CHAPTER 4

COMMUNITY STRUCTURE OF SPIDERS IN CONVENTIONAL VERSUS ORGANIC PADDY AGROECOSYSTEM

INTRODUCTION

Rice is an important cereal crop grown throughout the world in over 100 countries (Pathak and Khan 1994; Juliano 1993). It is the staple food for half of the world's population. China is the leading producer of rice in the world with about 163, 000, 000 tonnes. India is second in production of rice. It was 133,513,000 tonnes in the year 2003 (FAO, 2003). In India rice is the staple food for 65% of the total population (FAO, 2004) and is grown along the Indo-Gangetic flood plains, along the delta regions of the eastern coast of India and along the western coast areas. In several states like Tamilnadu, Uttar Pradesh, Punjab, Haryana and West Bengal etc it is the primary crop. Rice has a unique agro ecosystem since it requires standing water for its growth. In other agroecosystems standing water becomes detrimental for the survival of the crop .In India rice is grown as kharif crop, during the months of July and August. In Gujarat, paddy is grown only in one season between the months of July and November. The irrigated paddy is sowed during early or late July and the crop is transplanted in the month of August and harvested in the month of November. The sowing of paddy is determined by the onset of monsoon rain.

Rice fields represent a complex agroecosystem, as it supports a higher biodiversity of fauna than most of the natural ecosystems (Schoneley et al, 1998). Rice fields support three different habitats; during the initial phase of the cropping season it represents an aquatic habitat requiring standing water , as the cropping season progresses the water content of the rice fields decreases and at this stage the rice fields shows a semi aquatic habitat. Prior to the harvesting of the crop the rice fields have no standing water and the soil surface is dry.

It is because of this complex Agroecosystem, Rice agroecosystem becomes an ideal habitat to study diverse variety of fauna especially arthropods. A wide range of arthropod fauna comprises of insect pest, natural enemies and the neutral arthropods According to Channa and Amarasinghe (2003), arthropods are the predominant terrestrial invertebrates of the rice fields, chiefly consisting of insects and spiders which largely inhabit the rice plants as well as the weeds. Abdullah et al (1998) has documented about 36 families of insects and arachnids in the rice fields of Malaysia. Channa, (2000) had documented about 280 species of insects from 90 families and 60 species of arachnids from 14 families of the rice fields of Srilanka. It has been reported that there are more than 800 species of phytophagous insects found in the rice fields (Dale, 1994). Of the vast majority of the insects found in paddy, only 20 (Pathak and Khan, 1994) to 30 (Riessig et al, 1986) species of insects cause extensive economic damage to the rice crop. *Nilparvata lugens stal* (Brown Plant Hopper) BPH , *Nephotettix viresecens* (Green leaf hopper) GLH , *Chilo suppressalis* (Rice stem borer), *Scirpophaga incertulas* (Green leaf hopper), *Dicladispa armigera* (Rice Hispa) , *Cnaphalocrocis medinalis* (Rice leaf folder) and pentatomid bugs are the important insect pests of the Paddy fields.

Most of the above stated insect pests are the result of indiscriminate use of pesticides in the fields for the eradication of insect pests. As a result of the usage of broad spectrum pesticides there was resurgence of insects' pests (Sigsgaard, 2000) which were earlier not causing economic loss. Research and awareness in the Twenty first century have shown the toxic effect of pesticides on the non target animals including man. (Brown et al, 1983) There is an urgent need to reduce the use of pesticide to a need based spray. It is essential to promote more ecofriendly methods of pest management. Biological control by spiders is one amongst them. In the present study two guilds of spiders were observed in the Paddy fields the web Building spiders and the Hunting spiders

The web Building spiders comprised of

Family Araneidae: Orb – Web Building

Family Tetragnathidae: Orb – Web Building

Family Linyphiidae: Space web Building

Family Therrididae (comb footed spiders): Space web Building

Family Pholicidae: Irregular web Building

And the Hunting spiders (Wandering spiders) families comprising of

Oxyopidae: (Lynx spiders): Foliage hunters

Salticidae: Jumping spiders

Lycosidae: Ground Hunters

Thomisidae: Crab spiders

Clubionidae: Sac spiders

Gnaphosidae: Ground dwelling spiders etc.

Others being: Oonopidae; Heteropodidae, etc.

Spider guild structure is complex and numerically prevails in most parts of the rice fields. Spiders are entomophagous and feed on important insect pests present in the paddy field and crop,

The natural enemies in the rice fields are adequately represented by a variety of predators and parasitoids. Predators are represented by Spiders, Dragon flies, Damsel flies, predatory bugs, carabid beetles etc. The diversity of the parasitoids is less as compared to the predator in the rice fields and includes Hymenopteran wasps and Dipterans.

There are reports stating adequate representation of Spiders in the rice fields Way and Heong (1994), Ishijima et al (2004). Settle et al (1996) has reported 765 species of spiders from the rice fields of Indonesia while Barrion and Litsinger (1995) have recorded 342 species of spiders from the Southeast Asian region. But to establish their role as potential Bio-Control agents in the Agricultural fields it is necessary to study about their community structure, species diversity, density and richness and incorporate them as an integral component of Integrated Pest Management.

RESULTS

I. Species composition: Organic Field (Phase I and Phase II)

During Phase I, the nurseries were developer during the month of July. Nurseries were transplanted in an area of about 100 x 70 meters in the first week of August and harvesting was done in the month of November. A total of 307 individuals were collected in the entire cropping season. 30 species of spiders belonging to 21 genera and 7 families were identified (Table 1). Only two families were from the web building guild and the remaining five families were from Hunting spider guild.. Family Lycosidae and Araneidae were the most diverse families in paddy representing with 10 and 8 species respectively.

In Phase II, Nurseries were transplanted in the month of July and the crop was harvested in November. A total of 260 individuals belonging to 36 species, 26 genera and 11 families were collected. Families Lycosidae, Araneidae and Salticidae were the most diverse families, having 10, 10 and 5 species respectively in the paddy field. In terms of generic diversity family Araneidae was the most diverse with 7 genera.

Conventional field: Phase I and Phase II

In Conventional field, during the **Phase I,** the nursery of the paddy was transplanted during the month of July and the harvesting was done in the month of November. A total of 474 spiders were collected from the paddy field belonging to 45 species, 25 genera and 13 families were identified. Out of the

13 families of spiders collected 5 were from web building guild namely Araneidae, Tetragnathidae, Therrididae, Linyphiidae and Pholicidae. The remaining 8 families of spiders were from the hunter guild namely Salticidae, Oxyopidae, Thomisidae, Lycosidae, Heteropodidae, Clubionidae, Gnaphosidae and Oonopidae. The dominant family in the pesticide sprayed field was Araeneidae represented by 8 genera and 12 species. Amongst the weavers and non weavers both, the next in abundance were Salticidae and Lycosidae comprising of 5 genera, 10 species and 4 genera and 12 species respectively. Thomisidae comprised of 3 genera and 4 species, Clubionidae comprised of 2 genera and 3 species.

In **Phase II,** Nurseries were transplanted in the, 260 individuals belonging to 36 species, 26 genera and 11 families were collected. 5 families were of web builders Araeneidae, Tetragnathidae, Linyphiidae, Therrididae, and Pholicidae. Lycosidae, Oxyopidae, Salticidae, Clubionidae and Thomisidae, Heteropodidae comprised the community structure of spiders in paddy. In the **Phase II,** the family diversity of Araneidae was diverse in the paddy field represented by 8 genera and 12 species like in phase I. Lycosids collected and identified was the same as that of Phase I with 4 genera and 6 species. There was little variation of the species diversity of Lycosidae family 6 species were identified and in the case of Salticidae 8 species were identified. From the following families had only one genera and one species could be identified. Linyphiidae has *Linyphiia* genera, Oonopidae had *Triaeris* genera, Pholicidae had Pholcus; Therrididae had *Theridion*, Heteropodidae had *Thatanus*. Clubionidae had 2 genera namely *Clubiona* and *Chieracanthium* consisting of 3 species in total. There was no representation by the families Thomisidae and Gnaphosidae in the Phase II of the pesticide sprayed field. It may be noted that family Gnaphosidae had not been sighted in the organic fields also. However Thomisidae was represented by 2 genera and 2 species.

Organic field: Family composition

Phase I, In terms of abundance family Lycosidae is the highest which is 46.25% followed by Araeneidae which is 29.96%. The percent abundance of family Oxyopidae was 12.37% whereas Tetragnathidae and Clubionidae were definitely present but their percent abundance was only 5.53 and 2.28% respectively.

Phase-II In terms of abundance Lycosidae was 27.30%, Araeneidae were 24.23%, and Tetragnathidae contributed 10.38%. The percent contribution of Oxyopidae and Clubionidae were 5.76% and 4.23% respectively. It may be noted that whatever the percentage of the spiders in the agriculture field they have the potential to control insect pests.

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ORGANIC FIELD

Percentage Composition and Seasonal Dynamics

The seasonal dynamics of the spiders in the **Phase I** show that as the cropping season progresses relative abundance of spider families change. The percentage of Lycosids is maximum in August (88.46%) and the month of November also shows more than 75% Lycosids in the rice fields (78.26%), whereas Araeneids are maximum in the month of October which is 42.47%. Oxyopids and Salticids reached their peak density in the month of September (22.22% and 19.27% respectively). Tetragnathidae which is exclusively found in rice fields are around 8 % in the month of November. Clubionids and Thomisids are less than 6% in the rice fields and both the families are not found in the month of August and November. Some small percentage (2.68%) is found in the month of October but Thomisids are missing even in October. Month of October (n= 186) contributed to the maximum abundance of spiders constituting about 60.58% of the total spiders collected.

In **phase II**, September had more spiders (n=81, 31.15%) and October had comparatively less individuals (n=72; 27.69%). Some variation in the abundances of spiders in the two seasons was due to the transplantation of the nursery crop into the paddy field at different times. The population of family Lycosidae was almost constant throughout the cropping season except for the month of October which received a pesticide input twice within an interval of 15 days. Family Araneidae was not present during July (Transplanted stage), and from August Vegetative stage the population reached its peak and then decreased during the subsequent months till the harvesting of the crop.

Families Tetragnathidae, Linyphiidae and Therrididae showed a higher percentage composition during the month of October. This shows that either these families are resistant to the pesticide input or the density of the other spider families are very low in the pesticide input month. There is also a differential increase in the population density of spiders in both the phases. In phase I, it was in the late July when the nurseries were transplanted while in Phase II it was Early August. This is a yearly decision by the farmers depending upon rainfall in that monsoon season. The field needs flooding which becomes easier when the rainfall is adequate. The overall generation peak of the spider community occurred during the September month of the cropping season.

Conventional field: Percentage Composition and Seasonal Dynamics

Phase I

Family Lycosidae was dominant during July with 63.68% and with progress of the cropping stage. They show a gradual decline in abundance while second in terms of numerical abundance (29.01%) Therrididae, are present August. Therrididae shows two peaks during the entire cropping season. Family Araneidae are numerically dominant in September, comprising of about 39.43% of the monthly total of spider. Similar pattern is seen for the family Tetragnathidae; comprising of 14.8% in the month of September and October. Salticidae were present in constant density from September till November. Oxyopidae and Thomisidae were present in high numbers during July with 23.16% and 12.5% present. Family Clubionidae, Gnaphosidae and Pholicidae were present in smaller numbers during November with 2.23% while Heteropodidae and Oonopidae were dominant with 6.89% and 1.72% in October respectively.

Phase II

The population of Tetragnathidae remained high starting from August till October, comprising 38.63% and 61.29% for the month of September and October respectively and reaching its peak density of 9.5 individuals per 10 hills. Araeneidae population was very high during August and during the later months declined in population. In August the peak density achieved by family Araeneidae was 12.3 individuals per 10 hills. In terms of percentage composition in various months, during August and November Araeneids showed high abundance of 48.64% and 54.54%. Salticidae population reached peak density of 5 individuals per 10 hills in November; while at the start of the season its density was at 1.6 individuals per 10 hills. In terms of percentage composition, Salticidae were abundant in November (22.72%) and September (11.36%).

