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Net profit, avoidable loss and cost benefit ratio of certain insecticides against the brinjal shoot and fruit borer *Leucinodes orbonalis* Guen in Manipur

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Abstract
The present investigations were conducted to find out the net profit, avoidable losses and cost benefit ratio of different insecticides against the brinjaI shoot and fruit borer, *Leucinodes orbonalis* Guen. on brinjal. The minimum percent avoidable losses were recorded in cypermethrin and maximum in untreated control plots. Maximum fruit yield was recorded by treatment cypermethrin (108.64q/ha in 2015 & 102.42q/ha in 2016) which was followed by fenvalerate (92.17q/ha in 2015 & 93.56q/ha in 2016) and lowest in control (61.73q/ha in 2015 & 66.11q/ha in 2016). A gain of 46.91q/ha. in 2015 and 36.31q/ha in 2016 were observed with the treatment cypermethrin over the control and obtained the maximum net profit of Rs.25065.70/ha (in 2015) and Rs. 19235.70/ha(in 2016). As regards to the economics of the treatments, cypermethrin was the most economic treatment recorded in cost benefit ratio of 1:34.1 in 2015 and 1:26.18 in 2016. On the basis of cost benefit ratio, the treatments could be arranged in the following descending order of cost effectiveness i.e. cypermethrin > fenvalerate > acephate > achook > carbofuran.

Keywords: net profit, avoidable losses, cost benefit ratio, insecticides, *leucinodes orbonalis*, brinjal

Introduction
Brinjal, *Solanum melongena* L. is one of the important solanaceous vegetable crops cultivated in India (Anonymous, 2017a) [2] and is grown throughout the year (Kolhe, 2017) [6]. It is attacked by a number of insect pests which cause adverse effect on both yield and quality (Sarangdevot *et.al* 2006). Among these, brinjal shoot and fruity borer, *Leucinodes orbonalis* Guen is regarded as a major pest (Sawant and Patil, 2004) [12]. The attack of *L. orbonalis* cause shading of flower buds and bored holes of fruit plugged with excreta with maximum damage of shoot and fruit (Tiwari et.al. 2009). The pest is the most noxious and ubiquitous pest of brinjal (Naik *et.al*., 2008) [8]. The pest is reported to cause as high as 74% yield loss to brinjal fruits (Yadava and Sharma, 2008). Prasad et.al (2017) [10] estimated avoidable loss to an extent of 48.5%. However, the losses caused by this vary from season to season depending upon environmental factors (Gangwar and Sachan, 1981; Patel et.al., 1988) [4]. Based on the economic importance of this pest, avoidable losses and cost benefit ratio of different insecticides were assessed against the brinjal shoot and fruit borer, *L. orbonalis* Guen under the agro-climatic conditions of Manipur.

Materials and Methods
A field trial was conducted for two consecutive cropping seasons (2015 & 2016) at the experimental field of Zoology Department, Manipur College, Imphal to assess the avoidable losses and cost benefit ratio of different insecticides against the brinjaI shoot and fruit borer, *L. orbonalis* Guen. The experiment was laid out in a Randomized block design. There were six treatments including an untreated control, with three replications. One month old seedlings of brinjal variety Pusa kranti were transplanted adopting a spacing of 75cmX60cm.in a plot size of 6mX5m.
All recommended agronomic practices were followed to raise the crop. The treatments in the form of insecticidal sprays were sprayed to the plants with the help of hand compression sprayer and untreated control was sprayed with water only. The plants were sprayed two times at 15 days interval. The first spray was given after 45 days of transplantation. The treatments included cypermethrin 10EC (0.07%), fenvalerate 20EC (0.01%), acephate 75WP (0.06%), achook (2ml/litre of water) and carbofuran (3G). From each plot the numbers of infested shoot as well as non-infected shoot were recorded on four randomly selected plants one day before and3, 7 and 14 days after each spraying. Yield of healthy and infected brinjal fruit from each picking were also recorded for each plot.

