Insecticidal biopotentials of Ageratum conyzoides, Azadirachta indica and Chenopodium ambrosioides essential oils against leaf webber, Eucosma critica

Rajani and BS Chandel

Abstract
The intensive and indiscriminate use of insecticides in agriculture has caused many problems and contaminated water, air and soil causing environmental pollution and hazardous to human health and beneficial organisms. The present study was carried out to evaluate the larvicidal properties of eleven indigenous botanicals growing abundantly in the vicinity of Kanpur region of U.P., India. The eleven edible and non-edible oils and one synthetic insecticide i.e; Ageratum conyzoides Linn., Argemone maxicana Linn., Arachis hypogaea Linn., Azadirachta indica A. juss., Brassica juncea Linn., Chenopodium ambrosioides Linn., Mentha arvensis Linn., Mentha longifolia Linn., Ocimum basilicum Linn., Pongamia glabra Vent. Ricinus communis Linn. and Endosulphan were studied against 3rd larval stage of Eucosma critica Meyrick (Lepidoptera: Eucosmidae). The laboratory trial was done in three glass petridishes (10cm diameter) and replicated thrice by using each selected extracts per petri-dish. To record the ten larvae of E. critica were released inside each pair of petri-dishes and allow them to remain for 24 hours. These petri-dishes were kept as such under control conditions 27± 1.00 °C and Rh 75± 5 and mortality count was taken after 6h, 12h, 24 hours of exposure periods. The plant oils of A. conyzoides gave the best results when compared with the remaining ten extractives. The A. conyzoides extract gave the 78.10 per cent larval mortality, which is followed by A. indica (76.05 per cent), C. ambrosioides (73.40 per cent), R. communis (69.94 per cent), Endosulphan (71.41 per cent), P. glabra (68.01 per cent), O. basilicum (65.33 per cent), A. maxicana (57.50 per cent), M. arvensis (51.91 per cent), M. longifolia (50.97 per cent), B. juncea (61.42 per cent) and A. hypogaea (37.15 per cent) etc. The plant oils of A. conyzoides differs significant from remaining once except A. indica, whereas, Endosulphan, P. glabra, O. basilicum, A. maxicana, M. arvensis, M. longifolia, B. juncea and A. hypogaea, respectively, which, does not differ significantly to one another. A. hypogaea proved least toxic giving only 36.5 per cent mortality of the larvae of Eucosma critica.

Keywords: Ageratum conyzoides, Argemone maxicana, Eucosma critica and biorational

1. Introduction
Pigeonpea, Cajanus cajan (L.) Millsp, is one of the most important pulses and forms a regular proteinous diet of majority of people of this country. It is very important pulse crop and ranks only next to grain in its consumption and availability (Ayyar, 1963) [1]. India accounts pigeonpea for about 85.0 per cent of total supply in the world. C. cajan occupies an area of about 32.38 lac ha under cultivation with the total production of 23.16 lac metric tonnes and the productivity 7.15 q ha. Out of total cultivated area, U.P. occupies 5.26 lac ha, with the total production of 7.0 lac metric tonnes and 13.3 q ha−1 productivity as per estimate of Directorate of Pulses Research (Anonymous,1978) [2]. Pigeonpea, C. cajan crop contains 25.3 per cent protein, 57.2 per cent carbohydrate, 1.7 per cent fat and 12.2 per cent water (Meyrick, 1912) [3]. The main limiting factors in increasing the crop production, is the lack of high yielding and resistant genotypes for crop field and under storage conditions prevailing in different parts of the country (Lai et al., 1980) [4]. Thus, insect-pests are mainly responsible for the considerable reduction in the enormous amount of stored pulses grains (Singh and Singh, 1978a and Singh and Singh, 1978b) [5, 6]. This important leguminous crop is subjected to the attack of a large number of insect-pests, namely, gram pod borer, Heliothis armigera Hub. (Loganath et al. 2000 and Malarvannan et al. 2008a) [7, 8], pod fly, Melanagromyza obtusa Malloch (Bindra and Singh, 1972, Thobbi and Singh, 1978) [9, 10]. Leaf webber, Eucosma critica Meyrick (Pruth, 1969 and Srivastava, 1974) [11, 12]. Beside these plum-eating, Exelastis atomosa W. (Sinha et al. 1977) [13]. Bud butter fly, Euchrysops cnehus F. spotted pod borer, Maruca testululis Geyer
and pod bug, *Clavigralla gibbosa* Spin. and gram podfly are also
damage pulse crop (Shetgar and Puri, 1978) [14]. Out of
these insects, *Eucosma critica* has been found causing
evermore damage to red gram in various parts of U.P. and its
adjoining States (Fletcher, 1916) [15]. Parshad and Rao (1964)
have noted varied degree of its incidence in different parts of
India. At times, it may cause 100.0 per cent infestation. It was
once considered to be a minor pest of pigeon pea, but now, has
assumed the status of a major pest [16].

