Bio-efficacy of botanicals on chickpea pod borer (Helicoverpa armigera Hubner) and its growth and development stages under Bundelkhand region of Jhansi

Anil Patidar, Pradeep Kumar, Vishal Sarasaiya and Vikas Kumar Dhurve

Abstract
Investigations were carried out on Studies on “Bio-efficacy of botanicals on Chickpea Pod Borer (Helicoverpa Armigera Hubner) under Bundelkhand region of Jhansi” was carried out at the Experimental, Organic Research farm Kargunwa Ji Jhansi, Institute of Agricultural Sciences, Department of Entomology, Bundelkhand University Jhansi (Uttar Pradesh) during Rabi season of 2020-2021. During the course of investigation the present investigation was undertaken to find out suitable and low cost substitute for the management of Helicoverpa armigera (Hubner) on chickpea by using botanicals. The field trial was laid out in (RBD) design with three replications and nine treatments including control (water spray). The observations were recorded on average per cent pod damage caused by Helicoverpa armigera (Hubner) Mean number of chickpea pod borer per plant minimum was significantly recorded in (1.23, 1.21 and 1.02) in plot Nerium indicum at 0.05% foliar spray. Minimum pupil width was minimum in Nerium indicum (3.997) mm in T6 plot. Total development period of Pod borer (Helicoverpa armigera) minimum (1.913) days of egg period in rose, while minimum (17.687) days of larval period in T1 plot chickpea, minimum pre-pupal days (2.913) days of in T1 plot chickpea. Minimum pupal days (14.597) days of pupal period in T: Nerium indicum. Total development period (32.100) days of total development period in T: plot Nerium indicum. The highest grain yield was recorded (20.990) q/ha with T: Nerium indicum (0.05%) while lowest was (12.233) q/ha recorded in control T0 plot.

Keywords: Bio-efficacy, botanicals, Chickpea, Helicoverpa armigera (Hubner), larva, pupal

Introduction
The gram pod borer, Helicoverpa armigera (Hubner) (Lepidoptera: Noctuidae), is an insatiable feeder bug that feeds on more than 100 plant species including far reaching and monetarily significant yields like cotton, maize, tobacco, pigeonpea, chickpea, and tomato (Metcalf et al., 1992) [14]. The inclination of Helicoverpa armigera to benefit from the harvestable pieces of host plants, alongside its high polyphagy and fecundity, expansive geological assortment, transitory potential, facultative diapause, high fruitfulness, and tendency to develop resistance from insecticidal sprays (Mahmood et al., 2021 [13]; Meena et al., 2018 [12]; Kambrekar et al, 2016) [11], Increases in intensive crop production technologies due to broad spectrum insecticides because of utilization of wide range, food plants just as constant availability of usually liked food plants have supported Helicoverpa armigera to turn into a major pest of gram (Gautam et al, 2018 [10]; Goutham et al, 2018 [9]; Golvankar 2015 [8].

Gram pod borer, Helicoverpa armigera (Hubner) is perhaps the most annihilating and polyphagous pest in worldwide and feeds on more than 300 plant species and exclusively liable for extensive harm to many medium estimated light earthy colored moths estimating around 40 mm across the wings have a dull bit and dim region on the forewings. Females lay a few little white eggs separately. After bring forth in 3-4 days the caterpillars feed on the leaves for a brief time frame and therefore assault the units. A completely mature caterpillar is around 34 mm long, greenish to caramel in shading with dispersed short white hairs and covers itself in the dirt to make an earthen cell inside which it pupates. (Fite et al, 2020, Fitt et al, Fitt et al, Fathipour et al,2012) [5, 6, 7].

The life cycle is completed in about 30-45 days. The pest finishes eight ages in a year. 30-40 pods before its development. Yearly losses are assessed to be 15% in chickpea. The low yield of chickpea is ascribed to the ordinary episodes of pod drill which is viewed as one of the significant nuisances of chickpea crop. Botanicals and have received a lot of viable
consideration as substitutes to manufactured synthetics. Consequently, the field try was directed to assess some obscure botanicals to deal with the *Helicoverpa armigera* (Hubner) in Chickpea. Botanicals debase quickly from daylight, air, and appropriate dampness, which by and large makes them less poisonous to the climate, however may likewise expect them to be applied all the more regularly, applied accurately, and with more exact planning. (Fathipour et al,2012) [4], (Babu et al,2015) [5].

