Indian Journal of Entomology 86(3): 747-753 (2024) DoI. No.: 10.55446/IJE.2023.1263

COMBINATION OF CONTROL METHODS FOR BRINJAL FRUIT AND SHOOT BORER *LEUCINODES ORBONALIS*

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ABSTRACT

Brinjal fruit and shoot borer *Leucinodes orbonalis* Guenee is an insect pest that causes major economic losses to brinjal in Malaysia. Field experiment was conducted at the experimental research farm (2°59'10.46"N, 101°44'8.78"E), Agriculture Faculty, Universiti Putra Malaysia (UPM), Selangor, Malaysia. Treatment plots were assigned in a randomized complete block design (RCBD) with three replications. Six treatments were evaluated as follows: T1(chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W (0. 4mL/ ℓ)), T2 (neem oil @3mℓ/ ℓ), T3 (yellow sticky trap and hand-picking), T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W (0.4 mℓ/ ℓ) + yellow sticky trap + hand-picking), T5 (neem oil + yellow sticky trap and hand-picking) and T6 (control). Results found that the lowest shoot infestation (0.53± 0.13 %) lowest fruit infestation by number (8.15± 0.75 %) and weight (5.88± 0.66%), maximum fruit yield (26.93± 0.10 t/ ha) recorded in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) treated plot.

Key words: Brinjal, *Leucinodes orbonalis*, fruit and shoot borer, insecticides combination, chlorantraniliprole, thiamethoxam, sticky trap

Brinjal (*Solanum melongena* L.) is one of the most important vegetable cultivated in many temperate and tropical regions (FAO, 2003); The total eggplant cultivation area in Malaysia 2407 ha yielding 39311 mt it is cultivated in. Insect pest and diseases are the major constraints as its production and survey conducted in experimental farm, it was found that different species of insect pests, such as leafhoppers, grasshoppers, plant bugs, planthoppers, army worms, caterpillars, beetles, aphids, whiteflies, mites and thrips cause severe damage. Of these the shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Crambidae) causes major economic losses. This pest is widely distributed in South and Southeast Asia (Lal, 1975). The damage is estimated as high as 70% in India (Singh et al., 2008), reducing the market values of the fruits (Alam et al., 2003).

The current trend of *L. orbonalis* management shows that the majority of farmers mainly rely on insecticides (Alam et al., 2003). According to Borneo (2014) there are over 30 local and foreign companies produces pesticides with an over RM500 million in Malaysia. As reported by AVRDC (1994), brinjal growers apply insecticides up to fifty times during the crop season, while Alam et al. (2006) stated that farmers are presently spraying insecticide nearly 140 times or more in one cropping season. However, excessive dependence on huge quantities of insecticides alone causes ecological contamination and pest resistance (Ali, 1994).

To control *L. orbonalis*, there is no single practice that can be considered as effective, thus only combined methods can bring effective results (Srinivasan, 2008). As reported by Sasikala et al. (1999) that a combination of mechanical destruction of infested shoots and fruits, neem oil and the release of the egg parasitoid (*Trichogramma japonicum* Ashwood) was effective against *L. orbonalis*. According to Javed et al. (2017), a combination practices viz., *Trichogramma chilonis* + hoeing + clipping was found to be the most effective Alam et al. (2003) reported that the combination of a physical barrier and prompt destruction of infested shoots (sanitation) significantly decreased the damage. Different chemical and bio-insecticide were evaluated against *L. orbonalis*. Among the newer insecticides chlorantraniliprole 18.5 SC resulted in lowest fruit infestation and among bioinsecticides, *Beauveria* and *Bacillus thuringiensis* (Bt) were effective in reducing shoot infestation (Tripura et al., 2017). Taking into account these, a newer combined product of insecticide (chlorantraniliprole 8.77% W/W + thiamethoxam

17.54% W/W) along with other control methods namely botanical (neem oil), physical barrier (yellow sticky trap) and mechanical control (removing of infested shoots) were evaluated in the present study to compare combination approach and to determine the best IPM method.

