Influence of environmental factors on the biology of tamarind bruchid, *Caryedon serratus* (Olivier) on groundnut

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ABSTRACT

A laboratory experiment was carried out at the Department of Seed Science and Technology, Seed Research and Technology Centre, Rajendranagar, Hyderabad to study the influence of seasonal variations on the life stages of *Caryedon serratus* under ambient storage conditions both on the pods as well as kernels of groundnut for the efficient management of this pest throughout the year. The variations in the duration of each stage was correlated with the environmental factors like temperature and relative humidity. The January-February months, with 26.76°C maximum and 24.63°C minimum temperatures and 76.00% relative humidity recorded maximum durations for egg (14.60 days), larva (49.00 days), pupa (15.00 days) and adult longevity (21.60 days). Higher per cent of egg viability (58.80), larval survival (56.80) and adult emergence (86.60) were recorded during September-October during which lowest relative humidities (73.11% and 71.40%, at 7 am and 2 pm, respectively) were recorded. November-December recorded higher fecundity (29.20 eggs female⁻¹) when the minimum temperature was lowest (22.66°C). The period from September to February with 30.73-26.76°C and 22.66-25.75°C, maximum and minimum temperatures, respectively and 71.40-76.00% relative humidity was found to be most optimum and congenial for the bruchid growth and development. These findings revealed that proper control strategies could be planned for the management of *Caryedon serratus* from September to February to avoid post harvest losses in stored groundnut.

Key words: Biology, Caryedon serratus, Groundnut, Relative humidity, Tamarind bruchid, Temperature.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important cash and food crop in many parts of the tropics, particularly in semi-arid regions. Groundnut is grown on 26.40 million ha worldwide with a total production of 39.34 million tonnes and with an average productivity of 1.40 metric t ha⁻¹ (FAO, 2013). India is one of the largest producers of groundnut in the world with an area of 4.28 million ha., production of 7.92 million tonnes and productivity of 1.30 Kg ha⁻¹ (INDIADAT, 2014). The major producers of groundnut are Gujarat (26.34 %), Andhra Pradesh (19.08 %), Rajasthan (17.68 %), Tamil Nadu (9.54 %), Karnataka (7.63 %), Madhya Pradesh (7.25 %) and Maharashtra (5.34%). One of the main reasons for the low productivity of groundnut can be attributed to the improper storage conditions. Tamarind bruchid, (*Caryedon serratus*) has been reported as a pest of international importance in stored groundnut, causing considerable seed damage under storage. The storage problems of crops in developing countries, especially in tropical and semi-arid climates are not new for crops like groundnut and other legumes particularly in India. Among all storage pests, *Caryedon serratus* (Olivier) is a serious pest. It was found that *Tamarindus indica* L. and *Arachis hypogaea* L. were more suitable hosts as they supported faster development, better survival and higher fecundity of the bruchid (Mishra et al., 2009). *C. serratus* causes an average weight loss of about 63-75 per cent. Taking all these factors into consideration, the present investigation was carried out to determine the influence of seasonal fluctuations in temperature and relative humidity throughout the year on the biological aspects of the pest under ambient conditions for efficient management of the pest to reduce storage losses in groundnut.

MATERIALS AND METHODS

The experiment was conducted at the Department of Seed Science and Technology, Seed Research and Technology Centre, College of Agriculture, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad on DRG-12 variety of groundnut. The culture of *C. serratus* was obtained from the Department of Entomology, International Crops Research Institute for Semi-Arid Tropics, Patancheru, Hyderabad. The groundnut pods were properly cleaned and twenty five pairs of newly released adult insects were released in the cylindrical battery jars and covered with muslin cloth and tightened with rubber bands. Simultaneously, another set of *Caryedon serratus* culture

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was maintained in cloth bags by releasing 100 pairs of adults. The cloth bags and jars were left undisturbed for 60 days for use of adult pest population in the study. Fresh pods were provided as feed for the pest as and when required. The culture was maintained throughout the year to obtain different stages of the pest for the investigation. The female oviposited from three to five days after emergence from the cocoon. Small whitish transparent eggs were observed on the surface of groundnut kernel.

In order to observe the influence of environmental factors on the life cycle of the bruchid, a pair of newly emerged adults each were released artificially in twenty cylindrical battery glass jars filled with groundnut pods and kernels, covered with muslin cloth and tightened with rubber bands. The observations were made everyday for different generations during the study period from May to April. Data were collected on fecundity, egg viability, duration of egg, larval period, pupal period, adult longevity, pupation and adult emergence. Simultaneously, weather data like temperature and relative humidity were recorded under ambient laboratory conditions with the help of a thermohygrometer. The data were statistically analysed based on completely randomised design (Panse and Sukatme, 1985) after adopting necessary transformation.