Dating from traditional practices, different plant extracts have shown insecticidal properties and can be utilized adequately on field crops. Internationally botanical pest management is acquiring appreciation due to multiple mode of action, for example, antifeedant which hinder typical advancement of insect pest, repellent, antijuvenile chemical action, oviposition/inhibiting discouragement, antifertility/development disrupters and chemosterilants (Ahmed et al, 2012) [6]. The most notable and generally utilized is azadirachtin segregated from the seed, wood, bark, leaves and products of the neem tree (Azadirachta indica). Azadirachtin has both antifeedant and growth retardants properties (Babu et al, 2015) [6]. Thus, the natural control can be substitute framework, which might assume a significant part in accomplishing the objective of horticulture.

The pod borer *Helicoverpa armigera* Hubner is responsible for causing up to 90% damage in chickpea due to its regular occurrence from the vegetative growth to the pod arrangement stage. To deal with this issue, cultivators are enticed to increase the measures of pesticides, however aimless utilization of pesticides has resulted in residues in food chain. Botanicals are less expensive, promptly accessible, naturally protected and less hazardous in contrast with synthetic chemical insecticides (Fitt et al, 2000) [6]. The insecticidal properties of number of plants have been discovered long ago. Botanicals plants extracts are ecologically less destructive than manufactured pesticides to control pests. They have at least one valuable properties like biodegradability, wide range of movement and capacity to reduce insect resistance. Synergistic impact because of blending of various plant species assumes a vital part to control pest. Significant expense of chemical insecticides leads to search alternative source for pest management.

**Materials and Methods**

The present investigation was conducted at Experiment, Organic Research farm, Kargunwa Ji Jhansi, Institute of Agricultural Sciences, Department of Entomology, Bundelkhand University, Jhansi (Uttar Pradesh) during Rabi season of 2020-2021. Jhansi (Uttar Pradesh) which is situated at latitude 25° 27′N′, longitude 78°35′ E′ and at an altitude of 271 meters above the mean sea level. Seed of chickpea variety K-3256 was sown in well prepared experimental field at an area of (23.7 x 9 m²).The data from the field experiment were subjected to $\sqrt{x + 0.5}$ transformation and analyzed statistically for comparing treatments following Analysis of Variance techniques (ANOVA) for RBD design and the result were interpreted at 5% level of significance (Gomez and Gomez 1984), with 9 treatments including control with three replications with total plot size 2.0 m x 2.0 m (Gross) and 1.8 m x 1.8 m (Net) with spacing (30 x 10 cm).

**Methodology**

All the botanicals spray schedules were applied in the form of foliar spray with the help of knapsack sprayer (15 litre capacity). For deciding the amount of spray required per plot, the control plots were splashed with still up in the air the necessary shower liquid. The botanicals were sprayed at diverse yield stages i.e., pre-blooming stage, half blossoming stage, 100% blossoming stage and pod development.

**Method of application**

First spray application of respective botanicals was given on the initiation of the pests and subsequently one another spray was given after 20 days using manually operated knapsack sprayer having duromist nozzle with slight runoff stage. To prepare *Hibiscus rosa-sinensis*, *jasmine*, *Bougainvillea*, *Marigold* (Tagetes erecta), Chrysanthemum, *Gaillardia-pulchela*, Sadabahar (*Catharanthus roseus*), *Nerium indicum* flower extract, the required quantity of dried flowers was weighed (250g) on electric balance and grinded on electric grinder. The powder was kept in muslin cloth bag and soaked into 2 litres of water for overnight and thereafter, the bag was squeezed repeatedly until the out flowing fluid turns light in colour. Finally volume (5 litres) was prepared by adding water.

