Chapter 1
INTRODUCTION
Agriculture the latest private enterprise in India has been and will continue to be the lifeline of the Indian economy. Agriculture contributes nearly one fourth of the national gross domestic products, sustains livelihood of about two third of the population and is the backbone of the agro-based industries. In food sector alone agriculture contributes to about Rs. 250 thousand crores annually. Today country is facing challenging task of maintaining food security to meet the demand of its over growing population. Annual crop losses due to pests, diseases and weeds have been estimated at about Rs. 50 thousand crores in country.

Chickpea (*Cicer arietinum* Linn.) is the most important pulse crops grown in over 42 countries are South Asia, East Africa, North and Central America, Mediterranean Europe, Australia and North America. Globally, Chickpea is grown in 10.2 million hectare with an average production of 7.9 million tons and an average productivity of 770 kg/ha. India is the largest producer of chickpea in the world and has more than 80 percent of the world’s chickpea area (7.89 million hectare) and rank fifth in area and fourth in production among the food grains (Chhabra *et al.*, 1990; Bhatt and Patel, 2007). In India the major chickpea growing states are Madhya Pradesh, Rajasthan, Maharashtra, Karnataka and Uttar Pradesh. In India, The Uttar Pradesh alone contributes 7.02 percent in area and 7.96 percent in production.

Chickpea is a source of high quality protein for the people in many developing countries including India. Its average yield is 773 kg/ha which is far lower than its potential (up to 4 tons/ha) yield (Ali and Kumar, 2001). Chickpea by virtue of its multiple uses is raised for more than one purpose. Being legume crop, it fixes atmospheric nitrogen and enriches soil fertility. Tender shoots and green pods are used as vegetable. Whole grains
whether boiled, roasted or cooked are consumed by peoples, grains are used for making dal, flour etc. Germinated seeds are recommended to cure scurvy, oxalic acid intestinal disorder.

Among various factors which contribute to low yield in chickpea, damage by insect pests is considered as the most important factor (Reena et al., 2009; Sharma, 2005; Bhagwat et al., 1995). Chickpea attacked by 57 species of insect pests in India (Lal, 1992). Amongst them pod borer, *Helicoverpa armigera* (Hubner) (Lepidoptera; Noctuidae) is most important and accounts for about 90 to 95 percent of the total damage caused by all the insect pests (Sachan and Katti, 1994). Annual crop losses due to *H. armigera* has been estimated around Rs. 2000 crores despite the use of chemicals worth of Rs. 600 crores (Pawar, 1998; Thakor and Patel, 2008). It has become increasingly important and more acute in northern states (Jadhav et al., 1999). Chickpea is the most preferred host of this species which suffers losses to tone of 25 - 70 percent (Tripathi and Sharma, 1984). In India, it is much more serious in the state of Karnataka, Maharashtra, Andhra Pradesh, Tamil Nadu, Orissa, Punjab, Haryana and Uttar Pradesh. *Helicoverpa armigera* is one of the ubiquitous pest throughout old world feeding on about 182 plant species belonging to 47 botanical families in Indian subcontinent and is now estimated to feed more than 200 plant species (Ravi et al., 2005; Thakor and Patel, 2008; Shekharappa, 2009).

*Helicoverpa armigera* is active throughout the year but damage is caused from November to March. In mid hill zone of Himachal Pradesh the abundance of this pest was found from 3rd week of April to 2nd week of May (Nirmal et al., 1990). During *rabi* season its activity started during November to January and February on chickpea in Gujarat (Patel and Koshiya, 1997). The peak of larval population was observed during 3rd week of February in Tamil Nadu (Visalakshmi et al., 2000). In Madhya Pradesh the activity of *H. armigera*
started from 2\textsuperscript{nd} week of August and remained active up to 1\textsuperscript{st} week of January (Yadav and Shrivastava, 2006). The highest larval population of this pest was recorded during October on sorghum in Karnataka (Chakravarthy \textit{et al.}, 2008). Maximum numbers of moth were catch during the month of March in Rajasthan (Sharma and Srivastava, 2010). The mean monthly catches of \textit{H. armigera} was maximum during January to March, November and December at different localities of India (Pawar \textit{et al.}, 1983).