Population dynamics of Spiders

Organic Field: Phase I

Five species of web building spiders were abundant in the paddy fields comprising more than total individuals collected during all the seasons. *Argiope aemula , Argiope anasuja and Cytrophora cicatrosa* were found at the rate of 6.66 , 4.2 and 8 individuals per 10 hills respectively during the month of October (Earhead maturation stage) (Graph 4.7a) In all the other seasons these spiders were absent from the collections. *Neoscona theis* was present throughout the cropping season reaching its peak density of 4 individuals per 10 hills in the month of September and decline in the population thereafter till the end of the cropping season. It is seen that *Neoscona theis* is found to be present along the field margins prior to the transplantation of paddy crop. *Tetragnatha mandibulata* was absent during August and thereafter its population increased and reached to peak density of 2.6 spiders per 10 hills in October corresponding with the Earhead formation stage and 2.0 individuals per 10 hills in November representing the Earhead maturation stage of the crop.

The hunting spiders in the phase I, Lycosidae family contributed to the maximum dominance of the hunting spiders (Graph 4.9a). The species of hunting spiders showing individual dominance are *Pardosa birmanica* , *Pardosa sumatrana* , *Lycosa pictula* , *Evippa sohani* , *Hippasa mahabaleshwarensis* all the above from family Lycosidae and *Oxyopes shweta* from Family Oxyopidae.

Organic Field: Phase II

A. Web Builders

In the orb weaving guild members of the family Araneidae were numerically abundant. The density of *Neoscona theis* was high during August and September (7 and 4 individuals per 10 hills respectively) and later in the cropping season showed a gradual decline. *Cytrophora cicatrosa* was abundant during August and September (6 and 7 individuals per 10 hills) while *Leucage decorata* was abundant in September and October. While both of them were absent in the month of November (Graph 4.8b). Tetragnathidae family also contributed as biocontrol agents in the paddy fields. Among orb-weavers the members of the family Tetragnathidae namely *Tetragnatha mandibulata* and *Eucta javana* reached their peak density in October of 9 and 4 individuals per 10 hills respectively. *Labulla napula* belonging to the family Linyphiidae shows two peaks in the cropping season one during start of the cropping season in the month of July and the other during October, the density being 11 and 8 individuals per 10 hills in the months of July and October respectively. *Theridion manjithar* of the family Therrididae shows peak density in the month of October which corresponds with the Earhead maturation stage of the crop.

B. Hunting spiders

Three species of Lycosidae namely , *Evippa sohani* , *Pardosa birmanica* and *Lycosa* poonaensis reached their peak densities in September (Earhead formation stage) showing their peak densities of 3,10,and 5 individuals per 10 hills respectively (Graph 4.9b)) . *Oxyopes shweta* of the family Oxyopidae also shows peak of 6 individuals per 10 hills in September. *Chieracanthium melanostoma* show peak density of 4 individuals per 10 hills in October.

Conventional Field : Phase I

Web Building Spiders

Four Orb web building spiders were found in abundance during the cropping season (Graph 4.8c). *Argiope anasuja* was found in high density in the month of August. *Neoscona mukerjei* was in high density in September (4.5 individual per 10 hills). During October the population of *Neoscona mukerjei* declined to 0.5 per 10 hills attributed to the pesticide usage. *Cytrophora cicatrosa* was found in high numbers during September with density of 3.5 spiders per 10 hills. During October and November the population of *Cytrophora cicatrosa* was very less. *Leucage celebesiana* showed a gradual decline in its population from August to November with its density varying from 2.5 spiders per 10 hills to becoming absent in November.

Tetragnatha mandibulata was absent initially during the cropping season in July and August (Graph 4.8d). It reached its high density during September of 3.0 spiders per 10 hills and showed a gradual decline till November representing the post harvest stage. *Eucta javana* showed the highest density of 2.5 spiders per 10 hills in October, while in month of September and October it showed a decline. *Theridion manjithar* showed its peak density during August (23.5 spiders per 10 hills) and showed a wavy distribution.

Hunting spiders

In the month of August, *Hippasa mahabaleshwarensis* showed peak density in August (11 spiders per 10 hills) during the later months the spiders were absent. *Evippa sohani and Lycosa poonanesis* were both found in high densities in July and in the later stages of cropping season (Graph 4.8a) they showed a steady decline. *Phiddipus indicus* were present in August and September only and in the remaining months they were absent (Graph 4.8b). Peak density was attained in September.

Phase II

Web Builders

Araneidae, Tetragnathidae, Linyphiidae, Therrididae, Pholicidae. Amongst web builders; species density of Araneids reached their peak density in the month of August and declined from September to November (*Leucage decorata*) (Graph 4.8e) In Araneidae *Neoscona mukerjei* showed its peak population during August ,whereas *Neoscona theis* showed a uniform density during the months of September to November. In the Family Tetragnathidae peak density was seen in September (*Tetragnatha mandibulata* with 5.5 spiders per 10 hills), a decline in the population was seen till November. *Eucta javana* reached its peak density in the month of October. August and In November the species density was less. Table B shows the population dynamics of dominant spiders in paddy belonging to family Araeneidae and Tetragnathidae.

In the Hunting spiders families, no individual species of spider represented more than 10% of the population and hence were not chosen for the population dynamics study.

IV. Data distribution

A. Organic field

The distribution patterns of the spiders in both the years were found to be of geometric series. Such type of animal distribution pattern is the typical of recently disturbed habitats that experiences harsh climatic conditions and human interference. In both the study phases after comprehending the spider diversity, dominance, richness, population and species diversity etc, we find that the data distribution fits the geometric model for all the months, whereas fit the log model for all the months except November.

B. Conventional feild

The Data distribution in both the cropping months shows geometric model. This shows no difference with the distribution pattern of organic field.

In Phase II, Data Distribution of the Data for months except July and November Fits a truncated log model of distribution

V. Rank Abundance

Organic Field

In **Phase I** the rank abundance of the spider species in different months showed that several species are abundant having more than one individual. One way to visually assess species richness is to plot a rank abundance graph (Graph 4.11a). Such plots throw light on (i) Equitability in abundance of species and species richness (ii) Exact month of species richness. In the month of August only six species showed abundance having more than one representative. September showed a more even distribution of the species with about 18 species representing with more than one individual. Month of October had 22 species as representatives while November had 8 species representing themselves. In the present study it was observed that September and October are the two months which give the best habitat for the spiders to flourish. The crop is at its maturity stage providing right crop architecture for the site for web building and for the hunting spiders to hide and the ideal microclimate for its survival.

In the **Phase II** August and September are the months showing the Maximum spider species (Graph 4.11b) coinciding with the increase in the density of insect pests in paddy. In the **Phase II** of the study in the month of July shows no species having abundance of more than one. The month of August shows 11 species of spiders with abundance of more than two. In September 8 species of spiders showed abundance of more than two. In the month of October and November they were 6 and 5 respectively.

Conventional field

Phase I

During the Phase I of the study, (Graph 4.12a) the Months September and October show more evenness than the months of July and August. Five species of spiders were present in density of more than 4 individuals per sampling unit. It may however be noted that the species may be different during different months.

Phase II

In Phase II, August and October months show less even distribution of the spider species as against the other months (Graph 4.12b). Both these months have 6 and 3 species of spiders present in higher density (>4 individuals per sample unit). This shows that the disturbance may be one of the factors causing the decrease in evenness.

VI. Alpha diversity index

The Alpha diversity indices calculated by Simpson D, Shannon –Weiner H, Berger - Parker Dominance index shows the same trend in phase I and Phase II. The Values of H and D, helped to conclude that the distribution of spiders in one cropping season is contributed by more than one family. Species diversity is a result of multiple spider species flourishing on paddy field at the same time. The community structure of spiders, their relevance in the agricultural fields and ecological role are the factors which need emphasis and focus, if they have to be projected as potential biocontrol agents. The data observed: diversity, seasonal dynamics, abundance and evenness should be correlated either by the Simpson index, Shannon-Weiner index or any other diversity index. Other indices like Margalev d and Fisher Alpha are some of the other statistical formulas to show the diversity measure of a particular habitat.

PHASE I

October represented the maximum species richness, consisting of 20 species of spiders. Various diversity indices for October Shannon-Weiner (H) index 2.762± 0.009 , Simpson (D) index 16.275 , Berger-Parker Dominance index was lowest for the month of October. The Evenness index for October showed that more number of species represented in almost equal abundance in the month of October. Thus October represents the maximum species diversity (Table 4.3a) and abundance (4.1a). The Renyi diversity ordering

(Graph 4.13a) also confirms that the month of October is the most diverse. Margalef D and Fisher alpha for October were 4.585 and 10.10 respectively. Similar trend was seen in September though the values of "D, H, Evenness and Berger Parker dominance Index were a little less as compared to that of October.

Phase II

October represented the maximum species richness (Table 4.3b) with the occurrence of 24 species; followed by September (19 species) and August (18 species). The Simpson D index for October showed 16.57; D was maximum for November (18.071) and least for August (D= 6.492). The Shannon-Weiner Index for the corresponding months was 2.48 for November, 2.16 for August and 2.84 for October. The values of 'D' and 'H' shows that 'D' was highest for November while 'H' was highest for October. The uncertainty regarding the actual assessment of diversity for October and November can be done by Renyi's Diversity ordering(Graph 4.13b).Margalef D for October and November were 5.310 and 4.146 respectively, Fisher Alpha were 12.079 for October and 15.177 for November. The Berger –Parker dominance index for October and November were 0.131 and 0.173 respectively. Equitability or Evenness index showed values of 0.669 for November and 0.767 for October.

Conventional field

Phase I

Shannon Weiner index for the months of September and October were the highest in the cropping months. In the month of October H was 3.056 ± 0.013 and for the month of September H was at 2.886 ± 0.01. Both the months showed a significantly higher diversity ($P < 0.05$; Chi square test) than the other cropping months the values of Simpson Index (D) and Species number were maximum for the September and October months. This shows that that these months show the maximum species diversity (Table 4.4a).The Equitability index also shows the same trend stating that the evenness of the community of spiders is high during these months i.e. all the spider species are equally represented in the agricultural field. The Renyi diversity ordering also confirms that October shows the maximum species diversity (Graph 4.14a). The month of August has the highest value of Berger Parker Dominance index while September and October have the least values. This shows that in the month of August the dominance of single spider species is higher while in October and September no single spider species dominates the community in terms of abundance.

Phase II

Shannon-Weiner Index ('H'):(Table 4.4b) the value of H for August and September were 2.67± 0.013 and 2.62±0.019 respectively for October H was at 1.91±0.022. Simpson Index 'D': D for August and September were 10.778 and 19.33. The Values of D and H for the months of August and September show that the D is higher for September while H is highest for August. The values of H and D for the months of August and September shows alternative peaks hence Renyi diversity ordering done to find out the month showing the maximal diversity. Diversity ordering gives a more pictorial representation of diversity and also overcomes the lacunae created by the Simpson and Shannon –Weiner values. The diversity ordering (Graph 4.14b)) shows that the diversity during the months overlaps with each other. The evenness and the diversity measures are also similar for these two months. However looking at the Species Number, August shows 28 species while September shows 16 species. Equitability or Evenness index: it was high for August and September with 0.747 and 0.732 respectively. Berger-Parker Dominance Index for month of August and September the B-P values were 0.175 and 0.172 respectively. B-P Index showed the highest value of 0.333 for October.