The percent avoidable loss in yield was worked out using the following formula given below:

$$\text{Percent avoidable loss in yield} = \frac{\text{Highest yield in treated plot} - \text{Yield in untreated plot}}{\text{Highest yield in treated plot}} \text{ X } 100$$

The Cost Benefit Ratio (CBR) was calculated by using the formula given below:

$$\text{CBR} = \frac{\text{Value of Benefit expected (Rs/Ha)}}{\text{Value of cost of plant protection (Rs/ha)}}$$

Results and Discussion

Net profit, avoidable losses and cost benefit ratio of different insecticides against brinjal shoot and fruit borer *L. orbonalis* Guen (2015) are presented in table 1. The difference in the brinjal yield, which could be avoided due to insecticidal treatment in protected plot had been mentioned as avoidable loss. The minimum (0.00) percent avoidable loss was recorded in cypermethrin (Fig. 1) followed by fenvalerate (14.61), acephate (16.39), achook (36.48) and carbofuran (40.04). However, the maximum percent avoidable loss was recorded in control plot (43.18). The present finding of percentage of avoidable losses is more or less similar with the finding of Prasad *et.al.* (2017) [10].

Cost benefit ratio analysis of the treatments were work out in order to judge the cost effectiveness. During the first cropping season, the highest yield (108.64q/ha) was obtained in the treatment Cypermethrin (Fig. 1) being followed by 92.77 q/ha in Fenvalerate, 90.83 q/ha in Acephate, 68.78 q/ha in Achook and 65.14 q/ha in Carbofuran. The minimum yield was registered by the control treatment (61.73 q/ha). There was a gain of 46.91 q/ha in yield in the treatment Cypermethrin over the control and afforded maximum net profit of Rs. 25065.70/ha. Further, the data revealed that all the treatments show gain in yield over the control. On the basis of cost benefit ratio (CBR), the treatment cypermethrin could be adjudged as the most profitable treatment (1:34.11). It was followed by Fenvalerate (1: 22.23), Acephate (1:21.73), Achook (1:13.50) and carbofuran (1:1.93). So, Cypermethrin registered the highest yield at the cost of plant protection. Thus, based on the cost benefit ratio, the treatments could be arranged in the following descending order i.e. Cypermethrin > Fenvalerate > Acephate > Achook > Carbofuran.

The data on net profit, avoidable loss and cost benefit analysis during the second cropping season are presented in table 2. The data revealed that almost all the treatments afforded similar trend of efficacy with that of the first year. The minimum (0.00) percent avoidable loss was recorded in cypermethrin (Fig. 2) followed by fenvalerate (8.65), acephate (10.71), achook (27.38) and carbofuran (12.81). However, the maximum percent avoidable loss was recorded in control plot (35.45). The highest yield (102.42q/ha) was obtained in the treatment cypermethrin (Fig. 2) and the minimum yield was recorded in the control treatment (66.11 q/ha). Further, the gain in yield over control varied from 36.31 q/ha in cypermethrin to 04.19 q/ha in carbofuran. The maximum total cost of plant protection was registered with the treatment, cypermethrin (Rs. 734/ha) and the minimum was obtained in the treatment achook (Rs. 267.36/ha). The net profit was highest for cypermethrin with Rs.19235.7/ha being followed by fenvalerate showing a net profit of Rs. 14362.7/ha. However, the lowest was recorded in case of carbofuran (Rs. 1664.5/ha). Based on the cost benefit ratio (CBR), the highest cost benefit ratio was obtained from the plots treated with cypermethrin (1:26.18) followed by fenvalerate (1:19.55), acephate (1:18.80), achook (1:16.01) and carbofuran (1:2.60).

Table 1: Avoidable loss and cost benefit analysis of certain bioinsecticides in the management of the brinjal shoot and fruit borer, *L. orbonalis* on brinjal crop during 2015.