MATERIALS AND METHODS

The experiment was conducted at the experimental research farm (2°59'10.46"N, 101°44'8.78"E), Agriculture Faculty, Universiti Putra Malaysia (UPM), Selangor, Malaysia. The entire area of the research field was 231 m^2, separated into three equal sizes of blocks with each block further sub-divided into six plots (2 x 3 m^2). The space between the two blocks and plots was 1.0 m apart. To prevent spray drift, each replication plot separated from other plots by 1.0 m buffer zones. Seeds of the cultivar 'Round Purple' were sown in propagation tray and subsequently five-weeks-old, healthy seedlings free from disease and mechanical damage were chosen for transplanting. The seedlings were transplanted in 75 cm row to row and 60 cm between plants. Each plot consisted of three rows of five plant, for a total of 15 plants per plot. A recommended dose application of fertilizer 120:80:60 kg N, P, K and poultry manure (chicken dung) per hectare was applied to the crop. Nitrogen was applied in two split doses, 50% at field preparation before transplanting and 50% at the flowering stage. The plants were watered by the sprinkler irrigation system. In order to control the growth of weeds plots were covered with silver shine plastic. The experiment continued from December 2019 to February 2020.

Treatment plots were assigned in a Randomized complete block design (RCBD) with three replications. The following six treatments were used with each treatment replicated thrice. The treatments were as follows: T1(chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W (0. 4mL/ ℓ)), T2 (neem oil @3mL/ ℓ), T3 (yellow sticky trap and hand-picking), T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W (0.4 mL/ ℓ) + yellow sticky trap + hand-picking), T5 (neem oil + yellow sticky trap and hand-picking) and T6 (control).

Spraying was done thrice at fifteen days interval starting from initiation of ESFB infestation. Removing of damaged fruits and shoots were done at weekly interval and similarly the yellow sticky traps were replaced at 15 days' interval. The techniques in this study were adopted from Kumar et al., 2012; Onekutu et al., 2014; and Yousafi et al., 2018 with slight modifications.

Twenty days after transplanting, the plants were observed for the incidence of shoot infestation caused by *L. orbonalis*. The infested shoots by *L. orbonalis* wilted after a few days and then dried out. Healthy and infested shoots were recorded from five randomly selected plants from each plot. The observation was done two times: on the seventh day and fourteenth day after insecticidal application. To avoid recounting during the next observation the damaged shoots were marked using a ribbon tied around the infested shoots and % of the shoot infestation was worked out.

The fruits were harvested at seven days after each spray and recorded on number and weight basis. The harvested fruits were cut and checked properly for holes inflicted by *L. orbonalis* larva. Fruits with holes made by the larva of *L. orbonalis* were acknowledged as infested. Additionally, the weight of infested fruits and weight of marketable fruits were measured and calculated. The % fruit infestation (no. bases) and similarty fruit infestation (weight bases) was calculated. Data on shoot and fruit infestation, healthy fruits weight and numbers were subjected to one-way ANOVA and the means were compared using least significance differences (LSD, p=0.05).

RESULTS AND DISCUSSION

The effects of different treatments on the shoot infestation by *L. orbonalis* were significantly different ($F = 58.17$; df =5, 12; $p< 0.05$). T6 recorded the highest infestation with 7.85± 0.49%, followed by T3 with 2.31± 0.27%, T5 with 1.42± 0.26%, T2 with 1.60± 0.56%, and T1 with 1.01± 0.23%, T4 with 0.53± 0.13% (Table 1). There was also a significant difference between treatments on the number of infested shoots ($F = 40.85$; df =5, 12; $p < 0.05$). The result showed that T6 (untreated plot) recorded the most infested shoots with 15.33± 1.20, followed by T3 (yellow sticky trap and hand-picking) with 4.00± 0.58, T5 (neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking) with 3.00± 0.58, T2 (neem oil @3mℓ/ ℓ) with 3.00± 1.15, T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 2.33± 0.67, T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 1.33± 0.33. The result for number of healthy shoots between various treatments showed a significant difference ($F = 4.56$; df =5, 12; $p < 0.05$). The highest number of healthy shoots were recorded in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 254± 6.35, followed by T1 (chlorantraniliprole 8.77% W/W + thiamethoxam

17.54% W/W) with 223± 22.34, T5 (neem oil @3mℓ/ℓ + yellow sticky trap and hand-picking) with 211.67± 13.92, T6 (control) with 195± 5.77, T2 (neem oil @3mℓ/ℓ) with 188± 17.06, T3 (yellow sticky trap and hand-picking) with 172± 7.09.

