CHAPTER 1

GENERAL INTRODUCTION

Integrated pest management is today a most ecofriendly approach to dealing with insect pests of agriculture. As an applied science IPM has a structure that incorporates knowledge and information from several areas of research like Chemical control , Mechanical control , Biological control , Behavioural studies and ecological studies of insect pests and natural enemies; of these the Ecological study is central to IPM. It is now known that only biological control studies and ecological studies coupled with the knowledge of the behaviour of the insects is of prime importance in the **Integrated pest management (IPM).** With the dawn of agriculture in the human civilization monoculture practices started and this led to the emergence of phytophagous insects as pests along with the rodents. To counter these several ancient methods like domestication of cats for controlling of rodents started, but the management of insect pests was realized later on. It was in the 18^{th} century that a serious thought towards pest management came into being.

During the early phase of insect pest management metal poisons like Arsenic, Lead and Zinc were used in the control of insect pests, but soon the toxicity of metals to humans was realized and by 19^{th} century along with the industrial revolution, science and technology became more advanced which gave way to the development of synthetic organic pesticides (Whorton, 1974; Ordish, 1976). By the end of World War I, DDT gained popularity and was used in the control of a variety of insect pest mainly against mosquitoes, later on their use in agricultural fields to control agricultural pests began. DDT was highly

effective broad spectrum insecticide during the initial phases of its introduction but within 30 years of the first indiscriminate use of DDT, the resistance of insects towards DDT was noticed. Later on with the advancement in the medical sciences led to the knowledge about the biomagnification and toxicity of DDT to humans. Soon after, a new generation of chemicals namely Organophosphates, Carbamates and Pyrethroids made their way into the list of chemical insecticides used. From the beginning of 19th century chemical insecticides have gained popularity and are widely used presently for insect pest management (Jones, 1973). The total reliance on the chemical pesticides for pest suppression has taken its toll severely on Health and environment (Newsome, 1970; Kaaya, 1994; Pimentel et al 1992). Thus the knowledge about the effect of chemical pesticides has resulted in a broader acceptance of IPM and Conservation Biological control.

The history of biological control dates back to 4000 years ago when Egyptians used domestic cats to control rodents (Wise, 1993). While insect predation was recognized or the significance of entomophagy was seen in the Chinese citrus growers who placed the nests of predaceous ants (*Oecophylla smaragdina*) in trees to control the foliage feeding insects (Huang and Yang, 1979; Konishi and Ito, 1973). The date growers of Yemen collected predaceous ants from North Africa to use against controlling several insect pests of the Date Palm tree. The biological control using specialists' predators' dates back to 1762 with the introduction of Mynah bird from India

to Mauritius for locust control (Doutt, 1964). In the 20th century it was the specialist biological control that was given importance, it includes mainly the insect parasitoids and stenophagous predators. Insect Parasitism was not recognized until Bodenheimer (1931) observed and realized the importance of insect parasitism. Their observations led to the development of insect parasitoids as biological control agents. The drawbacks of insect parasitoids due to its regular augmentation in the fields and their failure to control multiple insect pests, led to the importance of generalist predators like spiders and carabid beetles, recently.

The importance of generalist predators like spiders and carabid beetles has long been neglected in their role as biocontrol agents. Only recently the importance of conservation biological control was realized which seeks to enhance natural enemies numbers using habitat management and diversification techniques. The present scenario of biological control is moving away from an era of specialist biological control agents to assemblages of natural enemies, which can be exploited as one of the natural regulatory mechanisms for pest management. The merit of the generalist predators comes from the fact that they can survive on alternate insect pests when the density of the major pest becomes low. Thus they can sustain themselves during low prey density by shifting on alternate prey while the specialist predators fail to do so and require periodic inundative releases.

Spiders are the dominant macroinvertebrate generalist predators found in terrestrial ecosystems (Turnbull, 1973; Wise, 1993). Most of the spiders are primarily insectivorous (Richert & Harp, 1987; Nyffeler, 1999; Nentwig, 1987). Due to the above said reasons spiders are presumed to play an important role as predators in agroecosystems (Nyffeler & Benz 1987, Nyffeler 1999).

There are about 40000 spider species currently known through out the world and most of them are predators of insects (Savory, 1977). Their abundance in natural and agroecosystem is very high. The annual average is about 50-150 individuals per sq m. (Nyffeler, 1982; Heong et al, 1991; Heidger et al, 1989). Thus despite their ubiquity and high densities (Dondale, 1970; Turnbull, 1973; Nyffeler and Benz, 1987) they are not yet recognized as biocontrol agents.

