Journal of Experimental Sciences Vol. 2, Issue 1, Pages 27-31 [2011]
www.jexpsciences.com

Regular Article

Comparative Performance of Some Insecticides and Botanicals against Chilli Fruit Borer (*Helicoverpa armigera*)

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ABSTRACT: The study was carried out in the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from February to June 2007 to determine the comparative efficacy of some chemical insecticides and botanicals against chilli fruit borer. The experiment comprised with twelve treatments and among them first six (T1-T6) were the application of insecticide and others (T7-T11) were botanicals. Treatments were T1: Sumicidin @ 6.0 ml/2 litre of water at 7 days interval; T2: Malathion @ 6.0 ml/2 litre of water at 7 days interval; T3: Ripcord @ 3.0 ml/2 litre of water at 7 days interval; T4: Marshal @ 6.0 ml/2 litre of water at 7 days interval; T5: Diazinon @ 6.0 ml/2 litre of water at 7 days interval; T6: Suntaf @ 2.5 ml/2 litre of water at 7 days interval; T7: Allamanda leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T8: Neem leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T9: Garlic clove extract @ 0.5 kg/2 litre of water at 7 days interval; T10: Ginger rhizome extract @ 0.5 kg/2 litre of water at 7 days interval; T11: Onion bulb extract @ 0.5 kg/2 litre of water at 7 days interval; T12: Untreated control. In total cropping season the lowest percentage of fruit infestation by number (5.72%) was recorded from the treatment T4 which was statistically similar (6.22%) with the treatment T8 and the highest (24.90%) was recorded from untreated control treatment which was closely followed (17.39%) by the treatment T5 and T11 (16.48%) and T10 (15.37%) respectively. Fruit infestation reduction over control by number estimated as the highest value (77.03%) was recorded from the treatment T4, while the lowest (30.16%) was recorded from T5 treatment. Fruit infestation reduction over control by weight was estimated and the highest value was (63.35%), recorded from the treatment T4, while the lowest (22.84%) reduction of fruit infestation over control was from the treatment T5. Highest weight of fruit yield (30.60 t/ha) was recorded from the treatment T4 and the lowest yield (24.48 t/ha) of fruit was recorded from untreated control treatment. Among different treatments as whole botanicals (T7-T11) were more effective than those of the chemicals insecticides (T1-T6).

Key words: Efficacy, Chemical control, Biopesticide, Fruit borer, *Capsicum frutescens*

