JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# BIOLOGICAL ACTIVITY OF *CYMBOPOGAN WINTERIANUS* AND *ALOYSIA CITRODORA* LEAVES EXTRACTS AGAINST THE BLACK CUTWORM, *AGROTIS IPSILON* (HUBN.) (INSECTA: LEPIDOPTERA: NOCTUIDAE)

**[1]KOKILA, S. and [2]JEYABALAN, D.**

[1]Research Scholar and [2]Associate Professor

Department of Zoology, Government Arts College, Udhagamandalam- 643002, The Nilgiris,

Tamil Nadu, India.

**Abstract:**

Black cutworm has a wide host range. *A.ipsilon* is a worldwide cosmopolitan pest over 30 important crops. However, larvae feed above ground until about the fourth instar. Present study was undertaken to evaluate the bioassay test of *Cymbopogan winterianus* and *Aloysia citrodora* plant extracts against *A.ipsilon*. Larvae were collected from Chincona village of Nilgiris.The study was conducted in the laboratory to evaluate the *Cymbopogan winterianus* and *Aloysia citrodora* plant extracts with different concentrations (0.5%, 1% and 2%). The biological activity was recorded of 24hrs under laboratory condition. The larval antifeedant activity was 85.45% and 90.35% in 4$^{th}$ instar larvae of *A.ipsilon* after the treatment of *Aloysia citrodora* and *Cymbopogan winterianus* plant extract at 2% concentration. Whereas 4$^{th}$ instar larval mortality was 90.42% and 98.32% after the treatment of *Aloysia citrodora* and *Cymbopogan winterianus* extract at 2% concentration. The pupal mortality was 85.36% and 94.15 at 2% of *Aloysia citrodora* and *Cymbopogan winterianus* extract. The larval duration of 4$^{th}$instar larvae of *A.ipsilon* was greatly extended after the treatment of *Cymbopogan winterianus* (9.02 days) than *Aloysia citrodora* (6.95 days ) at 2% concentration. The Pupal duration also extended after the treatment of *Aloysia citrodora* (13.56 days) and *Cymbopogan winterianus* (15.74 days) at 2% concentration. The fecundity also significantly reduced after the treatment of *Aloysia citrodora* and *Cymbopogan winterianus* and also recorded in adult longevity of *A.ipsilon*. The study was also conducted the nutritional indices of IV instar larvae of *A.ipsilon* after treatment of *Aloysia citrodora* and *Cymbopogan winterianus* extract**.** The *Cymbopogan winterianus* plant extract was more effective than *Aloysia citrodora* extract on larvae of *A.ipsilon* . High bioactivity was observed in the doses against *Cymbopogan winterianus* the greasy cutworm, *A.ipsilon* such result may offer an opportunity for developing alternatives to rather expensive and environmentally hazardous in organic insecticides.

**Key words:** *Agrotis ipsilon*, *Cymbopogan winterianus*, *Aloysia citrodora*, antifeedant, larvicide, pupicide, adulticide, pupal duration, adult duration.

## 1. INTRODUCTION

Black cutworm (*Agrotis ipsilon* Hufnagel) is a cosmopolitan pest that affects over 30 important crops. Black cutworm larvae feed above ground, and each one can consume over 400 cm2 of foliage during its development. The terminal and sub terminal instar stages account for 80% and 10% of foliage, respectively, and minimal foliage loss occurs during the early stages of development. Larvae in the fourth instar stage may sever the stems of young plants, and one larva may sever the stems of several plants in a single night. *A. ipsilon* larvae are not a climbing cutworm, so most of their feeding occurs below or at the soil surface level.

The black cutworm *Agrotis ipsilon* has a wide host range, feeding on nearly all vegetables and many important grains. It annually reinvades temperate areas, over wintering in warmer or subtropical regions. Long distance dispersal of adults has long been suspected in Europe, China, and North America. The basic pattern is to move north in the spring, and south in the autumn.

The adult is fairly large in size, with a wingspan of 40 to 55 mm. The forewing, especially the proximal two-thirds, is uniformly dark brown. Moths select low-growing broadleaf plants preferentially for oviposition, but lacking these will deposit eggs on dead plant material. Soil is an unsuitable oviposition site. The hind wings are whitish to gray, and the veins marked with darker scales. The adult pre-oviposition period is about seven to 10 days. The egg is white in colour initially, but turns brown with age. spherical in shape, with a slightly flattened base. The eggs normally are deposited in clusters on foliage. Females may deposit 1200 to 1900 eggs. Duration of the egg stage is three to six days. Eggs hatch in 5-10 days depending on temperature.

Black cutworm larvae are gray to nearly black in colour with a light dorsal band and a ventral surface lighter in colour. The distinct head is dark brown. The larvae have three pairs of true legs and five sets of fleshy, abdominal prolegs. Overall, the larva has a greasy appearance; earning the common name “greasy cutworm” in some parts of the world. Under magnification, the skin of larger larvae has a granular appearance. Black cutworm larvae can be distinguished from the more common dingy cutworm and several other species. For example, they grow, cutworm larvae molt and pass through several larval stages or instars. There are 6 to 9 larval instars with 7 instars most common. Full grown larvae are about 2 inches long. Larval development from egg hatch to pupa takes approximately 28 to 35 days depending on temperature. Pupation occurs below ground at a depth of 3 to 12 cm. The pupa is 17 to 22 mm long and 5 to 6 mm wide and dark brown. Duration of the pupal stage is normally 12 to 20 days. The entire life cycle from egg to adult takes 35–60 days. Multiple generations are produced until migration is triggered by weather conditions.

