

Evaluation of Insecticides for the Management of Litchi Fruit and Shoot Borer

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ABSTRACT

Litchi is an important subtropical evergreen fruit crop grown in Nepal, which have high nutritive value and refreshing taste. The Litchi growers are experiencing severe loss every year with the damage caused by several insect pests. Among them fruit and shoot borer *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae) is the one of the important insect pest. Experiments were conducted at RARS Tarahara on existing litchi orchard in RCBD design with four replication and five insecticides (Azadiractin, Chlorantraniliprole, Flubendiamide, Lambda cyhalothrin, and Dimethoate) with recommended doses in litchi orchard against *C. sinensis* during 2015 and 2016 to find out the efficient one. Among the tested insecticide chlorantraniliprole (18.5% w/w SC) and flubendiamide (39.35% m/m SC) each were found to be most efficient against *C. sinensis* and could be applied at the rate of 1 ml per 3 liter of water when fruit size was about pea and applied 3 times with 10 days interval. This result suggested that these two insecticides could be used for the management for *C. sinensis*. Farmers may reduce the losses and increase their income with the application of these insecticides

Keywords: *Conopomorpha sinensis*, Chlorantraniliprole, Flubendiamide, Litchi

सारांश

लिची, नेपालको उपोष्ण जलवायुमा हुने विशेष स्वाद रहेको तथा उच्च पोषकतत्वहरू भएको एक सदाबहार फल हो। यसको व्यावसायिक खेत नेपालको तराई भूभागमा विशेष रूपमा गरिन्छ भने यसमा भएको पोषण तत्वको महत्व र यसबाट हुने आर्थिक फाइदाको कारणले यसको विस्तार पहाडी जिल्लाहरूका उपोष्ण हावापानी भएको क्षेत्रमा पनि भएको पाइन्छ। लिची उत्पादनका प्रमुख समस्याहरू मध्ये कीराहरूले गर्दा हुने नोक्सानीको कारणले किसानहरूले व्यापक क्षति व्यहोनु परेको छ। ती कीराहरू मध्ये पनि लिचिको फलको गवारो (*Conopomorpha sinensis*) प्रमुख शत्रुको रूपमा पाइएको छ। यस अध्ययनमा गवारो कीरा व्यवस्थापनको लागि विभिन्न ५ वटा विषादीहरूको परिक्षण इस्वी संवत् २०१५ र २०१६ मा गरिएको थियो। प्राप्त नतिजाको आधारमा उक्त विषादीहरू मध्ये क्लोरानट्रानिलीप्रोल (१८.५% w/w SC) र फ्लुबेन्डीयामाइड ३९.३५% m/m क्रमशः १ मिलि प्रति ३ लिटर पानीमा लिचीको फल केराउको दाना बराबर भएको बेला देखि १० दिनको फरकमा ३ पटक बोट भिज्ने गरि छर्कदा कीरा नियन्त्रण उल्लेख्य भएको पाइयो।

INTRODUCTION

Litchi, *Litchi chinensis* Sonn (Sapindaceae: Sapindales), is an important subtropical evergreen fruit crop. Litchi fruit considered as one of the best fruits due to its high nutritive value as it contains carbohydrates, vitamin A, vitamin B, vitamin C, carotenoids, phosphorus, calcium and iron polyphenols (USDA 2019, Feng et al 2015). Cultivation of litchi is widely spread in Nepal and provides livelihood opportunities to litchi growers. Nineteen districts have been prioritized as potential litchi production in Nepal (FDD 2008). In Nepal, litchi covered area and production of 6835 ha and 36992 metric ton respectively with productivity of 7.40 metric ton per ha in 2016 (MoAD 2016).

The litchi growers are facing various biotic problems of several insect-pests such as fruit and shoot borer, litchi mite, bark eating caterpillar, leaf folder, litchi looper, litchi weevils etc., which caused severe loss to the growers (Kumar et al 2014). Among insect-pests, litchi fruit and shoot borer, *Conopomorpha sinensis* (Lepidoptera: Gracillariidae) is one of the major threats to litchi growers, causing severe losses to fruit as well as young shoots causing up to 24-48% and 7-70%, respectively (Srivastava et al 2015, Li et al 2014). *Conopomorpha sinensis* adult female lays eggs on leaves, shoot, or fruits stems singly or in groups and after hatched larvae penetrate the fruits, flower, tender shoots and leaves, and feed on seed neck immediately which causes poor fruit quality and fruits drop after infestation (Waite 2005, Schulte 2007, Huang et al 1994, Manzel 2002, Tsang and Liang 2007, Kumar et al 2014, Meng et al 2018). *Conopomorpha sinensis* attacks litchi and Longan (*Dimocarpus longan* Lour.) in south East Asia and southern China (Thanh et al 2006, Tran et al 2019) and is considered as a destructive pest causing significant economic losses (Zhang et al 2011). Due to its cryptic feeding behavior and overlapping of generation, *C. sinensis* is difficult to manage (Meng et al 2018). Like other crops, insecticides particularly organophosphates and carbamates are most powerful and widely accepted chemicals for the control of pests in litchi but, excessive reliance on insecticides has posed several adverse effects such as buildup of pest resistance to insecticide, outbreak of secondary pests, harmful to non-target organisms, health hazards and problems related to environmental pollution. Menzel (2002) and Chen (2011) reported that controlling of *C. sinensis* is not particularly effective owing to its boring habit, but selective pesticide may be effective for its management. Novel insecticides like diamides having low mammalian toxicity has been reported effective against various borers (Deshmukh et al 2010, Larrain et al 2014) which were included in our study.