Introduction

Chilli (*Capsicum frutescens* L.) belonging to the family Solanaceae is one of the important spice crops in Bangladesh. It has an important nutritive value especially rich in vitamin C and A (Muthukrishnan *et al.*, 1990). In Bangladesh 382,000 acres of land is under its cultivation and total production is approximately 186,000 metric tonnes per annum (BBS, 2005) and the per acre production is about 0.49 tones which is very low compared to that of other chilli growing countries in the World. The low yield of chilli in Bangladesh however, is not an indication of low yielding potentiality of this crop, but the fact that the low yield may be attributed to a number of reasons, such as unavailability of quality seeds of high yielding varieties, fertilizer management, insect and disease infestation and improper cultivation facilities. Chilli is susceptible to insect attack from seedling to fruiting stage. All parts of the plant including leaves, stems, flowers and fruits are subjected to attack (HDRA, 2000). About 51 species of insects and 2 species of mites belonging to 27 families under 9 orders along with snail and two species of millipedes are known to damage chilli crop both in the nursery and in the main field. Among these pests' aphids, fruit borers, thrips, mites are of serious in nature (Muthukrishnan *et al.*, 1990, Shahjahan and Ahmed, 1993). These insects' pests cause both qualitative and quantitative losses in chilli in the field. An overall reduction in the yield of chilli due to arthropod pests was up to 77 per cent and the joint infestation of thrips and mites caused losses up to 34 per cent (HDRA, 2000). Three species of fruit borer viz., *Heliothis armigera* Hb, *Spodoptera litura* F. and *Ostrinia nubilalis* Hb. belonging to Noctuidae bore into the tender and maturing fruits and feed the seeds inside resulting in hallowing and the fruit finally dropping off from the plant. In Bangladesh, very few research works have been done mainly on approaches for the management of chilli pests. These are mainly on, chemical control, cultural control, mechanical control, development of resistant varieties and use of botanical pesticides etc. Use of chemical to control pests is the most favorable means to our farmers till now. However, application of precise dose of the chemical to the field is a difficult job for them. Moreover, indiscriminate as well as long time use of chemical affects the soil and human health. Harmful chemical substances enter into the food chain that ultimately causes serious health hazards. Chemicals are mainly effective in controlling insect pests but they are not cost effective. Yield losses in case of application of different chemical insecticides were estimated at 40-100% and 15-50%, respectively in different areas of Bangladesh (Agranovsky, 1993). Eco-friendly management of pest such as use of botanical extracts has a great chance to save the beneficial soil microorganisms. Most of the botanical extracts are also cost effective and readily available near to the farmers in time. As a result botanical pesticides are becoming popular day by day. Now a day, these are being used against many insects. Use of botanical extract against insect pest control is however, a recent approach to insect pest management and it has drawn special attention to the Entomologist all over the world. In Bangladesh, only a few attempts have been made to evaluate botanical extracts against insect's pest (Karim, 1994). It would help to avoid environmental pollution caused by chemicals and thus become most rewarding one in our existing socio-economic conditions and environmental threat. Considering the above conditions the present piece of research work has been undertaken to know the extent of damage against different chemical insecticides and botanicals by chilli fruit borer; to know the comparative effect of different chemical insecticides and botanicals on infestation and yield of chilli against chilli fruit borer.

Materials and Methods

The study was carried out in the experimental field of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from February to June 2007 to determine of the comparative efficacy of some chemical insecticides and botanicals against chilli fruit borer. The experiment comprised with twelve treatments. Among the twelve treatments first six (T_1-T_6) were the application of insecticide and others (T_7-T_{11}) were botanicals. The details of the treatments were presented below: T_1: Sumicidin @ 6.0 ml/2 litre of water at 7 days interval'; T_2: Malathion @ 6.0 ml/2 litre of water at 7 days interval; T_3: Ripcord @ 3.0 ml/2 litre of water at 7 days interval; T_4: Marshal @ 6.0 ml/2 litre of water at 7 days interval; T_5: Diazinon @ 6.0 ml/2 litre of water at 7 days interval; T_6: Suntaf @ 2.5 ml/2 litre of water at 7 days interval; T_7: Allamanda leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_8: Neem leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_9: Garlic clove extract @ 0.5 kg/2 litre of water at 7 days interval; T_{10}: Ginger rhizome extract @ 0.5 kg/2 litre of water at 7 days interval; T_{11}: Onion bulb extract @ 0.5

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kg/2 litre of water at 7 days interval and T_{12}: Untreated control. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The layout of the experiment was prepared for distributing the treatment combinations in each plot of each block. There were 36 unit plots altogether in the experiment. The size of the plot was 2.0 m × 2.0 m. Seedlings of chilli were transplanted in the field with maintaining spacing 40 cm × 25 cm row to row and plant to plant, respectively. The distance between two blocks and two plots were 1.0 m and 0.5 m respectively. The experimental field was partitioned into the unit plots in accordance with the experimental layout and design. Well decomposed cowdung (10 t/ha) was applied at the time of final land preparation. The sources of fertilizers used for N, P, K, S and Zn were urea (210 kg/ha), TSP (300 kg/ha), MP (200 kg/ha), Gypsum (110 kg/ha) and Zinc sulphate (15 kg/ha), respectively (Rashid, 1993). The entire amounts of TSP, MP were applied during final land preparation. Only urea was applied in three equal installments at 30, 45 and 60 Days after transplanting (DAT). After establishment of seedlings, various intercultural operations were accomplished for better growth and development. Light over-head irrigation was provided with a watering can to the plots immediately after transplanting of seedling. Irrigation was also applied several times considering the moisture status of the field. Weeding was done whenever necessary considering to make the environment in the plots not suitable for the insect pests. Data were recorded on healthy and infested fruit at different stages and yield of chilli to find out the efficacy of the treatments. The percentage of fruit borer infested fruits was calculated using the following formula:

$$\% \text{ fruit borer infested fruit (by number)} = \frac{\text{No. of infested fruits}}{\text{Total No. of fruits}} \times 100$$

$$\% \text{ fruit borer infested fruit (by weight)} = \frac{\text{Weight of infested fruits}}{\text{Total weight of fruits}} \times 100$$