RESULTS AND DISCUSSION

The data related to the influence of environmental factors (seasonal variations) on the biology of Caryedon serratus (Table 1) suggested that fecundity varied significantly throughout the test period with a mean of 22.20 eggs female beetle\(^1\). Each female beetle laid maximum number of eggs (29.20) during November-December when the temperature was 22.66-27.11\(^\circ\)C and relative humidity (RH) was 76\% while, this was minimum (13.20 eggs) during the period from May-June when temperature and RH were 30.77\(^\circ\)C and 76.00\%, respectively. There was a gradual increase in the beetle fecundity with a gradual decrease in temperature from the period May-June to November-December and there after a gradual decrease in fecundity was noticed with a gradual rise in temperature from January-February to March-April. In a similar study Bhogeesh et al. (2012) clearly indicated that the temperature played a critical role in determining the female beetle efficiency to lay eggs. At lower temperatures (<27\(^\circ\)C) female beetle might have good physiological activity with lower metabolic rate for laying maximum number of eggs, but with the increase in temperature (>27\(^\circ\)C) the beetle metabolic rate might have been increased as a result of which metabolic reserves diversion has occurred to meet the respiratory needs of the beetle instead of utilizing them for egg laying. Relative humidity might not have significant effect on the fecundity.

The effect of temperature on the fecundity was also studied by Prasad et al. (2011) who reported that the fecundity, survival rates and developmental time of C. serratus were different at different temperatures and the fecundity of C. serratus reared at 25\(^\circ\)C was highest and it decreased with increase in temperature.

The egg duration differed significantly throughout the test period with a mean of 10.16 days. Beetle took minimum period (4.80 days) for hatching during March-April followed by May-June (5.80 days) indicating the suitability of this period (March to June) for the egg hatching of this pest when the temperature was more than 30\(^\circ\)C and it took maximum period (14.60 days) during January-February when the temperature was 26.76\(^\circ\)C. This indicated that higher temperatures might have hastened incubation period by providing higher metabolic activity within the egg during hot summer period. This incubation period was reported earlier as 9.58 days (Halle et al., 2002), 8.0 days (Devi and Rao, 2005) and 8.16 days (Bhogeesh et al., 2012). Sontakke et al. (1992) recorded minimum egg duration of 5.42 days during March-May and maximum of 14.57 days during December-February. Similarly, Hasansab et al. (2011) reported the average egg period as 6.30, 10.42, 5.48 and 7.12 days at ambient conditions, RH 50\%, 80\% and 90\% at temperature 30\(^\circ\)C, respectively.

Maximum egg viability (58.80\%) was recorded during September-October (25.75-30.73\(^\circ\)C temperature and 71.40-73.11\% RH) as against minimum egg viability (24.80\%) during March-April (26.42-30.41\(^\circ\)C temperature and 76.00\% RH) with a mean of 39.00\% (Fig.2). Egg viability varied significantly throughout the test period. Egg viability was observed to be gradually increased from May-June to September-October and from there after it was gradually decreased and reached to least viability during March-April. This finding clearly indicated that maximum egg viability was noticed at lowest relative humidity (71.40-73.11\% RH).
TABLE 1: Influence of environmental factors on the biology of tamarind bruchid, *Caryedon serratus*

