1. INTRODUCTION

Insect pests are a major constraint to production of food and fiber worldwide. Biological control agents, including arthropod natural enemies, entomopathogens (bacteria, nematode, virus, and fungus), plant-derived insecticides and insect hormones/pheromones are receiving significant interest as alternatives to chemical pesticides as key components of integrated pest management (IPM) system. Biotechnology has a significant role in improving efficacy, cost-effectiveness and in expanding the markets for these bioinsecticides. Several molecular techniques have been employed for identifying and monitoring establishment and dissimination of specific biotypes of natural enemies. Genetic engineering and insect transformation technology provide opportunities for the development of effective insect natural enemies conferring beneficial traits such as pesticide resistance, harsh climate hardiness and favourable sex ratio. Modern technologies provide an effective extraction process, formulation solvents and adjuvants, which can enhance the insecticidal activity of plant-derived safer insecticides. Through biotechnology and genetic engineering Production, formulation and storage, which are extremely important in the utilization of entomopathogenic fungi and nematodes, can be dramatically improved.

The introduction of genes coding for proteinaceous insect toxins (scorpion toxin, mite toxin, trypsin inhibitor), hormones (eclosion hormone, diuretic hormone) or metabolic enzymes (juvenile hormone esterase) into nucleopolyhedro viruses genome are some approaches to increase speed of kill, enhance virulent and extend host specificity of the virus. Genetic manipulation of Bacillus thuringiensis (Bt) genes encoding for proteins toxic to insects offers an opportunity to produce genetically modified strains with more potent and transgenic plant expressing Bt toxin. In addition to the Bt delta-endotoxin, several proteins that are effective against certain insects such as the vegetative insecticidal proteins (VIP), alpha-endotoxin, a variety of secondary metabolites and proteins of plant origin are amenable to genetic manipulation (Attathom, 2002). Biological control strategies involving beneficial insects, microorganisms that attack insect pests and plant-derived insecticide will provide sustainable control practices that
work in harmony with genetically engineered plants. Biotechnology can have a positive impact on food security from insect attack and can contribute to the sustainability of modern agriculture (Attathom, 2002).

Coleopteran insects are considered some of the most important pests to crop plants. For example, species of corn rootworm are the most destructive corn pests causing an estimated loss of over $1 billion annually. Important corn rootworm pest species include Diabrotica virgifera virgifera, the western corn rootworm; D. longicornis barberi, the northern corn rootworm, D. undecimpunctata howardi, the southern corn rootworm, and D. virgifera zeae, the Mexican corn rootworm. Colorado potato beetle (CPB; Leptinotarsa decemlineata), is another example of a coleopteran insect which is a serious pest of potato, tomato and eggplant world-wide. Curculionidae is the largest family among Coleopterans. They are characterized by, their distinctive long snout and geniculate antennae with small clubs; beyond that, Curculionidae have considerable diversity of form and size, with adult lengths ranging from 1 to 40 millimetres.

Among the coleopterans the Myllocerus species are important pest in India with a wide range of hosts. The adult weevils of Myllocerus spp feed on leaves, nibbling the leaves from the margins and eating away small patches of leaf lamina (Butani, 1979). The eggs are normally laid on the organic matter on the soil surface. The larvae of Myllocerus developed on roots and pupation takes place in earthen cocoons in soil. Adults emerge from the soil and are generally polyphagous. They feed with characteristic ladder like edges of leaf surface. It is very common to observe mating adults in the field. These weevils are one of the most difficult pests to control, especially in this case where larvae feed on economically important plants such as in Myllocerus subfasciatus which damage on brinjal. The adult of M. undecimpustulatus is a medium sized weevil. Adult weevils vary in length from approximately 6.0 to 6.84 mm; the female weevil is slightly larger than the male by 1.0 to 2.0 mm. Some of the notable features of this weevil’s are sharp femora (front and middle bidentate and hind femora tridentate); strongly angled humeri are broader than the prothorax, the yellowish coloration of the head, and the dark-mottled elytra.
The world of insect biology and management is fascinating. Knowledge of the biology and ecology of insect pests and their natural enemies is a prerequisite for methods compatible with IPM and/or organic pest management, which rather than eliminate insect pests aim to manage them. A successful management plan requires information about a species biology, how it interacts with the environment and other species as well as species behaviour and how behaviour of both pest and beneficial insects can be manipulated to prevent yield losses.