Increase or reduction over control was calculated using the following formula:

$$\% \text{ increase over control} = \frac{\text{Value in treated plot} - \text{value in untreated control plot}}{\text{Value in untreated control plot}} \times 100$$

$$\% \text{ reduction over control} = \frac{\text{Value in untreated control plot} - \text{value in untreated plot}}{\text{Value in untreated control plot}} \times 100$$

The data on the weight of healthy and infested fruits for each treatment from whole plot along with their number and weight were recorded. The data on the weight of fruits for each treatment from whole plot were recorded at each harvest. The plot yield was transformed into fruit yields in ton per hectare. Benefit cost ratio (BCR) was also calculated by the estimation of different pest management cost with adjusting with the control condition. The data obtained for different characters were statistically analyzed to find out the significance for different chemicals and botanicals that were used as treatments. The analysis of variance was performed by using MSTAT Program. The significance of the difference among the treatment combinations means was estimated by DMRT (Duncan's Multiple Range Test) at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

The present study was conducted to determine the comparative efficacy of some chemical insecticides and botanicals against chili fruit borer. Data on fruit borer infestation and their effect on yield were recorded. Highest number of healthy fruit (36.20) per plant was recorded from the treatment T_4 which was statistically identical (36.00 and 34.60) with the treatment T_8 and T_9, respectively (Table 1). On the other hand the lowest (24.93) number of healthy fruit was recorded from untreated control treatment which was closely followed (29.47) by the treatment T_5. On the other hand from other treatment healthy fruits were recorded and they were ranged were 30.40-33.60 and the numbers of fruits were intermediate level for this treatment comparing with the other treatments. Total fruiting stage due to the application of different chemical insecticides and botanicals in controlling fruit borer showed statistically significant variation in number of infested fruit. Lowest number of infested fruit per plant (2.20) was recorded from the treatment T_4 which was statistically identical (2.40) with that of the treatment T_8. On the other hand the highest (8.27) number of infested fruit was recorded from untreated control treatment which was closely followed (6.20) by the treatment T_5. At fruiting stage due to the application of different chemical insecticides and botanicals in controlling fruit borer showed statistically significant variation for fruit infestation in percentage for number of infested fruit. The lowest percentage of fruit infestation in number (5.72%) was recorded from the treatment T_4 which was statistically similar (6.22%) with the treatment T_8 and the highest (24.90%) was recorded from untreated control treatment which was closely followed (17.39%) by the treatment T_5 and T_{11} (16.48%) and T_{10} (15.37%) (Table 1). Fruit infestation reduction over control in number was estimated the highest value (77.03%) was recorded from the treatment T_4, while the lowest (30.16%) was recorded from treatment T_5. From the findings it is revealed that treatment T_4 and T_8 performed maximum healthy fruit and minimum infested fruit as well as minimum % of fruit infestation in number whereas in control treatment the situation is reversed. Among different treatments as whole botanicals (T_7-T_{11}) were more effective than the chemicals insecticides (T_1-T_6) under the present study (Table 1). Kulat *et al.* (2001); Prabal *et al.* (2000) reported from their experiment on extracts of some indigenous plant materials, which are claimed important as pest control like seed kernels of neem. Weekly spray application of the extract of neem seed kernel has been found to effective against borer (Karim, 1994). Sivaprakasam,. (1996); Saibllon *et al.* (1995) and Reddy *et al.* (1996) also reported the similar results earlier. Highest weight of healthy fruit (262.11 g) per plant was recorded from the treatment T_4 which was statistically identical (258.04 g) with the treatment T_8 (Table 2). On the other hand the lowest (199.76 g) weight of healthy fruit was recorded from untreated control treatment which was closely followed (222.11 g) by the treatment T_5. Total fruiting stage due to the application of different chemical insecticides and botanicals in controlling fruit borer showed statistically significant variation in weight of infested fruit. Lowest weight of infested fruit per plant (28.09 g) was recorded from the treatment T_4 which was statistically similar (28.79 g) with the treatment T_8. On the other hand the highest (71.79 g) weight of infested fruit was recorded from untreated control treatment which was closely followed (55.91 g) by the treatment T_5 (Table-2).