*A. ipsilon* has developed resistance in recent years to some of the conventional insecticides. Several attempts to combat the pest species on different crops using synthetic chemical pesticides culminated in problems like insecticide resistance, pest resurgence, outbreaks of secondary pests and environmental pollution. Keeping in view the economic importance of the insect pest and the hills crops in Nilgiris.

These natural products are mainly plant extracts which prove to have deleterious effects on target insects, without any problems can the environment suffering from contamination with harmful toxicants (Zhao *et al*., 1998). The use of natural product from plant origin is a new trend which may proof efficiency for pests control. These efficacies are manifested in several ways, including direct toxicity (Hiremath *et al*., 1997) and suppression of calling behavior (Khan and Sexena, 1986). The growing awareness of hazards associated with the large scale of synthetic insecticides has evoked a world-wide interest of pest control agents from plant origin (Marin-Bettelo, 1977).

Many problems have been encountered as a result of the extensive use of synthetic pesticides. Increasing problems concerning the application of such pesticides include pest resistance, residue, and contamination of human’s foods, mammalian toxicity and pollution of environments. Therefore, several insecticides occurring naturally in plants have been investigated as alternatives bio agents to the highly toxic synthetic chemical pesticides for pest control. Such natural products having pesticide activity are assumed to be environmentally more acceptable because of their low persistent nature and are less hazardous to humans (Elumalai *et al*., 2002; Arivoli *et al*., 2013).

Bioactive compounds of plant origin are considered as ecologically safe alternative and the plant extracts with complex mixtures of compounds have been widely investigated for their insecticidal repellent, ovicidal, antifeedant and antioviposition properties (Isman *et al*., 2001). While plant chemicals may produce toxic effects when ingested by insects, antifeedant activity may determine the extent of insect herbivores. Several researches have recorded the entomotoxic properties of the plant extracts from different plant species (Sadek *et al*., 2003; Ulrichs, 2008).

Lambrano *et al.* (2014) reported the deleterious effects of plant products on insects can be manifested in several manners including toxicity, mortality, antifeedant growth inhibitor, suppression of reproductive behavior and reduction of fecundity and fertility, growth inhibition, perturbation of reproductive behavior (reduction of fecundity and fertility). Among various classes of natural substances that introduced as natural biopesticides are essential oils from aromatic plants Isman and Grieneisen, 2014; Prakash *et al*. (2014). The deleterious effects of plant product on insects can be manifested in several manners including toxicity, mortality, antifeedant, growth inhibition, reduction of fecundity and fertility (Lambrano *et al*. (2014). Additionally Sharaby *et al.* (2015) reported that the essential oil of garlic, mint, cumin, caraway and parshely had antifeedant and starvation effects after the treatment of *A.ipsilon* larvae with the $LC_{50}$ value.

Kamaraj *et al.* (2018) showed reduction in growth and development of *H. armigera* and *S. litura* larvae when fed exclusively on Neem gum nano formulation (NGNF) treated castor leaves Elbadawy *et al*. (2019) indicate that *jojoba* oil was most effective against the $4^{th}$ instar larvae of *A.ipsilon* causing 60% mortality. Also, Elhosary *et al*. (2020) achieved a noticeable decrease in some growth indices after treatment of $4^{th}$ instar larvae of *A.ipsilon* with mango seed extracts and water fleabane leaves. Behavior, reduction of fecundity and fertility, growth inhibition, perturbation of reproductive behavior (Lambrano *et al.*, 2014).

The present work aims to study the effect of adding extracts to bait on some biological effects of larval instar of *A. ipsilon* in laboratory. Laboratory studies were carried out tosses the effectiveness of the plant extracts in controlling the black cutworm on cruciferous vegetables crops. Plant extracts have a great potential for pest management, which we shall review in light of recent literature. The main goal of the present study was to evaluate the biological activities of *Cymbopogan winterianus* (Citrionella) and *Aloysia citrodora* (lippia) plant extracts against the *A.ipsilon* larvae under controlled laboratory conditions for possible use as a safe biological method and alternative to chemical pesticides within the means of integrated pest control program.

## 2. MATERIALS AND METHODS

**Insect used:**

Black cutworm: *Agrotis ipsilon*

**Systematic Position:**

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Lepidoptera

Family: Noctuidae

Genus: *Agrotis*

Species: *ipsilon*

**Collection of Plants:**

*Cymbopogan winterianus* (Citronella) and *Aloysia citrodora* (Lippia) was collected from MPDA (Medicinal plant development area), Chincona village, Doddabetta, The Nilgiris, Tamil Nadu.

**Rearing of Black cutworm, *A. ipsilon***

The larvae were collected from cabbage field at Chincona village, Udhagamandalam, Tamil Nadu, India. Larvae were reared in laboratory condition at the Department of Zoology, Government Arts College, Udhagamandalam, Tamil Nadu, India. These laboratory-reared larvae were used for bioassays and the cultures were maintained throughout the study period.