Chemical control has proved to be successful weapon all over
the world. The synthetic insecticides have been found very
promising in suppressing this pest, but they are hazardous to
mammals including men and domestic animals. Their use may,
however, result the development of high degree of resistance
in insects (Patel, *et al.*1997) [17]. No systematic approach has so
far been adopted to work out economical effective control
measures of *Eucosma critica*. The complicated problem of pest
management has oriented the attention of agricultural experts
and administrators for rethinking of its solution. It is realized
now, that for satisfactory solution of many of the major
problems in the pest management researches, study of insect
life history and its extent of damage is of prime importance. It is
accepted that knowledge of the factors that influence the
distribution and abundance of insect-pests will be more
essential arms in wagging effective warfare against these
injurious enemies. With advancement in awareness about the
adverse effect of insecticides, entomologists have concentrated
their efforts for evolving other more convenient and safer
alternative methods viz., the use of resistant genotypes and
indigenous plant products for reducing the ravages of the pests
(Brahmaprakash, 2004) [18]. In recent past, the use of indigenous
plant materials have acquired an important position in the
modern approaches of pest control, as they are comparatively
safer to mammals and higher animals due to their rapid bio-
degradable nature (Gupta *et al.* 1988, Makanjuola, 1989,
2000.) [18, 20, 21, 22, 23].

Considering the above facts in view, the present studies were
undertaken to determine the effect of edible, non-edible
extracts and oils against *Eucosma critica* on Pigeonpea,
*Cajanus cajan*. An attempt has also been made to observe the
bionomics of *Eucosma critica* and evaluate the effect of
different oils on the growth, development and control of the
*Eucosma critica*.

2. Materials and Methods

2.1 Mass Culture of *Eucosma critica* Meyrick

The larvae of *Eucosma critica* Meyrick were obtained from the
mustard experimental fields of farmers of Fattepur Dakshin
village, Kanpur Nagar and maintained in the laboratory on
natural diets. The collected larvae were kept for at least 5 days
in the laboratory to check, whether or not, there are any other
infections before using them for experiments. *Eucosma critica*
Meyrick required for the study were mass reared on
cruciferous leaves in the laboratory. The mass culturing was
initiated by confining 10 larvae of *Eucosma critica* in the
plastic containers of 59 x 21 x 18 cm having green mustard
leaves which were covered with muslin cloth and secured
tightly with rubber band. Mass culturing of *Eucosma critica*
larvae was done at 28 ± 2° C temperature in the plastic
container and observed daily.

2.2. Collection of raw Materials

The plant materials used in the present investigation were
collected mainly from cultivated fields of the farmers,
wasteland and wild areas in the vicinity of Kanpur region. The
collected six materials viz; *Ageratum conyzoides* Linn.,
*Argemone maxicana* Linn., *Arachis hypogea* Linn.,
*Azadirachta indica* A. juss., *Brassica juncea* Linn.,
*Chenopodium ambrosioides* Linn., *Mentha arvensis* Linn.,
*Mentha longifolia* Linn., *Occimum basilicum* Linn., *Pongamia
glabra* Vent. *Ricinus communis* Linn. Were used for their
insecticidal efficacy against larvae of *Eucosma critica*
Meyrick.

2.3 Powder Preparation

Fresh collected plant materials like aerial parts and leaves etc.)
were washed with tap water and kept in the laboratory for 7
days for shadow air drying before making powder. Electric
grinder was used to have coarse powder then these were
passed through a 60-mesh sieve to get fine powder. Powders
were kept in polythene bags at room temperature and properly
sealed to prevent quality loss.