Table 4.1 a: Percentage composition of spider families (Phase I: Organic Field)

Family	Aug	Sept	Oct	Nov
Lycosidae	88.46	43.05	37.63	78.26
Salticidae	0	19.27	0	0
Clubionidae	0	2.77	2.68	0
Oxyopidae	0	22.22	10.75	8.69
Araeneidae	11.53	12.5	42.47	4.3
Thomisidae	0	5.55	0	0
Tetragnathidae	0	4.16	6.45	8.69

Table 4.1 b: Percentage composition of spiders (Phase II: Organic Field)

Family	July	August	September	October	November
Lycosidae	33.33	32.72	28.39	16.66	36.36
Araeneidae	0	34.54	29.62	22.22	18.18
Salticidae	13.33	1.8	0	4.16	4.54
Tetragnathidae	0	1.8	13.58	16.04	9
Linyphiidae	36.66	9	8.6	11.11	4.54
Therrididae	16.66	12.72	8.6	15.27	0
Others	0	7.27	11.11	12.5	27.27

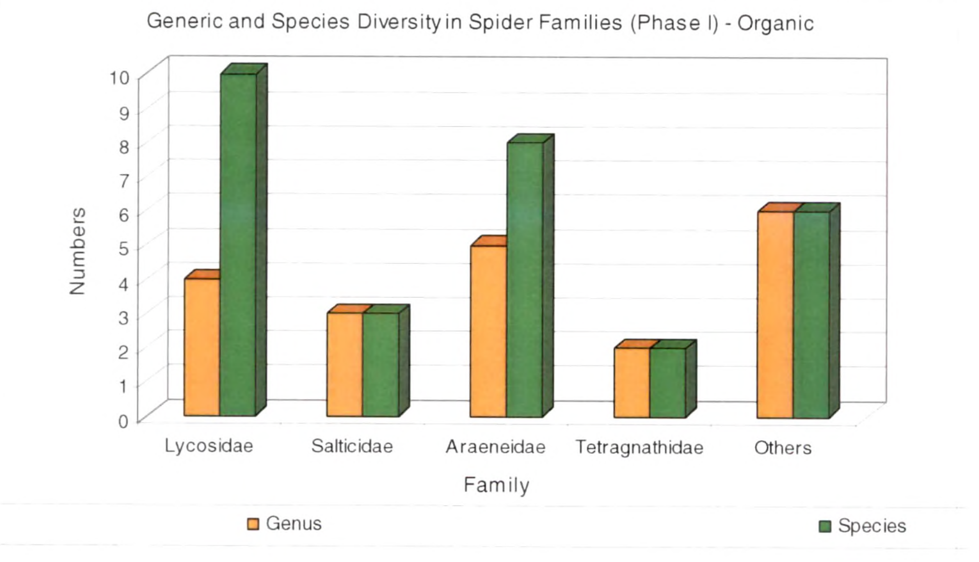
Table 4.3 a: Species Diversity and Evenness – Phase I

Diversity Measure	Aug	Sept	Oct	Nov
H	1.4922 ± 0.01	2.562 ± 0.01	2.7621 ± 0.08	1.8133 ± 0.01
D	4.51	11.11	16.27	7.027
Evenness	0.44	0.76	0.82	0.54
Fisher alpha	1.84	7.70	10.10	3.42
Berger - Parker	0.38	0.22	0.12	0.26
Species Number	5	18	20	7

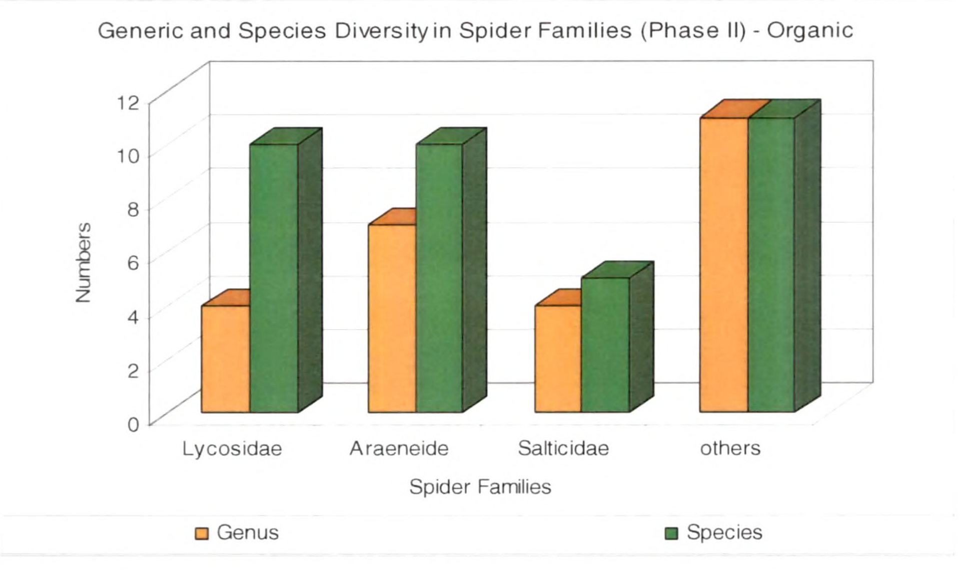
Table 4.3 b: Species Diversity and Evenness – Phase II

Diversity Measure	July	Aug	Sept	Oct	Nov
H	2.1613±0.04	2.6834	2.7722	2.8485	2.4873±0.02
D	6.49	15.96	17.05	16.57	18.07
Evenness	0.58	0.72	0.74	0.76	0.66
Fisher alpha	10.21	9.31	7.82	12.07	15.17
Berger - Parker	0.36	0.12	0.12	0.13	0.17
Species Number	14	18	19	24	14

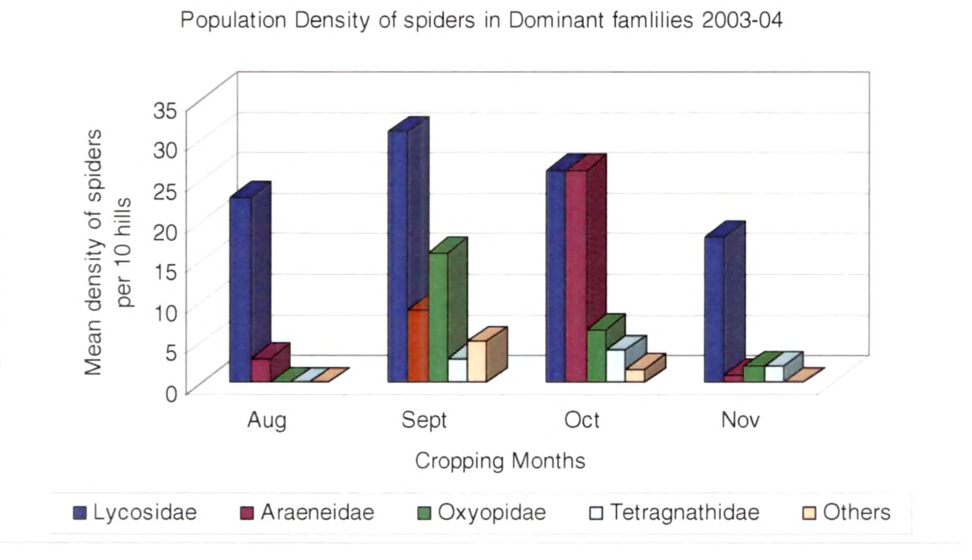
Graph 4.1 a: Generic and Species diversity – Phase I (Organic Field)



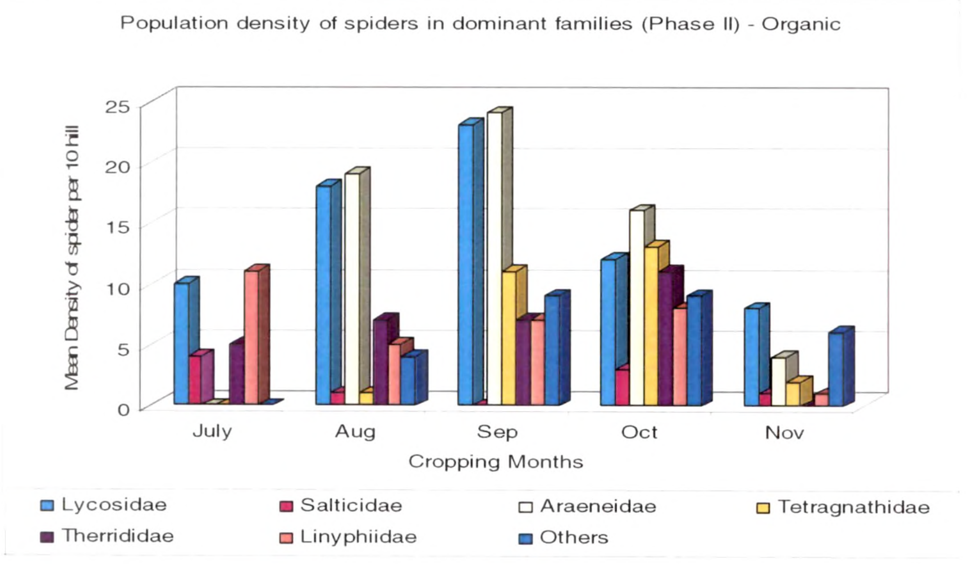
Graph 4.1ba: Generic and Species diversity– Phase II (Organic Field)



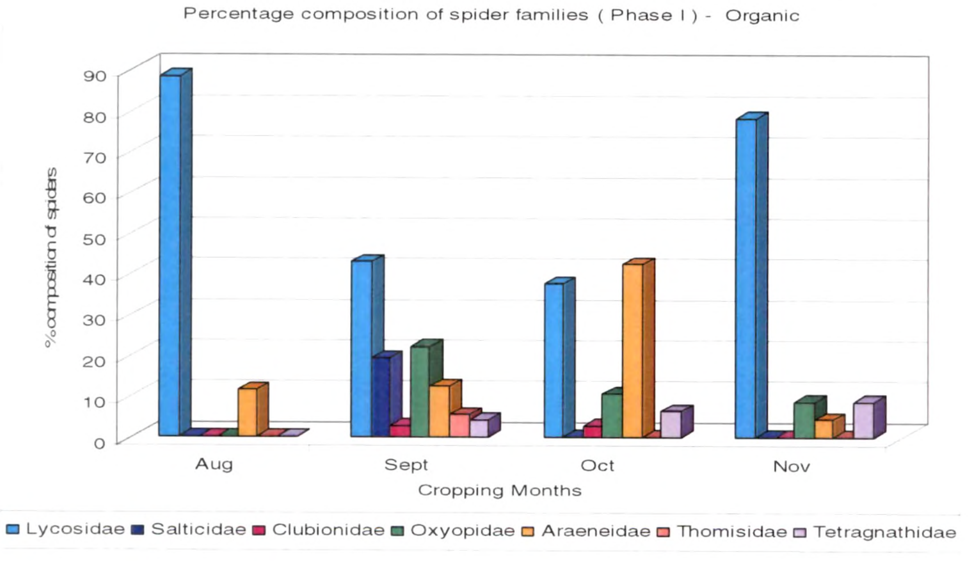
Graph 4.3 a: Relative abundance and density of spiders – Phase I (Organic Field)



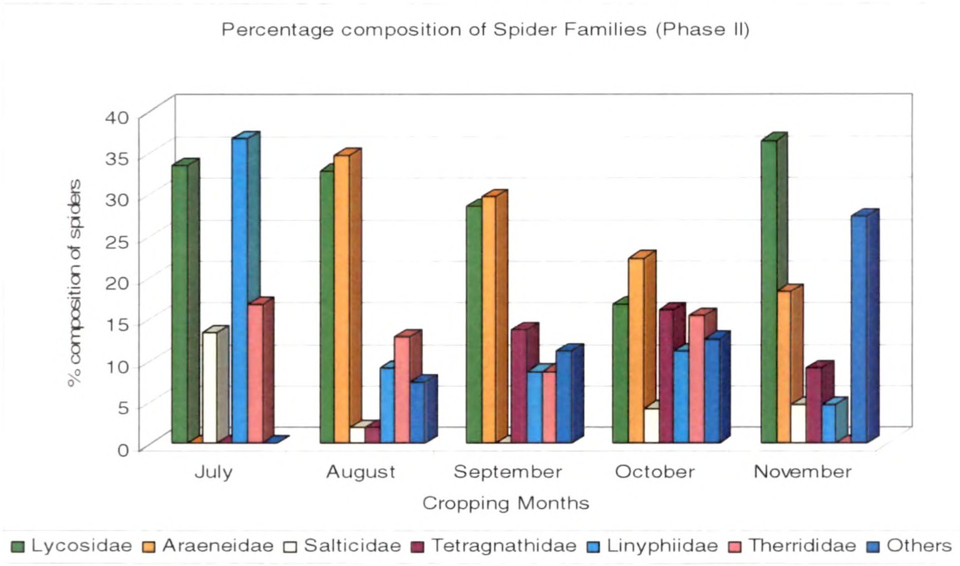
Graph 4.3 b: Relative abundance and density of spiders – Phase II (Organic)