**Method of recording observations**

The data was collected at 7 days interval from the field and recorded on the basis of treatments and replications. The data collection was started at the flower initiation stage of the chickpea plant in the field and continued upto maturity of the pods and after harvest of the crops. The data was collected on different parameters of the study such as number of total pod per five selected plants/plot; number of borer infested pods /5 selected plant/plot; total number of plants/plot; total number of infested plants/plot; total yield / plot; yield of borer infested pod/5 selected plants; no. of larvae / 10 infested pods (at harvest); no. of borers/ 20 infested pods; no. of grain / 20 pods (at harvest); no. of pods / 5 selected plant; no. of seeds / 5 selected plant; weight of 5 selected plants pod; 1000 seed weight; yield of chickpea per plot.

\[
\text{% pod infestation} = \frac{\text{Number of infested pod}}{\text{Total number of pod}} \times 100
\]

\[
\text{% increase or decrease over control} = \frac{\text{Mean value of treated plot}}{\text{Mean value of untreated plot}} \times 100
\]

Nine botanicals viz., *T*0 Control (water spray), *T*1 *Hibiscus rosa-sinensis* flower extract at (5%), *T*2 *Jasmine* flower extract at (5%), *T*3 *Bougainvillea* flower extract at (5%), *T*4 *Tagetes erecta* flower extract at (5%), *T*5 Chrysanthemum flower extract at (5%), *T*6 *Gaillardia pulchela* flower extract at (5%), *T*7 *Nerium indicum* flower extract at (5%), *T*8 *Catharanthus roseus* flower extract at (5%) were assessed for their efficacy against the Bio-efficacy of botanicals on Chickpea Pod Borer (*Helicoverpa Armigera* Hubner) under Bundelkhand region of Jhansi.

**Statistical analysis**

The data recorded on various parameters was analyzed as per RBD design as suggested by Gomez and Gomez (1984). The results was interpreted on the basis of ‘F’ test value and critical difference (CD) was calculated at 5% level of significance. The analysis of variance was calculated as per given by Panse and Sukhatme (1985).
**Results and Discussion**

**Mean number of chickpea pod borer per plant**

The data presented in Table 1 reveals that mean population per tagged plants showed significant variation amongst the treatment in comparison to population of chickpea after the post treatment of different botanicals spray. The highest pre-treatment at days before spray population was (2.920) in untreated control plot T₀ treatment while the lowest (2.003) in T₇ treatment. The post treatment with botanicals spray at 3rd day after spray was maximum 3.010 in control plot T₀. While minimum was (1.430) recorded in T₇ at Nerium indicum at 0.05% foliar spray. Similar trend in observation at post treatment of botanicals spray were recorded at 5, 7 and 10 (DAS = days after spray), maximum was (3.990, 5.330 and 5.617) with T₀ control plot. Similarly minimum was significantly recorded in (1.237, 1.210 and 1.020) in plot Nerium indicum at 0.05% foliar spray. The present finding corroborates with (Fite et al., 2020; Meena et al, 2018) [7, 12].

**Effect of Host on the pupal stage of Pod borer (Helicoverpa. armigera)**

The data presented in Table 2 reveals that host leaves on pre-pupal period stage at 1st day after feeding with host leaves showed significant variation in all treatment, the maximum was recorded in chickpea (1.678) days in T₁ plot amongst the treatment in comparison to minimum (0.530) days, of pre-pupal period in Nerium indicum. The pupal period after 3rd day after feeding on host leaves were found significantly maximum in Chickpea (17.427) days in T₁ plot while the minimum pupal period was in Nerium indicum (14.713) days in T₇ plot. The present finding are accordance with (Golvankar et al, 2015; Netam et al, 2018).

The data on pupal size length in (mm) was significantly maximum when feed with Chickpea (20.033) mm. in T₁ plot while the minimum pupal length was in Nerium indicum (14.993) mm. in T₆. In terms of width the pupal size was significantly maximum in chickpea (6.343) mm. in T₁ plot while the minimum pupal width was minimum in Nerium indicum (3.997) mm. in T₇ plot as per the similar findings of (Neupane et al., 2015; Netam et al, 2018).

**Effect of host on the total development period of pod borer (Helicoverpa armigera)**

**Egg period (days)**

The data presented in Table 3 reveals that host on egg period stage showed significant variation in all treatment, the maximum egg period was recorded in chickpea (2.460) days in T₁ plot amongst the treatment in comparison to minimum (1.913) days of egg period in rose.