IPM includes a series of pest management control methods. In this experiment, a combined product with other methods individually and in combination were used to evaluate the effectiveness of each treatment. The results indicated that the lowest shoot infestation was observed with in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) + yellow sticky trap + hand-picking). The results are in contrast with the findings by Rohokale et al. (2018) who indicated that the lowest shoot infestation was observed in chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC. As reported by Javed et al. (2017), the combination practices viz., hoeing + clipping + weeding were effective in reducing the shoot and fruit infestation Dutta et al. (2011), found that mechanical removal of infested fruits and shoots + pheromone trap + neem was found to be the most effective in reducing shoot damage. All treatments significantly reduced the shoot infestation, but the maximum reduction over control was recorded in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) treated plot. The results are in conformation with the findings of Rohokale et al. (2018) on chlorantraniliprole 8.8% + thiamethoxam17.5% SC. As well as combination of practices gave better results as compared to individual treatments. Combined treatment *Trichogramma chilonis* + hoeing + clipping was found to be the most effective (Javed et al., 2017). Kumar et al. (2012) reported the superiority of the combination methods of botanical, cultural practices, and chemical insecticides. Generally, the insects attracted to yellow sticky traps are leafhoppers, plant bags, whiteflies, grasshoppers, ladybird beetles, flea beetles, wasps, Muscidae, leaf beetles, flesh flies, crickets adult moth of *L. orbonalis* was detected on sticky traps. This result is in conformation with findings of Aravinda (2015) and Murtaza et al. (2019).

The number of infested fruits showed significant differences ($F = 65.17$; $df = 5, 12$; $p<0.05$) with treatments. It was noted that the highest number of infested fruits was T6 (control) with 34.33± 0.67, followed by T3 (yellow sticky trap and hand-picking) with 25.67± 1.20, T2 (neem oil @3mℓ/ℓ) with 18.33± 0.88, T5 (neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking) with 17.67± 1.33, T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 14.67± 1.45, and T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 10.00± 0.58 as shown. Similarly, there were also significant differences between treatments on the number of healthy fruits ($F = 14.42$; $df = 5, 12$; $p<0.05$). T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) produced the maximum number of healthy fruits with 123.67± 6.49, followed by T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 107.67± 6.67, T5 (neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking) with 97.00± 9.29, T2 (neem oil @3mℓ/ ℓ) with 85.33± 3.28, T3 (yellow sticky trap and hand-picking) with 74.00± 3.61, and T6 (control) with 63.67± 2.60 as shown. All treatments had a significant effect on fruit infestation ($F = 280.48$; df. = 5, 12; $p<0.05$); maximum was found in T6 (control) with 54.03± 1.33, followed by T3 (yellow sticky trap and hand-picking) with a mean value of 34.69± 0.06, T2 (neem oil @3mℓ/ ℓ) with 21.50± 0.86, T5 (neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking) with 18.30± 0.68, T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 13.70± 1.70, and T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 8.15± 0.75 (Table 1). All treatments had a considerable increased healthy fruits over control. Treatments 1 to 5 registered a corresponding 69.11, 34.02, 16.22, 94.24 and 52.35% increment of fruit number over control. Plot treated with chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking recorded the highest increase followed by T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W). Treatments 1 to 5 registered a corresponding 57.27, 46.61, 25.23, 70.87, and 48.53% of reduction in fruit infestation over the control, with maximum reduction being in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) + yellow sticky trap + hand-picking) with 70.87%.

Chlorantraniliprole is primarily effective on chewing pests through ingestion and by contact (Bassi et al., 2007). Obviously, the result revealed that T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) + yellow sticky trap + hand-picking), which was a combination control method of chemical and mechanical, was the most effective with minimum number of infested fruits. The result is partially in conformation with Rohokale et al. (2018) who indicated that chlorantraniliprole 8.8% + thiamethoxam17.5% SC was the most effective. The results from the present

Table 1. Effects of combination of methods on infestation caused by *L. orbonalis*

Treatments	No. healthy shoots (No)	No. infested shoots (No)	Infestation (%)
	Mean± SE		
T1	223± 22.34 ab	2.33± 0.67 bc	1.01± 0.23 c
T2	188± 17.06 bc	3.00± 1.15 bc	1.60± 0.56 bc
T3	172± 7.09 c	4.00± 0.58 b	2.31± 0.27 b
T4	254± 6.35 a	1.33± 0.33 c	0.53± 0.13 c
T5	211± 13.92 bc	3.00± 0.58 bc	1.42± 0.26 bc
T6	195± 5.77 bc	15.33± 1.20 a	7.85± 0.49 a
T1	107.67± 6.67 ab	14.67± 1.45 d	13.70± 1.70 e
T2	85.33± 3.28 cd	18.33± 0.88 c	21.50± 0.86 c
T3	74.00± 3.61 de	25.67± 1.20 b	34.69± 0.06 b
T4	123.67± 6.49 a	10.00± 0.58 e	8.15± 0.75 f
T5	97.00± 9.29 bc	17.67± 1.33 cd	18.30± 0.68 d
T6	63.67± 2.60 e	34.33± 0.67 a	54.03± 1.33 a