2.4. Preparation of Extractives

For the extraction, Soxhlet Apparatus was used; about 20g
powder of each category was extracted with 300 ml of alcohol
and distilled water). Extractions of each category of powder
were done in about 12 hrs. After soxhlet extraction, the
material was run on rotary evaporator. The extracts were
concentrated on rotary evaporator by removing the excess
solvent under vacuum. After evaporation of solvent the
remaining extracted material was kept on water bath for
removing remaining solvent from the extracts. The extracts
were stored at 4° C prior to application.

2.5 Experimental Apparatus

More Than one hundred glass petri-dishes (15cm diameter)
were used for the experiment, One hand compression poly
sprayer and muslin cloth was required for covering the petri-
dishes and ridges of plots either going or coming the larvae in
the cruciferous leaves in the petri-dishes.

2.6 Preparation of Stock Solution

In order to prepare 50 ml. stock solution of three per cent
concentration, calculated amounts of technical grades of
endosulfan and different concentrations i.e. 0.5, 1.0, and 2.0%,
of elven plant materials i.e., *Ageratum conyzoides* Linn.,
*Argemone maxicana* Linn., *Arachis hypogea* Linn.,
*Azadirachta indica* A. juss., *Brassica juncea* Linn.,
*Chenopodium ambrosioides* Linn., *Mentha arvensis* Linn.,
*Mentha longifolia* Linn., *Occimum basilicum* Linn., *Pongamia
glabra* Vent. *Ricinus communis* Linn. Were taken. This
amount was measured with the help of micropipette or
weighed with electrical balance as the case may be and poured
into 50 ml. volumetric flasks and ten ml. of benzene was added
to dissolve it and then adjusted the volume up to 50 ml. with
benzene.

2.7 Preparation of Emulsifier Solution

Five gm of triton X-100 was accurately weighed with the help
of electrical balance in a weighing tube and then poured into a
1000 ml. volumetric flask. Five hundred ml of distilled water
was added to it. The flask was vigorously shaken to mix the
triton X-100 with distilled water. This gave emulsifiable water
of 0.5%, 1.0, 2.0% concentration and endosulfan (0.002,0.004
and 0.007%), formulating allowance was given to the actual
ingredient present in its technical grade.

The formula used to find out actual amount of stock solution
required for making various concentrations of an insecticide is
given below:
Amount of Stock  × Concentration required
Solution Concentration of Stock Solution

Table 1: Details of the selected plant parts and their common name

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
<th>Part Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ageratum conyzaeides Linn.</td>
<td>Goat weed</td>
<td>Aerial part</td>
</tr>
<tr>
<td>Argemone maxicana Linn.</td>
<td>Satyamashi</td>
<td>Seed oil</td>
</tr>
<tr>
<td>Azadirachta indica A. juss.</td>
<td>Neem</td>
<td>Seed oil</td>
</tr>
<tr>
<td>Arachis hypogea Linn.</td>
<td>Groundnut</td>
<td>Seed oil</td>
</tr>
<tr>
<td>Brassica juncea Linn.</td>
<td>Brown mustard</td>
<td>Seed oil</td>
</tr>
<tr>
<td>Chenopodium ambrosioides L.</td>
<td>Indian warm seed</td>
<td>Seed oil</td>
</tr>
<tr>
<td>Mentha arvensis Linn.</td>
<td>Cornmint</td>
<td>Leaves</td>
</tr>
<tr>
<td>Mentha longifolia Linn.</td>
<td>Horsemint</td>
<td>Leaves</td>
</tr>
<tr>
<td>Ocimum basilicum Linn.</td>
<td>Sweetbasi</td>
<td>Leaves</td>
</tr>
<tr>
<td>Pongamia glabra Vent.</td>
<td>Karanja</td>
<td>Seed oil</td>
</tr>
<tr>
<td>Ricinus communis Linn.</td>
<td>Castorbean</td>
<td>Leaves</td>
</tr>
<tr>
<td>Endosulfan</td>
<td>Trade name-Thiodon</td>
<td>M/S. Hoechst pharmaceuticals Ltd, Mumbai</td>
</tr>
</tbody>
</table>