** Larval period (days)**

The data presented on larval period in Table 3 reveals that host on larval period stage showed significant variation in all treatment, the maximum larval period (days) was recorded in linseed (18.183) days in T₃ plot amongst the treatment in comparison to minimum (17.687) days of larval period in T₁ plot chickpea.

**Pre-pupal (days)**

The data presented on pre-pupal (days) in Table 3 reveals that host on pre-pupal stage showed significant variation in all treatment, the maximum pre-pupal stage (days) was recorded in amaranthus (2.943) days in T₆ plot amongst the treatment in comparison to minimum (2.913) days of in T₁ plot chickpea.

**Pupal period (days)**

The data presented on pupal (days) in Table 3 reveals that host on pupal stage showed significant variation in all treatment, the maximum pupal stage (days) was recorded in Chickpea (18.310) days in T₁ plot amongst the treatment in comparison to minimum (14.597) days of pupal period in T₇ Nerium indicum.

**Total development (days)**

The data presented on total development of Helicoverpa. armigera (days) in Table 5 reveals that total development showed significant variation in all treatment, the maximum total development (days) was recorded in Chickpea (42.523) days in T₁ plot amongst the treatment in comparison to minimum (32.100) days of total development period in T₇ plot Nerium indicum.

**Effect of different host on the length of larvae of different instar (mm) of (Helicoverpa. armigera)**

**First instar**

The data presented on length of larvae of different instar (mm) of Helicoverpa. armigera (days) in Table 4 reveals that total development (1st instar) showed significant variation in all treatment. The (1st instar) length was recorded in chickpea (2.073) mm. in T₁ plot amongst the treatment in comparison to minimum in Nerium indicum (1.670) mm. of length in T₇ plot.

**Second instar**

The data presented on length of larvae of different instar (mm) of H. armigera (days) in Table 5 reveals that total development (2nd instar) showed significant variation in all treatment. The (2nd instar) length was recorded in chickpea (4.050) mm. in T₁ plot amongst the treatment in comparison to minimum in Togetus erecta (3.590) mm. of length in T₄ plot.

**Third instar**

The data presented on length of larvae of different instar (mm) of H.armigera (days) in Table 5 reveals that total development (3rd instar) showed significant variation in all treatment. The (3rd instar) length was recorded in chickpea (11.870) mm. in T₁ plot amongst the treatment in comparison to minimum in Nerium indicum (8.120) mm. of length in T₇ plot.

**Fourth instar**

The data presented on length of larvae of different instar (mm) of H.armigera (days) in Table 5 reveals that total development (4th instar) showed significant variation in all treatment. The (4th instar) length was recorded in chickpea (12.540) mm. in T₁ plot amongst the treatment in comparison to minimum in Nerium indicum (11.340) mm. of length in T₇ plot.

**Fifth instar**

The data presented on length of larvae of different instar (mm) of H. armigera (days) in Table 4 reveals that total development (5th instar) showed significant variation in all treatment. The (5th instar) length was recorded in chickpea (22.197) mm. in T₁ plot amongst the treatment in comparison to minimum in Nerium indicum (19.113) mm. of length in T₇ plot.
Sixth instar
The data presented on length of larvae of different instar (mm) of *H. armigera* (days) in Table 5 reveals that total development (6th instar) showed significant variation in all treatment. The (6th instar) length was recorded in chickpea (27.690) mm. in T7 plot amongst the treatment in comparison to minimum in *Nerium indicum* (21.710) mm. of length in T7 plot.

Seventh instar
The data presented on length of larvae of different instar (mm) of *Helicoverpa armigera* (days) in Table 5 reveals that total development (7th instar) showed significant variation in all treatment. The (7th instar) length was recorded in chickpea (28.560) mm. in T1 plot amongst the treatment in comparison to minimum in 21.957.

Eighth instar: The data presented on length of larvae of different instar (mm) of *H. armigera* (days) in Table 5 reveals that total development (8th instar) showed significant variation in all treatment. The (8th instar) length was recorded in chickpea (29.970) mm. in T1 plot amongst the treatment in comparison to minimum in *Nerium indicum* (24.170) mm. of length in T7 plot.

