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Summary

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- Tea, the wonder beverage was first named *Thea sinensis* and is now known as *Camellia sinensis*. All over the world 'tea' is a popular invigorating and refreshing drink having excellent medicinal properties. It is the main agro-industry of North-East India including the Dooars, Terai and the Darjeeling foothill region.

- Different problems are associated with tea crop production, among which one of the major problems is crop loss due to pest attack, specially insect pests.

- About 300 species of arthropod pests are known to attack tea in India, lepidoptera form the largest order of the pest species (Chen and Chen, 1989).The chewing caterpillars generally may cause up to 40% crop loss.

- Among the lepidopteran tea pests, looper (*Buzura suppressaria)* caterpillar is one of the major defoliating pests of tea. Besides this, a new species of looper has emerged in the Dooars and Terai region, called black inch worm *Hyposidra talaca*. It is also causing substantial loss of tea crop.

- Red slug (*Eterusia magnifica*) caterpillar is one of the major defoliating tea pests of North-East India. The pest attacks mature tea leaves and becomes abundant in pockets of Terai-Dooars plantations.

- The tea leaf roller *Caloptilia theivora* has been known to occur in North-East India since 1988, infesting about 40-60% of the shoots in young and mature tea. It exploits young tea leaves while nesting inside a rolled-up leaf and deposits its faeces in the nest. The faecal contaminations of the made tea causes deterioration of quality, hence lower price of the product.

- To overcome the crop loss, population of tea pests are mostly managed chemically by synthetic insecticides. Various problems are associated with excess use of chemical pesticides. Besides affecting tea export due to high pesticide residue (MRL), these also affect human health, non-targets, environment and induce resistance in the target pests.

- In view of these problems associated with synthetic pesticides, and also due to a greater acceptance of organic tea (as compared to chemically managed conventional tea) by health conscious consumers, the future protection and production of tea appear to depend largely on non-conventional control methods. One of the ecofriendly approaches of biological control is conservation of the microbial bio-agents or application of some of the effective bacterial control agents in the tea ecosystem.

- The pesticide formulations in which entomopathogenic bacteria are the active components are known as bacterial pesticides. Numerous subspecies and strains of *Bacillus thuringiensis* have been isolated from dead and dying insect larvae, and in most cases the isolate showed toxic activity to the insect from which it had been isolated.

- In the present research study, a survey of the naturally occurring bacterial bio-agents occurring in the lepidopteran pests of tea from Terai and the Dooars was done. Entomopathogenic bacteria that were naturally infecting and killing the major lepidopteran pests were collected, isolated, characterized, then bioassayed in laboratory and field. Testing was done to determine their bio-efficacy, so that in future, microbial pesticides may be developed out of these, and the same may be integrated in biocontrol and IPM programs of tea.

- For knowing the natural occurrence of the entomopathogenic bacteria, population sampling of the host insects (*B. suppressaria*, *H. talaca*, *C. theivora* and *E. magnifica*) was done randomly from the tea plantations of Terai and the Dooars of Darjeeling foothill region and the adjoining plains.

- Dead and diseased larvae were collected from the field and from laboratory reared population and were surface sterilized with 70% alcohol and stored in double distilled water in refrigerator at –20°C, for bacterial isolation in future.

- Koch's postulate with the bacterial isolate was tested and the bacteria were characterized following morphological, biochemical and physiological procedures.

- After characterization, the bacteria were bioassayed with determination of the percentage mortality, LC_{50} and LT_{50} values in laboratory.

- Bioassay of cross-infectivity to lepidopteran tea pests of same habitat was performed.

- The most commonly occurring entomopathogenic bacterial strains of loopers were: *Bacillus* sp. BS01 of *B. suppressaria*, *Bacillus* sp. HT01 and *Bacillus* sp. HT02 of *H. talaca*. Several other bacterial strains (fourteen) isolated from the loopers were occurring in less frequency.

- Cross-infectivity to beneficial lepidopteran like silk worm was also determined before conducting field experiment.

- Field killing efficacy of the bacterial isolate (HT01) was determined by spraying in aqueous medium in RBD at Terai tea plantations.

- The three *Bacillus* strains (BS01, HT01, HT02) were found to be different from each other and also from commercial formulation of *Bacillus thuringiensis kurstaki* in respect of characteristics and infectivity. The LC_{50} and LT_{50} values were found to be lower in case of *Bacillus* sp. HT01 than the other two bacteria and from *Btk*. A field application of this bacterial strain (HT01) was conducted and a significant control of *H. talaca* population was obtained within 7 days at all concentration (without any sticker or spreader).

- In case of *Caloptilia theivora* four *Bacillus* strains (*Bacillus* sp. CT01, *Bacillus* sp. CT02, *Bacillus* sp. CT03 and *Bacillus* sp. CT04), and a strain of *Enterobacter* (*Enterobacter* sp. DD01) were isolated.

- The bioassay revealed that the bioassay it was found that the LC_{50} and LT_{50} values were lower in case of *Bacillus* sp. CT04 as compared to other four *Bacillus* strains and *Btk*. A field study was therefore conducted to know the field efficacy of the *Bacillus* sp. CT04 and a successful control was obtained on 7^{th} day at 3000 and 4000µg/ml concentrations.

- A bacterial strain named *Bacillus* sp. RS01 was isolated from *Eterusia magnifica*. The strain was found to be fairly pathogenic for killing early stage caterpillars of *E. magnifica*. Bioassay and field study conducted with *Bacillus* sp. RS01 strain to know its exact toxicity under field conditions registered a successful control of *E. magnifica* population but at a high concentration of 12,000µg/ml within 7 days.

- Report of development of insect resistance to *Btk* has stimulated new research to find additional *Bt* strains that have specific activity spectrum against the concerned insect pests. So, after considering all the findings it may be said that the bacterial strains (*Bacillus* sp. BS01; HT01, HT02; CT01, CT02, CT03, CT04; RS01 and *Enterobacter* sp. DD01) may be taken as potential candidates and developed in future as microbial biopesticides with a better killing efficacy than the commercially available *Bacillus thuringiensis kurstaki* (*Btk*) which is already in used for controlling different lepidopteran tea pests.