In this regards new generation insecticides could be an option and can be suitable to incorporate in integrated pest management program because they have selective action, are less hazardous, low mammalian toxicity (Qi and Casida 2013) and do not contaminate to the food chain in the environment (Kuldeep et al 2004). The acute oral toxicity, LD₅₀ of flubendiamide and chlorantraniliprole fall under toxicity category III and IV with the 2000 and 5000 mg/kg respectively for human risk assessment which have low selectivity toward mammals than insects (Lahm et al 2009). Our main objective of this research was to find out the efficacy of novel insecticides with low mammalian toxicity for the management of *C. sinensis* in Litchi.

MATERIALS AND METHODS

Field experiment was conducted at eastern terai of Nepal, Regional Agricultural Research Station (RARS), Tarahara, Sunsari (26°70'39"N, 87°28'53"E and 450 masl) on litchi orchard for consecutive two years during 2015 and 2016, April to May. Mean minimum and maximum temperature during the period of experiment were 23.9±0.3 and 33.1±0.2 and 23.1±0.6 and 32.5±0.2°C in 2015 and 2016 respectively. Experiments were conducted during fruiting stage of litchi plant (variety -Muzaffarpur). This cultivar was introduced from India which are grown in the Terai and low hills and its fruits mature from mid-May to mid-June. The variety is early maturing and color of the fruit is deep pink (Singh et al 2012). Treated litchi plants were approximately 15 years old. Different insecticide, some of having low mammalian toxicity, (Table 1) was compared with control (water sprayed). In each replication 4 trees were assigned comprising each tree for one treatment. The experiment was conducted in a randomized complete block design (RCBD) with four replications. One tree in all replication was assigned as control sprayed only with water.

Table 1. Description of different insecticide used in the experiment on litchi orchard against *Conopomorpha sinensis* during 2015 and 2016 Nepal

SN	Common name	Trade name	Mode of action ^a	Formulation	Dose
1	Azadirachtin	Nico Neem	UN ^b	0.15% w/w EC	5 ml/L water
2	Chlorantraniliprole	Coragen	Rynodine receptor Modulator (RyR)	18.5 % w/w SC	1 ml/3L water
3	Flubendiamide	Fame	Rynodine receptor Modulator	39.35% m/m SC	1 ml/3L water
4	Lambda cyhalothrin	Sumo	Sodium channel modulator	2.5% EC	1.5ml/L water
5	Dimethoate	Rogar	Acetylcholinesterase inhibitor	30% EC	1.5ml/L water

^aSource- IRAC, 2019. ^bUN - Compounds of unknown or uncertain MoA

First application of the insecticides was done when the fruits were of pea size and continued for three times in 10 days interval. Randomly 100 fruits were collected from each tree after 15 days of last spraying. Collected samples were dissected and observed with hand-lens for the presence of *C. sinensis*. Damage by the larvae in the litchi fruits was confirmed by their presence. Number damaged were managed in spread sheet and converted to percent infestation which was subjected to the ANOVA analysis with Tukey’s HSD post-hoc mean comparison using SPSS 2016 (SPSS 2016).

RESULTS

Mean per cent infestation of *C. sinensis* during both years showed that all the insecticides were significantly effective as compared to control. However, chlorantraniliprole was found to be best causing minimum damage in both 2015 and 2016 with the damage percentage of 12.0 ($P \leq 0.01$) and 15.3 ($P \leq 0.01$) respectively followed by flubendiamide (Figure 1, Figure 2). Flubendiamide treated tree incurred *C. sinensis* damage by only 22.8 and 20.0 % in two consecutive year of 2015 and 2016 respectively (Figure 1, Figure 2) which were significantly effective than control. Pooled analysis ($P \leq 0.01$) between both year also ($P \leq 0.01$) revealed that the chlorantraniliprole is superior among all tested treatment in terms of damage percentage followed by flubendiamide (Table 2).