**Culture of test organism:**

The larvae were reared on cabbage field in agriculture land from Chincona village of Nilagiri district. Multiple field visits were conducted, to collect the larvae. The larvae were handpicked and transferred were plastic container with little amount of moist soil, the collected black cut worm were transported to the laboratory. The culture was established using Cabbage leaves in a plastic container of 25×10 cm and maintained at room temperature and relative humidity of 70-75%. Sieving the culture separated the 4$^{th}$ instar larvae were used for subsequent experiment. The culture was continuously maintained in the containers throughout the study period.

**Preparation of extracts**:

*Cymbopogan winterianus* and *Aloysia citrodora* were washed in tap water, cut into small pieces and air dried. After the plants were completely dry, they have been ground into powder and then macerated in different solvent (ethanol) at room temperature for 3 days and filtered. The combined filtrate were concentrated to dryness by rotary evaporation at 50ºC and kept in a freezer. In preparing test concentrations, each plant extract were volumetrically diluted in ethanol.

The scientific and English name and the used parts of the plants are shown in the following table:

| Scientific name | Family | Local name | Part used |
|---|---|---|---|
| *Aloysia citrodora* | Verbenaceae | Lippia | leaf |
| *Cymbopogan wintiranus* | Poaceae | Citrionella | leaf |

**Antifeedant Activity:**

Antifeedant activity of *Aloysia citrodora* and *Cymbopogan winterianus* extracts was using leaf disc no choice method (Isman *et al*., 1990). Required concentration of *Aloysia citrodora* and *Cymbopogan winterianus* extracts (0.5%, 1.0%, 2%) was prepared mixing with ethanol. Fresh Cabbage leaf (for *A. ipsilon*) discs of 3 cm diameter were punched using a cork borer and dipped in 0.5, 1.0, 2.0 % for *Aloysia citrodora* and *Cymbopogan winterianus* extracts and air dried for 5 minutes. After air drying, treated leaf discs were kept inside the Petri dishes (15mm × 90 mm diameter) separately containing wet filter paper to avoid drying of the leaf disc and single 2hrs post starved fourth instar larva of *A. ipsilon* was introduced on each treated leaf disc. One treatment with respective solvent alone was used as positive control and one treatment with *Aloysia citrodora* and *Cymbopogan winterianus* was considered as negative control. Ten replications were maintained for each treatment. A progressive consumption of leaf area by the larva in 24 hrs period was recorded in control and treatments using a leaf area meter. Leaf area consumed in plant extract and fraction treatments was corrected from the control. The percentage of antifeedant index was calculated using the formula of (Ben Jannet *et al*., 2000).

$$\text{Antifeedant Index} = \frac{C-T}{C+T} \times 100$$

Where C and T represent the amount of leaf eaten by the larva on control and treated discs respectively.

**Insecticidal Activity:**

Fresh leaves were treated with different concentrations (0.5%, 1.0%, 2%) of *Aloysia citrodora* and *Cymbopogan winterianus* plant extracts. Petioles of the cabbage leaves were tied with wet cotton plug (to avoid early drying) and placed in round plastic trough (29 cm X 8 cm). In each concentration 10 pre-starved (2hours) IV instar larvae of *A.ipsilon* were introduced individually and covered with muslin cloth. Five replicates were maintained for all concentrations and the number of dead larvae was recorded after 24hours up to pupation. Percentage of larval mortality was calculated and corrected by Abbott's formula (Abbott, 1925).

Abbott's percent correct mortality=

$$\frac{\%\ \text{mortality in treated} - \%\ \text{mortality control}}{100 - \%\ \text{mortality in control}} \times 100$$

**Growth Regulation Activity of *Aloysia citrodora* and *Cymbopogan winterianus* plant extracts:**

Growth regulation activities of *Aloysia citrodora* and *Cymbopogan winterianus* plant extracts were studied three different concentrations against IV instar larvae of *A. ipsilon*. Ten larvae were introduced in a petri plate having cabbage leaves treated with different concentration of plant extracts. Water treated leaves were considered as control. After 24hours feeding, the larvae were transferred to normal leaves for studying the developmental periods. For each concentration five replicates were maintained. During the developmental period deformed larvae, pupae, adults and successful adults emerged were recorded. In addition, weight gain by the treated and control larvae were also recorded.

**Consumption of food:**

The larvae were taken out and were reared till they reached the third instar. From this culture, third instar larvae were collected and divided into 5 replicates (10 larvae in each replicate). Quantitative data of food consumption and utilization was recorded for fourth instar of the *A. ipsilon* under study as per the details of Wald Bauer (1968). The larvae and the respective host leaves were weighed separately and then placed in petri dishes. The larvae were allowed to feed on the leaves for 24 h and then the weights of the larvae and the remaining leaf material, and faecal matter in the Petri dish were determined. Fresh food was supplied every 24 h and the related weights were also taken every 24h. From these fresh weight measurements, growth and food utilization were calculated.