Treatments	Healthy fruit weight (kg plot^{-1})	Infested fruits weight (kg plot^{-1})	%Infested fruits weight
	Mean± SE		
T1	11.23± 1.50 b	1.42± 0.41 cd	12.18± 1.91 cd
T2	8.76± 0.50 cd	2.08± 0.08 c	23.92± 1.66 bc
T3	7.41± 0.50 de	2.83± 0.31 b	39.039± 6.94 b
T4	15.25± 0.53 a	0.90± 0.13 d	5.88± 0.66 d
T5	10.09± 0.52 bc	1.65± 0.05 c	16.47± 0.97 cd
T6	5.64± 0.73 e	5.01± 0.25 a	91.58± 11.27 a

Treatments	Healthy fruit weight (t ha^{-1})	infested fruits weight (t ha^{-1})	Total yield (t ha^{-1})
	Mean± SE		
T1	18.72± 2.50 b	2.37± 0.68 cd	21.09± 3.18 b
T2	14.60± 0.84 cd	3.47± 0.13 c	18.06± 0.83 b
T3	12.35± 0.84 de	4.71± 0.52 b	17.06± 0.55 b
T4	25.42± 0.89 a	1.51± 0.22 d	26.93± 0.10 a
T5	16.82± 0.87 bc	2.76± 0.08 c	19.58± 0.86 b
T6	9.40± 1.21 e	8.35± 0.41 a	17.75± 1.41 b

T1= chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W (0.4mℓ/ ℓ); T2= neem oil @3mℓ/ ℓ; T3= yellow sticky trap and hand-picking; T4= chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W (0.4mℓ/ ℓ) + yellow sticky trap + hand-picking; T5= neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking; T6= control. Means followed by similar letters within column not significantly different at p = 0.05.

study confirm the effectiveness of combination methods reported by Rahman et al. (2006). Similarly, removal and prompt destruction of the EFSB infested shoots and fruits at regular intervals have been suggested as an effective strategy (Rahman et al., 2002; Talekar, 2002; Duca et al., 2003; Satpathy et al., 2005). Rahman et al. (2002) and Yousafi et al. (2018) reported that cultural control (removal of infested shoots) combined with physical practices (use of light traps) proved an adaptable and practical strategy for keeping the fruit infestation low.

The fruit infestation (weight) showed a significant difference between treatments ($F = 32.66$; df = 5, 12; $p<0.05$). It also followed the same trend as observed in shoot infestation with maximum being in T6 (control) with a mean value of 91.58± 11.27%, followed by T3 (yellow sticky trap and hand-picking) with 39.04± 6.94%, T2 (neem oil @3mℓ/ ℓ) wtih 23.92± 1.66%, T5 (neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking) with 16.47± 0.97%, T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 12.18± 1.91%, and T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) + yellow sticky trap + hand-picking) with 5.88± 0.66%. There were significant differences between the treatments on the weight of infested fruits ($F = 36.85$; $df = 5, 12$; $p < 0.05$). Maximum infested fruit weight was recorded in T6 (control) with 5.01± 0.25 kg, followed by T3 (yellow sticky trap and hand-picking) with 2.83± 0.31 kg, T2 (neem oil @3mℓ/ ℓ) with 2.08± 0.08 kg, T5 (neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking) with 1.65± 0.05 kg, T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 1.42± 0.41 kg, and T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 0.90± 0.13 kg. Similarly, there were significant differences between the treatments on the weight of healthy fruits ($F = 17.49$; $df = 5, 12$; $p < 0.05$). Maximum healthy fruit weight was recorded in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 15.25± 0.53 kg, followed by T1(chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 11.23± 1.50 kg, (Table 1).

Among all control methods, the maximum reduction over control was obtained in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) + yellow sticky trap + hand-picking) followed by T1 with 99.15%. In the same way, all control methods recorded a substantial reduction in fruit infestation by weight compared to control. Among all treatments, the highest reduction over the control was recorded in T4 with 81.92%, and thus the combination of methods in reducing fruit infestation was superior. The lowest (43.59%) was obtained from the mechanical method (yellow sticky trap and removal of infested shoots). Similarly, in terms of total fruit yield, the maximum increment over control was obtained in T4 with 51.72%. Similarly, all control methods produced a significant amount of fruit infestation over control on a weight basis. The treatments viz., T1, T2, T3, T4 and T5 caused 71.62, 58.44, 43.59, 81.92, and 66.95% reduction of fruit infestation over the control, respectively; maximum reduction of 81.92% was obtained in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) + yellow sticky trap + hand-picking), indicating the superiority of the combination methods. The result showed that, among all treatments, the most superior control method was T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) + yellow sticky trap + hand-picking) with 51.72% increment over control, followed by T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 18.82%, T5 (neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking) with 10.31%, T3 (yellow sticky trap and hand-picking) with 3.89%, and T2 (neem oil @3mℓ/ ℓ) with 1.75% increment. The present findings in accordance with those of Rahman et al. (2009); Mandal et al. (2009); and Dutta et al. (2011). Pheromone traps + mechanical control (removal of infested shoots) + insecticide was reported to be the best.

