3. MATERIAL AND METHODS

Materials and methodology adopted to achieve various objectives outlined in the scope of this study, during the period of investigation are presented as under:

3.1 Maintenance of S. aptus culture in laboratory

Mass culture of S. aptus was maintained in the laboratory by using the prey mites, O. coffeae as per the method developed by Perumalsamy et al., (2010). To maintain the stock culture different stages of the predator S. aptus (grub, adult, pupa) along with RSM infested leaves were collected from the mite infested tea fields of Tocklai Tea Research Institute (26º47ʹ N latitude, 94 º 12ʹ longitude) and maintained in the laboratory at room temperature (25 ± 2°C, 75 ± 5% RH and 16L: 8D photoperiod).

Newly emerged adult male and female beetles were collected and placed in a small Plexiglas box (3.5cm X 2cm) for mating and egg laying. At the bottom of the box moist cotton pad was placed on which mite laden mature tea leaves of 3cm² were placed to retain their moisture. The box was covered with fine muslin net to provide sufficient ventilation.

After mating, the females were transferred to separate containers and allowed them to lay eggs on the surface of mite infested leaves. The egg laden leaves were then removed periodically and placed in separate containers for hatching. The larval instars after hatching were provided with mite infested tea leaves for feeding until they undergo pupation. The pupae were collected from the containers and kept separately for the emergence of the adults. The cycle was repeated to produce a mass culture of the the
predatory beetle for carrying out all experiments. All the developmental stages of the beetles were collected and handle with the help of a fine tipped camel hair brush.

Plate 3.1 - Photograph showing rearing of *S. aptus* under laboratory condition.
Plate 3.2- Photograph showing adult and grubs of *S. aptus* feeding on RSM in tea field
3.2 Maintenance of *O. coffeae* culture in laboratory

A culture of RSM was maintained in the laboratory following the detached leaf culture method of Roy *et al.*, 2010. Pure culture of RSM was maintained by collecting adult mites from the tea fields of Tocklai, Jorhat. Fresh mature tea leaves (6cm$^2$) of one of the susceptible clones TV1 clone were used for culture purpose. The tea leaves were placed on water soaked cotton pads (ca 1.5 cm thick) in plastic trays (42×30×6.5 cm) with their top surface facing upward. The red spider infested leaves were cut into small pieces and placed on the new leaves arranged in the trays. Rearing trays were kept under controlled conditions (temperature 25 ± 2°C, relative humidity 75 ± 5 %, and photoperiod 16L: 8D h). Water was added to the rearing trays as and when necessary to keep the cotton moist and thereby prevent the leaves from dying. Withered leaves were replaced with new ones at regular interval of four days.
Plate 3.3 – Photograph showing rearing of RSM by leaf culture method under laboratory condition
3.3 Evaluation of predatory potentiality of S. aptus against RSM.

Predation is an important component of ecological aspects as it regulates the populations on which they feed. Experiment on feeding preference of each stage of the coccinellid predator S. aptus against RSM was conducted in the laboratory following the methods of Sattar et al., 2007. Plexi glass box of 3.5cm in breadth and 2cm in length were used for the observation of daily consumption by S. aptus. The lid of the glass boxes were perforated with small pores and was covered with a fine mesh cloth so that the small larval instar cannot drive out from the small pores to the outside and also get proper ventilation for survival.

3.3.1 No-choice feeding of S. aptus on red spider mite

In order to find out the predatory efficiency of S. aptus in no-choice condition, different life stages of RSM (eggs, larva, nymphs and adults) were offered separately. Matured tea leaves collected from the field and leaflets of 4cm² cut from the whole leaf should be used for the experiment. Each life stages of RSM (100 numbers) were transferred from the mite infested leaves using a fine camel hair brush individually onto the leaflets. First instar larva of S. aptus were released onto each leaflets. The leaflets with prey and predator were placed on wet cotton kept in a petridish (9 cm dia) and covered with fine muslin cloth and placed in an environmental chamber (EYELA FLI-2000) at 25±2°C, 75±5% RH and 16L:8D photoperiod. Instar wise predatory potential was assessed by examining the leaflets at 24 h interval. The RSM used in the experiment was taken from original laboratory culture to make sure of the same age.
Daily consumption by each instar of *S. aptus* was recorded at 24 h interval. Presence of cast cuticles of *S. aptus* grub was examined to confirm the developmental stages and the number of prey consumed during each larval instar was recorded. To maintain the original prey density fresh set of RSMs were provided on a daily basis to the predator. Each experiment was replicated five times.