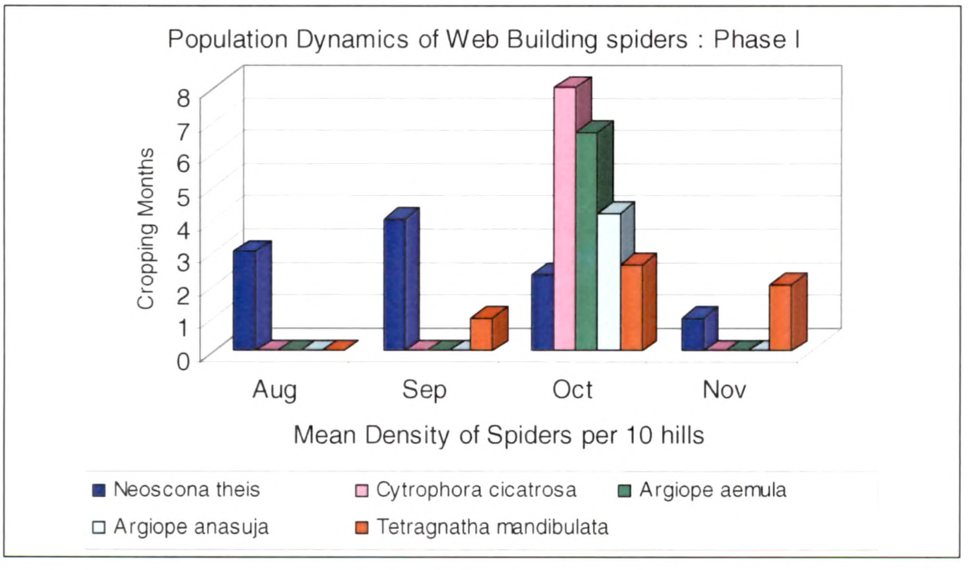
Graph 4.5 a: Percentage composition of Spider Families - Phase I (Organic)



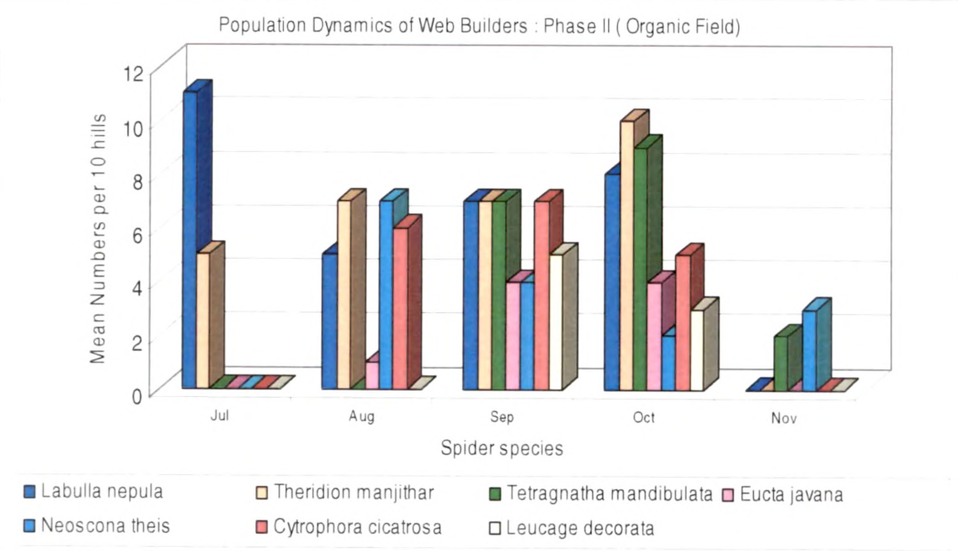
Graph 4.5b: Percentage composition of Spider Families - Phase II (Organic)



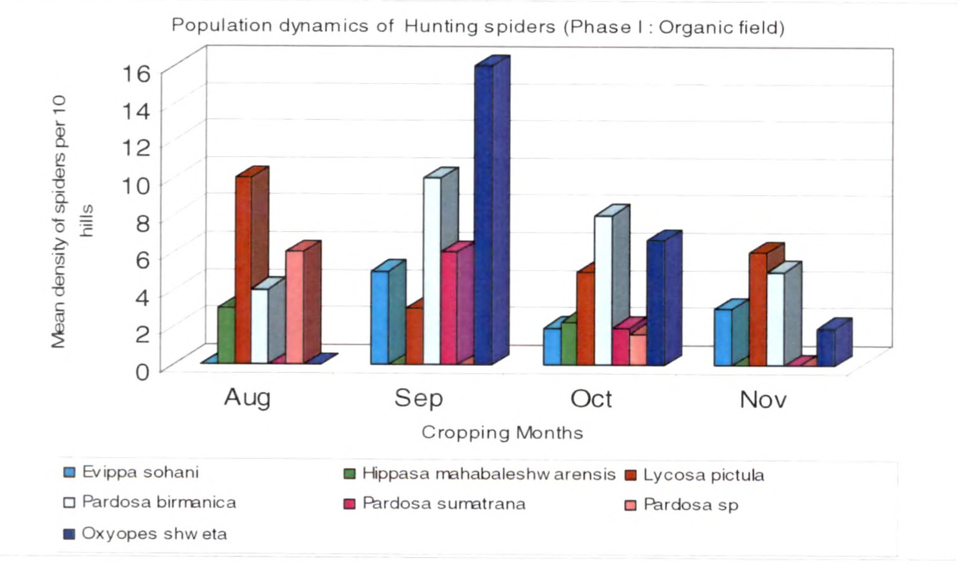
Graph 4.7 a: Population Dynamics of Web Building spiders: Phase I (Organic)



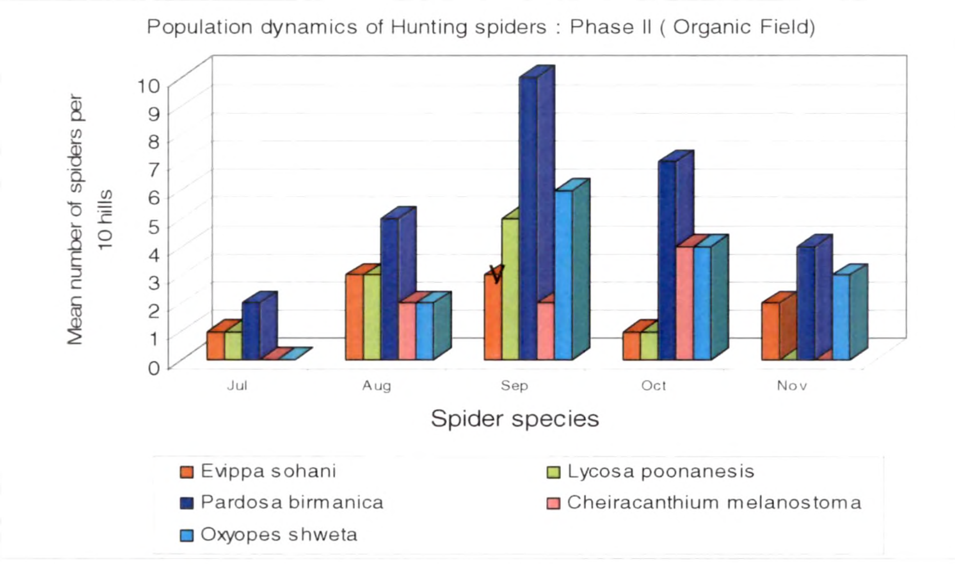
Graph 4.7 b: Population Dynamics of Web Building spiders: Phase II (Organic)



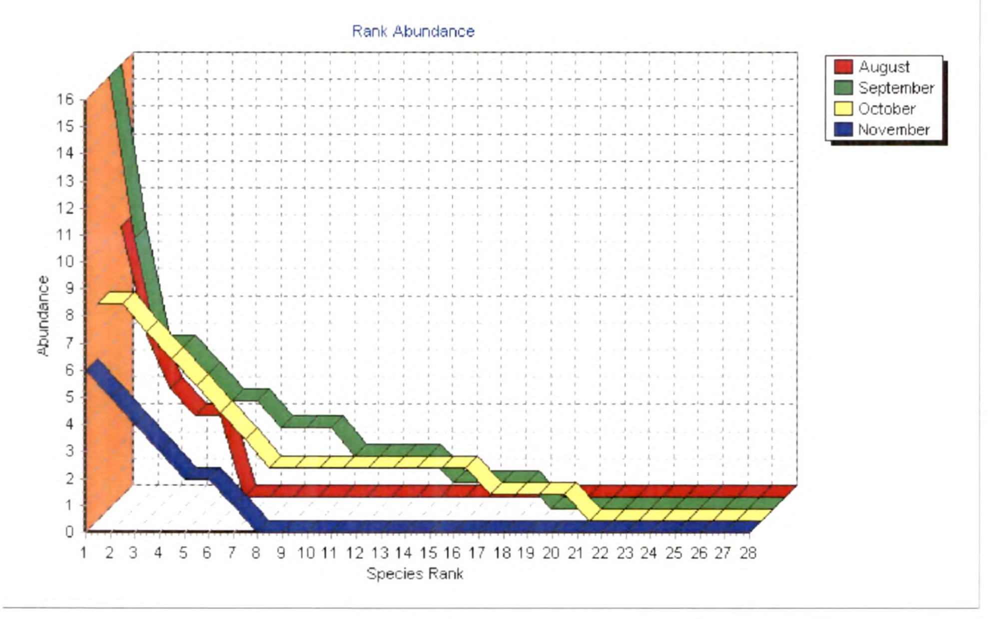
Graph 4.9a: Population Dynamics of hunting spiders: Phase I: Organic Field



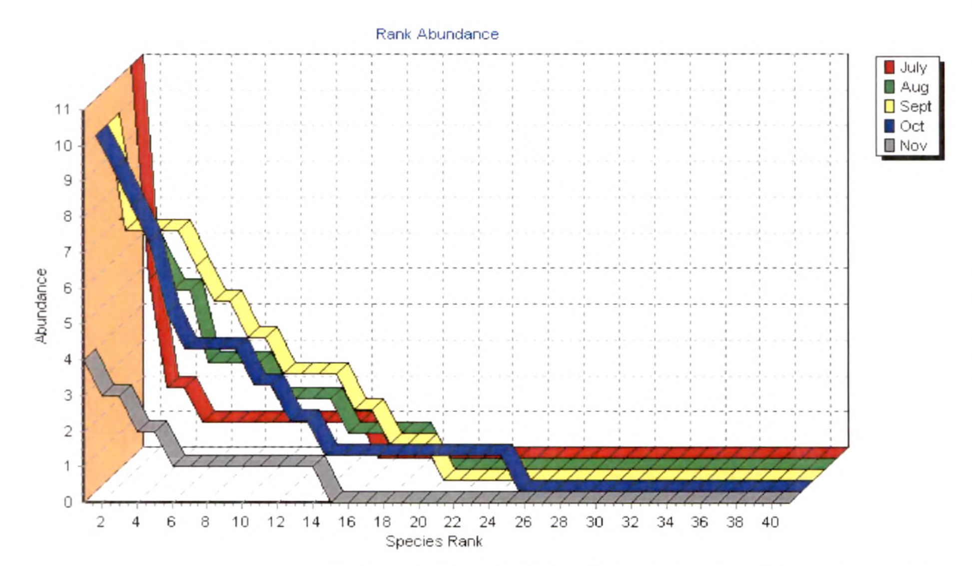
Graph 4.9b: Population Dynamics of hunting spiders (Phase II) Organic Field