Table 1. Effect of different chemical insecticides and botanicals against chilli fruit borer in number per plant in total cropping season during February to June, 2007

Treatment	Fruit of chilli			Reduction over control (%)
	Healthy (No.)	Infested (No.)	Infestation (%)	
T_1	33.20 bcd	4.00 fg	10.75 e	56.83
T_2	31.80 cde	5.40 d	14.53 c	41.65
T_3	32.60 bcde	4.80 e	12.82 d	48.51
T_4	36.20 a	2.20 i	5.72 h	77.03
T_5	29.47 f	6.20 b	17.39 b	30.16
T_6	33.60 bc	3.60 gh	9.67 f	61.16
T_7	32.80 bcd	4. 40 ef	11.85 d	52.41
T_8	36.00 a	2.40 i	6.22 h	75.02
T_9	34.60 ab	3.20 h	8.45 g	66.06
T_{10}	30.87 def	5.60 cd	15.37 c	38.27
T_{11}	30.40 ef	6.00 bc	16.48 b	33.82
T_{12}	24.93 g	8.27 a	24.90 a	--
$LSD_{((0.05)}$	2.132	0.454	1.059	--
CV(%)	7.91	5.76	4.87	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
T_1: Sumicidin @ 6.0 ml/2 litre of water at 7 days interval; T_2: Malathion @ 6.0 ml/2 litre of water at 7 days interval; T_3: Ripcord @ 3.0 ml/2 litre of water at 7 days interval; T_4: Marshal @ 6.0 ml/2 litre of water at 7 days interval; T_5: Diazinon @ 6.0 ml/2 litre of water at 7 days interval; T_6: Suntaf @ 2.5 ml/2 litre of water at 7 days interval; T_7: Allamanda leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_8: Neem leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_9: Garlic clove extract @ 0.5 kg/2 litre of water at 7 days interval; T_{10}: Ginger rhizome extract @ 0.5 kg/2 litre of water at 7 days interval; T_{11}: Onion bulb extract @ 0.5 kg/2 litre of water at 7 days interval; T_{12}: Untreated control

Total fruiting stage due to the application of different chemical insecticides and botanicals against chilli fruit borer in controlling fruit borer showed statistically significant variation for fruit infestation in percentage for weight of infested fruit. The lowest percentage of fruit infestation in weight (9.69%) was recorded from the treatment T_4 which was statistically similar (10.03%) with the treatment T_8. On the other hand the highest (26.44%) fruit infestation was recorded from untreated control treatment which was closely followed (20.40%) by the treatment T_5 and T_{11} (19.56%) and T_{10} (19.05%). Fruit infestation reduction over control in weight was estimated the highest value (63.35%) was recorded from the treatment T_4, while the lowest (22.84%) reduction of fruit infestation over control was T_5 treatment.

