Evaluation of Some Plant Origin Commercial Biopesticides against Red Spider Mite, *Oligonychus coffeae* Nietner (Acarina: Tetranychidae) in Tea

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Abstract An experiment was conducted to evaluate some plant origin commercial biopesticides against red spider mite in tea under both in the Entomology Laboratory and main farm of Bangladesh Tea Research Institute (BTRI), Srimangal, Moulivibazar during the period from March 2013 to December 2014. Bio-Cawach (*Pongamia pinnata*), Karanza (*Azadirachta indica* + *Pongamia pinnata*), Miticon (Various herbs, alkaloids and salt of fatty acids), Neemakar (Neem, Karanja & Tulsi), Rescue (*Vitex negundo* + *Clerodendron infortunatum*) and Torpedo (*Sophora alopecuroides* + *Stemona sessilifolia*) were considered as treatments and dosages were @ 0.8 ml, 1.0 ml, 1.0 ml, 0.5 ml and 0.5 ml, respectively. Data were collected at 24 HAT, 48HAT, 72HAT (Hours after Treatment) in the laboratory and at weekly interval in field condition. Results indicated that all the biopesticides showed the toxic effect on red spider mite in tea and significantly reduced mite population both in laboratory and field conditions. In laboratory condition, Miticon showed the highest (93.28%) toxic effect at 72HAT followed by Karanza (92.55%) against red spider mite where as Bio-Cawach, Neemakar, Rescue and Torpedo exhibited pronounced acaricidal action (89.78%~91.67%) at 72HAT. Similar trend of toxicity was found at 24HAT & 48HAT. The mortality was in a linear trend i.e. increasing with increasing of time. From the field evaluation, it was found that the highest (81.34%) reduction in mite population was observed in Miticon treated plot followed by Rescue treated plot (81.01%). The lowest (74.07%) reduction in mite population was observed in Bio-Cawach treated plot. The order of toxicity of the six plant origin commercial biopesticides on adult red spider mite in both laboratory and field condition was: Miticon>Rescue>Neemakar>Karanza>Torpedo>Bio-Cawach. Application of the tested biopesticides did not affect the natural predators such as *Stethorus gilvifrons* and *Oxyopes* sp. Tea samples made from biopesticide-treated shoots were found taint free when subjected to organoleptic evaluation. These eco-friendly low cost plant products can therefore be incorporated in the strategy of integrated pest management (IPM) to reduce the load of chemical pesticides in tea.

Keywords Tea; Red Spider Mite; *Oligonychus coffeae*; IPM; Plant Products; Biopesticides

Introduction Tea, a popular health beverage in the world, is produced from the leaves of evergreen shrub *Camellia sinensis* L (O Kuntze). It is a perennial crop grown under monoculture on large contiguous areas providing favourable conditions for a variety of pests. Tea plants are subjected to the attack of several pests such as insects, mites and nematodes. In world tea, 1034 species of arthropods and 82 species of nematodes are associated with tea plants (Chen and Chen, 1989). In Bangladesh tea, so far 25 insects, 4 mites and 10 species of nematodes have been recorded (Ahmed, 2005). Among them, Tea mosquito bug, Red spider mites & Termites are the major pests in mature tea plantation; while Aphids, Jassids, Thrips, Flushworms and Nematodes are the major pests in nursery and young tea plantation (Mamun and Ahmed, 2011). Mite pests are the notorious pests of many agricultural crops over the world. More than 60,000 species of mites have been described from various regions of the world (Evans, 1992). Red spider mite, *Oligonychus coffeae* Nietner (Acarina: Tetranychidae) is one of the major and serious pests of tea in all most all tea producing countries of south-east Asia and African countries. Hundreds of spider mites are found on the upper and undersurface of every tea leaf, together with
thousands of eggs (Ahmed, 2005). Red spider mites are responsible for depredation of yield and debilitation of tea plants causing considerable crop loss. It has been estimated that 9.57% crop loss occurred due to this pest (Ali et al., 1994). Most of the valley circles reported severe infestation of red spider mites, which are more prevalent and alarming round the year for the tea industry (BTB, 2014). The larvae, nymphs and adult mites cause the damage. When the infestation is severe in hot and dry weather, the whole leaf changes to a bronze color as a result of feeding on chlorophyll of leaves and the infested plants defoliate (Sana, 1989). It may also be mentioned here that the red spider mite prefers mature leaves, and young leaves are not normally attacked, but in severe outbreaks when the growth of the bushes checked, particularly under conditions of drought, both young and mature leaves may be equally attacked. Thus, drought accelerates the mite infestation in tea plantation. Nowadays, drought is a common phenomenon and therefore, infestation of red spider mite is emerging threat to the tea industry of Bangladesh.

