159859	1:3.60
T_3	Flubendiamide 480 SC	320.00	142.69	1001	44351	224000	179649	1:4.05
T_4	Ponneem (1:1)	285.75	127.42	0825	44175	200025	155850	1:3.52
	Econeem plus 10000ppm							

T_5		280.82	125.22	0900	44250	196574	152324	1.3.44
T_6	Carbosulfan 25 EC	310.00	138.23	1200	44550	217000	172450	1:3.87
T_7	Control	192.25	-	-	42000	134575	92575	1:2.20

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