### 3.3.2 Free choice feeding of *S. aptus* on RSM

To assess the predatory efficiency of *S. aptus* in a free choice condition, different life stages of RSM were offered together. Leaflets of 4cm² cut from the whole leaf should be used for the experiment. 50 numbers of each life stages of RSMs were provided to the newly hatched *S. aptus* larvae in the leaflet arranged as described above. For 2nd and 3rd instar larvae the total number of RSM life stages provided per day was 150. The daily consumption of different instars of *S. aptus* on a variety of prey stages were observed at every 24 h interval under stereomicroscope by subtracting the number of *O. coffeae* individuals left in the cage. The experiment was replicated five times.

**Statistical Analysis** - Data on the predatory potential of *S. aptus* was determined by analysis of variance (ANOVA) and means were separated by Tukey’s multiple comparison test.

### 3.3.3 Impact of temperature on predator potentiality

To study the influence of temperature on predatory efficiency of *S. aptus* the experiment was conducted in three temperatures (21°C, 27°C and 32°C) under laboratory condition.
The selected temperatures reflect the thermal condition which is generally experienced by the predator in different field crops in temperate areas. Hundred numbers of RSM adults were introduced onto the leaflet arranged in petriplate as described above. The experiment was conducted with one day old third instar larva and adults of *S. aptus*. Both were starved for 3h and were released individually in the plates. Each experiment was replicated five times. After 24h number of red spider mite consumed was recorded. Data were subjected to ANOVA and means were separated by Duncans multiple range test.

### 3.3.4 Influence of predator densities on the predatory efficiency

Experiment was carried out to know the effect of different predator prey densities on the efficacy of *S. aptus* against RSM on tea. A constant number of RSM adults (200nos) were transferred to the leaflets with a fine camel brush. To each mite laden tea leaf adults of *S. aptus* were offered at a ratio of 1:200, 2:200, 3:200 and 4:200. The study was also conducted using third and fourth instar grub at a predator prey ratio of 1:100, 2:100, 3:100 and 4:100. The experiment was conducted in petridish lined with moist cotton pad in completely randomized design (CRD). Control was maintained where 200 and 100 adult mites without any predator. Each experiment was replicated five times and observations on the number of prey consumed were worked out after 24h. The optimum ratio of predator was also determined in green house to test the potentiality of *S. aptus* as a biocontrol agent of RSM. Young tea plants of 4-5 month old were obtained from the nursery of Tocklai Tea Research institute and inoculated with
100 mixed stages of RSM. One day old second instar larvae was released onto each plant at a density of 1,2,3,4 per plant in such a way that the ratio of *S. aptus* larva should be 1:100, 1:50, 1:33, and 1:25 predator prey ratio. Plants with 100 mixed stages of RSM without predator was kept individually as control. Each experiment was replicated three times. The experiment was terminated after seven days and count the number of RSM left in each treatment. The data obtain from different experiment were subjected to analysis of variance (ANOVA) and means were separated by Tukey’s multiple comparison test.

Plate 3.4- Study the feeding potential of *S. aptus* at different predator density under laboratory condition
3.3.5 Functional response study of *S. aptus* to different prey density of *O. coffeae*-

The functional response is one of the most important aspects in the dynamics of a predator-prey relationship, and is a major component of population models (Berryman 1992, Schenk and Bacher 2002). To find out the prey consumption rate by the predator at different prey densities, and the influence of prey stage on the functional response of the predator, the mites were provided in the experimental plate periodically. The experimental arena consisted of fresh mature tea leaf placed on moist cotton in Petri plates. Experiment on functional response of different larval instars and adult male and female of *S. aptus* was carried out in the laboratory at 25°C and 75 ± 5% RH. The larvae and adults were starved for 6 hours before the experiment was initiated to minimize individual hunger levels as suggested by Nakamura (1977). The experiment was set up with six different densities of adults i.e. 10, 12, 24, 48, 60 and 80 for all the stages of *S. aptus*. To study the functional response of *S. aptus* against eggs of red spider mite the experiment was set up with 20, 40, 80, 120, 160 and 200 densities of eggs respectively. Egg stage was preferred for functional response study because it comprises the major proportion of mite population. Different predator stages, the first, second, third and fourth-instar larvae and adult (< 24 h old), of *S. aptus* were individually transferred with a fine camel hair brush onto the leaf. Each experiment was replicated five times.