Table 2: Preparation of different formulations of the selected plant materials

<table>
<thead>
<tr>
<th>Concentration (%)</th>
<th>Amount of Stock Solution (ml)</th>
<th>Amount of Benzene (ml)</th>
<th>Amount of Emulsifiable Water (ml)</th>
<th>Total Amount (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>2.50</td>
<td>22.50</td>
<td>475.00</td>
<td>500.00</td>
</tr>
<tr>
<td>0.50</td>
<td>5.00</td>
<td>20.00</td>
<td>475.00</td>
<td>500.00</td>
</tr>
<tr>
<td>1.00</td>
<td>10.00</td>
<td>15.00</td>
<td>475.00</td>
<td>500.00</td>
</tr>
<tr>
<td>1.50</td>
<td>15.00</td>
<td>10.00</td>
<td>475.00</td>
<td>500.00</td>
</tr>
<tr>
<td>2.00</td>
<td>20.00</td>
<td>5.00</td>
<td>475.00</td>
<td>500.00</td>
</tr>
<tr>
<td>Endosulfan</td>
<td>35 EC</td>
<td></td>
<td></td>
<td>0.700</td>
</tr>
</tbody>
</table>

Insecticidal Bioassay

Third instars larvae third instar larvae of *Eucosma critica* were used to test the biological efficacy of each insecticide. Preliminary laboratory trials were conducted to formulate the various concentrations for further experiments to determine a suitable concentration on which insect mortality ranging from 15.0 to 85.0 per cent could be obtained. One ml. of each of the three concentrations of various insecticides was sprayed with the help of Potter’s tower at 0.28 kg per sq.cm. pressure in clean petri-dishes of 10 cm diameter and kept under an electric fan to dry the films of insecticides. Twenty (twenty four hour starved) larvae of the similar age were then released over the dry film. After conducting the preliminary trials the regular experiments were carried out under laboratory conditions. The third instar larvae of *Eucosma critica* were used for the purpose. The insecticides of the plant origins were tested by dry film technique. The spraying of the insecticides was done in glass petri-dishes (10cm diameter) by potsy spray tower, using 1.0 ml. of solution (insecticidal preparation) per petri-dish. Three concentrations were tested in three replications, along with over control (Benzene + emulsified water). To record the mortality, the spray petri-dishes were gently shaken under an electric fan till the liquid phase evaporated leaving behind a uniform dry film of insecticide on the glass surface. The spray tower was thoroughly rinsed with the insecticide solution. Ten larvae of known age were then released inside each pair of petri-dishes and allow remaining there up to two hours. After which, they were transferred to the fresh petri-dishes containing fresh food for feeding. These petri-dishes were kept as such under control conditions (27 ± 2°C temp. 5% ± 5% relative humidity) and mortality count was taken after 6, 12, 24 hours of exposure.

For contact toxicity test, the fresh leaves of arhar, *Cajanus cajan* were taken from unsprayed field and washed thoroughly with tap water. The each leaf was dipped into desired concentration of each extract and dried under the fan, then kept them into petri-dishes (15 cm in diameter) separately. A control with Benzene + emulsified water was run simultaneously. Now, ten known healthy larvae and adults of bug were released into each petri-dishes after drying the extract of treated leaf. The mortality of the nymph and adult aphids were counted after 6, 12, 24 hours of the released. For the assessment of the toxic effect, the mortality counts were taken 6 hrs, 12hr and 24hr. after treatment. In the mortality counts, both dead and moribund larvae were counted as dead, which could be easily distinguished from the living ones on examination with naked eyes or binocular microscope, where necessary and they showed no signs of life despite prodding’s. The observed mortality of the larvae in the treatments was adjusted with mortality occurring in control by Abbott’s formula (1925) [24]. In insecticidal test, the percentage mortality was converted into transformed back value. Thus data were subjected to statistical analysis of variance and comparison was made with the corresponding results obtained among their extracts and control.