**The indices include:**

Consumption index (CI), Growth rate (GR), Approximate digestibility (AD), Efficiency of conversion of digested food (ECD), Efficiency of conversion of ingested food (ECI). The formulae of Waldbauer (1968) used in the calculation of these indices is as follows:

$$\text{CI (Consumption index} = \frac{\text{Wt of food consumed}}{\text{Wt of instar x number of feeding days}}$$

$$\text{GR (Growth rate)} = \frac{\text{Wt gain of instar}}{\text{Mean wt of instar x Number of feeding days}}$$

$$\text{AD (Approximate digestibility)} = \frac{\text{Wt of food consumer - Wt of faeces}}{\text{Wt of food consumed}} \times 100$$

$$\text{ECD (Efficiency of Conversion of digested food)} = \frac{\text{Wt gain of instar}}{\text{Wt of food consumed - Wt of faeces}} \times 100$$

$$\text{ECI (Efficiency of conversion of ingested food)} = \frac{\text{Wt gain of instar}}{\text{Wt of food consumed}} \times 100$$

The weights were expressed in milligrams (mg). The values are based on five observations for each parameter; standard deviations were also calculated.

**Statistical analysis**

All data was subject to analysis of variance and the treatment mean was separated by Duncan̓s Multiple Range Test (Duncan, 1995).

## 3. RESULTS:

Table 1 provides the average food consumption of IV instar larvae of *A. ipsilon* after the treatment of *Aloysia citrodora* and *Cymbopogan winterianus* plant extract. In control on IV instar larvae has no antifeedant activity after the treatment of extract *Cymbopogan winterianus* at 1% and 2% treatment, the maximum antifeedant activity was recorded from *Cymbopogan winterianus* 45.34% and 90.35%, followed by *Aloysia citrodora* the antifeedant was 33.34%and 85.45% at 1% and 2% treatment respectively. As show in table 2 it was remarkable that there was inverse proportion between the larval weight and the concentration of *Aloysia citrodora* and *Cymbopogan winterianus*. The highest effect on larval weight was obtained from the *Cymbopogan winterianus* extract treatment at 2% (108gm / 4$^{th}$instar larva) followed by *Aloysia citrodora* (132gm /larva) leaf extract at the same concentration.

**Table 1. Antifeedant activities of *Aloysia citrodora* and *Cymbopogan winterianus* plant extracts against fourth instar larvae of *A. ipsilon***

| **Treatment (%)** | **Antifeedant (%)** | |
|---|---|---|
| | ***Aloysia citrodora*** | ***Cymbopogan winterianus*** |
| Control | 00 $^{d}$ | 00 $^{d}$ |
| 0.5 | 26.13 $^{c}$ | 32.15 $^{c}$ |
| 1.0 | 33.34 $^{b}$ | 45.34 $^{b}$ |
| 2.0 | 85.45 $^{a}$ | 90.35 $^{a}$ |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

**Table 2. Effect of *Aloysia citrodora* and *Cymbopogan winterianus* plant extracts on weight gain of fourth instar larvae of *A. ipsilon***

| Treatment (%) | Larval weight (mg) | |
|---|---|---|
| | ***Aloysia citrodora*** | ***Cymbopogan winterianus*** |
| Control | 282 [a] | 270 [a] |
| 0.5 | 182 [b] | 177[b] |
| 1.0. | 165 [c] | 127[c] |
| 2.0 | 132 [d] | 108[d] |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

Data presented in Table (3 and 4) clearly demonstrated that the larval and pupal mortality percentages after treating the 4th instar of *A. ipsilon* was influenced by the tested plant extracts. Mortality percentages were determined on the 1, 3, 5, 7 and 9 days. Extract of *Cymbopogan winterianus* at 2% caused the highest larval mortality was 98.32% and pupal mortality was 94.15%. when compared with the control followed by *Aloysia citrodora* leaf extract at 2% being larval mortality was 90.42% and pupal mortality was 85.36% respectively.

**Table 3. Larval and pupal mortality of *A.ipsilon* larva after the treatment of *Aloysia citrodora* plant extracts.**

| Treatment (%) | Larval mortality (%) | Pupal mortality (%) |
|---|---|---|
| Control | 0[d] | 0[d] |
| 0.5 | 28.34[c] | 25.32[c] |
| 1.0 | 40.51[b] | 36.52[b] |
| 2.0 | 90.42[a] | 85.36[a] |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

**Table 4. Larval and pupal mortality of *A.ipsilon* larva after the treatment of *Cymbopogan winterianus* plant extracts.**

| Treatment (%) | Larval mortality (%) | Pupal mortality (%) |
|---|---|---|
| Control | 0[d] | 0[d] |
| 0.5 | 35.34[c] | 30.32[c] |
| 1.0 | 60.51[b] | 42.52[b] |

| | | |
|---|---|---|
| 2.0 | 98.32 a | 94.15 a |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

**Table 5. Larval duration of *A.ipsilon* after the treatment of *Aloysia citrodora* plant extract.**

| Treatment (%) | Larval duration (days) | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| Control | 2.16d | 2.38d | 2.75d | 3.70d |
| 0.5 | 3.12c | 3.28c | 3.50c | 4.18c |
| 1.0 | 4.40b | 4.58b | 4.86b | 5.32b |
| 2.0 | 5.92a | 6.12a | 6.28a | 6.95a |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