Treatment	Conc.	Fruit Yield (q/ha)	Increase in yield over control (q/ha)	Avoidable Loss (%)	Cost of increased yield over control (Rs/ha)	Cost of control (labour + insecticide/ha) (Rs/ha)	Total cost of Plant Protection (Rs/ha)	Net Profit (Rs/ha)	Cost Benefit Ratio
Cypermethrin	0.02	108.64	46.91	–	25800.50	367.4	734.8	25065.70	1:34.1
Fenvalerate	0.02	92.77	31.04	14.61	17072.00	367.4	734.8	16337.20	1:22.23
Acephate	0.06	90.83	29.10	16.39	16005.00	352	704	15301	1:21.73
Achook	2ml/l H2O	68.78	7.05	36.68	3877.50	131.68	267.36	3610.14	1:13.50
Carbofuran	3G	65.14	03.41	40.04	1875.50	320	640	1235.50	1: 1.93
Control	H2O	61.73	0.00	43.18	0.00	–	–	–	–

Cost of Brinjal Fruit = 550/q

Total Cost based on two rounds of treatment

For one treatment = Cost of insecticide/ha + cost of labour (2labour/day @Rs. 100/hour)

Table 2: Avoidable loss and cost benefit analysis of certain bioinsecticides in the management of the brinjal shoot and fruit borer, *L. orbonalis* on brinjal crop during 2016. Cost of Brinjal Fruit = 550/q Total Cost based on two rounds of treatment for one treatment = Cost of insecticide/ha + cost of labour (2labour/day @Rs. 100/hour)

Treatment	Conc.	Fruit Yield (q/ha)	Increase in yield over control (q/ha)	Avoidable Loss (%)	Cost of increased yield over control (Rs/ha)	Cost of control (labour + insecticide/ha) (Rs/ha)	Total cost of Plant Protection (Rs/ha)	Net Profit (Rs/ha)	Cost Benefit Ratio
Cypermethrin	0.02	102.42	36.31	—	19970.50	362	734.8	19235.7	1:26.18
Fenvalerate	0.02	93.56	27.45	8.65	15097.5	367.4	734.8	14362.7	1:19.55
Acephate	0.06	91.45	25.34	10.71	13937.00	352	704	13233	1:18.80
Achook	2ml/l H2O	74.38	8.27	27.38	4548.50	131.68	267.36	4281.14	1:16.01
Carbofuran	3G	70.30	4.19	12.81	2304.50	320	640	1664.5	1:2.60
Control	H2O	66.11	0.00	35.45	0.00	—	—	—	—

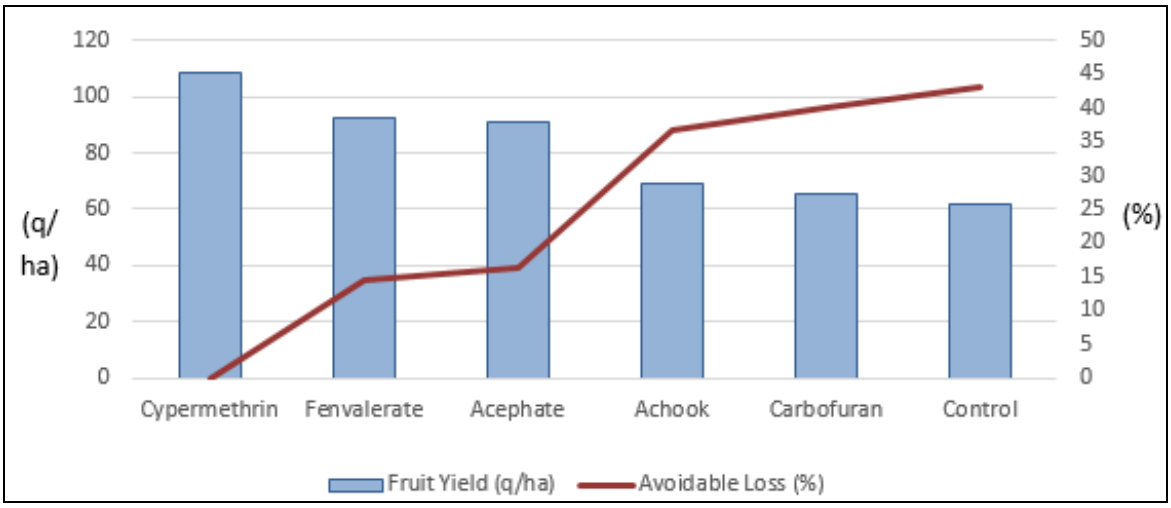

Fig 1: Effect of various Treatments on brinjal fruit yield (2015)

