INTRODUCTION

The new millennium is facing major agroecosystem problems. The main problem is that of insect pest and usage of insecticide. As the problem of insects became acute more and more pesticides were pressed into service. With indiscriminate use of chemical pesticides insects became more and more tolerant to these chemicals. This has resulted into serious detrimental side effects like development of resistance by insect pests towards chemicals, destruction of non-target beneficial insects (Predators and Pollinators) and immense accumulation of the pesticides into the environment. In last 40 years, 31 insect species have been reported which become resistant to different pesticides in India, out of which 5 insect pests are of agricultural crops (Tewari and Sharma, 1996).

Pesticides enter the food chain through various routes like edible items, inhalation, contact etc. and get biologically magnified into the living organisms including the non-target animals – the man (Brough et al., 1996). For example,

![Diagram]

Cypermethrin spray for controlling pest population (mites) → Apple orchard (Apples are produced commercially) → Red and Healthy Fruits (Full of Pesticides) → Consumed by Human beings (who pay more money as well loose health)

Time has come to find out alternative solutions, which can reduce the use of pesticides but at the same time regulate the insect pest population. The only bright thought the scientific community specially the entomologists, have at the moment is the concept of Integrated Pest Management (IPM).

IPM is a comprehensive approach to pest control that uses a combination of Biological, Cultural, Mechanical, Pheromonal, Chemical and Natural Control methods. One single component cannot solve the pest infestation problem and whenever tried have either
taken too long or have not worked singly. Therefore, different components of IPM should be used for timely and effective control of pest population.

Biological Control Method is one of the major and most effective tactics of IPM (Dhulia and Yadav, 1994). Bio-control method includes the use of various predators against the serious pests in the agricultural fields especially insects (Ambikadevi, 1998) and Arachnids. There are several effective predators, both vertebrates and invertebrates, which could perform the function of bio-control agents.

One such biological agent is Spider. They are chiefly entomophagous, ubiquitous, diverse and harmless creatures. They belong to:

- Phylum : Arthropoda
- Class : Arachnida
- Order : Araneae.

Spiders are the dominant predators of terrestrial ecosystem and occupy seventh position in the global diversity (Coddington and Levi, 1991) About 80 families of spiders have been recorded from the world over, out of which 43 families have been so far represented in India (Tikader, 1987). However, there are only few attempts of taxonomic studies of spiders. There is also a lacunae in the field of spider identification and other related studies. Spiders can be easily distinguished from insects by the following characters:

1. Body divisible into Cephalothorax and Abdomen, which is not segmented
2. Four pairs of legs, present on cephalothorax.
3. Absence of Antennae and wings.
5. Presence of simple eyes.

BIOLOGY OF SPIDERS
Spiders can be categorized into Weavers and Non-Weavers (Tikader, 1987). Their life span is about one year but few live for 10 or 25 years (Smith, 1971; Vijayalakshmi and Preston, 1993). More the longevity of the predator, the more effective biological control agent it becomes. Life cycle of the spider consist of egg, spiderling and adult spiders.

Egg:
Spiders are oviparous. Eggs are laid in large number in a protected silk shelter called egg cocoon or eggsac; methods of construction, shapes and designs of which vary with different species of spiders. Egg sacs are fastened onto the blades of grass (Fig. 118), leaves and stems of plants and on fences, hidden in earth crevices, in the accumulated debris, on the bark of trees (Sketch 1), under stones or on walls or may even be kept strung in webs (Sketch 2) (Vijayalakshmi and Preston, 1993). The egg cocoon are of various shape; like spindle shape (like *Cyrtophora* sp.), tennis ball (viz. *Argyrodes* sp., *Pholcus* sp., *Scytodes* sp. etc.), star shape (like *Uloborus* sp.), disc shape (like members of family Lycosidae, Clubionidae, Salticidae), irregular shape (like *Argiope* sp.) or flat (like members of family
Thomisidae). Bristowe (1958) describes the eggsac of Pholcus (Pholcidae) as rather like a bundle of tennis balls in a string bag.