<table>
<thead>
<tr>
<th>Period / Parameter</th>
<th>Fecundity (no. of eggs female)</th>
<th>Egg duration (days)</th>
<th>Egg viability (%)</th>
<th>Larval period (days)</th>
<th>Larval survival (%)</th>
<th>Pupal period (days)</th>
<th>Adult emergence (%)</th>
<th>Adult longevity (days)</th>
<th>Temperature (°C)</th>
<th>Relative humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Minimum</td>
<td>at 7 am</td>
</tr>
<tr>
<td>May-June</td>
<td>13.20</td>
<td>5.80</td>
<td>27.60</td>
<td>19.40</td>
<td>4720</td>
<td>7.20</td>
<td>42.80</td>
<td>12.20</td>
<td>30.77</td>
<td>30.76</td>
</tr>
<tr>
<td></td>
<td>(3.69)*</td>
<td>(2.50)*</td>
<td>(31.66)*</td>
<td>(4.45)*</td>
<td>(43.39)*</td>
<td>(2.76)*</td>
<td>(40.85)*</td>
<td>(3.56)*</td>
<td>31.80</td>
<td>28.93</td>
</tr>
<tr>
<td>July-August</td>
<td>19.00</td>
<td>6.80</td>
<td>31.40</td>
<td>22.80</td>
<td>5540</td>
<td>11.00</td>
<td>63.20</td>
<td>19.00</td>
<td>30.73</td>
<td>25.75</td>
</tr>
<tr>
<td></td>
<td>(4.41)</td>
<td>(2.69)</td>
<td>(34.07)</td>
<td>(4.82)</td>
<td>(48.52)</td>
<td>(3.38)</td>
<td>(52.69)</td>
<td>(4.41)</td>
<td>30.73</td>
<td>25.75</td>
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<tr>
<td>September-October</td>
<td>22.40</td>
<td>10.60</td>
<td>58.80</td>
<td>31.60</td>
<td>5680</td>
<td>11.80</td>
<td>86.60</td>
<td>19.80</td>
<td>30.73</td>
<td>25.75</td>
</tr>
<tr>
<td></td>
<td>(4.78)</td>
<td>(3.32)</td>
<td>(50.06)</td>
<td>(5.66)</td>
<td>(48.93)</td>
<td>(3.49)</td>
<td>(68.58)</td>
<td>(4.50)</td>
<td>30.73</td>
<td>25.75</td>
</tr>
<tr>
<td>November-December</td>
<td>29.20</td>
<td>13.00</td>
<td>47.60</td>
<td>39.80</td>
<td>5520</td>
<td>15.00</td>
<td>84.00</td>
<td>21.20</td>
<td>27.11</td>
<td>22.60</td>
</tr>
<tr>
<td></td>
<td>(5.44)</td>
<td>(3.67)</td>
<td>(43.62)</td>
<td>(6.34)</td>
<td>(47.98)</td>
<td>(3.93)</td>
<td>(66.58)</td>
<td>(4.65)</td>
<td>26.76</td>
<td>24.63</td>
</tr>
<tr>
<td>January-February</td>
<td>27.20</td>
<td>14.60</td>
<td>43.80</td>
<td>49.00</td>
<td>4860</td>
<td>15.00</td>
<td>66.40</td>
<td>21.60</td>
<td>26.76</td>
<td>24.63</td>
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<tr>
<td></td>
<td>(5.26)</td>
<td>(3.88)</td>
<td>(41.43)</td>
<td>(7.03)</td>
<td>(44.19)</td>
<td>(3.93)</td>
<td>(54.62)</td>
<td>(4.69)</td>
<td>30.41</td>
<td>26.42</td>
</tr>
<tr>
<td>March-April</td>
<td>17.20</td>
<td>4.80</td>
<td>24.80</td>
<td>21.00</td>
<td>4340</td>
<td>9.20</td>
<td>41.80</td>
<td>12.80</td>
<td>30.41</td>
<td>26.42</td>
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<td></td>
<td>(4.20)</td>
<td>(2.30)</td>
<td>(29.82)</td>
<td>(4.63)</td>
<td>(41.20)</td>
<td>(3.10)</td>
<td>(40.27)</td>
<td>(3.61)</td>
<td>29.60</td>
<td>25.69</td>
</tr>
<tr>
<td>Mean</td>
<td><strong>22.20</strong></td>
<td><strong>10.16</strong></td>
<td><strong>39.00</strong></td>
<td><strong>30.60</strong></td>
<td><strong>51.10</strong></td>
<td><strong>11.53</strong></td>
<td><strong>64.13</strong></td>
<td><strong>17.77</strong></td>
<td><strong>29.60</strong></td>
<td><strong>25.69</strong></td>
</tr>
<tr>
<td>CD at 5% level</td>
<td>0.22</td>
<td>0.16</td>
<td>1.98</td>
<td>0.18</td>
<td>2.38</td>
<td>0.35</td>
<td>3.40</td>
<td>0.31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Square root values in paranthesis

* Angular transformation values in paranthesis
Sontakke et al. (1992) also reported minimum egg viability during March-May and maximum during September-November.