**Table 6. Larval duration of *A.ipsilon* after treatment of *Cymbopogan winterianus* plant extract.**

| Treatment (%) | Larval duration (days) | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| Control | 2.16d | 2.37d | 3.75d | 3.92d |
| 0.5 | 3.05c | 3.25c | 4.43c | 4.15c |
| 1.0 | 5.38b | 5.56b | 5.85b | 5.96b |
| 2.0 | 7.18 a | 8.34 a | 8.52 a | 9.02 a |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

Table 5 and 6 provides the larval duration of *A. ipsilon* after the treatment of *Aloysia citrodora* and *Cymbopogan winterianus* extracts. The larval duration was greatly extended after the treatment. The maximum larval duration was recorded after the treatment of *Cymbopogan winterianus* extract of 4th instar larvae of *A. ipsilon* was 9.02 days at 2% followed by *Aloysia citrodora* extract at 2% (6.95 days) concentration. Data presented in Table 7 and 8 indicated that all treatments decreased the pupal duration, adult longevity and fecundity of *A. ipsilon* when 4th instar larvae were treated with the plant extracts. *Cymbopogan winterianus* extract at 2% ranked the first causing the shortest adult longevity being 2.85 and 3.08 days for male and female, respectively and fecundity was 410 followed by *Aloysia citrodora* leaf extract at 2% achieved pupal duration was 13.56 at 2% concentration and adult longevity was 4.06 and 5.50 days for male and female, the fecundity was 815 respectively.

**Table 7. Pupal, adult duration and fecundity of *A.ipsilon* after the treatment *of Aloysia citrodora***

| Treatment (%) | Pupal duration (days) | Adult longevity (days) | | Fecundity (Nos. of Eggs) |
|---|---|---|---|---|
| | | Male | Female | |
| **Control** | 8.16$^{c}$ | 7.58$^{a}$ | 9.02$^{a}$ | 1825$^{a}$ |
| 0.5 | 9.28$^{bc}$ | 6.50$^{b}$ | 7.66$^{b}$ | 1400$^{b}$ |
| 1.0 | 10.14$^{b}$ | 5.20$^{c}$ | 6.35$^{c}$ | 900$^{c}$ |
| 2.0 | 13.56$^{a}$ | 4.06$^{d}$ | 5.50$^{d}$ | 815$^{d}$ |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

**Table 8. Pupal, adult duration and fecundity of *A. ipsilon* after the treatment of *Cymbopogan winterianus* Plant extract.**

| Treatment (%) | Pupal duration (days) | Adult longevity (days) | | Fecundity (Nos. of eggs) |
|---|---|---|---|---|
| | | Male | Female | |
| **Control** | 9.83$^{c}$ | 8.52$^{a}$ | 9.90$^{a}$ | 2056$^{a}$ |
| 0.5 | 10.06$^{c}$ | 7.38$^{b}$ | 6.62$^{b}$ | 1800$^{b}$ |
| 1.0 | 13.14$^{b}$ | 4.25$^{c}$ | 5.31$^{c}$ | 750$^{c}$ |
| 2.0 | 15.74$^{a}$ | 2.85$^{d}$ | 3.08$^{d}$ | 410$^{d}$ |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

**Table 9. Nutritional indices of IV instar larvae of *A. ipsilon* after the treatment of *Aloysia citrodora* Plant extract.**

| Treatment (%) | GR (mg/ day) | CI (mg/day) | AD (%) | ECD (%) | ECI (%) |
|---|---|---|---|---|---|
| **Control** | 0.58$^{c}$ | 3.71$^{b}$ | 80$^{b}$ | 18.8$^{a}$ | 16.5$^{a}$ |
| 0.5 | 0.63$^{c}$ | 4.29$^{a}$ | 82$^{b}$ | 16.35$^{b}$ | 15.40$^{ab}$ |
| 1.0 | 0.80$^{b}$ | 4.83$^{a}$ | 86$^{ab}$ | 15.20$^{bc}$ | 14.22$^{b}$ |
| 2.0 | 0.92$^{a}$ | 4.76$^{a}$ | 88$^{a}$ | 14.32$^{c}$ | 13.02$^{b}$ |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

**Table 10. Nutritional indices of IV instar larvae of *A.ipsilon* after treatment of*Cymbopogan winterianus*Plant extract.**

| Treatment (%) | GR (mg/ day) | CI (mg/day) | AD (%) | ECD (%) | ECI (%) |
|---|---|---|---|---|---|
| **Control** | 0.76 c | 3.86 c | 90 b | 19.5 a | 20.4 a |
| 0.5 | 0.82 b | 5.30 a | 92 b | 18.51 a | 18.40 b |
| 1.0 | 0.95 a | 4.90 b | 94 ab | 15.36 b | 15.10 c |
| 2.0 | 0.96 a | 5.78 a | 98 a | 13.86 c | 10.20 d |

Within a column means followed by the same letters are not significantly different at 5% level by DMRT

Data presented in Table 9 and 10 indicated that all treatments greatly affected the nutritional parameters of *A. ipsilon.* When 4$^{th}$ instar larvae were treated with either one of the plant extracts. *Cymbopogan winterianus* extract at 2% ranked the first causing the consumption and relative growth rate were reduced. Approximate digestibility was increased after the treatment of *Cymbopogan winterianus*. *Aloysia citrodora* leaf extract at 2% achieved consumption and relative growth rate was minimum recorded than *Cymbopogan winterianus* extract at 2% concentration.