Results and Discussion

Table 3: Mean Mortality of *Eucosma critica* Meyrick in case of different combination in laboratory condition:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Concen-tration</th>
<th>Mean 6 hrs.</th>
<th>Mortality %</th>
<th>After 12 hrs.</th>
<th>After 24 hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ageratum conyzaeides Linn..</td>
<td>0.5</td>
<td>54.78 (66.7)</td>
<td>61.22 (76.8)</td>
<td>71.56 (90.0)</td>
<td></td>
</tr>
<tr>
<td>Ageratum conyzaeides Linn.</td>
<td>0.1</td>
<td>83.85 (98.9)</td>
<td>77.70 (95.5)</td>
<td>83.85 (98.9)</td>
<td></td>
</tr>
<tr>
<td>Ageratum conyzaeides Linn.</td>
<td>2.0</td>
<td>90.00 (100.0)</td>
<td>90.00 (100.0)</td>
<td>90.00 (100.0)</td>
<td></td>
</tr>
<tr>
<td>Argemone maxicana Linn.</td>
<td>0.5</td>
<td>52.77 (63.4)</td>
<td>59.00 (73.5)</td>
<td>63.44 (80.0)</td>
<td></td>
</tr>
<tr>
<td>Argemone maxicana Linn.</td>
<td>1.0</td>
<td>77.70 (95.5)</td>
<td>83.85 (98.9)</td>
<td>83.85 (98.9)</td>
<td></td>
</tr>
<tr>
<td>Argemone maxicana Linn.</td>
<td>2.0</td>
<td>83.85 (98.9)</td>
<td>90.00 (100.0)</td>
<td>90.00 (100.0)</td>
<td></td>
</tr>
<tr>
<td>Azadirachta indica A. Juss.</td>
<td>0.5</td>
<td>39.15 (39.9)</td>
<td>48.85 (56.7)</td>
<td>52.78 (63.4)</td>
<td></td>
</tr>
<tr>
<td>Azadirachta indica A. Juss.</td>
<td>1.0</td>
<td>48.85 (56.7)</td>
<td>52.78 (63.4)</td>
<td>59.01 (73.5)</td>
<td></td>
</tr>
<tr>
<td>Azadirachta indica A. Juss.</td>
<td>2.0</td>
<td>66.15 (82.3)</td>
<td>66.15 (82.3)</td>
<td>83.85 (98.9)</td>
<td></td>
</tr>
<tr>
<td>Arachis hypogea Linn.</td>
<td>0.5</td>
<td>0.00 (0.0)</td>
<td>23.85 (16.4)</td>
<td>35.21 (33.3)</td>
<td></td>
</tr>
<tr>
<td>Arachis hypogea Linn.</td>
<td>1.0</td>
<td>6.14 (1.1)</td>
<td>30.99 (26.5)</td>
<td>41.15 (43.3)</td>
<td></td>
</tr>
<tr>
<td>Arachis hypogea Linn.</td>
<td>2.0</td>
<td>18.44 (10.3)</td>
<td>41.15 (43.3)</td>
<td>59.00 (73.5)</td>
<td></td>
</tr>
<tr>
<td>Brassica juncea Linn.</td>
<td>0.5</td>
<td>37.22 (36.6)</td>
<td>43.77 (43.9)</td>
<td>45.00 (50.0)</td>
<td></td>
</tr>
<tr>
<td>Brassica juncea Linn.</td>
<td>1.0</td>
<td>41.15 (43.3)</td>
<td>46.92 (53.4)</td>
<td>48.84 (56.7)</td>
<td></td>
</tr>
<tr>
<td>Brassica juncea Linn.</td>
<td>2.0</td>
<td>54.78 (66.7)</td>
<td>56.79 (70.0)</td>
<td>59.00 (73.5)</td>
<td></td>
</tr>
<tr>
<td>Chenopodium ambrosioides L.</td>
<td>0.5</td>
<td>39.15 (39.9)</td>
<td>48.85 (56.7)</td>
<td>52.78 (63.4)</td>
<td></td>
</tr>
<tr>
<td>Chenopodium ambrosioides L.</td>
<td>1.0</td>
<td>48.85 (56.7)</td>
<td>52.78 (63.4)</td>
<td>59.01 (73.5)</td>
<td></td>
</tr>
<tr>
<td>Chenopodium ambrosioides L.</td>
<td>2.0</td>
<td>66.15 (82.3)</td>
<td>66.15 (82.3)</td>
<td>83.85 (98.9)</td>
<td></td>
</tr>
</tbody>
</table>
The table 4 reveals that indigenous plant oils of *Ageratum conyzoides* Linn. gave the best results when compared with the remaining seven selected naturally occurring plant extracts. The *Ageratum conyzoides* Linn. gave the 78.10 per cent larval mortality, which is followed by *Azadirachta indica* A. juss. (76.05 per cent), *Chenopodium ambrosioides* Linn. (73.40 per cent), *Ricinus communis* Linn. (69.94 per cent), Endosulphan (71.41 per cent), *Pongamia glabra* Linn. (68.01 per cent), *Ocimum basilicum* Linn. (65.33 per cent), *Argemone maxicana* (57.50 per cent), *Mentha arvensis* Linn. (51.91 per cent), *Mentha longifolia* Linn. (50.97 per cent), *Brassica juncea* Linn. (61.42 per cent) and *Arachis hypogaea* Linn. (37.15 per cent) etc. The plant extract of *Azadirachta indica* Linn. gave the 78.10 per cent larval mortality, which does not differ significantly to another. *Arachis hypogaea* proved least toxic giving only 36.5 per cent mortality of the larvae of *Eucosma critica* in the laboratory experiments.
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Figure 1: Mean mortality of *E. critica* in different exposure period irrespective of treatments

