Effect of natural hosts and alternate food sources on the biological parameters of acaraphagous predator, Stethorus rani Kapur

U. AMALA and D. S. YADAV
National Research Centre for Grapes, Pune - 412 307, Maharashtra, India
E-mail: amala.uday@gmail.com

ABSTRACT: Effect of different food sources viz., red spider mites, aphids, pollen, honey and extra floral nectary on the biological parameters of acaraphagous predator, Stethorus rani (Coccinellidae : Coleoptera) was studied. Adult coccinellids fed upon red spider mites, aphids and pollen recorded highest longevity, mean fecundity, egg hatchability and adult emergence rate. The survival rate of larvae and pupae on the natural hosts and honey was statistically superior from the diet consisting of extra floral nectaries and pollen. The study concluded that alternate food containing honey (20 ml in 100 ml distilled water) and pollen (5g) can be used to maintain immature and adult stages of S. rani under in vitro conditions under sub optimal or lesser availability of natural hosts.

Keywords: Food source, Stethorus rani, predator

INTRODUCTION

Red Spider mite, Tetranychus urticae Koch, a polyphagous pest, and is a major sucking pest of grapes causing serious threat to grapevine cultivation in India. The nymphs and adults of the mites suck the sap from the lower surface of the leaves resulting in the development of pale chlorotic spots. The feeding activity of mites causes severe discoloration, removal of chlorophyll thereby affecting the photosynthetic ability of the leaves. Infested leaves presents a burnt up appearance finally withers and dry off. Severe infestation of mites cause delay in the ripening of the berries and reduce the sugar content of the berries (Kulkarni et al., 2008). Several coccinellid species belonging to the genus Stethorus have been documented as the natural enemies of red spider mites (James et al., 2001; Ragkou et al., 2004; Roy et al., 2005; Latifian, 2012). Among them S. rani Kapur is an active native predator of the red spider mites infesting grapes in Maharashtra.

Maintenance of laboratory stock culture of predatory insects is a pre-requisite to study their predatory potential against the target mite hosts and to conduct compatibility studies with recommended chemicals. The survival and fecundity of acaraphagous predator are the important factors to be considered while rearing to assure the continuous supply of the bio-agents for the in-vitro studies. Coccinellid predators feed on a wide variety of non-prey foods like fruits, fungi, pollen, seeds, honeydew (Lundgren, 2009). Adriaens et al. (2008) reported that coccinellid predator, Harmonia axyridis survived in a wide range of habitats and variety of non-prey foods. In this study, an attempt was made to explore the suitability of different natural hosts and alternate foods to rear S. rani and their impact of predator biology so as to standardize the dietary inputs for the in vitro rearing of S. rani in the absence of appropriate mite hosts.

MATERIALS AND METHODS

The present study was undertaken in the Entomology Laboratory of National Research Centre for Grapes, Pune, Maharashtra. The initial stock culture of the S. rani was established by collecting the beetles foraging on the mite colonies in the grape field. The beetles were brought to the laboratory (27-28 °C and 65-70% RH) and maintained in plastic boxes (5x17cm) covered with fine mesh to provide sufficient ventilation to the insects. The experiment was conducted in a Completely Randomized Design (CRD) with five replication of each diet. The treatments included two natural insect hosts viz., red spider mites, Tetranychus urticae Koch, and aphids, Aphis craccivora Fab. and three alternate food sources viz., pollen (5g), honey (20ml in 100 ml distilled water), and extra floral nectaries of bottle gourd (Lagenaria siceraria). Both food sources and water were replaced every day regularly. To obtain eggs, one day old adult beetles (10 female: 10 male) were collected from the stock culture and allowed to mate in a small glass petri dish (9 cm diameter) for 24h provided with the selected five different diets. After 24h, female beetles were separated and kept for oviposition. The eggs were collected daily and kept over sterilized slightly moist filter paper maintained in glass petri dish so as to prevent dehydration of eggs.
Biological parameters of *S. rani*

The number of eggs per replicate was counted for a period of 20 days. The hatching percentage of the eggs was worked out by taking the ratio of the number of hatched eggs by the total number of eggs laid by the adults. The grubs hatching out from the eggs were collected instantaneously using fine brush taken in petri dishes twice a day to avoid cannibalism. Five replicates of predatory larvae (20 larvae per replicate) were taken in petri dishes provided with five different diets. The predatory larvae were observed regularly for the change in instars and formation of pupae. The behavior of pupation, number of survived larvae and pupae were recorded. The survival rate of larvae, pupae and adult emergence rate was worked out. The predator was reared for two generations using the natural and alternate foods.

Statistical Analysis

General Linear Model (GLM) procedures were used to perform the analysis of variance (ANOVA) and the treatments means were compared using Tukey’s Honest Significance Difference (HSD) at 5% level of significance.

RESULTS AND DISCUSSION

The effect of different food sources over the survival and development of immature stages of *S. rani* was presented in Table 1. The mean fecundity of the adults supplied with mites (91.20) was statistically on par with the pollen (F = 76.22; P<0.0001). The number of eggs laid by the adults supplied with aphids was found higher (69.60). Beetles fed with extra floral nectaries recorded lowest mean fecundity of the beetles which was statistically on par with that of honey. The hatching percentage of eggs was found highest in the adults supplied with mites (81.81 per cent) which was on par with the aphids (66.90 per cent) and pollen (65.59 per cent). Beetles supplied with extra floral nectaries recorded higher hatching percentage of 56.92 which differed significantly different from that of honey (F = 24.04; P<0.0001).