## 4. DISCUSSION

The black cutworm, *Agrotis ipsilon* (Hufn.) is a major pest attack seedling of many economic plants. It's actually one of the most important insect pests of vegetables and several field crops in Nilagiris (Salem *et al*., 1982). The wide range of natural host of the target insect could be increase the resistance to the natural and /or alternative toxic chemicals. It's interesting that on strictly biochemical criteria polyphagy may enhance the potential of a species to develop resistance Krieger *et al*. (1971). Slight toxicity of tested Cappers extracts that obtained in the results may be due to developed resistance of target insect. Significant reduction in the total number of eggs laid by *Tetranychus urticae Koch*. was recorded during 15 days period for all *C. aegptia* extracts tested by Hussein *et al*. (2006).

This finding accordance with our results in the reduction percentage of adult female fecundity emerged from treated larvae, which recorded almost more than 50% reduction in comparison with control. Our results in toxicity of *Cymbopogan winterianus* and *Aloysia citrodora* the effect on oviposition of emerged adult from treated larvae of *A. ipsilon* are matched with that found by Upadhyay *et al*. (2006) they concluded that, extracts of *Cymbopogan winterianus* and *Aloysia citrodora* leaf showed antifeedant activity, larval and pupal mortality, larval and adult duration, adult longevity, fecundity and food consumption activities against the *A. ipsilon*. Rodrigo *et al.* (1992) and sharaf *et al.* (2000) shed some light on the antifeedant effect of these extracts according that obtained in several studies using such compounds extracted from natural sources and examined against some insect pests (Reyes-Chilpa *et al*., 1995; Musayimana *et al*., 2001 and Simmonds, 2001). Effect of low concentration was more observed than that obtained at higher as shown in our results; this observation may be due to the little amount of food consumption that correlated with very limited active or effective chemical groups at high concentration as a result to the antifeedant effect in contrast that found at low concentration.

Similar to the present study, Rani and Murty (2009) studied the antifeedant activity of flower head extract of *Spilanthes acmella* against the third instar larva of *Spodoptera litura*. In another study, Sudhakar *et al*. (1978) reported that ether extract of *Datura metel*, *Lantana camara*, *Aloe vera*, *Eurphobia royleana* and rhizome of *Acorus calamus* possessed high antifeedant activity against *Athalia lugens*. However, in the present study, *Aloysia citrodora* extract was found to possess low Feeding deterrence Index than *Cymbopogan winterianus.*

However, mortality caused by the *Cymbopogan winterianus* extracts was found to be significantly high compared to *Aloysia citrodora* extract at the same concentration. Habib *et al*. (2011) demonstrated that the leaf and seed extracts of *jimsonweed*, *Datura stramonium* caused contact toxicity to adults of *T. castaneum*. Studies showed that some secondary plant compounds, such as eugenol and its constituents caused contact toxicity to *T. castaneum.*

The adult mortality might be attributed to contact toxicity or to the induction of some unknown physiological changes (Mathur *et al*., 1985). Effective adhesion of extracts to spiracles of pest and their death due to suffocation might be one of the many possible reasons of adult mortality. In the present study, the plant extracts significantly reduced the fecundity and food consumption compared to control. Also, there was significant reduction in the number of larvae and pupation. It was also observed that adult longevity was significantly reduced different concentrations of plant extract. Results from the present study on the larval and pupal duration effect are in agreement with Jaipal *et al*. (1983) and Malarvannan *et al*. (2008). Prolongation of larval life with morphological aberrations in *Dysdercus koenigii* was reported when treated with *Lantana* leaf extract (Jaipal *et al*., 1983).

This results coincide with the earlier findings of Jeyasankar (2012) reported that antifeedant, insecticidal and growth inhibitory activities of selected plant oils on black cutworm, *A.ipsilon*. Among various classes of natural substances that introduced as natural biopesticides are essential oils from aromatic plants (Isman and Grieneisen, 2014; Prakash *et al*., 2014). There are numerous researches on the pesticidal activity of essential oils from Lamiaceae family (Rajendran and Sriranjini, 2008; Isman *et al*., 2011; Ebadollahi, 2011). The advantage of using plant essential oils is that are easily available and have been used extensively for medicinal purposes, implying that they have low or no toxicity to humans (Upadhyay, 2013).

The biological activity (larval and pupal mortality, larval and pupal duration, pupal weight, GR, ECI, ECD, AD, and CI effects) of the tested plant extracts has great effect on growth and development of *A. ipsilon. Cymbopogan winterianus* extract has the greatest effect where all larvae died after 4-8 day from feeding on the treated as a result of starvation and toxic effect. The oil gave highly significant variation comparing with the *Aloysia citrodora*. The results obtained indicated that tested *Cymbopogan winterianus* extract caused significant larval and pupal mortality as compared with *Aloysia citrodora* extract. In addition, the *Cymbopogan winterianus* plant extract prolonged significantly the larval and pupal duration as compared to the control. Also, significantly reduced the percentage of adult emergence and significantly decreased the weight of the resulted pupae as compared with the *Aloysia citrodora* extract. Moreover, the tested plant extracts caused malformation of pupae and adults of *A.ipsilon.* However, the abnormal emerged adults were all died within few days. Similar findings, were also obtained by many authors using different botanical oils (Das,1986) on *Callosobruchus chinesis* (Trivedi,1986) on *Rhyzopertha dominica* and *Tribolium castaneum* (Baskran and Janarthanan, 2000) on *Sitotroga cerealella* and *C. chinensis* (Pavela, 2005) on larvae of *Spodoptera littoralis* ( Abdel El-Aziz *et al.*, 2007) on *A. ipsilon* and (Moawad and Ebadah, 2007) on *Phthorimaea operculelle.*