In several species the eggsac is taken care of till the young spiderlings emerge. In some cases the female carries the eggsac adhered to her spinnerets as in Lycosa (Lycosidae) (Sketch 3) or held by chelicerae as in case of Pholcus (Pholcidae) (Sketch 4) or held under sternum as found in Pisaurina (Pisauridae) (Sketch 5). Number of eggs in an eggsac varies from few to several hundreds depending on the species. Incubation period ranges from 10 to 14 days (Tikader, 1987).

**Spiderlings (Young ones):**

Eggs hatch in 10 to 14 days and spiderling remains in the eggsac for 2 to 6 weeks, and leave the eggsac after first moult only. Spiderling immediately after leaving the egg is incomplete in many respects since it is incapable of feeding or spinning. After series of molts it attains full adulthood. Spiderling appears similar to its parents except in size. Initially the spiderling is pale coloured and less thickly clothed with hair or spines. During the first 2-3 molts many occur and speedily attain its characteristic shape and markings. In the following molts very little alteration is observed, except for an increase in size. After final moult the spider becomes sexually mature.

A male undergoes about 5 molts before becoming sexually mature while female has to moult 7 or 8 times. The first moult takes place while the newly hatched spider is still with the rest of the brood either in or close to the cocoon. The later molts are generally accomplished by the spider attaching all its legs together with silk to the web above, while the body hangs below. By a series of violent efforts the old skin splits along the sides of body and wriggles itself free, leaving a complete cast (Exuvia). The number of molts and intervals at which they occur vary from species to species. One or two days before moulting take place the spider stops feeding. After moulting, remains in helpless condition for one hour. By this time the integument hardens.

Many newly hatched spiderlings disperse by ballooning when they emerge from the eggsac. This is primarily to escape from the cannibalistic tendencies of their siblings and to seek new hunting grounds. Such act also help to avoid overcrowding and sibling rivalries (Dean and Sterling, 1985). However, there are many spiders, which do not leave their nest for a week or more, even after the first moult.

**Adults:**

Sexual dimorphism occurs in many species, the female normally being significantly larger than the males. Male spider can be distinguished by the swollen or knobbed tip of the palps and the particular form they assume is highly characteristic of the species to which spider belongs.

Most of the spiders are highly cannibalistic solitary creatures and practice bizarre courtship rituals. In many species of spiders female kills the male for a handy source of protein for her newly fertilized eggs.
Several species produce sound (Acoustic communication) during courtship and agonistic displays (Rovner, 1975). For example, males of genus Steatoda (Theridiidae) produce sound by scraping together the elements of a stridulatory organ located on the posterior cephalothorax and anterior abdomen (Breene et al., 1993).

The male spider discharges a packet of sperm on a specially made web and absorbs the sperm into its pedipalps, which serve as the copulatory organs. Courtships in Weavers and Non-weavers are different. Male Orb-weavers and other web spiders with poor vision announce their approach by plucking the strands of the female's webs in a special way or drumming out a recognizable tattoo. Others stroke and tap the females cautiously.

While non-weavers like wolf spider and jumping spiders dance and wave their legs before their mates. The Nursery web spider presents his mate with a fly to keep her occupied before mating. In some species, the male binds the female loosely with silk to immobilize her before transfer of sperm takes place (Vijayalaxmi and Preston, 1993). Males of some species die soon after mating.

Spiders of many families show parental care. Female wolf spider (Family: Lycosidae) carries the cocoon attached beneath the abdomen or held by the jaws (Family: Pholcidae). The females of family Theridiidae and Pholcidae (Crossopnza sp.) do not leave the cocoon until the young ones hatch out. However, in Lycosidae, after the spiderlings hatch out, the brood continues to ride on the mother's back for about a week (Sketch 6).

A very few species of spiders are fatal to human being viz. Funnel web Mygalomorph (Family: Diplundae), Phoneutria fera (Family: Ctenidae), Loxosceles reclusa (Family: Loxocelidae) and Latrodectus sp. (Family: Theridiidae). The condition caused by the bite of these spider is called Arachnidism (Vijayalaxmi and Preston, 1993).

ROLE OF SPIDERS IN BIOLOGICAL CONTROL
Spiders exhibit a very diverse range of lifestyles and foraging behaviour (Nyffeler et al., 1994b). The spider plays a vital role in controlling population of different insects by feeding on every stage of their life cycle by showing a wide spectrum of feeding habits. Thus spiders functions as Biological control agents irrespective of their occurrence in house or in the fields. A few important and more commonly found spider families, which feed on important pests, are listed below in tabular form.