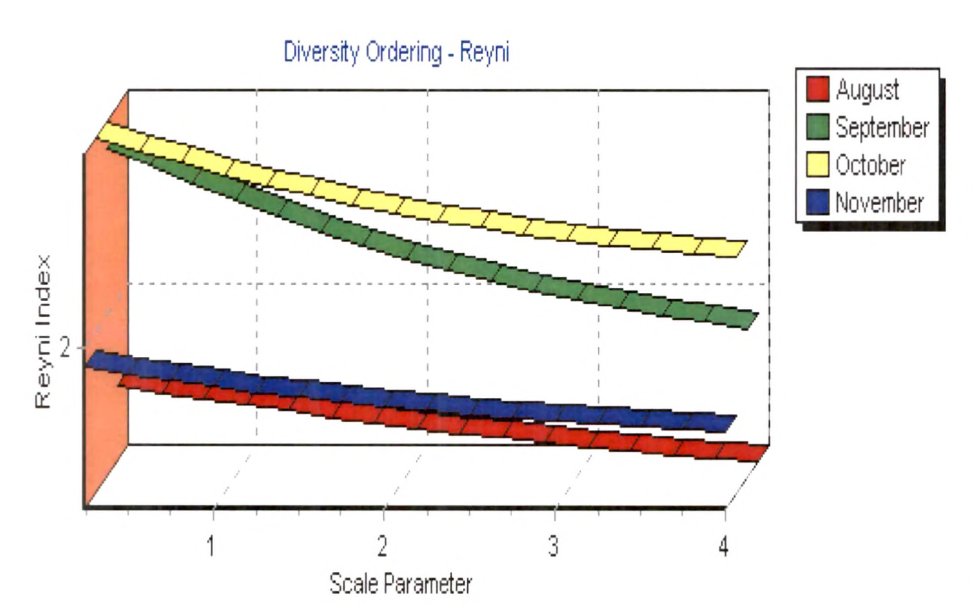
Graph 4.11a: Rank Abundance of Spider species – Phase I (Organic field)



Graph 4.11b: Rank Abundance of Spider species – Phase II (Organic field)



Graph 4.13a: Renyi diversity Ordering – Phase I (Organic field)



Graph 4.13b: Renyi diversity Ordering – Phase II (Organic field)

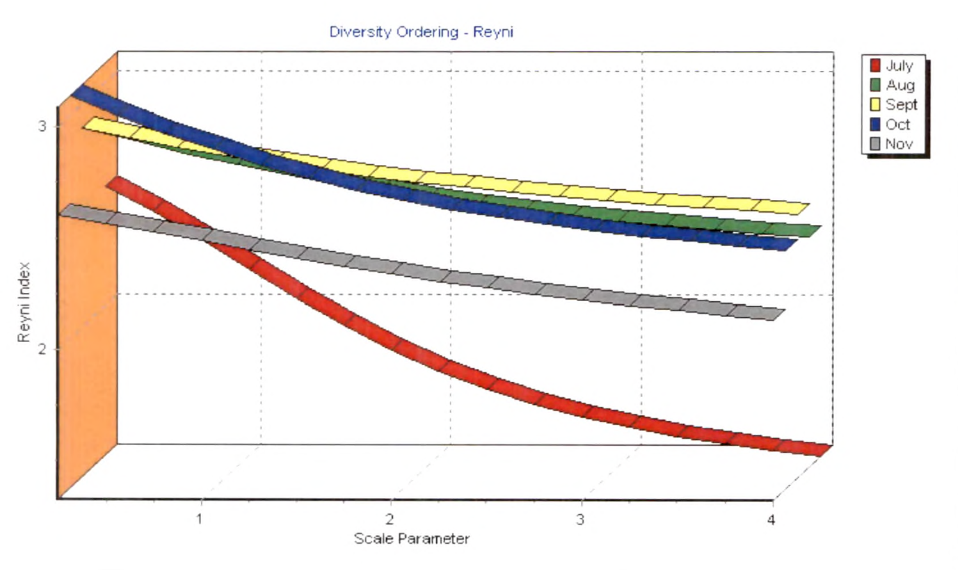


Table 4.2 a: Percentage composition of the spiders – Phase I (Conventional field)

Family	June	July	August	September	October	November
Araeneidae	0	0	9.8	39.43	7.35	10.63
Linyphiidae	0	0	7.4	0	2.94	17.02
Lycosidae	100	63.88	31.4	9.8	13.23	0
Oxyopidae	0	23.16	9.8	0	0	6.3
Salticidae	0	0	0	23.94	20.58	21.27
Therrididae	0	0	29.01	7	16.17	25.53
Thomisidae	0	12.5	5.5	4.2	10.29	8.51
Tetragnathidae	0	0	0	14.8	14.7	6.38
Others	0	0	1.2	1.4	10.2	4.2

Table 4.2 b: percentage composition of the spiders – Phase II (Conventional field)

Family	July	August	September	October	November
Araeneidae	0	48.64	22.72	19.35	54.54
Salticidae	0	6.75	11.36	9.67	22.72
Lycosidae	0	5.4	9.09	3.22	4.54
Clubionidae	0	0	4.54	3.22	0
Tetragnathidae	0	22.97	38.63	61.29	13.63
Others	0	16.21	13.63	3.22	4.54
Total	0	74	44	31	22

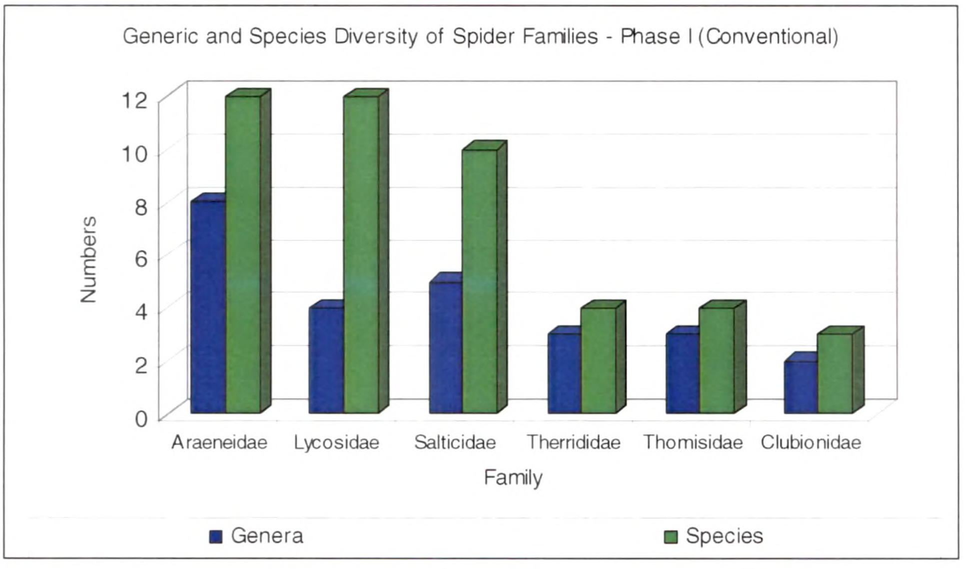
Table4.4 a: Species Diversity and Evenness measures – Phase I (Conventional)

Diversity Measure	Jun	Jul	Aug	Sept	Oct	Nov
H	0.8554	2.0061	2.4704	2.8864±0.01	3.056±0.01	2.4476±0.01
D	2.0061	7.6527	8.1303	17.378	19.741	11.129
Evenness	0.2064	0.4842	0.5962	0.6966	0.7376	0.5907
Fisher alpha	0.6717	2.3013	5.1779	13.743	20.868	8.7045
Berger - Parker	0.6724	0.2083	0.2901	0.1267	0.1343	0.1739
Species Number	3	8	18	25	30	16
Margalev d	0.4925	1.6368	3.3415	5.6303	6.8971	3.9178

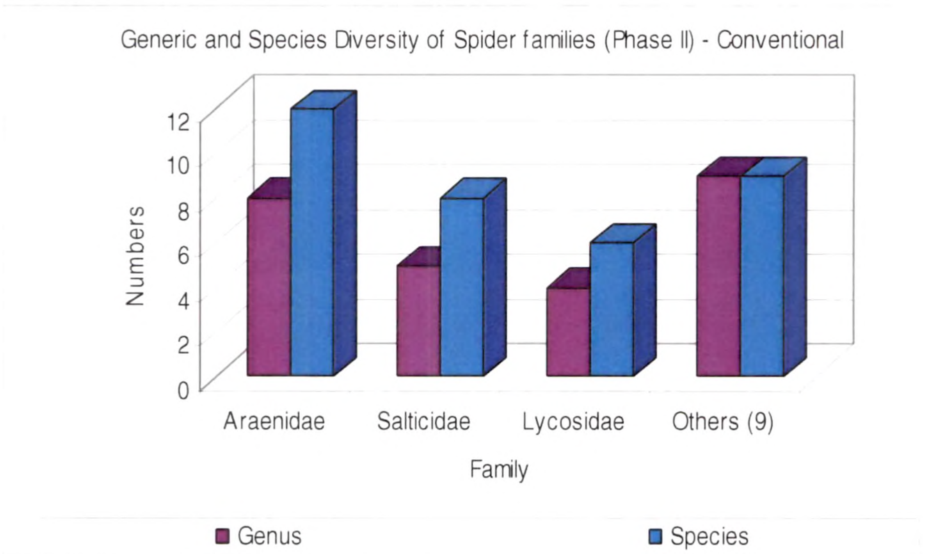
Table 4.4 b: Species Diversity and Evenness measures – Phase II (Conventional field)

Diversity Measure	Jul	Aug	Sept	Oct	Nov
H	0	2.679±0.0133	2.6235±0.019	1.9175±0.022	2.5001±0.0268
D	1	10.778	19.333	5.8879	19.25
Evenness	0	0.7475	0.7321	0.5350	0.6976
Fisher alpha	0	13.193	14.664	4.5872	16.572
Berger - Parker	1	0.1752	0.1724	0.3333	0.1818
Species Number	1	28	16	10	14
Margalef d	0	5.902	4.454	2.5115	4.2057

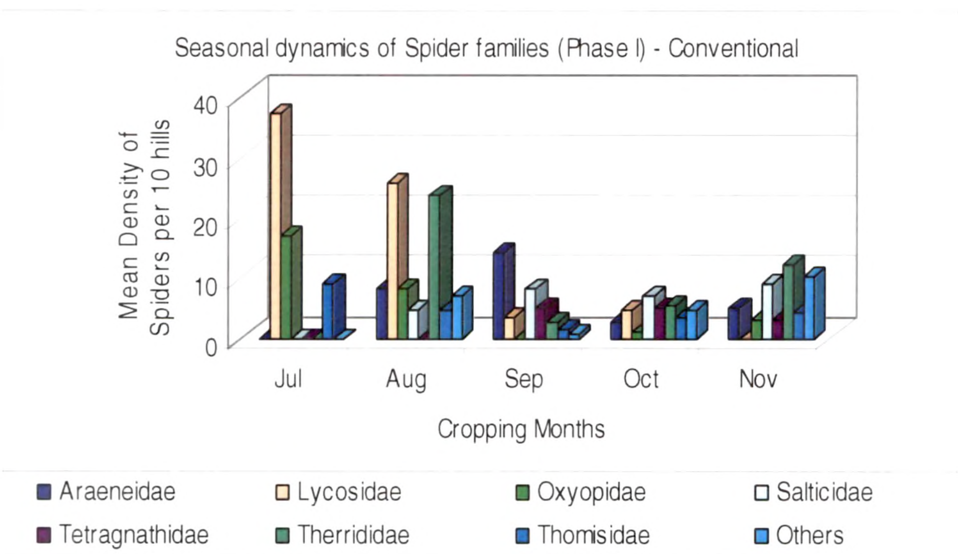
Graph 4.2 a: Generic and Species diversity of spiders – Phase I (Conventional Field)