Data analysis
Data were analyzed in Microsoft Excel (http://www.microsoft.com/). To describe the functional response of *S. aptus* to different prey densities the various parameters were put in the Holling disc equation (Holling 1959a),

\[ \frac{Na}{P} = \frac{aNT}{1 + aThN}, \]

where

- \( Na \) is the total number of prey consumed per predator (\( P \)) during a specific period of time (\( T \))
- \( N \) is the initial density of the prey
- \( T \) total time in days when prey was exposed to the predator,
- \( A \) is rate of successful attacks
- \( Th \) is the time required to handle each prey by the predator handling time is defined as the time that the predator requires to pursue, kill, and digest the prey (Holling 1963).

The parameters \( a \) and \( Th \) were calculated using a linear regression technique where \( \frac{1}{Na} \) was regressed on \( \frac{1}{N} \). \( a \) is the reciprocal of the slope and \( Th \) is the intercept. The \( a/Th \) value indicates the effectiveness of predation. Maximum predation rate (\( K \)) was calculated as \( T/Th \).
Plate 3.5- Photograph showing the functional response study of S. aptus at different prey density

3.3.6 Numerical response study of S. aptus to different prey density of O. coffeae-

The numerical response of S. aptus to various densities of O. coffeae was conducted in terms of number of eggs laid by an individual predator to the rate of prey attack. For the experiment, freshly emerged male and female predatory beetles (one of each) were selected at random from the stock culture and introduced into a small plastic plexiglass box. After mating the female beetles were transferred to the boxes with a fine brush which were confined with mite laden leaf discs. The number of adult mites introduced in the leaf discs was at a density of 20, 40, 60 and 80 to study the numerical response of S. aptus. Each treatment was replicated ten times. The experiment was repeated for seven consecutive days.

The number of prey consumed and number of eggs laid by the predator in each prey density was counted every day. Daily consumption was
calculated by deducting the number of prey individuals left from the number of individuals brushed in the box and were replaced daily from the stock culture to maintain the original number of prey in each treatment. The number of egg laid by the predator in different prey density was counted daily and was removed from the experimental boxes every day.

The results of numerical responses and oviposition at different prey density were fitted to regression equations. The regression model whose $R^2$ value was closer to 1 was selected to fit the data.

3.4 Study of seasonal population dynamics of *S. aptus*

3.4.1 Study area and sampling

All the experiments were performed in the field of Tocklai Tea Research Institute, Jorhat, Assam (26º47ʹ N latitude, 94 º 12ʹ longitudes). To know the seasonal incidence of *S. aptus* in tea, field investigation was carried out for a period of one year from January to December 2013 following the method of Perumalsamy *et.al.* 2010. The experimental plot consists of 300 tea bushes which are further divided into three subplots (A, B and C) each consisting of 100 bushes. To maintain a normal environmental condition application of insecticide was avoided during the period of the study. To assess populations of *S. aptus* and *O. coffeae*, sampling was conducted at fortnightly interval for a period of one years. Twenty five leaves were selected randomly from each plot. Leaves collected from the three sub plots were placed in plastic bags separately and brought to the laboratory. Different developmental stages of
S. aptus and O. coffeae were counted under stereomicroscope (LEICA EZ4D) using 8 x magnifications. Weather parameters during experimental period were obtained from the metrological division of Tocklai Tea Research Institute. Correlation coefficients were worked out between meteorological data and population of predator and also between predator and their prey population.

Plate- 3.6 Photograph showing: (A) the study area, (B). Observation of pest and predator in the study area
3.5.1 Lifecycle and morphometric observation of S. aptus

Biological study of S. aptus and its morphometric observations were carried out under laboratory condition at room temperature in different season of the year. Adults of S. aptus of both sexes were collected from the stock culture and confined in plexiglas box, covered with a lid which was perforated with small pores for proper aeration. In each box sufficient amount of food was supplied regularly. This experiment had comprised of ten replications.

All biological parameters including egg incubation, larval and pupal period (days), pupal and adult survival, longevity of male and female (days), were recorded daily.

**Egg:** Freshly laid eggs were isolated from the boxes and placed in separate petri dishes and individually examined under a stereo-zoom microscope (EZ4D) at 10 x magnifications to note length and width as well as other morphological characteristics. The time taken from egg laying to hatching was considered as incubation period. To record the same a total of fifty eggs in ten replications were taken for the study.