Table 5: Mean mortality of *Eucosma critica* in different exposure period irrespective of concentration

<table>
<thead>
<tr>
<th>S.No</th>
<th>Treatments</th>
<th>Mean</th>
<th>Mortality %</th>
<th>After</th>
<th>Mean %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Ageratum conyzoides</em></td>
<td>67.05 (84.8)</td>
<td>85.91 (99.49)</td>
<td>87.95 (99.88)</td>
<td>80.30 (97.2)</td>
</tr>
<tr>
<td>2.</td>
<td><em>Arachis hypogea</em></td>
<td>33.04 (29.7)</td>
<td>41.21 (43.4)</td>
<td>53.55 (64.7)</td>
<td>42.6 (44.9)</td>
</tr>
<tr>
<td>3.</td>
<td><em>Argemone maxicana</em></td>
<td>47.59 (54.6)</td>
<td>55.9 (67.3)</td>
<td>61.78 (77.6)</td>
<td>55.09 (67.3)</td>
</tr>
<tr>
<td>4.</td>
<td><em>Azadirachta indica</em></td>
<td>34.56 (32.2)</td>
<td>34.35 (31.9)</td>
<td>42.55 (45.8)</td>
<td>37.15 (36.5)</td>
</tr>
<tr>
<td>5.</td>
<td><em>Brassica juncea</em></td>
<td>35.73 (34.1)</td>
<td>44.99 (49.9)</td>
<td>53.78 (65.1)</td>
<td>44.83 (49.7)</td>
</tr>
<tr>
<td>6.</td>
<td><em>Chenopodium ambrosioides</em></td>
<td>58.00 (72.0)</td>
<td>74.46 (92.9)</td>
<td>87.95 (99.88)</td>
<td>73.47 (92.0)</td>
</tr>
<tr>
<td>7.</td>
<td><em>Mentha arvensis</em></td>
<td>40.45 (42.1)</td>
<td>44.33 (48.9)</td>
<td>56.33 (69.3)</td>
<td>47.03 (53.6)</td>
</tr>
<tr>
<td>8.</td>
<td><em>Mentha longifolia</em></td>
<td>23.85 (16.4)</td>
<td>25.09 (18.0)</td>
<td>32.17 (28.4)</td>
<td>27.03 (20.7)</td>
</tr>
<tr>
<td>9.</td>
<td><em>Ocimum basilicum</em></td>
<td>46.97 (53.4)</td>
<td>56.19 (69.1)</td>
<td>74.64 (93.0)</td>
<td>59.26 (73.9)</td>
</tr>
<tr>
<td>10.</td>
<td><em>Pongamia glabra</em></td>
<td>41.09 (43.2)</td>
<td>46.95 (53.4)</td>
<td>54.01 (65.5)</td>
<td>47.35 (54.1)</td>
</tr>
<tr>
<td>11.</td>
<td><em>Ricinus communis</em></td>
<td>54.67 (66.6)</td>
<td>68.59 (86.7)</td>
<td>85.90 (99.49)</td>
<td>69.72 (88.0)</td>
</tr>
<tr>
<td>12.</td>
<td><em>Endosulphan</em></td>
<td>50.85 (60.2)</td>
<td>62.19 (78.2)</td>
<td>70.9 (88.4)</td>
<td>61.31 (77.0)</td>
</tr>
<tr>
<td>13.</td>
<td>Control (Untreated)</td>
<td>00.00 (00.0)</td>
<td>00.00 (00.0)</td>
<td>21.14 (13.04)</td>
<td>07.04 (01.5)</td>
</tr>
</tbody>
</table>

(Figures within parenthesis represent the transformed back value).