Chlorantraniliprole was the most effective insecticide and it has an insecticidal activity on a large number of lepidopterans (Sattelle et al., 2008). Sen et al. (2017) reported the combination of chlorantraniliprole + lambda cyhalothrin produced a substantial reduction. Tripura et al. (2017) found that chlorantraniliprole recorded the lowest fruit infestation and the highest marketable fruit yield. Mainali et al. (2015) reported that the highest marketable yield was recorded with chlorantraniliprole Onekutu et al. (2014) found that nylon net barrier with the weekly cutting of infested shoot and the application of lambda cyhalothrin 5% EC were superior. He found that integrating physical barrier of nylon netting, weekly clipping of infested shoot and monthly application of lambda cyhalothrin 5% EC were effective. Amin et al. (2014) reported the efficacy of hand picking and destruction of infested shoots and fruits.

The efficacy of treatments on the marketable yield was significantly different ($F = 17.47$; $df = 5, 12$; $p<0.05$). The production was assessed in terms of the total fruit harvest, marketable yield or healthy fruits yield and infested fruits harvest obtained. The highest marketable fruits were obtained from T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 25.42± 0.89 t ha^{-1}, followed by T1 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) with 18.72± 2.50 t ha^{-1}), T5 (neem oil @3mℓ/ ℓ + yellow sticky trap and hand-picking) with 16.82± 0.87 t ha^{-1}, T2 (neem oil @3mℓ/ ℓ) with 14.60± 0.84 t ha^{-1}, T3 (yellow sticky trap and hand-picking) with 12.35± 0.84 t ha^{-1}, and lastly, T6 (untreated control plot) with 9.40± 1.21 ha^{-1}. The effectiveness of treatments on the weights of infested fruits was significantly different (F

= 36.89; df = 5, 12; p<0.05), with maximum infested fruits recorded in T6 (control) with 8.35± 0.41 t ha^{-1}, T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 1.51± 0.22 t ha^{-1} with the best. The result conforms with Tripura et al. (2017) chlorantraniliprole.

Maximum yield was obtained in T4 (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking) with 26.93± 0.10 t ha^{-1}. It was also found that chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W + yellow sticky trap + hand-picking provided the highest increase (63.02%)(Table 1).

Therefore, combination of methods was found superior Onekutu et al. (2014) indicated that integrating physical barrier of nylon netting, weekly clipping of infested shoot and monthly application of Karate® 5EC is one of the effective ways. The efficacy of readily combined formulation with two active ingredients (chlorantraniliprole 8.77% W/W + thiamethoxam 17.54% W/W) against *L. orbonalis* has been reported previously. Rohokale et al. (2018) observed that chlorantraniliprole 8.8% + thiamethoxam17.5% SC with 10.47% was the most effective with highest yield. Sen et al. (2017) reported that the highest marketable fruit yield was obtained with chlorantraniliprole 9.3% + lambda cyhalothrin 4.6% ZC @ 28 and 35 g a.i./ ha. Whereas Kumar et al. (2012) found that the combination of botanical, cultural practices and chemical insecticides were found to be significantly effective. Sasikala et al. (1999) reported that the application of neem oil (0.2%) and the release of egg parasitoid (*T. japanicum*) effectively minimized the mechanical destructions of shoots and fruits, thereby demonstrating excellent. The effective management of this pest can be brought about only by effective combination practices, particularly the borer insects (*L. orbonalis*).

ACKNOWLEDGEMENTS

The authors would thank Mr. Audi Jamaludin from the Department of Plant Protection, Universiti Putra Malaysia for his assistance during the laboratory works. A special thanks go to the farm management Unit, Faculty of Agriculture for their permission in conducting the cultivation in the field.

FINANCIAL SUPPORT

There was no financial support.

AUTHOR CONTRIBUTION STATEMENT

ABR formulated the study, ABR and MAB performed all the bioinformatics analysis, ABR drafted the manuscript, and NAA supervised and reviewed the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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(Manuscript Received: April, 2023; Revised: May, 2023;
Accepted: May, 2023; Online Published: June, 2023)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e23263