Several attempts to combat the pest species on different crops using synthetic chemical pesticides culminated in problems like insecticide resistance, pest resurgence, outbreaks of secondary pests and environmental pollution. Keeping in view the economic importance of the insect pest and the hills crops in Nilagiris. Laboratory studies were carried out the effectiveness of *Aloysia citrodora* and *Cymbopogan winterianus* plant extracts in controlling the black cutworm on cruciferous vegetables crops. Essential oils including Plant extracts must have a great potential for pest management, which we shall review in light of recent literature. Some plant extracts, essential oils or their constituents described in this review have demonstrated high efficacy against coleopteran stored products insect pests responsible for post-harvest damage.

## 5. CONCLUSION

Control of black cutworm is currently based on heavy use of many insecticides, which damage the environmental and a threat of public health via food residues, ground water or accidental exposure. The problem caused by pesticide and their residues have amplified the need for effective and biodegradable pesticides. The evaluation of the efficacy of tested, plants dealt with the biological activity against *A.ipsilon*. Moreover, the efficacy of these *Cymbopogan winterianus* and *Aloysia citrodo*ra leaf extract on food consumption, utilization and larval duration was studied. The results obtained are summarized as follows: The data obtained indicated that the highest larval mortality, pupal mortality, larval duration, pupal duration, fecundity and adult longevity percent was caused by the highest concentration by *Cymbopogan winterianus* tested than *Aloysia citrodora*. The percentage of larval and pupal mortality increased significantly with the increase of doses used. The mean larval duration was significantly prolonged and pupal duration prolonged. The percentage of adult emergence reduced. Moreover, *Cymbopogan winterianus* extract caused significant reduction in food consumption index (F.C.I.), growth rate (G.R.), approximate digestibility (A.D.), efficiency of conversion of ingested food (E.C.I) and efficiency of digested food to body substance (E.C.D.).The best treatment was *Cymbopogan winterianus* extracts at 2% concentration followed by *Aloysia citrodora* at the same concentration.

## 6. REFERENCES

1. Abbott, WS. (1925). A method of computing the effectiveness of an insecticide. *J. Econ. Ent.*, 18: 265-267.
2. Abd El-Aziz., Shadia, E., Elsayed, A., Omer and Aly. Sabra, S. (2007). Chemical composition of *Ocimum americanum* essential oil and Its biological effects against, *Agrotis ipsilon* (Lepidoptera: Noctuidae). *Rese. J. Agric. And Biol. Scie.*, 3(6): 740-747.
3. Arivoli, S. and Samuel, T. (2013) Antifeedant Activity, Developmental Indices and Morphogenetic Variations of Plant Extracts against *Spodoptera littoralis* (Fab) (Lepidoptera: Noctuidae). *Journal of Entomology and Zoology Studies*, 1, 87-96.
4. Baskaran, R. K. M. and Janarthanan, R. (2000). Effect of dust formulations of certain plant oils against important pests of paddy and cowpea in storage. *J. Ent. Research*. 24(3): 271-278.