1. C.D. for period means at the same concentration = 4.0987
2. C.D. for concentration means at the same period = 3.1122

The table 5 indicated that overall mean concentration gave the 80.8 per cent mortality of third instar larvae of *Eucosma critica*. The table 5 also indicated that over all the three concentrations differ significantly from each other. The concentration 2.0 per cent is superior to concentration 1.0 and concentration 0.5 per cent of plant extracts. The concentration of 2.0 per cent killed the maximum percent (97.2 per cent) of third instar larvae of *Eucosma critica* followed by 1.0 per cent concentration (92.0 per cent) and 0.5 per cent (20.7 per cent) of larvae, respectively.

It was also observed that the difference in percentage of kill of larvae in concentration of 2.0 per cent and 1.0 per cent is greater than the difference in percentage of kill of larvae in 1.0 per cent and 0.5 per cent in all the three periods. The difference in percentage kill of larvae in period 24 hrs and 12 hrs is greater than the difference in percentage kill in period 12 hrs and 6 hrs in all the three concentrations.
Table 6: Mean Mortality percentage of *Eucosma critica* to different exposure periods, irrespective of treatments under laboratory conditions.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Groups</th>
<th>Mean Mortality %</th>
<th>After Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>6 hrs.</td>
<td>12 hrs.</td>
</tr>
<tr>
<td>Plant oils and Endosulphan</td>
<td>G1</td>
<td>44.48</td>
<td>53.34</td>
</tr>
<tr>
<td></td>
<td>G2</td>
<td>00.00</td>
<td>00.00</td>
</tr>
</tbody>
</table>

(Figures within parenthesis represent mean percentage transformed back value)

1. C.D. for period means at control = 13.0055
2. C.D. for period means at treated = 02.4476
C.D. for control Vs treated at the same period = 08.4467

The table 6 indicates that the maximum percentage of larvae killed was (80.1 per cent) after 24 hrs and minimum larval mortality percentage (64.0 per cent) after six hours. The period of 24 hrs is significantly superior to period of 12 hrs and 6 hrs periods in both control and plant oils. The overall effect of all the plant extracts in killing the larvae is greater than that of untreated control in all the three periods. Finally, it can be concluded on the basis of the table 6 that all the 11 plant extract and endosulphan are highly toxic to third instar larvae leaf webber, *Eucosma critica*. Among all the 11 plant oils and endosulphan, the rhizome extract of *Ageratum conyzaides* Linn. is the most toxic to the third instar larvae of *Eucosma critica* and placed at the top of the merit, whereas *Arachis hypogea* Linn. leaf extracts placed at the bottom of the merit of the insecticidal effectiveness all eleven selected plant oils and endosulphan.

Table 7: Analysis of variance table of mean mortality percentage of the larvae of *Eucosma critica* Meyrick in laboratory.

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F.</th>
<th>S.S</th>
<th>M.S.</th>
<th>F. Calculated Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replications</td>
<td>2</td>
<td>1548.2200</td>
<td>775.7764</td>
<td>31.7875</td>
</tr>
<tr>
<td>Control Vs treated</td>
<td>1</td>
<td>1981.2411</td>
<td>24912.0080</td>
<td>1020.7199***</td>
</tr>
<tr>
<td>Treatments (I)</td>
<td>11</td>
<td>16994.0300</td>
<td>1545.0041</td>
<td>633.3032***</td>
</tr>
<tr>
<td>Concentrations (C)</td>
<td>2</td>
<td>13075.7600</td>
<td>6537.8845</td>
<td>267.8759**</td>
</tr>
<tr>
<td>Insecticides X Concentrations</td>
<td>22</td>
<td>1724.2700</td>
<td>96.5578</td>
<td>3.9562**</td>
</tr>
<tr>
<td>Error (a)</td>
<td>72</td>
<td>1757.2550</td>
<td>24.4063</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>98</td>
<td>37080.7701</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Periods (Pd)</td>
<td>2</td>
<td>18593.3700</td>
<td>9296.8650</td>
<td>151.8029***</td>
</tr>
<tr>
<td>Pd. (Control Vs. Treated)</td>
<td>2</td>
<td>1296.3193</td>
<td>649.6956</td>
<td>10.6178***</td>
</tr>
<tr>
<td>PeriodsX Treatments</td>
<td>22</td>
<td>1562.5633</td>
<td>71.0256</td>
<td>1.5973**</td>
</tr>
<tr>
<td>PeriodsX Concentrations</td>
<td>4</td>
<td>1400.5973</td>
<td>275.1490</td>
<td>4.4927**</td>
</tr>
<tr>
<td>Error (b)</td>
<td>148</td>
<td>9067.1611</td>
<td>61.2431</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>198</td>
<td>31988.0666</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