Spiders belong to Order Araenae and are some of the dominant invertebrate predators found in almost all the terrestrial ecosystems (Turnbull, 1973; Wise, 1993). The word spider comes from the English verb "Spinnen" meaning to spin. Both males and females have 6 to 8 silk glands called spinnerets in the ventral side of posterior abdomen by which they spin their web. There are about 37,927 species of spiders; belonging to 3526 genera and 109 families (Paltnick, 2001-03). Spiders are predominantly insectivorous (Richert and Harp, 1987; Nyffeler, 1999; Nentwig, 1987; Nyffeler and Benz, 1987) occupying a variety of habitats like subsoil; above soil and on the plants (aerial). They have been known to occupy a variety of guilds. The concept of

guild was extended to arthropod fauna by Root (1973). Spiders have been grouped into different guild types by different scientists. Of these the classification given by Uetz (1977) divided the spiders into two guilds, Web builders and Wandering spiders. The other guild classification was given by Young and Edwards (1990), which divide the spiders into five groups namely Web matrix builders, Web sheet builders, Web- orb builders, Wandering active and Wandering – ambush.

The most commonly seen spiders in agroecosystems belong to the families' namely Salticidae, Oxyopidae, Lycosidae, Thomisidae, Therrididae, Linyphiidae, Tetragnathidae, Gnaphosidae and Araeneidae (Nyffeler, 1999; Dolly Kumar and Shivakumar, 2004). Of these the Family Oxyopidae is of potential interest as these lynx spiders are hunters, which hunt their prey on the foliage and don't use webs. Since they are highly mobile and have a broad diet breadth feeding on lepidopteran, heteropteran and dipteran insects. They are also found in high numbers in the agroecosystems (Dolly Kumar and Shivakumar, 2004). Hence they are of interest as biocontrol agents.

The theoretical knowledge about the generalist predators is not enough while implementing involving them in IPM programme. There are several factors that should be taken into account during the ecological study of the predators and pests (Walters, 2003). The ecological studies include factors like

population dynamics during the entire cropping season and the community composition in agricultural field. These two parameters provide insights about the population of any spider species at any given cropping stage and the composition of spider fauna of the field. The factor influencing the population dynamics of the spiders needs to be addressed on a broader perspective. The study regarding the vertical stratification of spiders in different crops provides information about the resource partitioning and interspecific competition occurring among the spider community. The feeding ecology and behavioral studies will be useful in analyzing the biocontrol potential of spiders in the field (Luzak, 1979; Richert and Lawrence, 1997; Jackson and Pollard, 1996). The feeding ecology studies include the functional response and the numerical responses, both of which deal with the behavior of the spider to increasing prey density. Majority of the spider species show type II functional responses (Kiritani and Kakiya, 1975; Mansour et al, 1980). The numerical response deals with the increase in the predator number in response to an increase in prey number. Little studies have been carried out on the feeding ecology of spiders in agroecosystems, most of which are restricted to the orb weavers as it is easy to collect the prey entangled in the webs and to estimate the spider consumption. The weavers are sedentary for most of their life so they are quite easy to locate in the field. On the contrary the hunters are highly mobile and are difficult to locate in the field, so the field study regarding the feeding ecology of hunters is difficult, under these conditions it is difficult to get a precise idea regarding their food consumption

hence lab studies are undertaken to overcome these difficulties (Marc et al, 1999). The prey choice studies are important as it gives an idea to which prey species the spider will prefer in the field when a diverse array of insects are available.

Much of the work on spiders has been concentrated to Europe and America (Whitcomb ,1974; Luzak, 1979; Nyffeler, 1982; Richert and Lockley ,1984; Marc et al ,1999; Rypstra et al, 1999; Samu et al, 1999; Greenstone and Sunderland ,1999; Wise et al ,1999; Uetz et al, 1999). Apart from this the work in Asia is scattered and is restricted to Israel (Mansour et al, 1980) on cotton and grape vineyards and to South East Asia (Heong et al, 1991; Barrion and Litsinger, 1995; Sigsgaard, 2000) in paddy.

The knowledge on the diversity and distribution of spider in India is sparse as compared to other regions of the world listed as above. The first detailed account of the Indian spiders was done by Pocock (1900), which lists 216 species, under 17 families. The most comprehensive work on spiders of India was carried out by Tikader (1987) listed 1066 species belonging to 43 families. Other workers who have carried out research on Indian spiders include, Gravely (1920), Sadana (1965-1982), Tikader et al (1959-1988), B H Patel (1973-1986), Vijaylakshmi (1980) and Siliwal (2000). The main focus of spider research in India is given to the taxonomic identification while the assessment of the ecological importance of spiders in agroecosystems in India has been neglected and is the need of the hour.

Hence the present study was undertaken to understand certain ecological parameters. Field studies were undertaken to know the seasonal fluctuation, population dynamics and community structure and vertical stratification of spiders in the three agroecosystem. In additions to the field studies, Laboratory studies were also undertaken to know the behavioral feeding ecology aspect regarding the feeding potential, functional and numerical response and prey preference studies. Such a study will definitely give us a way to minimize the usage of chemical pesticides and also in understanding biocontrol potential of the spiders and devising various IPM packages for different crops. This will be also helpful in keeping the environment free from pesticides.