Table 2. Pooled damage percentage of litchi borer among treated orchards in 2015 and 2016 on Regional Agricultural Research Station (RARS), Tarahara, Sunsari

SN	Treatment	Damage (\pm SE) %
1	Azadirachtin	65.25 \pm 4.17c
2	Chlorantraniliprole	13.61 \pm 2.54a
3	Flubendiamide	21.38 \pm 2.06a
4	Lambda cyhalothrin	46.38 \pm 5.76b
5	Dimethoate	49.13 \pm 4.10b
6	Control	87.13 \pm 2.62d

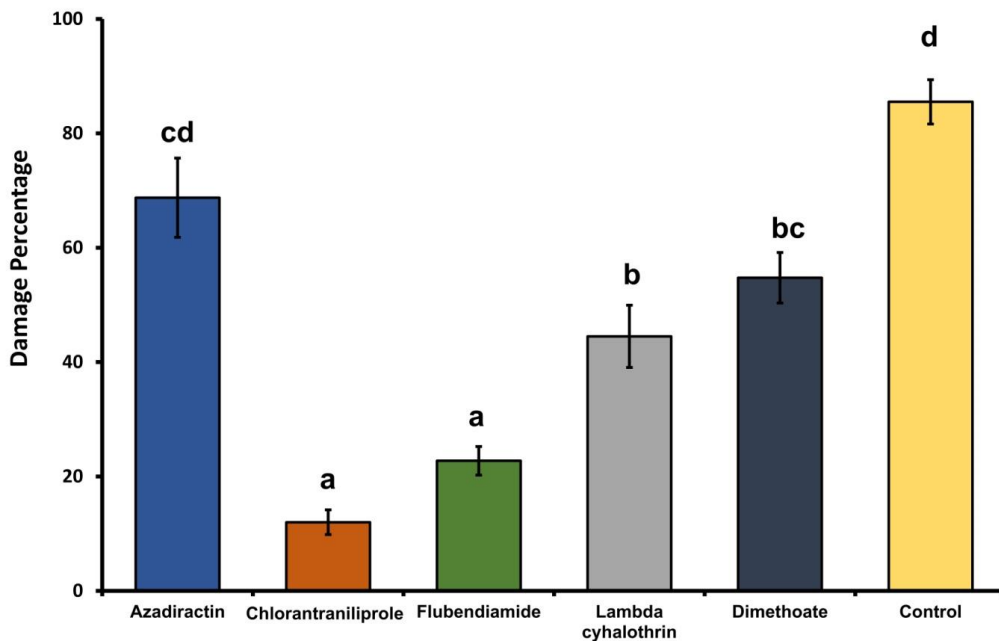


Figure 1. Mean percentage damage caused by *Conopomorpha sinensis* on Litchi in 2015 on Regional Agricultural Research Station (RARS), Tarahara, Sunsari (Bars with same letter for each treatment represents the damage was not significantly difference at $P < 0.05\%$).