To combat this mite problem different groups of pesticides have been used in the tea fields since 1960. Pesticides such as Sulphur, Ethion, Quinalphos, Propargite, Abamectin, Dimethoate, Fenvalerate, Fenpropathrin, Fenazaquin, Bifenthrin, Hexythiazox, Spiromesifen and Fenpyroxymate etc. are the commonly used miticides for the control of red spider mite in tea plantation in Bangladesh (Mamun et al., 2014). Indiscriminate use of chemical pesticides may render the tea unsuitable for consumer & trade due to residual effect and increase the cost of pest management by developing resistance in the pest. In order to search an environmentally safe alternative, scientists considered the pesticides of biological origin in the place of synthetic pesticides. Replacement of synthetic insecticides by bio-rational insecticide is a universally acceptable and practicable approach worldwide (Rathi and Gopalakrishnan, 2006). Current trends in eco-friendly insect pest-management practices emphasize on the preparation and application of new botanical and microbial pesticide formulations, mass rearing techniques for biocontrol agents, evaluation of field bio-efficacy and conservation of biological agents, cultural control measures, genetic techniques in pest and vector management, and pheromone attractants and repellents (Mamun and Iyengar, 2010). In this context, biopesticides are being considered as environmentally safe, selective, biodegradable, economical and renewable alternatives for use in IPM programmes in tea.

Biopesticides are natural plant products and may be grown by the planters with minimum cost and extracted by indigenous methods. Biopesticides are secondary metabolites, which include alkaloids, terpenoids, phenolics etc. It is estimated that the plants may contain as many as 4000,000 secondary metabolites. Botanical products are environmentally safe, less hazardous, economic and easily available. Certain products derived from indigenous plants are used for tea pest control. The pool of plants possessing insecticidal substances is enormous (Kabaru and Gichia, 2001). Today, over 2000 species of plants are known to possess some insecticidal activity (Jacobson, 1989). As many as 2121 plant species have been reported to possess pest control properties; 25 of these plants species possess the characteristics required for an ideal botanical insecticide and are therefore more promising for use in organic pest control programmes (Radhakrishnan, 2005). Botanicals like neem, ghora-neem, mahogoni, karanja, adathoda, sweet flag, tobacco, derris, annona, smart weed, burweed, datura, calotropis, bidens, lantana, chrysanthemum, artemisia, marigold, clerodendrum, wild sunflower and many others may be grown by planters with minimum expense and extracted by indigenous methods (Mamun and Ahmed, 2011). These botanical materials can be used as an alternative to chemical pesticides. This will be very helpful in minimizing the undesirable side effects of synthetic pesticides. A few works have been done on some indigenous plant extracts for the control of red spider mite in tea. But no work has been done on commercially formulated plant products against red spider mite in tea in Bangladesh. Based on the foregoing, the present study was undertaken to evaluate the some plant origin commercial biopesticides i.e. Bio-Cawach (Pongamia pinnata), Karanza (Azadirachta indica + Pongamia pinnata), Miticon (various herbs i.e. alkaloids and salt of fatty
acids), Neemakar (Neem, Karanja & Tulsi), Rescue (Vitex negundu + Clerodendron infortunatum) and Torpedo (Sophora alopecuroides + Stemona sessilifolia) against red spider mite, Oligonychus coffeae in tea.

Materials and Methods
An experiment was carried out to evaluate the bioefficacy of some plant origin commercial biopesticides against red spider mite Oligonychus coffeae Nietner (Acarina: Tetranychidae) infesting tea under both in the Laboratory and main farm of Bangladesh Tea Research Institute (BTRI), Srimangal, Moulovibazar during the period from March 2013 to December 2014. The red spider mite was collected from different sections of BTRI main farm and reared in the Entomology Laboratory, BTRI, at 27–30°C temperature, 70%–80% relative humidity and 16:8 hours light: dark photoperiod on a susceptible tea clone, BT2 by following detached leaf culture method of Helle and Sabelis (1985) with slight modifications.