Table 2. Effect of different chemical insecticides and botanicals against chilli fruit borer in weight per plant in total cropping season during February to June'07

Treatment	**Fruit of chilli**			Reduction over control (%)
	Healthy (g)	**Infested (g)**	**Infestation (%)**	
T_1	241.08 bcd	45.25 de	15.80 ef	40.24
T_2	231.61 def	53.75 bc	18.84 bcd	28.74
T_3	233.60 cde	52.46 bc	18.33 cd	30.67
T_4	262.11 a	28.09 f	9.69 h	63.35
T_5	218.19 f	55.91 b	20.40 b	22.84
T_6	247.20 abc	43.75 e	15.04 fg	43.12
T_7	237.28 bcde	49.27 cd	17.24 de	34.80
T_8	258.04 a	28.79 f	10.03 h	62.07
T_9	251.90 ab	40.86 e	13.94 g	47.28
T_{10}	227.70 de	53.59 bc	19.05 bc	27.95
T_{11}	222.11 ef	53.97 b	19.56 bc	26.02
T_{12}	199.76 g	71.79 a	26.44 a	--
$LSD_{((0.05)}$	13.77	4.238	1.593	--
CV(%)	8.45	5.20	5.52	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
T_1: Sumicidin @ 6.0 ml/2 litre of water at 7 days interval; T_2: Malathion @ 6.0 ml/2 litre of water at 7 days interval; T_3: Ripcord @ 3.0 ml/2 litre of water at 7 days interval; T_4: Marshal @ 6.0 ml/2 litre of water at 7 days interval; T_5: Diazinon @ 6.0 ml/2 litre of water at 7 days interval; T_6: Suntaf @ 2.5 ml/2 litre of water at 7 days interval; T_7: Allamanda leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_8: Neem leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_9: Garlic clove extract @ 0.5 kg/2 litre of water at 7 days interval; T_{10}: Ginger rhizome extract @ 0.5 kg/2 litre of water at 7 days interval; T_{11}: Onion bulb extract @ 0.5 kg/2 litre of water at 7 days interval; T_{12}: Untreated control

Highest yield of fruit (12.24 kg/plot) was recorded from the treatment T_4 which was statistically identical (12.08 kg/plot) with the treatment T_8 (Table 2). On the other hand the lowest yield of fruit (9.79 kg/plot) was recorded from untreated control treatment which was closely followed (11.03 kg/plot) by the treatment T_5 and T_{11} (11.08 kg/plot) respectively. From other treatments fruit yield per plot were recorded and they were ranged from 11.28 to 11.71 kg/plot and their yield performance were comparatively intermediate level with the above mentioned treatments. Highest weight of fruit yield (30.60 t/ha) was recorded from the treatment T_4 which was statistically similar (30.19 t/ha) with the treatment T_8 (Table 3). On the other hand, the lowest yield (24.48 t/ha) of fruit was recorded

from untreated control treatment which was closely followed (27.57 t/ha) by the treatment T_5 and T_{11} (27.69 t/ha). Again from other treatment yields per hectare were recorded and they ranged from 28.21 t/ha-29.28 t/ha. Among different treatments as whole botanicals (T_7-T_{11}) were more effective than the chemical insecticides (T_1-T_6) under the present study.

Table 3. Effect of different chemical insecticides and botanicals on yield per plot and hectare in chilli during February to June'07

Treatment	Yield (kg/plot)	Yield (t/ha)	Increase over control (%)
T_1	11.45 abc	28.63 abc	16.95
T_2	11.47 abc	28.66 abc	17.08
T_3	11.50 abc	28.76 abc	17.48
T_4	12.24 a	30.60 a	25.00
T_5	11.03 c	27.57 c	12.62
T_6	11.64 abc	29.09 abc	18.83
T_7	11.46 abc	28.66 abc	17.08
T_8	12.08 ab	30.19 ab	23.33
T_9	11.71 abc	29.28 abc	19.61
T_{10}	11.28 bc	28.21 bc	15.24
T_{11}	11.08 c	27.69 c	13.11
T_{12}	9.79 d	24.48 d	--
$LSD_{((0.05)}$	0.728	1.821	--
CV(%)	8.77	8.77	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability
T_1: Sumicidin @ 6.0 ml/2 litre of water at 7 days interval; T_2: Malathion @ 6.0 ml/2 litre of water at 7 days interval; T_3: Ripcord @ 3.0 ml/2 litre of water at 7 days interval; T_4: Marshal @ 6.0 ml/2 litre of water at 7 days interval; T_5: Diazinon @ 6.0 ml/2 litre of water at 7 days interval; T_6: Suntaf @ 2.5 ml/2 litre of water at 7 days interval; T_7: Allamanda leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_8: Neem leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_9: Garlic clove extract @ 0.5 kg/2 litre of water at 7 days interval; T_{10}: Ginger rhizome extract @ 0.5 kg/2 litre of water at 7 days interval; T_{11}: Onion bulb extract @ 0.5 kg/2 litre of water at 7 days interval; T_{12}: Untreated control