Survival rate of larvae and pupae of *S. rani* was found highest in the natural hosts which was on par with that of honey. Grubs supplied with extra floral nectaries and pollen recorded comparatively lower survival rate of the immature stages of the predatory beetle (F = 50.48; P<0.0001). There was significant difference in the longevity of adult beetles supplied with different foods (F = 44.18; P<0.0001) (Table 2). The longevity of the adults was found highest in the insects supplied with mites followed by pollen and aphids and they were statistically on par with each other. The adult beetles supplied with the extra floral nectaries survived 15.60 days followed by the honey (7.20 days). The adult emergence per cent was found maximum in the beetles supplied with natural hosts *viz.*, mites followed by aphids, honey and these three treatments were statistically on par with each other. Extra floral nectaries recorded lower adult emergence rate of 16.67 per cent.

Natural hosts like mites, aphids and artificial food consisting of pollen recorded positive influence over the growth, development and reproductive parameters of the adults. The results are in conformity with the observations made by Sarwar and Saqib (2010) who reported that the predatory coccinellid, *Coccinella septempunctata* L. reared on aphids provided consistent results during the rearing period. The pollen substitute was claimed to be a well-defined nutritive resource rich in protein and amino acids for development and

<table>
<thead>
<tr>
<th>Food Source</th>
<th>Mean Fecundity (days)</th>
<th>Hatching Percentage of Eggs</th>
<th>Larval survival Percentage</th>
<th>Percent Pupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Spider Mites</td>
<td>91.20±8.95&lt;sup&gt;a&lt;/sup&gt;</td>
<td>81.81±4.10&lt;sup&gt;a&lt;/sup&gt;</td>
<td>83.74±5.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>76.99±6.81&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Aphids</td>
<td>69.60±9.24&lt;sup&gt;b&lt;/sup&gt;</td>
<td>66.90±14.46&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>61.00±11.94&lt;sup&gt;b&lt;/sup&gt;</td>
<td>64.48±13.16&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pollen</td>
<td>79.40±9.26&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>65.59±15.32&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>10.00±7.91&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.00±0.00&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Honey</td>
<td>14.00±4.64&lt;sup&gt;c&lt;/sup&gt;</td>
<td>16.45±7.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>75.00±7.91&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>62.30±7.51&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Extra Floral Nectary</td>
<td>29.40±9.56&lt;sup&gt;c&lt;/sup&gt;</td>
<td>56.92±10.98&lt;sup&gt;b&lt;/sup&gt;</td>
<td>31.00±12.94&lt;sup&gt;c&lt;/sup&gt;</td>
<td>22.38±13.44&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>F value (4,16)</td>
<td>76.22P&lt;0.0001</td>
<td>24.04P&lt;0.0001</td>
<td>50.48P&lt;0.0001</td>
<td>58.00P&lt;0.0001</td>
</tr>
</tbody>
</table>

Means followed by same letter do not vary significantly from each other by HSD (0.05)
Effect of natural hosts and alternate food on acaraphagous predator

Table 2. Effect of dietary constituents on the adults of S. rani

<table>
<thead>
<tr>
<th>Food Source</th>
<th>Adult Emergence rate (%)</th>
<th>Longevity of Adults (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Spider Mites</td>
<td>81.74±6.74</td>
<td>24.0±2.36</td>
</tr>
<tr>
<td>Aphids</td>
<td>55.38±2.67</td>
<td>20.6±1.14</td>
</tr>
<tr>
<td>Pollen</td>
<td>0.0±0.00</td>
<td>22.40±1.95</td>
</tr>
<tr>
<td>Honey</td>
<td>66.06±5.67</td>
<td>7.20±2.86</td>
</tr>
<tr>
<td>Extra Floral Nectary</td>
<td>16.67±2.37</td>
<td>15.60±2.70</td>
</tr>
<tr>
<td>F value (4,16)</td>
<td>25.74P&lt;0.0001</td>
<td>44.18P&lt;0.0001</td>
</tr>
</tbody>
</table>

Means followed by same letter do not vary significantly from each other by HSD (0.05)

reproduction of insects (Roulston and Buchman, 2000; Carter et al., 2006; Van der Steen, 2007). The sustained development and reproduction of native coccinellid beetle, Harmonia axyridis (Pallas) provided with pollen diet was reported by Berkvens et al. (2008).

Honey source recorded significant survival rate of immature stages of the beetle. Honey being a rich source of monosaccharides and disaccharides served as vital energy reserve (Pemberton and Vandenberg, 1993) thereby provided better survival rate of immature stages of the predator. Honey and water diet as a convenient food source for survival of coccinellid beetle, Delphastus catalinae was reported by Simmons et al., 2012. Extra floral nectaries recorded better growth and development of immature and adult stages of the predator. Extra floral nectaries as an alternate option to favour the survival and increased fitness of coccinellid predators was reported by Almeida et al. (2011). Predacious coccinellid, Chilocoris kuvuna Silv. foraging upon the pollen and extra floral nectaries under field conditions has been reported by Nalepa et al.(1992). Alternative foods like honey and pollen can be used as a food source that supports the immature stage development and reproduction of adult coccinellid predators. Use of pollen and other plant foods at times when the host insect population is scarce, provides a competitive advantage to the survival of native coccinellid predators of insects. From the present study it can be concluded that, rearing of S. rani in vitro is possible using artificial food sources consisting of honey for the larval stages and pollen for the adults of the predator during the period of scarce availability of natural host insect.

REFERENCES


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