The test materials
Formulations of six commercial plant origin biopesticides viz., Bio-Cawah, Karanza, Miticon, Neemakar, Rescue and Torpedo were collected from different multinational companies (Table 1).

Short descriptions of the commercial biopesticides are enumerated below:
Bio-Cawah (Pongamia pinnata)
Bio-Cawah is a modern biopesticide based on botanical extract of Karanja (Pongamia pinnata). Karanjin is the active ingredient and is formulated as 4% emulsifiable concentrate (EC) i.e. 40,000 ppm. It kills by choking the nervous system & gives prolonged control. It is eco friendly, effective, economical & knock down extract. It is compatible with all conventional fungicides & insecticides (Anonymous, 2011).

Karanza (Azadirachta indica + Pongamia pinnata)
Karanza is a plant based broad spectrum pesticides including insecticide, acaricide, nematicide, fungicide and bactericide activity. It is composed of Neem (Azadirachta indica) and Karanj (Pongamia pinnata) together in farmer friendly EC formulation.

Miticon (various herbs, alkaloids and salt of fatty acids)
Miticon is a broad spectrum eco-friendly pest controller containing extracts of various herbs (alkaloids) and salt of fatty acids, which are very helpful in controlling a wide range of sucking pests. The product is excellent against red spider mites and other mites in tea. Miticon kills the pest by contact as well as by stomach poison. It helps in removing the toxicity of pest infestation. It is bio-degradable & does not leave residue in made tea (Anonymous, 2011).

Neemakar (Neem, Karanja & Tulsi)
Neemakar is a unique composition of Neem, Karanja & Tulsi supplied by Shakti Biotech, India. It is effective against all types sucking & chewing pests. The active ingredient is 23000 ppm herbal extracts. It disturbs the life cycle of pest by acting as antifeedant, repellent & anti-ovipositor. No insect can develop resistance against it. It also acts as insect growth inhibitor (Anonymous, 2011).

Rescue (Vitex negundu+Clerodendron infortunatum)
Rescue is a powerful botanical formulation with instant result to control red spider mites and other mites. Rescue is the most modern botanical composition of Indian Perivet Tree (Vitex negundu) and Hill Glory

<table>
<thead>
<tr>
<th>Commercial Name</th>
<th>Technical Name</th>
<th>Manufacturer/Supplier Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bio-Cawah</td>
<td>Pongamia pinnata</td>
<td>Shakti Biotech, India</td>
</tr>
<tr>
<td>Karanza</td>
<td>Azadirachta indica + Pongamia pinnata</td>
<td>BioScience, India</td>
</tr>
<tr>
<td>Miticon</td>
<td>Various herbs (alkaloids)</td>
<td>Shakti Biotech, India</td>
</tr>
<tr>
<td>Neemakar</td>
<td>Neem, Karanja &amp; Tulsi</td>
<td>Shakti Biotech, India</td>
</tr>
<tr>
<td>Rescue</td>
<td>Vitex negundu + Clerodendron infortunatum</td>
<td>Shakti Biotech, India</td>
</tr>
<tr>
<td>Torpedo</td>
<td>Sophora alopecuroides + Stemona sessilifolia</td>
<td>Shakti Biotech, India</td>
</tr>
</tbody>
</table>
Bower (Clerodendron infortunatum). It kills mites by direct contact and disturbs the life cycle by anti oviposition & feeding deterrence. Rescue is effective against mites, aphids & jassids etc. It gives prolonged control against all mites. The efficacy of rescue is not affected by high temperature. Rescue is safe for natural predators & parasitoids. It is compatible with other chemical pesticides but not with foliar nutrients & copper fungicides (Anonymous, 2011).

Torpedo (Sophora alopecuroides+Stemona sessilifolia)

Torpedo is a broad spectrum pest control weapon of plant origin of Pea flower tree (Sophora alopecuroides) & Wild asparagus (Stemona sessilifolia). Torpedo can give fast & fantastic relief from vulnerable pest attack. It is an ultimate trendsetter for the control of red spider mites and loopers. It can kill the pest by contact as well as by stomach poison. This formulation also interferes with the life cycle of the mites and thus gives a prolonged control of mites. These are eco-friendly, economic, target-specific & biodegradable. Torpedo is very effective against mites, loopers, caterpillars, aphids, jassids etc. These are safe for natural predators & parasites. It is compatible with other insecticides but not with foliar fertilizers, copper fungicides & plant growth regulators (Anonymous, 2011).