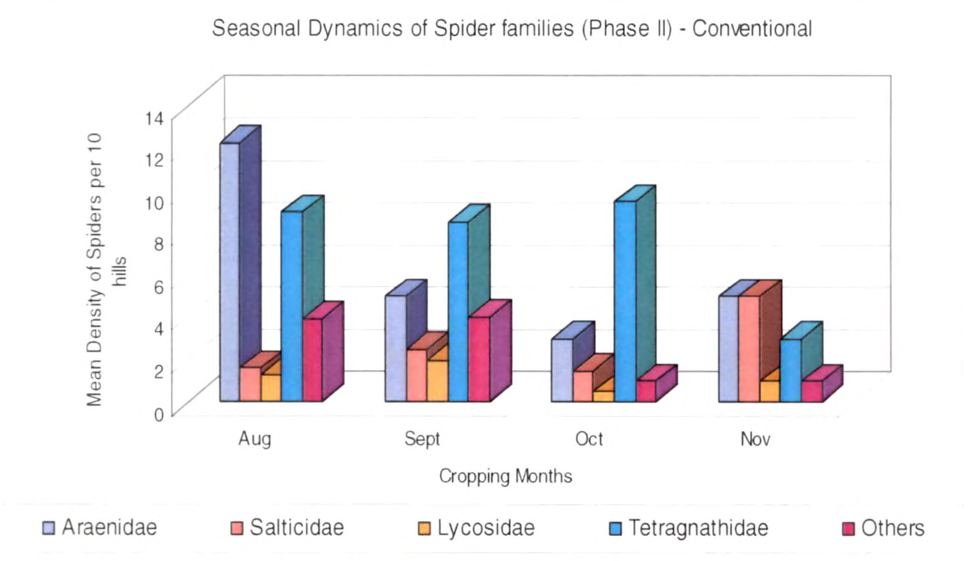
Graph 4.2 b: Generic and Species diversity of spiders – Phase II (Conventional Field)



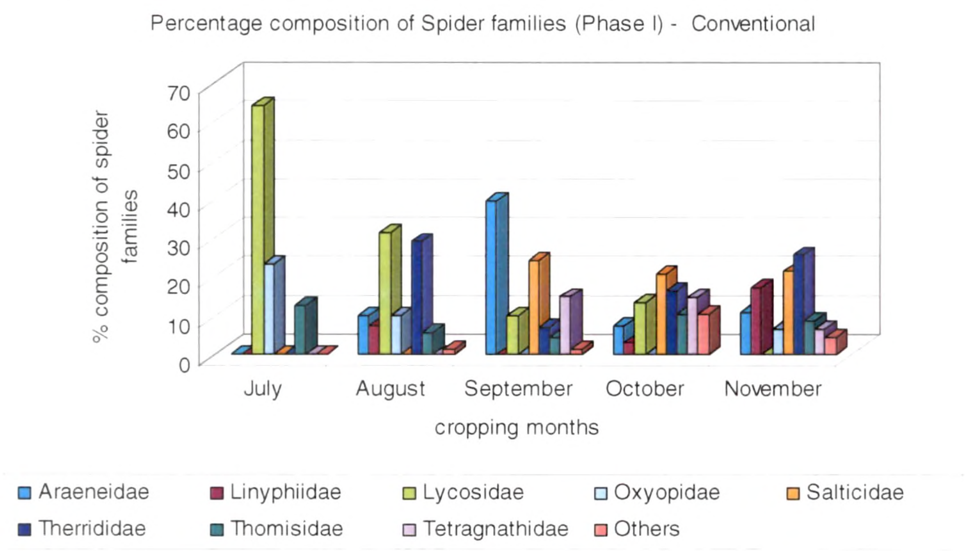
Graph 4.4 a: Relative abundance and Density of spiders – Phase I (Conventional field)



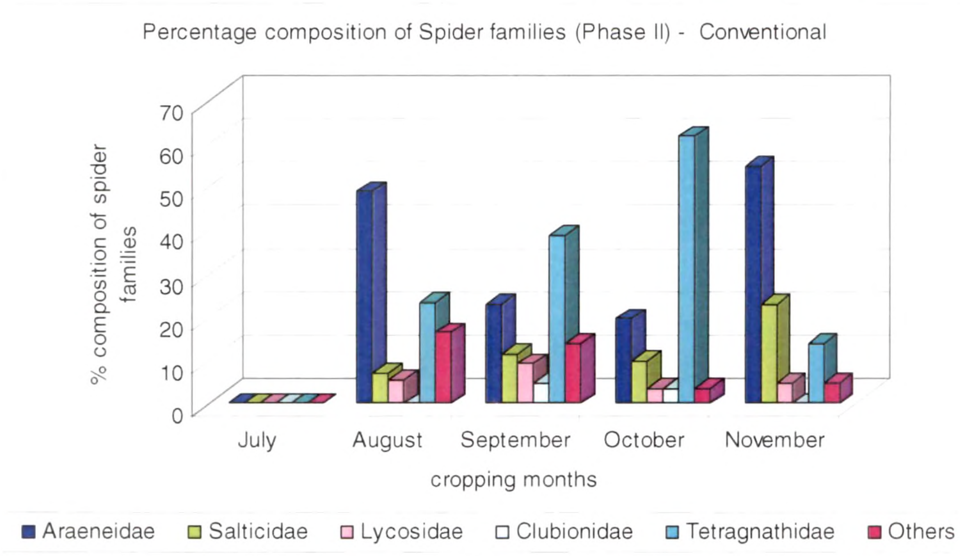
Graph 4.4 b: Relative abundance and Density of spiders – Phase II (Conventional field)



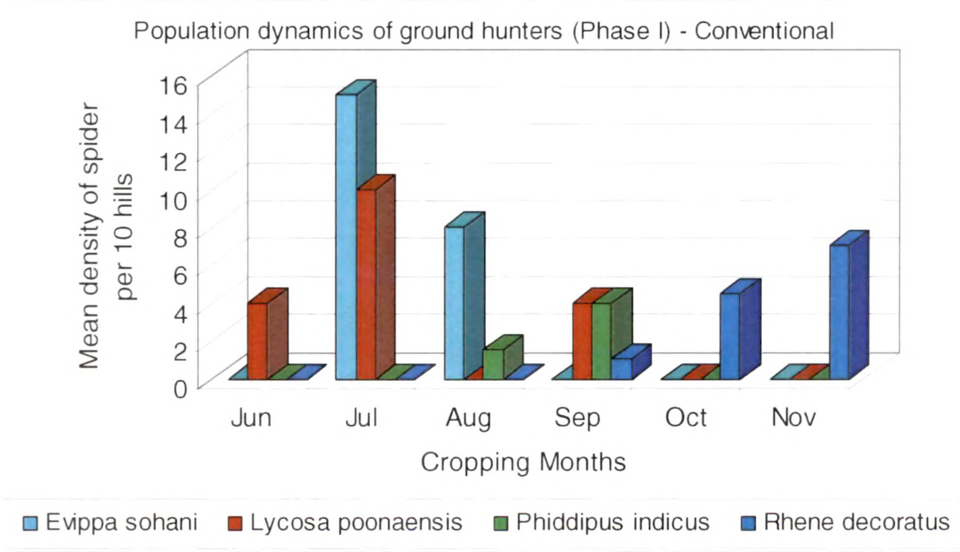
Graph 4.6a: Percentage Composition of spider families – Phase I (Conventional field)



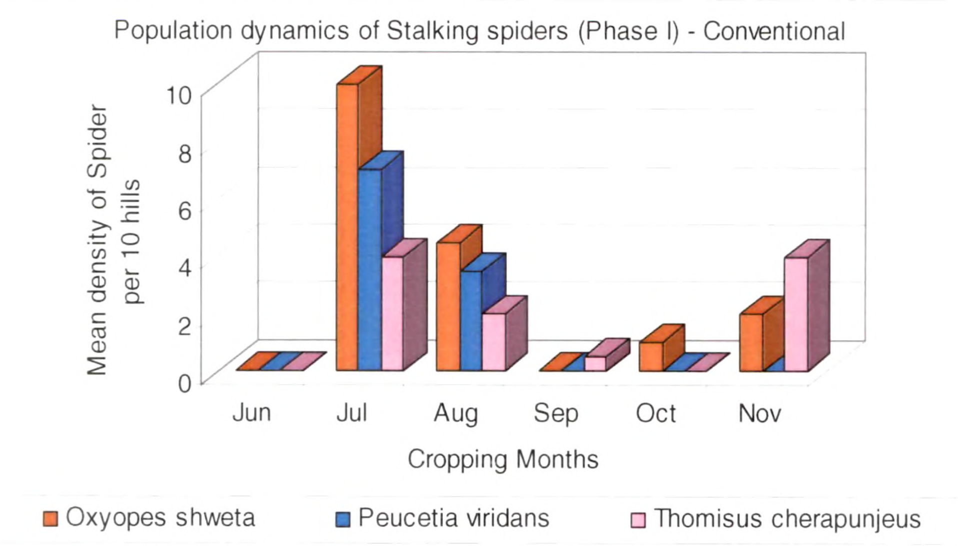
Graph 4.6 b: Percentage Composition of spider families – Phase II (Conventional field)



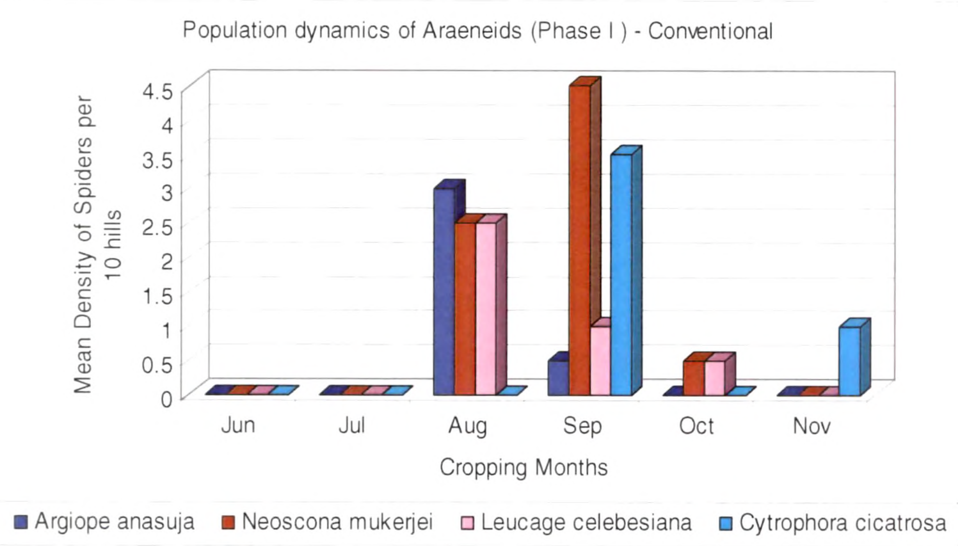
Graph 4.8 a: Population Dynamics of Ground Hunters – Phase I (Conventional Field)