Table 4. Economic analysis for different chemical insecticides and botanicals in controlling chilli fruit borer during February to June'07

Treatments	Cost of pest Management (Tk.)	Yield (t/ha)	Gross return (Tk.)	Net return (Tk.)	Adjusted net return (Tk.)	Benefit cost ratio
T_1	43,000	28.63	858,900	815,900	81,500	1.90
T_2	44,000	28.66	859,800	815,800	81,400	1.85
T_3	44,000	28.76	862,800	818,800	84,400	1.92
T_4	45,000	30.6	918,000	873,000	138,600	3.08
T_5	42,000	27.57	827,100	785,100	50,700	1.21
T_6	48,000	29.09	872,700	824,700	90,300	1.88
T_7	31,000	28.66	859,800	828,800	94,400	3.05
T_8	38,000	30.19	905,700	867,700	133,300	3.51
T_9	41,000	29.28	878,400	837,400	103,000	2.51
T_{10}	38,000	28.21	846,300	808,300	73,900	1.94
T_{11}	35,000	27.69	830,700	795,700	61,300	1.75
T_{12}	0	24.48	734,400	734,400	--	--

T_1: Sumicidin @ 6.0 ml/2 litre of water at 7 days interval; T_2: Malathion @ 6.0 ml/2 litre of water at 7 days interval; T_3: Ripcord @ 3.0 ml/2 litre of water at 7 days interval; T_4: Marshal @ 6.0 ml/2 litre of water at 7 days interval; T_5: Diazinon @ 6.0 ml/2 litre of water at 7 days interval; T_6: Suntaf @ 2.5 ml/2 litre of water at 7 days interval; T_7: Allamanda leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_8: Neem leaf extract @ 0.5 kg/2 litre of water at 7 days interval; T_9: Garlic clove extract @ 0.5 kg/2 litre of water at 7 days interval; T_{10}: Ginger rhizome extract @ 0.5 kg/2 litre of water at 7 days interval; T_{11}: Onion bulb extract @ 0.5 kg/2 litre of water at 7 days interval; T_{12}: Untreated control

Fruit yield per hectare increased over control and was estimated to be the highest value (25.00%) as recorded from the treatment T_4, while the lowest (12.62%) reduction of fruit yield per hectare over control was recorded from T_5 treatment. Among different treatments as a whole, botanicals (T_7-T_{11}) were found more effective than the chemicals insecticides (T_1-T_6) in the present study. The results of the present study were more or less with the findings of another researcher. Torner *et al.* (1993) reported that the *Capsicum annuum* plant caused yield losses of 59, 48, 26 and 9%, respectively.

Economic analysis of different chemical insecticides and botanical were calculated and presented in Table 4. In this study, the untreated control did not require any pest management cost. For botanical extract labor cost was also involved with the product value. In the chemical treated plot cost of chemicals and labor for the application were included for the total cost. Considering the controlling of chilli fruit borer highest benefit cost ratio (BCR) (3.51) was recorded in the treatment T_8 as application of Neem leaf extract @ 0.5 kg/2 litre of water at 7 days interval and next highest BCR was found in T_4 (3.08) which was treated with Marshal @ 6.0 ml/2 litre of water at 7 days interval. On the other, hand the minimum benefit cost ratio (1.21) was recorded in treatment T_5 with application of diazinon @ 6.0 ml/2 litre of water at 7 days interval. From the above findings it was found that the commercially produced neem leaf extract was best in controlling the insect pests

of chilli and also gave the highest BCR. On the other hand, the botanicals used in this study had more fruit borer controlling ability. Thus the botanicals could be used by the farmers depending on their availability for safety of human health and environment.

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