**Grub:** Newly hatched grubs were isolated with the help of a camel hair brush. To avoid cannibalism, newly hatched (2 h old) larva was kept singly in separate boxes and maintained in 10 replications by providing with the red spider laden leaf as food. The first as well as the subsequent instar larvae were also observed under the microscope to record their morphological characteristics. With the development of the instars the amount of food consumption also gradually increased. The duration of various larval instars were observed on the basis of emoulted skins of instar and differentiated the
instars by observing the head capsule. The duration of development from egg hatching to pupation was considered as the larval period.

**Pupa:** The larvae which are transformed into pupae were isolated and were kept separately in petri dishes till adult emergence and observations were recorded twice a day at morning and evening. The time taken from pupa formation to adult emergence was regarded as pupal period.

**Adult:** The newly emerged adults of both sexes were kept in petri dishes individually and provided with sufficient number of mite for feeding. Observations were made regularly on longevity of adult male and female in days.

Parameters like pre oviposition period, oviposition period, post oviposition period, egg laying /female/ day, fecundity, sex ratio and measurement of egg, larva, pupa and adults were recorded. The time after emergence of adults and start of egg laying was considered as pre-ovipositional period, the period of egg laying was considered as oviposition and post-oviposition period of female was recorded as period between the days of female ceased egg laying to the day of death. To study the percent hatchability, eggs were harvested in Plexiglas box and kept for hatching.

### 3.5.2 Mantainence of *S. aptus* on alternative food sources

An experiment was carried out to study the longevity and oviposition of the predator *S. aptus* feeding on different alternate food sources under laboratory condition. The experiment was conducted in a completely randomized block design with ten
replication for each food source. The rate of predation on different food sources by *S. aptus* adult were observed after 24 h interval. Adult longevity, fecundity and egg hatchability of *S. aptus* were assessed on alternate food source. The following alternate foods were used to perform the experiment.

1. No food (starvation).
2. Honey droplets.
3. Pollen
4. Pollen + honey droplets

In treatment 2 and 4, honey was diluted with water in a ratio of 3:1 (v/v) and supplied through a cotton pad placed on the periphery of the plexiglass box. These cotton pads were changed every second day to make it moist and also to avoid contamination.

### 3.5.3 Life table study of *S. aptus*

To know the developmental, survival, fecundity and age specific survival rate of *S. aptus* fed on *O.coffeae*, life table study was carried out in laboratory condition. Life table study of a predator is essential before utilized it in integrated pest management programme. To carried out the experiment males and females of *S. aptus* were randomly taken from the stock culture and maintained on tea leaflets infested with RSM for oviposition in plexiglass boxes. The boxes were closed with a perforated lid to prevent escape of the beetles. The egg laden leaves were then placed in a petridish (9.5 dia.) containing cotton pad soaked with water. Number of eggs laid by each beetle was counted. A group of 100 eggs were used to study the life table of *S. aptus* under
laboratory conditions at 25±2°C, 70-75% RH. The data were recorded daily on egg hatching and number of individuals surviving at each stage until all stages emerged into adults. Each female was kept separately on the fresh mature tea leaflet where a male was also offered to assist fertilization. Five pairs of male and female were selected randomly and transferred into separate container for life table and fertility table study. The data on number of eggs d⁻¹ and number of eggs female⁻¹ were observed daily until the death of the adult. Parameters considered for life table study like the age specific fecundity, age specific survival rate, gross reproductive rate, intrinsic rate of natural increase (rm), net reproductive rate, mean generation time and finite rate of increase at 25±2°C were determined according to Birch (1948), Deevey (1947) and Southwood (1978). Doubling time was determined according to Mackauer (1983). The net reproductive rate (R₀) indicates the rate of population multiplication in each generation, which is measured in terms of number of females produced per generation, \( R₀ = l_x m_x (\sum l_x m_x) \). Mean length of generation time (Tc) is the mean time from birth of parents to birth of offspring. The precise value of mean length of a generation was calculated using the formula, \( Tc = (\sum l_x m_x)/ R_0 \).