5. Das, G. P. (1986). Pesticidal efficacy of some indigenous plant oils against the pulse beetle, *Callosobruchus chinensis* (Linn.) (Coleoptera: Bruchidae). *Bangladesh J. Zool.* 14(1): 15-18.
6. Ebadollahi, A. (2011). Susceptibility of two *Sitophilus* species to essential oils from *Foeniculum vulgare* and *Satureja hortensis. Ecol.Balk*. 3(2): 1-8.
7. Elbadawy, M.A.E., Azab, M.M., El din, A.M.S and Radwan, E.M.M. (2019). Toxicity of some plant oil nanoemulasions to black cutworm, *A.ipsilon* (Lepidoptera: Noctuidae). *Nanotechnol. Agric. Food Environ.* 1:1-10
8. Elhosary, R.A., Yacoub, S.S., and Elhefny, A.S. (2020). Effect of some plant extracts on black cutworm *A.ipsilon* under laboratory conditions. *Egypt.J.Agric.Res.*91(2):495-506.
9. Elumalai, K., Krishnappa, K., Anandan, A., Govindarajan, M. and Mathivana, T. (2010). Antifeedant Activity of Medicinal Plant Essential Oils against *Spodoptera litura* (Lepidoptera: Noctuidae). *International Journal of Recent Scientific Research*, 2, 262-268.
10. Habib, K. Kumar, S. and Manikar,S. (2011). Biochemical effect of carbaryl on oxidative stress, antioxidant enzymes and osmolytes of *cyanobacteium calothrix. Bull environ contam toxicol*,20 (1978), pp.707-714.
11. Hussein, H. Abou-Elelia, M., Amer,S.A.A. and Momen,F.M. (2006). Repellency and toxicity of extracts from *Capparis aegypita* to *Tetranychus urticae* Koch. *Acta phytopatholentomol. hung.* 41:331-340.
12. Isman, M.B. and Grieneisen, M.L. (2014). Botanical insecticide research: many publications, limited useful data. *Trends Plant Sci*. 19:140–145.
13. Isman, M.B., Miresmailli, S. and MacHial, C. (2011). Commercial opportunities for pesticides based on plant essential oils in agriculture industry and consumer products. *Phytochem. Rev*. 10 (2): 197–204.
14. Jaipal, S., Singh, Z. and Chanhan, R. (1983). Juvenile hormone like activity of some common Indian plants. *Indian journal of agriculture science,* 53(8):730-733.
15. Jeyasankar,A. (2012). Antifeedant, insecticidal and growth inhibitory activities of selected plant oils on black cutworm, *Agrotis ipsilon* (Hufnagel) (Lepidoptera: Noctuidae). *Asian Pac.J. Trop*. Dis.2:347-351.
16. Kamaraj, C., Gandhi, P. R. , Elango, G., Karthi, S., Chunge, M. and Rajakumar, G. (2018). Novel and environmental friendly approach; Impact of Neem (*Azadirachta indica*) gum nano formulation (NGNF) on *Helicoverpa armigera* (Hub.) and *Spodoptera litura* (Fab.)". *International Journal of Biological Macromolecules*, 107: 59-69.
17. Krieger, R.I., Feeny,P.P ., and Wilkinson,C.F.(1971). Detoxication enzymes in the guts of caterpillars. An evolutionary answer to plant defenses? *Science*,172(3983).579-581.
18. Laambrano, R.H., Gallardo, KC. and Verbel, J.O. (2014). Toxicity and antifeedant activity of essential oils from three aromatic plants grown in Colombia against *Euprosternae laeasa* and *Acharia fusca* (Lepidoptera: Limacodidae). *Asian Pac. J. Trop Biomed*., 4 (9): 695-700.
19. Mathur,R.N., Singh, Balawant and Lal, Kishori.(1958). Insect pests of flowers, seeds and fruits of forest trees. *Indian forest bulletin* No.223 (Entomology) (New series). PP:105.
20. Pavela, R. (2005). Insecticidal activity of some essential oils against larvae of *Spodoptera littoralis. Fitoterapia*, 76 (7/8): 691-696.
21. Prakash, A., Rao, J., Berline, J., Pokhare, S.S., Adak T. and Saikia, K. (2014). Botanical pesticides for the management of plant nematode and mite pests. In: *Advances in plant biopesticides. Singh D. (Ed).* pp. 89–118. Springer. London.
22. Rajendran, S. and Sriranjini, V. (2008). Plant products as fumigants for stored-product insect control. *J. Stored Prod. Res*., 44: 126–135.
23. Rani and Murthy (2009). Biological activity of certain botanical extracts as larvaicides against the yellow fever mosquito, *Aedes aegypti.L. Journal of biopesticides*,2(1): 72-76.
24. Rodriguez, E. and Levin, D.H. (1975). Biochemical Parallelism of Repellents and Attractants in Higher Plants and Arthropods. In: Recent advances in phytochemistry biochemical interaction between plants and insects. pp: 215270.Wallace, J.M. and R.L. Mansell(eds.) *Plenum Press New York*, pp: 425.
25. Sadek, M.M. (2003) Antifeedant and Toxic Activity of *Adhatoda vasica* Leaf Extract against *Spodoptera littoralis* (Lpidoptera: Noctuidae). *Journal of Applied Entomology*, 127, 396-404.
26. Sharaby, A and Nojiban, E.L. (2015). A evaluation of some plant essential oils against the black cut worm *A.ipsilon. Glob. J.Adv. Re s*,2,701-711.s
27. Simmonds, (2001). Importance of flavonoids in insect-plant interactions: feeding and oviposition. *Jodrell laboratory*, UK. Pp:245-252.
28. Sudhakar, T.R., Pandey, N.D. and Tewari, G.C. (1978). Antifeeding property of some indigenous plants against mustard sawfly proxima. *Indian. j. agric. Sci*. 48(1):16-18.
29. Trivedi, T. P. (1986). Use of vegetable oil cakes and cow-dung ash as dust carrier for pyrethrin against *Rhizopertha dominica* (Fabr.) and *Tribolium castaneum* (Herbst.). *Plant Protection Bulletin Faridabad*. 39 (1-2): 27-28.
30. Ulrichs, C.H., Mews, I., Adhikart, S., Bhattacharya, A. and Goswami, A. (2008). Antifeedant Activity and Toxicity of Leaf Extracts from *Portesia coarctata Takeoka* and Their Effects on the Physiology of *Spodoptera littoralis* (F.). *Journal of Pest Science*, 18, 79-84.
31. Upadhyay, A.R.K. (2006). Insecticidal properties of Kareel plant (*Capparis decidus*: *Capparidaceae*) a desert shrub: A review. *World Journal of Zoology,* 8 (1): 75-93.
32. Zhao, B., Grant, G.G., Langevin, D. and Mac Donald, L. (1998). Deterring inhibiting effects of quinolizidine alkaloids on spruce budworm (Lepidoptera: Tortricidae) oviposition. *Environ. Entomol.* 27, 984 – 992.