There are many methods for management of insect pest problems of crops such as breeding and cultivation of resistance varieties and application of chemical insecticides. The high yielding varieties introduced during green revolution in India, responding to high nitrogen and pre disposed them to pests. Farmers out of anxiety started using pesticides indiscriminately. Even though, over all consumption of pesticides is low, but the injudicious use of pesticides resulted harmful effects to the man and environment. About 25 million cases of acute occupational pesticides poisoning in developing countries each year have been reported. The pesticides have polluted the soil, water and air, which are natural resources used for benefit of humanity. The pesticides residue on food grains, milk product, eggs and vegetables are causing health problems to human beings when consumed. The pesticides have destroyed the useful insects like parasites, predators and beneficial organism like honey bees, frogs and insectivorous birds. \textit{Helicoverpa armigera} has built-up resistance to commonly use pesticides, methomyl, chloropyriphos, quinolphos, acephate, fenvalerata and monocrotophos and synthetic pyrethroides up to 20-60 folds depending on the location. (Singh \textit{et al.}, 2002).
In mid 1980s, the new concept was emerged to control the insect pests in less harmful way in community led programme called integrated pest management that combines, cultural, mechanical, bio-pesticides and chemical pesticides.

Bio-pesticides are certain natural plant products that belong to the so called secondary metabolites that include thousands alkaloids, terpenoids, phenolics and minor secondary chemicals. The plant kingdom offers us a diverse array of complex chemical structure and almost every imaginable biological activity. Neem (*Azadirachta indica*) has emerged as the single most important source of insecticides made from isolates from different parts of the neem tree. These compounds and neem extracts almost every type of biological activity conceivable against wide range of insects. More than 300 species of insects are reportedly affect the behavior and physiology of insects rather than killing them. Neem has justifiably received the maximum attention during last three decades (Kumar and Prasad, 2002). All parts of neem tree possess insecticidal property but seed kernel is the most active. Neem products appear to be quite promising against *Helicoverpa armigera* (Hubner).

Viral bio-pesticides of baculovirus group namely Nuclear Polyhedrosis virus (NPV) after great scope as crop protection against on high value crops against lepidopteran pests like *Helicoverpa armigera* (Misra *et al*., 1991). More than 500 baculoviruses have been reported in India have great potential in IPM (Pawar *et al*., 1990). Nuclear Polyhedrosis viruses kill the insects when they are ingested. Diseased larvae move frequently to the periphery of plant and die showing symptoms by hanging from the plant upside down in the form of “V” called “Klipfel kranid”. 
Many spores farmer and non spores farming bacteria are known to be effective against wide spectrum insects and pests. The crystalliferous *Bacillus Thuingiensis (Bt)* has been found to be effective against several species of lepidopteran insects (Gupta, 2007). Its insecticidal activity is primarily caused by parasporal crystal (delta endotoxin) produced during sporulation.

Fungi unlike bacteria or viruses do not require ingestion for infection. Their pathogenesis begin with germination of conidia on the cuticle and penetration and development inside the host leading to death of host essentially under high humid condition of several fungi infecting insects, the green muscardine (*Metarhizium anisopliae*) (Gundannavar *et al.*, 2007), *Beauveria bassiana* (Dhembare and Siddique, 2004) and *Nomuraea rileyi* (Gundannavar *et al.*, 2008) have shown promise against *Helicoverpa armigera* (Hubner).

Keeping this in view to minimize the use of synthetic insecticides and promote the use of microbial agents and bio-pesticides the present studies were undertaken with following objectives.

1. To study the population dynamics of *Helicoverpa armigera* Hub. And its natural enemies in agro climatic conditions of western plain zone.

2. To study the efficacy of bio-pesticides & neem based pesticides against *Helicoverpa armigera* Hub. In the field and lab conditions.

3. To work out the economics of bio-pesticides.