**Laboratory bioassay of commercial biopesticides against red spider mite in tea**

For laboratory evaluation of plant extracts, 30 healthy adult female of red spider mites were released on a healthy detached tea leaf of BT2 in the laboratory. The selected biopesticides viz. Bio-Cawach, Karanza, Miticon, Neemakar, Rescue and Torpedo were used at 0.8 mL, 1.0 mL, 1.0 mL, 1.0 mL, 0.5 mL and 0.5 mL, respectively. Each treatment was replicated thrice. Direct toxicity test was done in complete randomized design under laboratory. Each product was sprayed on the both surfaces of leaf using glass atomizer. The number of live red spider mite was counted by a magnifying glass at 24, 48 and 72 hours after treatment. Each treatment was replicated thrice. Original data were corrected by Abbott’s (1987) formula: Percentage of corrected mortality=(Observed mortality-Control mortality/100-control mortality)×100

**Field evaluation of commercial biopesticides against red spider mite in tea**

A field trial was conducted to evaluate the efficacy of different commercial plant products against red spider mite in tea fields at BTRI main farm. The experiment was laid out in RCBD with seven treatments including control each having three replications. The plot size was kept as 5 x 5 m² having 30 tea bushes. Each plot in the experiment was separated by two buffer rows of non-experimental tea. Thirty bushes per replication were considered for each treatment along with unsprayed control. Sections with heavy infestation of red spider mite were chosen for this study. After selection of the plots, pretreatment count was taken in the respective plots and two rounds of foliar spray were given at 15 days interval with hand operated Knapsack sprayer with water volume of 1000 litres/ha. Post treatment observations were taken at weekly interval for four weeks after treatment. Observations on mite population were made on both adaxial and abaxial side of the ten randomly collected mature leaves per replication for each treatment of different plant extracts along with unsprayed control using mite brushing machine (Model-Leedom Engineering, USA) and a compound microscope. Field performance of tested biopesticides against red spider mites in tea was calculated by using Henderson & Tilton (1955) formula.

**Effect of biopesticides on natural enemies i.e. Stethorus gilvifrons and Oxyopes sp.**

The biopesticides were also tested for its effect on the mortality of two important predators of red spider mite i.e. Stethorus gilvifrons and Oxyopes sp. in the laboratory condition. Ten adult predators were placed in rectangular jars (9.5 cm×7.5 cm×20 cm) with mite infested tea leaves. Approved concentration of tested biopesticides were sprayed directly onto adults of Stethorus gilvifrons and Oxyopes sp. Spraying was performed as described for the laboratory bioassay and observed everyday for mortality.

**Organoleptic test in respect of quality**

A field experiment was also conducted to study whether tested biopesticides have imparted any taint to black tea. Tea shoots were harvested on 7th day after spraying of selected biopesticides at approved
concentration and processed separately in a mini CTC machine. The samples were forwarded to a professional tea taster for assessment of taint as positive or negative and for organoleptic test. Leaf infusion, liquor color, briskness, strength & creaming down parameters were considered for organoleptic test and standard score was as >34 being Excellent (E), 32~34 being Above Average (AA), 30~32 being Average (A) and <30 being Below Average (BA) out of 50.

Statistical analysis
The experimental data were statistically analysed by Completely Randomized Design (factorial CRD) and Randomized Complete Block Design (RCBD) using MSTAT statistical software in a microcomputer. The results are expressed as Mean ± SE and data were statistically analyzed by one-way ANOVA, with the level of significance set at p<0.05. The mean values were separated by Duncan’s Multiple Range Test (DMRT).