Recently, DNA barcoding method based on short DNA sequences has been used as an effective tool for identification of many animals (Blaxter 2003; Hebert et al., 2003a, 2003b; Hajibabaei et al., 2006). The mitochondrial cytochrome oxidase c subunit 1 (COI) gene is one of the most popular markers for population genetic and phylogeographic studies across the animal kingdom (Avise, 1994). Its popularity has increased even more since it appears that the M1-M6 partition of the COI gene (hereafter referred to as the Folmer region) as an efficient identification tool for Metazoan species, turning it into the core fragment for DNA barcoding (Hebert et al., 2003). Nevertheless, COI based DNA barcoding sometimes is beset with problems: (a) in some taxa, such as Porifera, Anthozoa, fungi, plants (Seifert et al., 2007, Huang et al., 2008, Hollingsworth et al., 2009), the Folmer region shows little resolution at the species level so that other COI regions such as 13-M11 (Erpenbeck et al., 2006), or other genes such as the nuclear ribosomal ITS (Seifert, 2009) have been proposed for barcoding purposes, and (b) the occurrence of nuclear copies of the COI gene (so-called ‘numts’) may confuse DNA barcoding results and may lead to an overestimation of taxonomic diversity (Song et al., 2008).

**Problem statement**

Among class Insecta the Coleoptera (Coleopterans) are one of the most destructive pests of agricultural crops. Their life cycle, feeding habits and demonstrated ability to develop resistance to chemical insecticides have made their control an increasing agricultural problem. Now the control of these insect pests is mostly accomplished primarily by the use of chemical insecticides. Chemical insecticides cause many environmental problems.
Their exhaustive use has resulted in pollution of soils and underground water. Moreover, a number of synthetic insecticides have lost their efficacy against certain pests due to the development of resistance in these insects. The use of *B. thuringiensis* as a biopesticide is a viable alternative for insect control in agriculture and other areas (i.e., disease vectors) and will intensify crop production in an economically sustainable and environmentally friendly way. Though *B. thuringiensis* has been used over the decades on Lepidopterans, its effectiveness on Coleopteran pests has been limited due to inadequate research. The Cry toxins produced by *B. thuringiensis* are highly specific; harmless to humans, vertebrates, and plants; and completely biodegradable, so they cause no residual toxic products to accumulate in the environment (Schnepf *et al*., 1998).

**Aims and Objectives**

Sustainable agriculture can be achieved not only through proper agricultural practices but also through continuous research and development of new technologies, particularly agricultural biotechnology, which is probably a very important investment to achieve greater competitiveness in the world market. Knowledge and continuous research is the key to assess the potential of biotechnology to increase agricultural productivity and to contribute to sustainability of agricultural systems. Potential improvements of bio-control agents involving beneficial insects and microorganisms that work in harmony with genetically engineered plants are examples of the utilization of biotechnology that lead to sustainable control practices. These lead to the development and registration of naturally occurring and genetically altered bio-insecticides, which include arthropod natural enemies, entomopathogens (bacteria, nematode, virus, and fungus), plant-derived insecticides and insect hormones. The increasing impact of *M. undecimpustulatus* has elicited concern among farmers in general and brinjal growers in particular, who require effective pest management options. Relatively little is known about *M. undecimpustulatus* and *M. subfasciatus* weevils and the dearth of information presents a challenge for designing pest management strategies.

Considering the significance of this insect the present work has been undertaken to work on the biology, molecular systematics, pheromone identification and biological
control measures. The fulfilment of the below objectives will help us in understanding the biology, pheromone identification and biological control of the pests.

The general aim of this study was to make comprehensive systematic treatment of the *Myllocerus* genus. The work was divided into three parts with three milestones.

1. To characterize the *Myllocerus* species complex using morphological and molecular systematics

2. To isolate and identify the response of pheromone components of *Myllocerus subfasciatus*

3. To investigate the efficacy of selected *Bt* isolates on *Myllocerus undecimpustulatus* growth and development