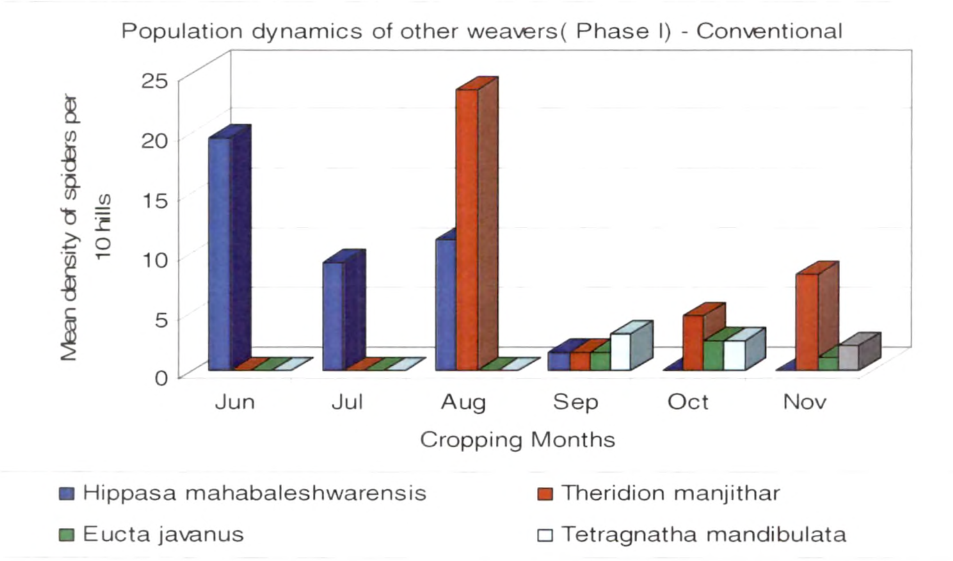
Graph 4.8 b: Population Dynamics of Stalking spiders – Phase I (Conventional Field)



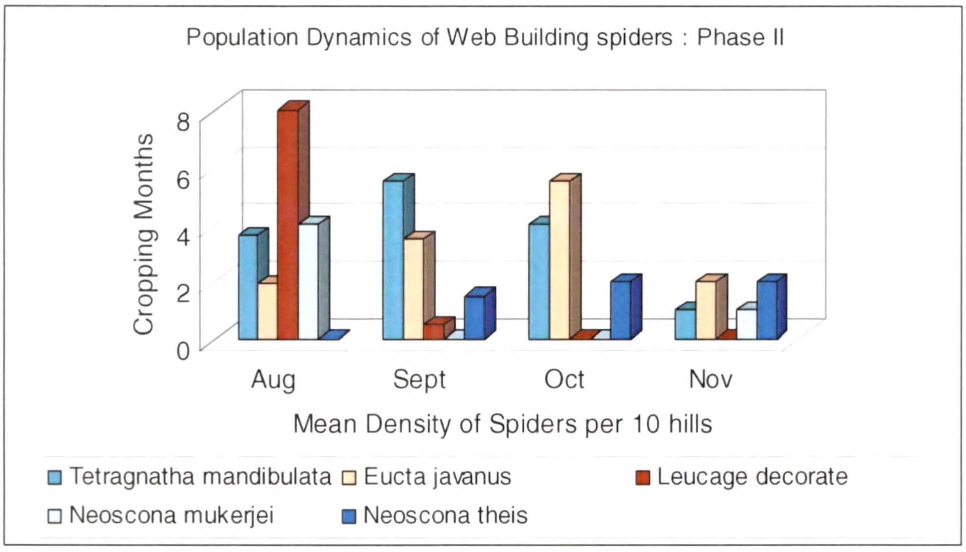
Graph 4.8 c: Population Dynamics of Araenid spiders – Phase I (Conventional Field)



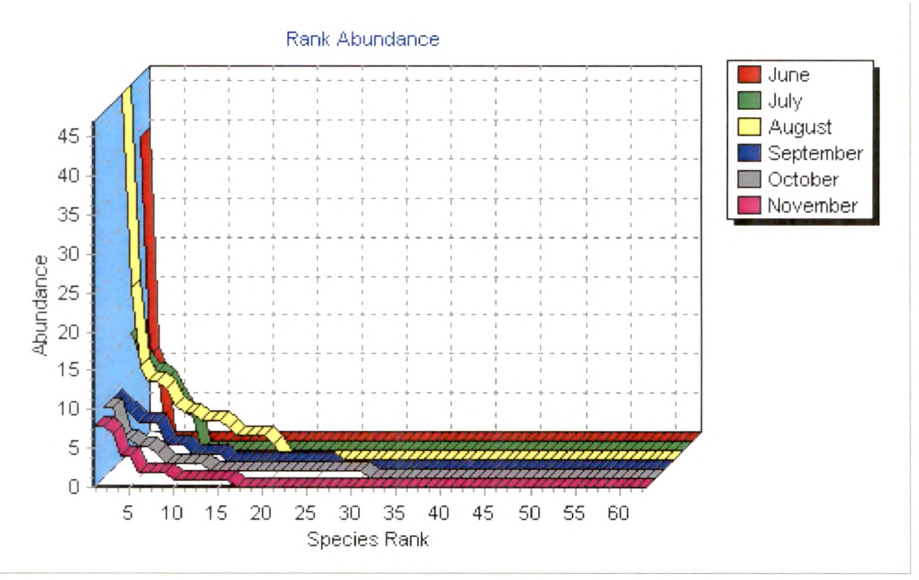
Graph 4.8 d: Population Dynamics of other Weavers – Phase I (Conventional Field)



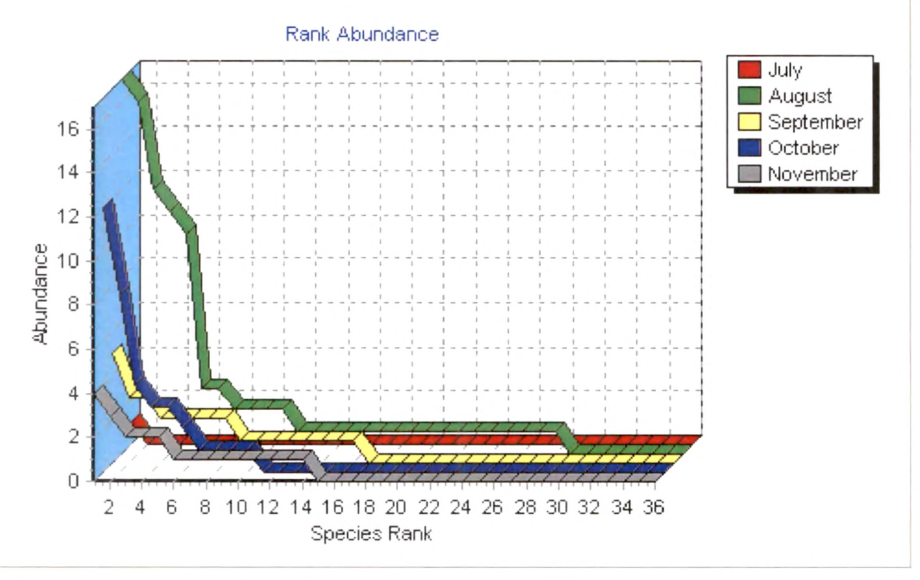
Graph 4.8 e: Population Dynamics Web Building spiders –Phase II (Conventional Field)



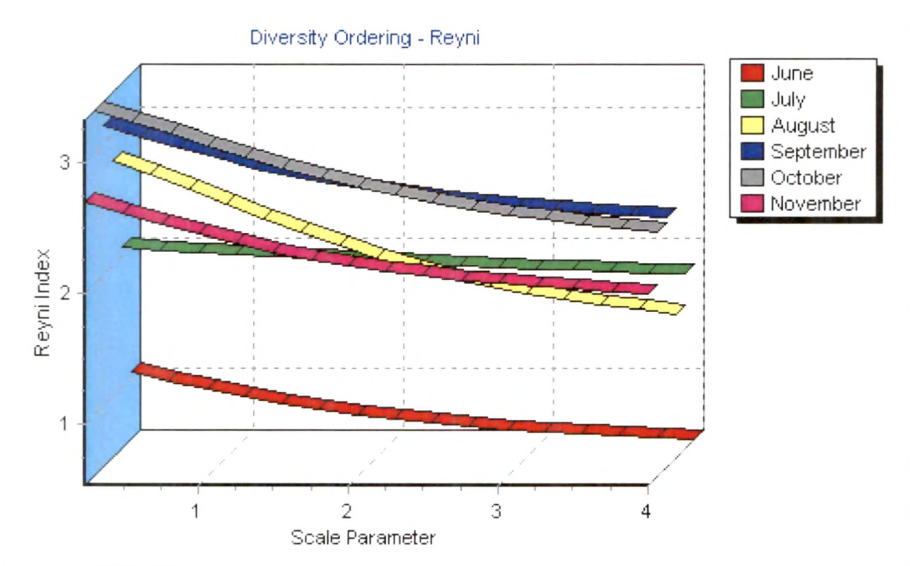
Graph 4.12 a: Rank abundance of spiders - Phase I (Conventional Field)



Graph 4.12 b: Rank abundance of spiders - Phase II (Conventional Field)



Graph 4.14 a: Renyi Diversity Ordering – Phase I (Conventional Field)



Graph 4.14 b: Renyi Diversity Ordering – PhaseII (Conventional Field)

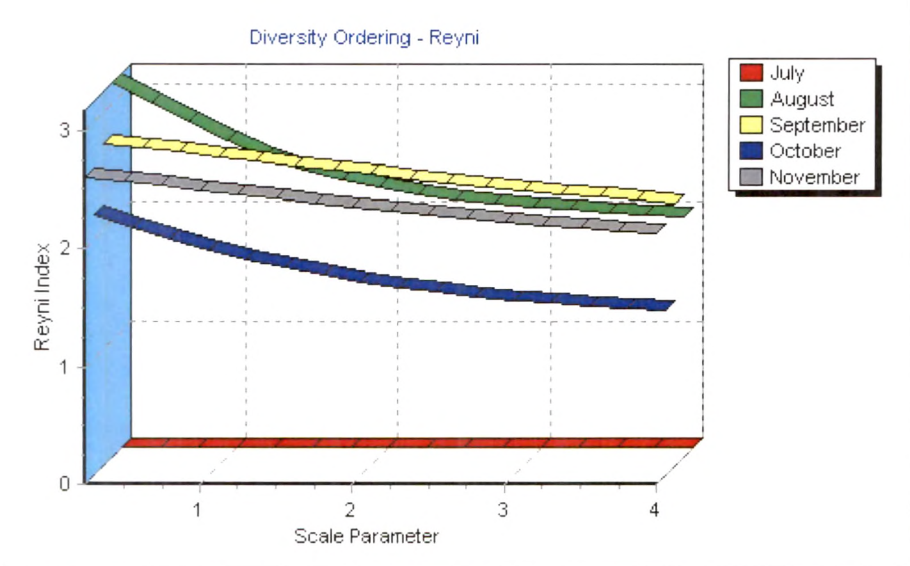
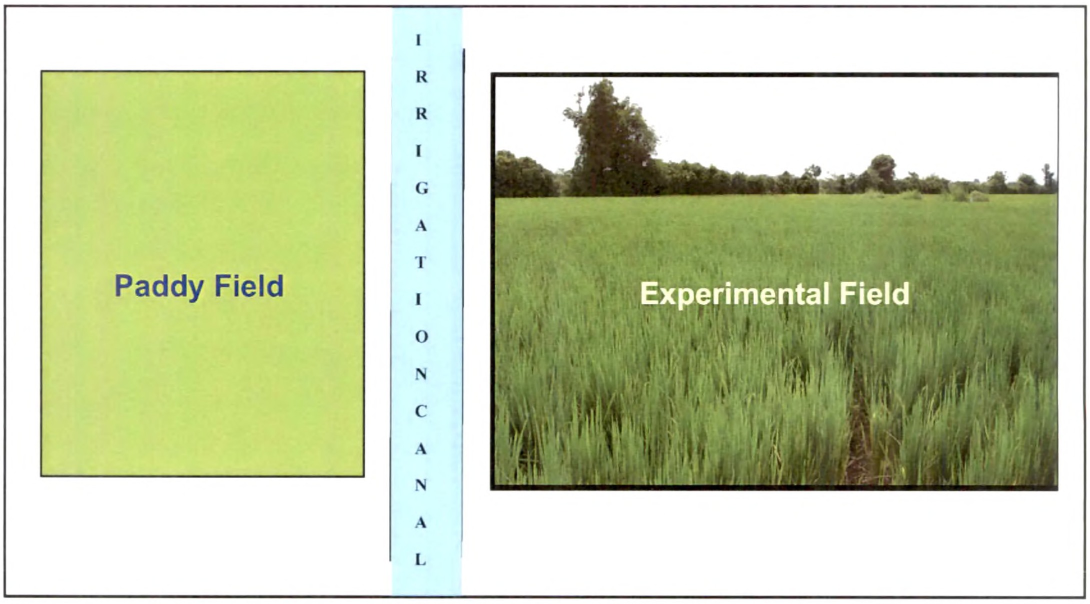