N.S. = Non significant
** = Significant at 0.1 level of significance
*** = Significant at 0.01 level of significance.

The finding of the present investigation revealed that extract of *Argemone Mexicana* *Azadirachta indica* and *Chenopodium ambrosioides* possesses remarkable insecticidal activity against 3rd instar larvae of *Ecosma critica*. Based on percentage reduction of larvae, the following order of mortality was observed:* Ageratum conyzaides* (78.10) > *Azadirachta indica* A. juss (76.05 per cent) > *Chenopodium ambrosioides* Linn. (73.40 per cent) > *Ricinus communis* Linn., (69.94 per cent) > Endosulphan (71.41 per cent) > *Pongamia glabra* Linn. (68.01 per cent)> *Ocimum basilicum*
Linn. (65.33 per cent) > Argemone maxicana (57.50 per cent) > Mentha arvensis Linn. (51.91 per cent) > Mentha longifolia Linn. (61.42 per cent) > Brassica juncea Linn. (55.4 per cent) > Arachis hypogea Linn. (37.15 per cent), respectively.

In the conformity of above insecticidal biopotent, the toxicity of extractives of Argemone mexicana was tested against 3rd instar larvae of Eucosma critica In our study mortality increased with increase in concentration at all the doses up to 24 hrs of exposure. Similar to the present investigation, several studies documented the insecticidal activity of Argemone mexicana on different pests. Malarvannan et al. (2008, 2008a) found that toxic properties of leaf crude extracts of A. maxicana against two lepidoptenan species, Spodoptera litura and Helicoverpa armigera [25]. Majeed and Abidunnisa (2011) reported that ultra-low concentrations (0.5 to 0.80 g/cm2) of aqueous crude extracts from leaves of Argemone mexicana L. caused 80 to 96% repellency of adults of T. castaneum and the rice weevil Sitophilus oryzae (L.) at 1 h after application [26] Kangade and Zamble (2013) conduced a laboratory trial at 1.5 and 2.0 mL/kg concentrations of rice grains coated with Argemone mexicana leaf extracts were fed by the larvae of C. cephalonica and reported that up to 40% larval mortality observed [27].

Zeinab and Abou, (2015) showed the toxic effect of chloroform and methanol leaves and seeds crude extracts of Argemone mexicana against medically important vectors Cx. piperis and Ae. Aegypti [28] Sharma et al., (2016) evaluated the effect of Argemone mexicana leaves extract of different solvents on gut of Heliothis armigera (Hub.) and after 24 and 96 hours of treatment Heliothis armigera showed severity of the damage of epithelial lining and epithelial cells with vacuoles at certain places [29] Ashwini et al., (2017) found that the toxicity bioassay of A. mexicana extracts caused greater mortality on third instars larvae (LD50 = 5.33 mg-1) than C. inermis (LD50 = 7.26 mg-1). In many countries, plant derived products are being used by the farmers from ancient times and it triggered the scientists to search for eco-friendly insecticides from plant kingdom [30].

5. Conclusion
Bio-chemical substances may have anti-pest properties against insects. Based on this principle, botanical pesticides are invented and utilized for control of insect pests. Conclusively, Ageratum conyzoides, Azadirachta indica A. juss and Chenopodium ambrostoides Linn. showed strong insecticidal biopotent with 70 t0 to 100,00 per cent larval mortality. Keeping in view the imperative demand of safer plant protects and aiming to minimize the negative effects of pesticides, present study is undertaken to study the impact of plant extracts on control of 3rd instars larvae of Eucosma critica.

6. Acknowledgement
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7. References