Table 2 Laboratory evaluation of some commercial botanical biopesticides against red spider mites infesting tea

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dosage</th>
<th>Percent Mortality*</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24 HAT</td>
<td>48 HAT</td>
<td>72 HAT</td>
</tr>
<tr>
<td>T1- Bio-Cawach</td>
<td>0.8 ml/L</td>
<td>64.28±1.04d</td>
<td>75.56±1.42e</td>
</tr>
<tr>
<td>T2- Karanza</td>
<td>1.0 ml/L</td>
<td>66.27±1.68c</td>
<td>78.84±1.03d</td>
</tr>
<tr>
<td>T3- Miticon</td>
<td>1.0 ml/L</td>
<td>70.24±0.96a</td>
<td>80.20±1.38b</td>
</tr>
<tr>
<td>T4- Neemakar</td>
<td>1.0 ml/L</td>
<td>68.14±1.26b</td>
<td>79.43±2.06c</td>
</tr>
<tr>
<td>T5- Rescue</td>
<td>0.5 ml/L</td>
<td>69.98±1.32a</td>
<td>81.36±2.14a</td>
</tr>
<tr>
<td>T6- Torpedo</td>
<td>0.5 ml/L</td>
<td>62.86±1.47e</td>
<td>80.33±1.40b</td>
</tr>
<tr>
<td>Sx</td>
<td>1.346</td>
<td>1.263</td>
<td>1.126</td>
</tr>
<tr>
<td>Probability level</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
</tbody>
</table>

*Mean of three observations (30 adults/observation) HAT= Hours after treatment ± Standard error of means at a given concentration
Within column values followed by different letter(s) are significantly different by DMRT at p<0.05

Results and Discussion
Laboratory bioassay of commercial biopesticides against red spider mite in tea
Results revealed that all the tested biopesticides showed toxic effect on red spider mite in tea and reduced mite population significantly in laboratory condition. In laboratory condition, Miticon showed the highest (93.28%) toxic effect at 72 HAT followed by Karanza (92.55%) against red spider mite where as Bio-Cawach, Neemakar, Rescue and Torpedo exhibited pronounced acaricidal action (89.78~91.67%) at 72HAT at the concentration of 0.8 ml/L of water (Table 2). Similar trend of toxicity was found at 24HAT & 48HAT. The mortality was in a linear trend i.e. increasing with increasing of time. The order of toxicity of the tested biopesticides on adult red spider mite was Miticon>Rescue>Neemakar>Karanza>Torpedo>Bio-Cawach (Figure 1).

Field evaluation of commercial biopesticides against red spider mite in tea
From the field evaluation, it was found that all the biopesticides have acaricidal value to reduce the infestation of red spider mite significantly. The highest (81.34%) reduction in mite population was observed in Miticon treated plot followed by Rescue treated plot (81.01%) (Table 3). The lowest (74.07%) reduction was observed in Bio-Cawach treated plot. In field condition, similar trend of order of toxicity in respect of acaricidal activity i.e. Miticon>Rescue>Neemakar>Karanza>Torpedo>Bio-Cawach was also found (Figure 2).
Different plant origin biopesticides were applied to control red spider mites infesting tea. Selvasundaram (1993) found that the two commercial biopesticides RD and Esterrimax (derived from Pongamia glabra) @ 150 ml/ha reduced the number of red spider mite (84.04% bio-efficacy) on par with propargite (85.99% bio-efficacy).

**Effect of biopesticides on Stethorus gilvifrons and Oxyopes sp.**

Result revealed that no mortality of adult of *Stethorus gilvifrons* and *Oxyopes* sp. was found till 14 days after spraying in all the treatments. Application of the tested biopesticides did not affect the non-target organisms such as *S. gilvifrons* and *Oxyopes* sp. Sarmah et al. (2009) also found no mortality to the adults of *S. gilvifrons* using the aqueous plant extracts.

**Organoleptic test in respect of quality**

Tea samples prepared from biopesticide-treated shoots was found taint free when subjected to organoleptic evaluation. Organoleptic test revealed that leaf infusions of made teas prepared from plant extract-treated leaves as coppery and liquor strength as strong, scoring 32.20–33.80 with Grade AA on a 50-point scale (Table 4).

Table 3 Field performance of some commercial botanical biopesticides against red spider mites infesting tea