List of Spider and their prey on which they feed in agricultural ecosystem.

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<tr>
<th>Sr. No.</th>
<th>Spider (Family)</th>
<th>Predates on the following Pests</th>
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<td>10.</td>
<td><em>Oxyopes sp.</em> (Oxyopidae)</td>
<td>Banana thrips (<em>Thrips hawaiiensis</em> Morgan)</td>
<td>Veer, 1984</td>
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As these spiders feed on various insects (including insect pests), they are of great importance to the agriculturists, entomologist and ecologist concerned with issues of natural and biological control. But still their role as biological control agents in agroecosystem is not well established. In the last decade spate of new information regarding the behaviour of spiders in different agroecosystems have become available and this has increased the awareness about the spiders as beneficial organisms.

In India or abroad there is a dearth of work on spiders as biocontrol agents. Majority of work done in India pertains to taxonomy of spiders, which also is inadequate. Few studies have been done on the spider diversity and their density in cotton fields. Patel and others (1986) reported the ground activity of entomophagous spiders in cotton fields in Gujarat State (North and Central Gujarat region).

Considering the important role spiders can play in agroecosystem as biocontrol agents, the present study was initiated in August 1997. In this study the focus is on identification of spider, observing their feeding habits and to recommend them as biocontrol agents.
agents in the fields of Cotton, Pigeonpea and Banana in the Baroda district. The significance of studying spider communities is as follows:

Spiders have been playing great role as natural bio-control agents against insect pests, being a generalist predator and showing a moderate effective functional response (Samu and Biro 1993). With expansion of agricultural practices and areas the spiders are likely to exert only a limited effect on prey population but this effect can be significant, especially in the early stages of pest population growth (Riechert and Lockley, 1984) Review of literature show that effective pest control by spiders has been successful in a number of cases (Banana: Singh et al., 1997; Cowpea: Nandakumar and Sheela, 1996; Brinjal: Krishnamoorthy and Mani, 1996; Orchards: Bogya and Mols, 1996) in other instances the role of spiders, although present in large densities was harder to assess (Nyffeler and Breene, 1992).

Another aspect why spiders are important is that not only certain spider species interact with certain insect pests but they also comprise an important part of animal communities. By increasing the stability of agroecosystems, the likelihood of pest outbreaks are reduced by the spider just as predators do in natural ecosystems.

The role of spiders as biocontrol agents can be greatly understood by observing their feeding habits, life cycle, population and their survival rate in the insecticide sprayed agricultural fields. Once the effectiveness and economics are worked out, spiders could be projected as one of the best bio-control agents and their role will be recognized in overall IPM strategies. This work indicates around 20 families of spiders, which were not reported till now, as effective bio-control agents in the agricultural fields of cotton, pigeonpea and banana.

To increase their effectiveness, the spider population has to be left undisturbed with no or less usage of pesticides on one hand and on the other hand the population of spiders could be increased artificially by providing web sites, on the periphery of agricultural fields.

Specific spiders can also be bred and reared in the laboratory and released in the agricultural fields as bio-control agents.

In this new millennium, there must be attempts to provide maximum information that will enable all concerned agriculture scientists, pesticide manufacturers, naturalists, environmentalist to take solemn pledge to minimize the use of chemicals in agriculture.

It is time to make everyone aware that less use of chemicals actually increases the yield. There must be attempts to educate and impress the farmers with role of natural predators in the control of insect pests, so that less and less pesticides which will be not only eco-friendly but also health friendly.

It is hoped that this piece of research will definitely open a new path in the field of IPM and also will help to spread a message of awareness to the society that “SAVE SPIDERS”.

1 Introduction
Sketch 1. Eggsac fastened onto the bark

Sketch 2. Eggsac hanging in the web.

Sketch 3. Female *Lycosa* sp. with eggsac adhered to her spinnerets.
Sketch 4. Female *Pholcus* sp. carrying eggsac in its chelicerae.

Sketch 5. *Pisaurina* sp. With eggsac held under the cephalothorax.

Sketch 6. Female *Lycosa* sp. with spiderlings on her back.