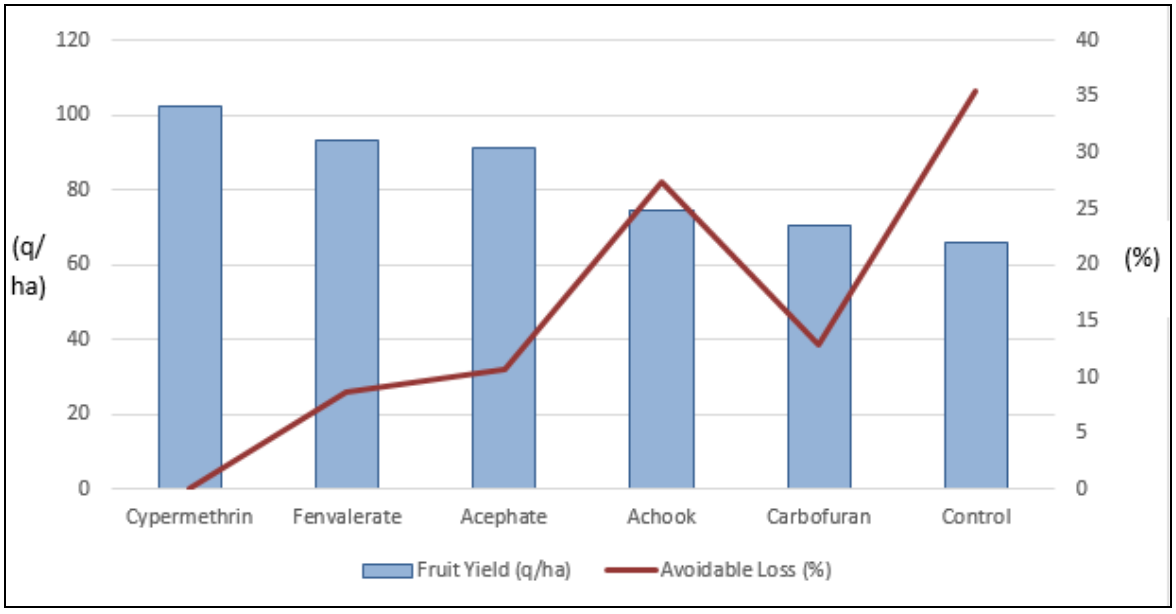

Fig 2: Effect of various Treatments on brinjal fruit yield (2016)

Cypermethrin was also gave maximum cost benefit ratio in the management of *Helicoverpa armigera* (Hubner) in tomato (Indira & Devi, 2014) [5].

Thus in both the cropping seasons, the treatment cypermethrin could be adjudged as the most profitable treatment and it was followed by fenvalerate and acephate. However, the lowest cost benefit ratio was obtained in the treatment carbofuran. The present finding was in agreement with the result of Agnihotri *et al* (1999). Application of neem product, Achook was observed to be quite inferior (1:3.6 in 2007 and 1:4.90 in 2008)

compared to other insecticidal treatment in both point of view of cost benefit ratio as well as shoot and fruit borer infestation. These finding are also in conformity with that of Muralikrishna (1995), Patnaik & Singh (1997) [9] and Basu (2000).

Conclusion

Among the five different bioinsecticides evaluated cypermethrin was the most economic treatment against *L. orbonalis* Guen infesting brinjal. Cypermethrin exhibited higher brinjal fruit yield. The minimum and maximum percent avoidable losses were recorded in cypermethrin and control plot respectively and the highest cost benefit ratio was also recorded from the plots treated with cypermethrin.

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