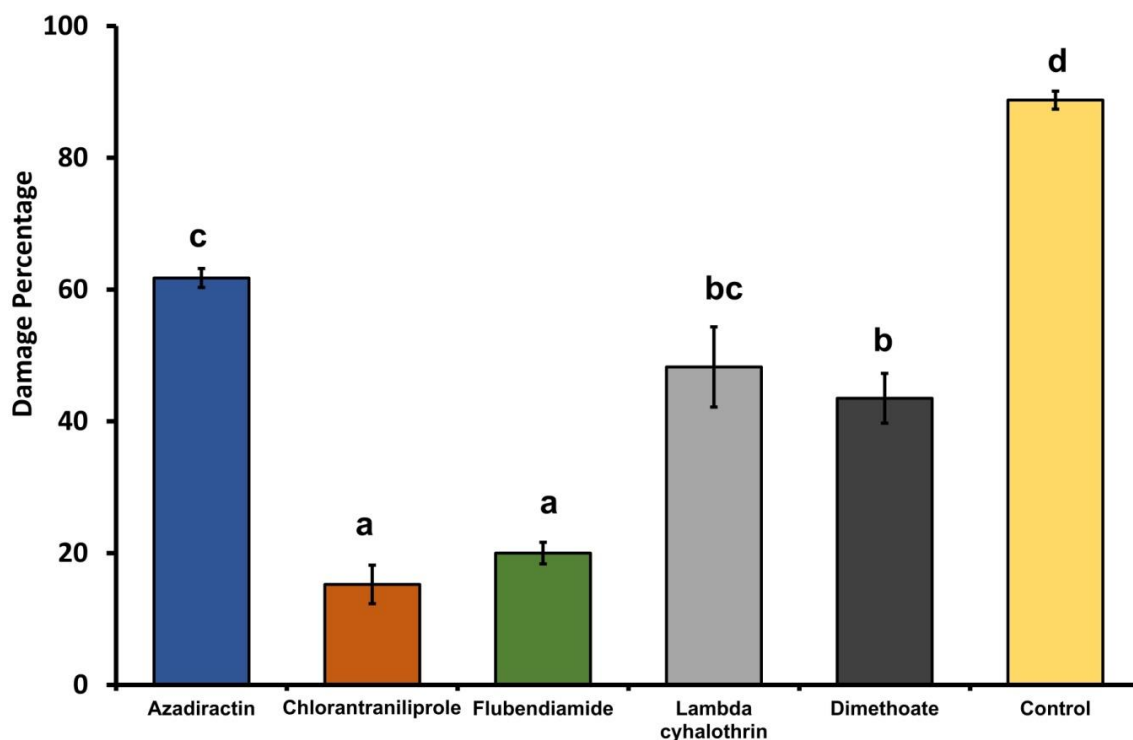


Figure 2. Mean percentage damage of *Conopomorpha sinensis* on Litchi in 2016 on Regional Agricultural Research Station (RARS), Tarahara, Sunsari (Bars with same letter for each treatment represents the damage was not significantly difference at $P < 0.05\%$).

DISCUSSION

Chlorantraniliprole was found to be effective in our study which was also revealed by various researchers for the management of borers (Larrain et al 2014, Rajavel et al 2011, Coslor et al 2018, Huang et al 2016). Rajavel et al (2011) showed chlorantraniliprole effectiveness against brinjal shoot and fruit borer; Larrain et al (2014) proved its effectiveness for *Tuta absoluta* in tomato; Coslor et al (2018) when injected chlorantraniliprole in the apple trunk found moderate to high mortality of *Choristoneura rosaceana*. Similar result was found on rice stem borer, *Chilo suppressalis* (Walker) (Huang et al 2016). Chlorantraniliprole is a novel anthranilic diamide insecticide, effective for control of lepidopteran insect pests, as well as some species in the orders coleoptera, diptera, and hemiptera (Hannig et al 2009). Lai et al (2012) and Han et al (2012) reported that chlorantraniliprole sublethal concentration effect on development of *Spodoptera exigua* and *Plutella xylostella*. Based on feeding cessation and reduction in feeding damage, chlorantraniliprole and flubendiamide is among the fastest-acting insecticides available for control of Lepidopteran pests (Hannig et al 2009, Tohnishi 2005).

Our result showed that flubendiamide was also found effective against *C. sinensis* with low damage rate in both year. Devi and Singh (2016) reported that flubendiamide was effective against yellow stem borer *Scirophaga incertulas* walker. Similarly, Dhaka et al (2015) and Deshmukh et al (2010) found less damage caused by pod borer, *Helicoverpa armigera* (hubner) in vegetable pea, legume pod borer *Maruca vitrata* (Geyer) in pigeonpea (Sreekanth et al 2015), spotted stem borer, *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) in maize (Arunkumara et al 2017) when treated with flubendiamide. Vijayraghavendra and Basavangoud (2017) when treated sapota with the flubendiamide found that the yield was significantly higher than control against sapota fruit borer, *Phycita erythrolophia*.

Khushwaha and Painkara (2016) reported that both chlorantraniliprole and flubendiamide was found effective in managing *Leucinodes orbonalis* and suggested that these insecticide could be used in integrated pest management system. The percent infestation in our result varied from 12 to 85.5% in

2015 whereas it ranged from 15.25 to 88.75% in 2016. Srivastava (2017) study was in line with our study where he found the infestation of the insect up to 59.35% on dropped fruit.

However, neem-based insecticide was not found effective against *C. sinensis*. Similar result was found in legume pod borer, *Maruca vitrata* Fabricius (Lepidoptera: Pyralidae) and Fruit Borers of Guava (*Psidium guajava* L.) (Yule and Srinivasan 2013; Kaul and Yogesh 2003). Dimethoate was not found effective in our result however Drouin and wong (1975) reported that it was found effective against poplar borer *Saperda calcarate*, it may be effective against stem borer than fruit borer. Our result suggests either of chlorantraniliprole or flubendiamide could be used to minimize damage and loss caused by *C. sinensis*. Selectivity of the chlorantraniliprole and flubendiamide have more towards the insect ryanodine receptor (Lahm et al 2009) thus have low mammalian toxicity (Tohnishi 2005, EFSA 2013).

CONCLUSION

Best on our results we conclude that litchi fruit borer, a major pest of litchi could be managed by application of chlorantraniliprole (18.5% w/w SG) or flubendiamide (39.3% m/m). Both pesticide could be applied @ 1 ml per 3 liter of water. It should be applied at least 3 times with 10 days interval. Since these insecticides have selective activity against insects than mammalian receptors, it may reduce the health risk to human and livestock health .

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