The arbitrary value of innate capacity for increase \( (r_c) \) was calculated from the following formula, \( r_c = (\log_e R_0)/TC \). This is the arbitrary value of \( r_m \). Innate capacity for increase \( (r_m) \) is the maximal rate of increase attained by a population of a particular organism at any particular combination of environment and expressed as the number of females per day and calculated using the formula, \( \sum e^{-rm} xl_x m_x = 1 \), where, \( x \) is age of
the individual in days, \( l_x \) is number of individuals alive at age \( x \) as a proportion of one; \( m_x \) = number of female offspring produced per female in the age interval \( x \). The value for \( x, l_x \) and \( m_x \) were taken from the data on fecundity.

Corrected generation time \( (T) \) was calculated using the following formula, \( T = \frac{\log_e R_0}{r_m} \). Finite rate of natural increase \( (\lambda) \) is the multiplication per female in unit time of population with stable age distribution. This was calculated as \( \lambda = \text{antilog } e^{m} \).

Weekly multiplication of the population \( (W_m) \) was calculated by using the formula, \( W_m = (e^{m})^7 \). Doubling time \( (Dt) \) is defined as the time in days that was required by a population to double in number (Campbell and Mackauer, 1975) and was calculated using the formula, \( Dt = \frac{\log 2}{r_m} \).

### 3.6 Study on the mass culture of \( S. aptus \)

For the purpose of the mass culture of the predator \( S. aptus \), different artificial diets were tried and observations were made on its longevity and survival rate under laboratory conditions. The initial stock culture of \( S. aptus \) was maintained by collecting the adult beetles from the tea fields of Tocklai Tea Research Institute. The beetles were brought to the laboratory, nourished with mite laden leaf and placed in plastic boxes (5x17cm) covered with fine muslin cloth to provide sufficient ventilation.

From the stock culture, newly emerged adults were kept in separate containers in pairs (male and female) and provided with different combinations of artificial diets (Table 3.1). Similar diets were also provided to the different developing stages from first instar
grub of the predator. All the nutritional ingredients for diets were procured from the local market. The composition of the diets was as follows:

Table 3.1: Different combination of artificial diets used for mass rearing of *S. aptus*

<table>
<thead>
<tr>
<th>Diets</th>
<th>Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet 1</td>
<td>Casein (60 g) + Glucose (40 g) in 250 ml of water</td>
</tr>
<tr>
<td>Diet 2</td>
<td>Protinex (40 g) + Yeast (30 g) + Honey (20 ml) + Glucose (10 g) in 250 ml of water</td>
</tr>
<tr>
<td>Diet 3</td>
<td>Yolk (25 ml) + Milk (50 ml) + Honey (25 ml)</td>
</tr>
</tbody>
</table>

Diets were provided in cotton swabs stuck on the periphery of the rearing container and replaced daily with fresh diet to avoid contamination. The experiment was conducted in a Completely Randomized Design (CRD) with five replications for each diet. The same type of diets was provided to the adult and grub continuously from the day of emergence until death. Pure water was also given in cotton swabs in addition to the diets, as described by Krishnamoorthy (1984). The adult-rearing containers were checked periodically and data on the larval duration and adult longevity were recorded.

3.7 Studies on the effect of pesticides against *S. aptus*

3.7.1 Adulticidal bioassay

Adults of *S. aptus* were collected from the tea fields of Tocklai Tea Research Institute and maintain a laboratory culture by providing natural host in small containers. The
The toxicity of pesticides to *S. aptus* adults and larval instars were evaluated with the laboratory cultured population. Three commonly used acaricides were selected to study the bioassay under laboratory condition at recommended doses. The name and chemical class of the tested acaricides were listed below.

**Table 3.2: Names of Insecticide tested against *S. aptus* under laboratory conditions.**

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Name of the chemical</th>
<th>Dilution</th>
<th>Chemical nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Propargite 57 EC</td>
<td>1:400</td>
<td>(250ml in 100 L)</td>
</tr>
<tr>
<td>2</td>
<td>Bifenthrin 8 SC</td>
<td>1:1600</td>
<td>(62.5ml in 100 L)</td>
</tr>
<tr>
<td>3</td>
<td>Hexythiazox 5.45 EC</td>
<td>1:2500</td>
<td>(40ml in 100L)</td>
</tr>
</tbody>
</table>

The toxicity of pesticides on the larval instars was assessed using the filter paper method. An amount of 0.5 ml of each tested pesticide solution was added on what man filter paper placed in glass petri plate of 90 mm diameter. Now five numbers of one day old larval instar grub were placed in each petriplate for five minutes. Each pesticide was sprayed in their recommended dose and the control sample was treated with water only. The larvae were then transferred from the petriplate using a soft brush onto red spider laden tea leaf disc placed in plexiglass box. The experiment was replicated six times and each replication contains five grubs. The numbers of live grubs were counted after 4h, 6h, 12h and 24h of treatment. Individuals displaying coordinated movement
were considered as alive while mortality was determined by the failure to move when larvae were probed by a smooth camel hair brush. The data were expressed as per cent mortality of grub at each treatment, in relation to untreated control using Abbott’s formula (Abbott, 1925).