Significant difference was observed in the duration of larval period throughout the period under testing. Similar trend, like that of incubation period, was observed for the larval period, as there was a gradual increase in larval period until January-February and there after a gradual decrease was noticed. Maximum larval period (49.00 days) was observed during January-February when the temperature ranged between 24.63-26.76°C with relative humidity of 76.00%, while, it was minimum (19.40 days) during May-June, when temperature was 30.77°C and relative humidity was 76.00%. On an average 30.60 days period was required for the larva to go for pupation. Entire larval period was observed to be spent within the groundnut kernel itself. Similarly, Hasansab et al. (2011) reported grub periods of 21.08, 23.08, 20.72 and 19.18 days at ambient conditions, RH 50%, 80% and 90%, respectively. Mean grub development was earlier recorded in the month of March (83.70). The fecundity was adversely affected at extreme relative humidity (60% and 80%) and reported that the total developmental period was 185.30 days at 20°C and 158.30 days at 25°C and 60% RH. The combination of 30°C and 70% RH was proved propitious for egg laying (63.84 eggs). However, optimum combination of 30°C and 70% RH was most conducive for the growth and development giving rise to the highest survival percentage (83.70). The fecundity was adversely affected at extreme temperature of 20 and 30°C. In contrast, the

The adult emergence was lowest during summer period i.e., March-June (<43%) while it was highest during September-December (>84%). Significant variation in the adult emergence was not observed among September-October (86.60%) and November-December (84.00%) months. Adult emergence was observed to be more during monsoon and winter periods (from July-August to January-February) with lower temperature and high humidity. This finding revealed that this period is more congenial for bruchids’ reproduction and multiplication.

Adult longevity differed significantly among the periods of testing. Adult bruchids survived for less time (12.20 and 12.80 days) during summer period (May to June and March-April, respectively) as compared to winter period (21.20 and 21.60 days during November-December and January-February, respectively) with a mean of 17.77 days. The mean duration of female and male adult bruchids was earlier reported to be 30.2 days and 27.4 days (Devi and Rao, 2005) and 74.03 and 80.61 days (Bhogeesh et al., 2012), respectively. Hasansab et al. (2011) also reported the average longevity of adult male was 12.78, 20.98, 14.58 and 13.18 days and adult female was 17.94, 25.44, 17.34 and 15.52 days, respectively at ambient conditions, RH 50%, 80% and 90% at 30°C.

It took 41 days from oviposition until the emergence of fully grown larva. It took 52 days from oviposition until the emergence of fully adult bruchids (one life cycle of the bruchid). Devi and Rao (2005) reported the duration of total life cycle of Caryedon serratus from egg laying to adult emergence as 46 days. Priyanka et al. (2013) found that the beetle took about 35-47 days for completing its life cycle.

An overall analysis of effect of temperature and relative humidity on the developmental period and survival of Caryedon serratus (Olivier) revealed that increasing temperature and relative humidity influenced the bruchid development. This finding was supported by Mishra et al. (2012) who studied on the growth and development of Caryedon serratus (Olivier) at different levels of temperature (20, 25, 30 and 35°C) and RH (60, 70 and 80%) and reported that the total developmental period was minimum (33.50 days) at 35°C and 80% RH and maximum (185.30 days) at 20°C and 60% RH. The combination of 30°C and 70% RH was proved propitious for egg laying (63.84 eggs). However, optimum combination of 30°C and 70% RH was most conducive for the growth and development giving rise to the highest survival percentage (83.70). The fecundity was adversely affected at extreme temperature of 20 and 30°C. In contrast, the
intermediate temperature range of 25 to 30°C was congenial for egg laying. Lower temperature with 60 to 80% RH proved propitious for adult survival.

CONCLUSION
In the present investigation, it can be concluded that seasonal variations acted differently on various stages of life cycle of C. serratus. Female beetles tends to lay maximum number of eggs during November-December which can be stretched up to March. Least incubation period was required when eggs were laid during March-April. As far as viability of eggs was concerned maximum egg hatch was observed in September-October, while March-April was unsuitable period for C. serratus. For larvae, May-June was considered most optimum with least larval duration of 19.40 days followed by March-April (21.00 days). For efficient pupation, July-August was more suitable with 80.40% pupation. May-June was also considered to be the most suitable period for pupal stage where it took a minimum of 7.20 days for completing the pupal stage. For adult emergence, September-December was optimum resulting in maximum number of adults from pupae. The adult longevity was found to be maximum (21.60 days) from January-February.

Overall, January-February was found to be optimum for C. serratus when the temperature ranged from 24.63-26.76°C with relative humidity of 76.00%. Similarly May-June period with considerably higher temperature of 30.77°C and 76.00% humidity was found to be least suitable for this insect. This pest causes maximum storage loss during the period from September to February and hence, good management practices must be undertaken during this period to minimize the storage losses in groundnut.

REFERENCES