<table>
<thead>
<tr>
<th>Treatment (No. of mites)</th>
<th>% effectiveness of biopesticides after application*</th>
<th>Overall Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>After 1st spray After 2nd spray After 3rd spray After 4th spray</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1st week 2nd week 3rd week 4th week</td>
<td></td>
</tr>
<tr>
<td>T1 - Bio-Cawach 800 ml 38</td>
<td>70.83±1.20e 66.48±1.66e 84.33±0.96e 74.64±1.58e</td>
<td>74.07±1.35d</td>
</tr>
<tr>
<td>T2 - Karanza 1000 ml 36</td>
<td>73.22±1.31d 69.47±1.70c 88.23±1.12d 80.02±1.37c</td>
<td>77.74±1.38c</td>
</tr>
<tr>
<td>T3 - Miticon 1000 ml 42</td>
<td>78.93±1.64b 70.34±1.28b 92.56±1.26a 83.52±1.66a</td>
<td>81.34±1.46a</td>
</tr>
<tr>
<td>T4 - Neemakar 1000 ml 48</td>
<td>76.65±1.28c 71.44±1.56a 89.32±1.72c 79.88±1.52d</td>
<td>79.37±1.52b</td>
</tr>
<tr>
<td>T5 - Rescue 500 ml 40</td>
<td>79.58±1.72a 72.00±1.44a 91.28±1.80b 81.18±1.46b</td>
<td>81.01±1.61a</td>
</tr>
<tr>
<td>T6 - Torpedo 500 ml 39</td>
<td>68.64±1.54f 67.78±1.38d 83.61±1.42c 79.76±1.14d</td>
<td>74.95±1.37d</td>
</tr>
</tbody>
</table>

Sx 1.410 0.824 0.862 0.365 0.728 Probability level 0.05 0.05 0.05 0.05 0.05

*Mean of three observations ± Standard error of means at a given concentration Within column values followed by different letter(s) are significantly different by DMRT at p<0.05

Figure 2 Effectiveness of different plant origin biopesticides against red spider mite in field

Among the tested biopesticides, Miticon showed the highest toxic effect, whereas Bio-Cawach showed lowest toxic effect against the red spider mite in both laboratory and field conditions. Muraleedharan and Selvasundaram (1993) found that the two commercial neem products namely, RD-9 Repelin (ITC) and Neemgold (SPIC) @ 1000 ml/ha reduced the incidence the both pink mites and flushworms. Babu et al. (2009) stated that a new herbal product, Derrimax (derived from *Pongamia glabra*) @ 150 ml/ha reduced the number of red spider mite (84.04% bio-efficacy) on par with propargite (85.99% bio-efficacy).

Table 4 Tasters’ score of made tea produced from plant extracts treated shoots

<table>
<thead>
<tr>
<th>Treatment (No. of mites)</th>
<th>Leaf infusion</th>
<th>Liquor strength</th>
<th>Tasters’ score*</th>
<th>Grade</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 - Bio-Cawach 800 ml 38</td>
<td>Coppery (7.4)</td>
<td>Strong (7.5)</td>
<td>32.80</td>
<td>AA</td>
<td>No taint</td>
</tr>
<tr>
<td>T2 - Karanza 1000 ml 36</td>
<td>Coppery (7.6)</td>
<td>Strong (7.3)</td>
<td>33.40</td>
<td>AA</td>
<td>No taint</td>
</tr>
<tr>
<td>T3 - Miticon 1000 ml 42</td>
<td>Coppery (7.3)</td>
<td>Strong (7.4)</td>
<td>33.30</td>
<td>AA</td>
<td>No taint</td>
</tr>
<tr>
<td>T4 - Neemakar 1000 ml 48</td>
<td>Coppery (7.7)</td>
<td>Strong (7.5)</td>
<td>32.60</td>
<td>AA</td>
<td>No taint</td>
</tr>
<tr>
<td>T5 - Rescue 500 ml 40</td>
<td>Coppery (7.6)</td>
<td>Strong (7.6)</td>
<td>33.10</td>
<td>AA</td>
<td>No taint</td>
</tr>
<tr>
<td>T6 - Torpedo 500 ml 39</td>
<td>Coppery (7.5)</td>
<td>Strong (7.4)</td>
<td>32.90</td>
<td>AA</td>
<td>No taint</td>
</tr>
</tbody>
</table>

*Quality score including Leaf infusion, Liquor colour, Briskness, Strength & Creaming down
Conclusion
It has been observed from the result that the plant origin commercial botanicals used in the experiment had direct toxic effect against red spider mite infesting tea. The tested biopesticides are commercially available in the country and the planters may use these biopesticides in tea pest management especially for the control of red spider mite, *O. coffeae* in tea in Bangladesh. Therefore, bio-rational pesticide based integrated pest management should be emphasized so that the plant extracts could be used for sustainable crop protection and also gives idea for their better use under IPM program ensuring a healthier pesticide-free tea beverage.

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