The effect of pesticide was also evaluated against the adults of *S. aptus*. The adults were placed in a petriplate and each treatment and control (distilled water) was sprayed from a distance of 25 to 30 cm on the surfaces of the beetle using a glass atomizer (constant pressure 2.5 kg/cm2). Each treatment was replicated six times with five adult beetles per replication. Mortality of the predators on both treated and control plates were recorded after, 6h, 12h 24h and 48h of treatment and corrected mortality was worked out by using Abbott’s (1925) formula. The percent mortality was subjected to analysis of variance (ANOVA).

### 3.8 Studies on the effect of aqueous extracts of certain plants on *S. aptus* mortality

Alternation of chemical pesticides with bio-rational insecticide is universally accepted for sustainable production. Among the various approaches that are available today, the effective utilization of natural resources for pest management gain special attention (Prakash and Rao 1997). In and around tea plantations a number of botanical plants are available. Most of the native botanicals have effective pesticidal, ovicidal and antifeedant properties (Schoonhoven 1982; Schmutterer 1990). Therefore a study was carried out to find out some botanicals having acaricidal properties and their effect on
non target organisms like predator of RSM for future use in pest management programme.

3.8.1 Collection and Preparation of Extract- Leaves of certain medicinal plants such as *Nyctanthes arbor-tristis* L. (Oleaceae), *Phlogacanthus thyrsiformis* Nees (Acanthaceae) and matured fruits of *Sapindus mukorossi* L. (Sapindaceae) were collected from their natural habitats from different areas of Jorhat (26°45′18.5″N, 94°12′32.4″E), Assam. All the leaves and mature fruits were shade dried and pulverized to a powder in an electric blender and the powder was used for the preparation of aqueous leaf extracts. Different quantities (20, 40, 60 and 80 g) of the *N. arbor-tristis*, *P. thyrsiformis* and *S. mukorossi* powder were weighed separately into plastic containers (2l capacity) containing 1l of distilled water to make 2, 4, 6 and 8% w/v concentration. All the spray fluids (treatment and untreated control) were mixed with three drops of teepol (Teepol-AG®), National Organic Chemical Industries Limited, Mumbai, India) by a needle tip to give the extracts a slightly sticky characteristic.

3.8.2 Effect of Aqueous Extract- To find out the anti insect properties of crude aqueous extracts to red spider mite and *S. aptus*, a direct spray test was carried out following the method of Haider *et al.*, (2010). Mature tea leaves of TV1 clones were collected from the experimental plot and washed thoroughly with distilled water and air dried. Three tea leaves cut into 4cm diameter disc for each treatment and dipped for upto five seconds in the solutions to ensure complete wetting. Thereafter the treated
leaves were kept under ceiling fan for 15 minutes to evaporate the emulsion. Water soaked cotton pad were placed over the petriplate and placed the treated leaf disc on it with its ventral surface down. Twenty adult mites were released on each leaf disc with a camel hair brush. Each treatment was replicated five times. Mite mortality was recorded after 24 hour interval.

To study the toxicity of the plant extracts on the predator, five adults of *S. aptus* (24 h old) and third instar larvae (freshly emerged) were placed in Plexiglass box (2 x 3.5 cm), lined with filter paper (Whatman No. 1). Larvae and adults were sprayed with 2, 4, 6 and 8% crude aqueous extracts along with control (water + teepol) using a glass atomizer (constant pressure 2.5 kg/cm²). There were five replicates for each treatment. After treatment, larvae and adult were transferred individually to clean sealed Plexiglass box (2 x 3.5 cm) lined with a moistened (Whatman No. 1) filter paper with perforated lids fitted with small piece of cloth for proper aeration. Both larvae and adults of *S. aptus* were provided with known number of preys (RSM) daily on strips of fresh matured tea leaves