Mortality (%) of (*H. armigera*) larvae after spraying of botanicals
1st days after spray
The data presented in Table 5 reveals that mean larvae population per tagged plants showed significant variation amongst the treatment. Mortality per cent of larvae showed significant difference in terms of mortality rate. At 1st day treatment with highest mortality rate to minimum in *Nerium indicum* (29.807%) of length in T7 plot.

2nd days after spray
The data presented in Table 5 reveals that mean larvae population per tagged plants showed significant variation amongst the treatment. Mortality per cent of larvae showed significant difference in terms of mortality rate. At 2nd day treatment with highest mortality rate was minimum in *Nerium indicum* (33.527%) of length in T7 plot.

3rd days after spray
The data presented in Table 5 reveals that mean larvae population per tagged plants showed significant variation amongst the treatment. Mortality per cent of larvae showed significant difference in terms of mortality rate. At 3rd day treatment with highest mortality rate was minimum in *Nerium indicum* (40.350%) of length in T7 plot, while lowest was recorded in untreated plot.

4th days after spray
The data presented in Table 5 reveals that mean larvae population per tagged plants showed significant variation amongst the treatment. Mortality per cent of larvae showed significant difference in terms of mortality rate. At 4th day treatment with highest mortality rate (45.723%) while lowest was recorded in untreated plot.

5th days after spray
The data presented in Table 5 reveals that mean larvae population per tagged plants showed significant variation amongst the treatment. Mortality per cent of larvae showed significant difference in terms of mortality rate. At 5th day treatment with highest mortality rate was highest mortality rate (50.090%) with plot T7 in treatment *Nerium indicum* while, lowest was recorded in untreated plot.

6th days after spray
The data presented in Table 5 reveals that mean larvae population per tagged plants showed significant variation amongst the treatment. Mortality per cent of larvae showed significant difference in terms of mortality rate. At 6th day treatment with highest mortality rate was (56.190%) with *Nerium indicum* (0.05%) T7 plot, which while lowest was recorded in untreated plot.

7th days after spray
The data presented in Table 5 reveals that mean larvae population per tagged plants showed significant variation amongst the treatment. Mortality per cent of larvae showed significant difference in terms of mortality rate. At 7th day treatment with highest mortality rate was (64.290) with *Nerium indicum* (0.05%) T7 plot, which while lowest was recorded in untreated plot.

Pupal mortality percentage (%)
The data presented in Table 5 reveals that mean pupal mortality per cent per tagged plants showed significant variation amongst the treatment. The highest pupal mortality rate was (23.750%) with *Nerium indicum* (0.05%) in T7 plot, which while lowest was (11.980%) recorded in Control (0.00%) in T0 plot.

Adult emergence (%)
The data presented in Table 5 reveals that mean adult emergence per cent per tagged plants showed significant variation amongst the treatment. Treatments showed significant difference in terms of mean adult emergence per cent. The highest mean adult emergence per cent was (88.590) % with untreated plot T0 while lowest was (5.527%) recorded in Control (0.00%) in T0 plot.

Yield parameters
Pod damage %
The data presented in Table 5 reveals that mean pod damage per-cent per tagged plants showed significant variation amongst the treatment. Treatments showed significant difference in terms of pod damage per-cent. The lowest mean pod damage per cent was (36.411%) with T7 *Nerium indicum* with plot T7 while highest was recorded (36.411%) in control T0 plot.

Grain yield (q/ha)
The data presented in Table 5 reveals that grain yield (q/ha) plants showed significant variation amongst the treatment. Treatments showed significant difference in terms of grain yield. The highest grain yield was recorded (20.990) q/ha with T7 *Nerium indicum* (0.05%) while lowest was (12.233) q/ha recorded in control T0 plot.
### Table 1: Mean number of Helicoverpa armigera (Hubner) Population/5 plants

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Conc. %</th>
<th>Pre-treatment</th>
<th>Post treatment</th>
</tr>
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<tr>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
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</table>
Figures in the parentheses are transformed values × ± 0.5 value

### Table 5: Mortality (%) of *Helicoverpa armigera* larvae after spraying of biopesticides

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Conc. %</th>
<th>Mortality of <em>Helicoverpa armigera</em> (%)</th>
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<tr>
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<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>T&lt;sub&gt;1&lt;/sub&gt;</em> Chickpea</td>
<td>0.05%</td>
<td>0.11</td>
</tr>
<tr>
<td><em>T&lt;sub&gt;2&lt;/sub&gt;</em> Jasmine</td>
<td>0.05%</td>
<td>0.14</td>
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<td><em>T&lt;sub&gt;3&lt;/sub&gt;</em> Bougainvillea</td>
<td>0.05%</td>
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</tr>
<tr>
<td><em>T&lt;sub&gt;4&lt;/sub&gt;</em> Tagetes erecta</td>
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<td>0.19</td>
</tr>
<tr>
<td><em>T&lt;sub&gt;5&lt;/sub&gt;</em> Chrysanthemum</td>
<td>0.05%</td>
<td>0.21</td>
</tr>
<tr>
<td><em>T&lt;sub&gt;6&lt;/sub&gt;</em> Gaullardia pulchela</td>
<td>0.05%</td>
<td>0.23</td>
</tr>
<tr>
<td><em>T&lt;sub&gt;7&lt;/sub&gt;</em> Nerium indicum</td>
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<td>0.25</td>
</tr>
<tr>
<td>C.D.</td>
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<tr>
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</table>

Figures in the parentheses are transformed values × ± 0.5 value

### Conclusion

Looking to the overall effectiveness of various botanicals spray schedules tested against Chickpea pod borer (*Helicoverpa armigera*), it can be concluded that significant variation observed on the highest pre-treatment at days before spray population was significant amongst the treatment in comparison to population of chickpea after the post treatment of different botanicals spray. Significant variation in all treatment, the maximum was recorded in chickpea days in *T<sub>1</sub>* plot amongst the treatment in comparison to minimum days, of pre- population period in *Nerium indicum*. The pupal period after 3<sup>rd</sup> day after feeding on host leaves were found significantly minimum pupal period was in *Nerium indicum*. Minimum pupal length was in *Nerium indicum* mm. In *T<sub>6</sub>* in terms of width the pupal size was significantly pupal width was minimum in *Nerium indicum* mm. Significant variation was observed on effect of Host on the total development period of Pod borer (*Helicoverpa armigera*) in all treatment, the maximum egg period was recorded in chickpea in *T<sub>1</sub>* plot amongst the treatment in comparison to minimum days of egg period in rose. Significant variation was observed on larval period stage showed significant variation in all treatment, the maximum larval period (days) was recorded in linsedd in *T<sub>1</sub>* plot amongst the treatment in comparison to minimum days of larval period in *T<sub>1</sub>* plot chickpea. Significant variation was observed on pre-pupal (days) reveals that host on pre-pupal stage showed significant variation in all treatment, the maximum pre-pupal stage (days) was recorded in amaranthus with days in *T<sub>6</sub>* plot amongst the treatment in comparison to minimum days of in *T<sub>1</sub>* plot chickpea. Significant variation was observed on pupal (days) reveals that host on pupal stage showed significant variation in all treatment, the maximum pupal stage (days) was recorded in in *T<sub>7</sub>* plot amongst the treatment in comparison to minimum days of pupal period in *T<sub>1</sub>* *Nerium indicum*. Significant variation was observed on total development of *Helicoverpa armigera* (days) reveals that total development showed significant variation in all treatment, the maximum total development (days) was recorded in Chickpea days in *T<sub>1</sub>* plot amongst the treatment in comparison to minimum days of total development period in *T<sub>1</sub>* plot *Nerium indicum*. Significant variation was observed on the total development (1<sup>st</sup> instar) showed significant variation in all treatment. The (1<sup>st</sup> instar, 2<sup>nd</sup> instar, 3<sup>rd</sup> instar, 4<sup>th</sup> instar, 5<sup>th</sup> instar, 6<sup>th</sup> instar, 7<sup>th</sup> instar, 8<sup>th</sup> instar length was recorded minimum in *Nerium indicum* of length mm. in *T<sub>7</sub>* plot. Significant variation amongst the treatment due to mortality (%) of (*Helicoverpa armigera*) larvae after spraying of botanicals. Mortality per cent of larvae showed significant difference in terms of mortality rate.

### References

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