PLATE II

PHTOGRAPH SHOWING THE LOCATION OF THE STUDY AREA AND THE ADJOINING GEOGRAPHICAL FEATURES IN BOTH CONVENTIONAL AND ORGANIC FIELD

Site I – Conventional Paddy Field (Timbi)



Site II– Organic Paddy Field

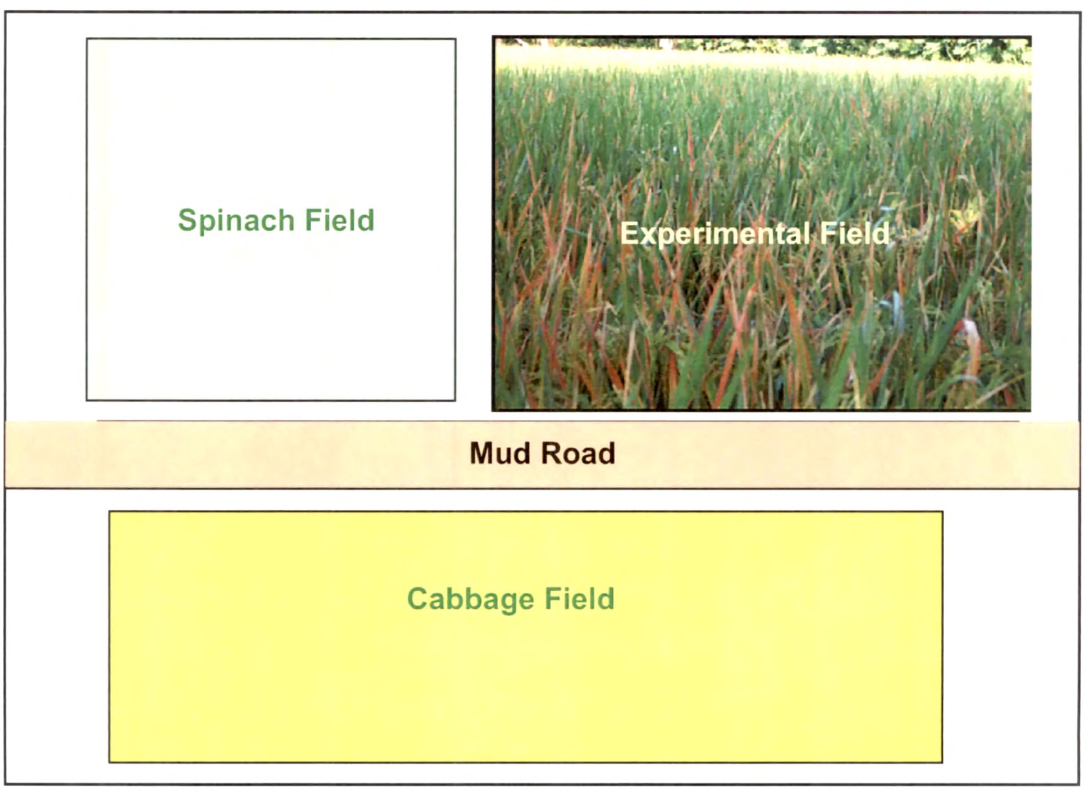


PLATE III

STAGES OF THE PADDY CROP IS SHOWN

TRANSPLANTED PADDY - TWO WEEKS OLD

PADDY - 1 MONTH OLD (VEGETATIVE STAGE)

PLATE IV

STAGES OF THE PADDY CROP IS SHOWN

PADDY - GRAIN FILLING STAGE

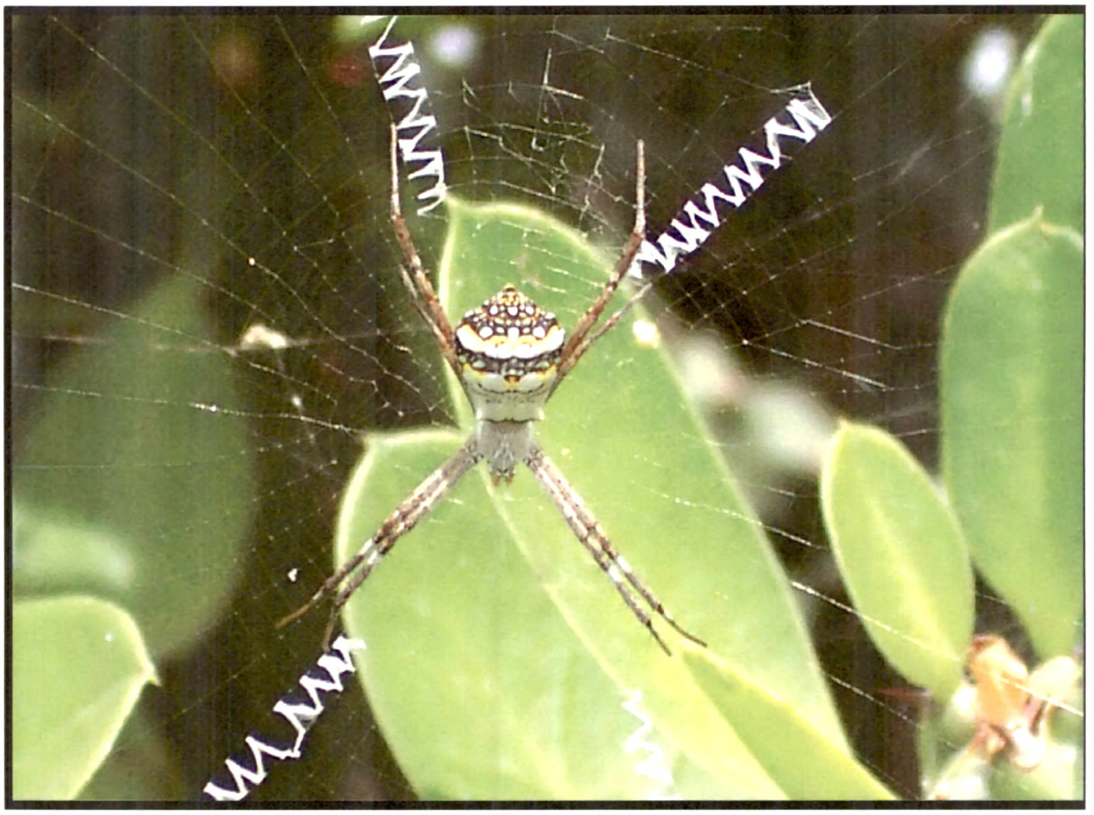
PADDY GRAIN MATURATION STAGE

PLATE V

Orb Weavers on margins of paddy field

Hunting spiders controlling Homopterans

ARGIOPE AEMULA (ORB WEB SPIDER) ALONG FIELD MARGINS



LYCOSID SPIDER ON THE PADDY HILL

PLATE VI

Tetragnathids on the blades of paddy crop feeding on Grasshoppers

TETRAGNATHA MANDIBULATA (LONG JAW SPIDER)

EUCTA JAVANUS ALONG THE LENGTH OF PADDY LEAF

PLATE VII

Lynx spiders as generalist predators

Clubionid web on paddy blade

LYNX SPIDER (OXYOPES SHWETA) IN PADDY

WEB OF SAC SPIDERS (CLUBIONIDAE) IN PADDY

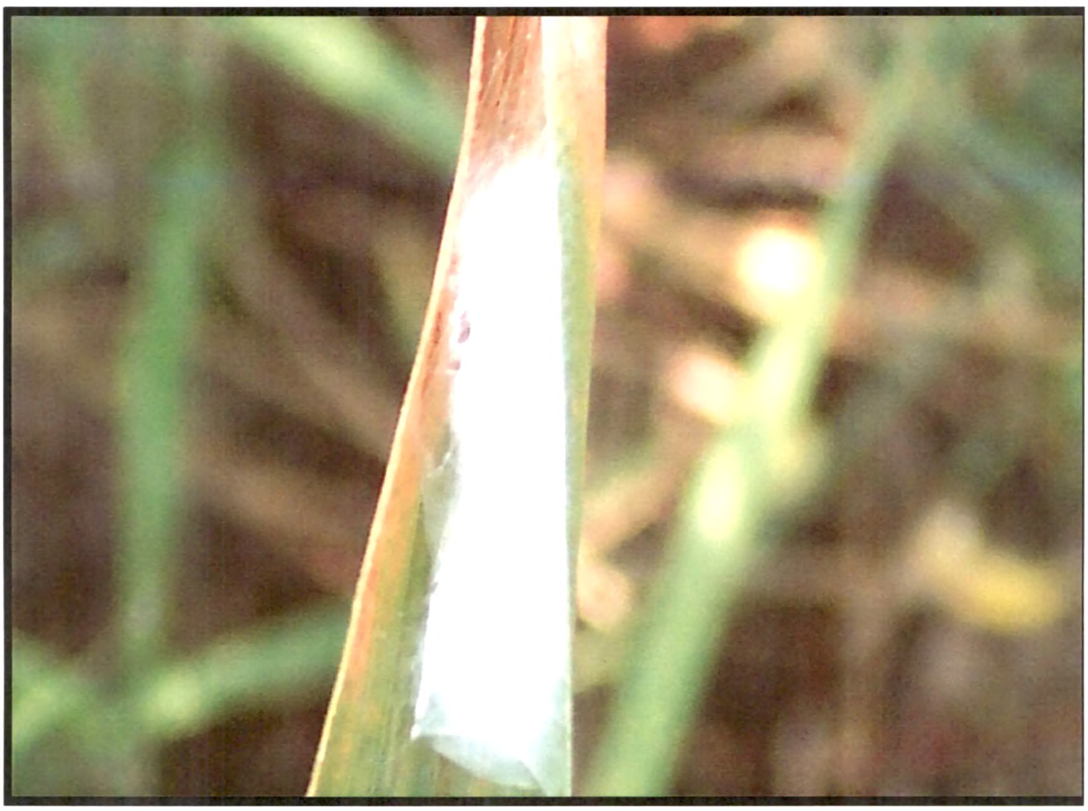


PLATE VIII

EGG SAC AND THE ADULT CYTROPHORA CICATROSA

EGG SACS OF CYTROPHORA CICATROSA SUSPENDED BETWEEN

VENTRAL VIEW OF CYTROPHORA CICATROSA IN ITS WEB

PLATE IX

Neoscona sp. in its web between paddy hills (Dorsal View)

Neoscona sp controlling coleopteran pest

DORSAL VIEW OF NEOSCONA SP IN ITS WEB

NEOSCONA THEIS PREDATING ON BEETLE

PLATE X

Other biocontrol agents of paddy field

Predatory Odonates in paddy field

HYMENOPTERAN FOUND IN PADDY

DRAGONFLY IN RICE FIELD

PLATE XI

SIX SPOTTED BEETLE FOUND ALONG THE FIELD MARGINS

DAMSELFLIES ALONG THE FIELD MARGINS

SIX SPOTTED BEETLE FOUND ALONG THE FIELD MARGINS

DAMSELFLY

PLATE XII

Predatory Dragonflies

PLATE XIII

Insect pests of Paddy

Larva of Rice stem borer feeding stem of paddy crop

Adult White fly sucking the fluid from various parts of Rice crop

RICE STEM BORER

WHITEFLY IN PADDY CROP

PLATE XIV

Hairy caterpillar damaging the leaves of rice crop

Slug seen during Grain filling stage

AMSACTA ALBUSTRIGA IN PADDY

SLUGS IN PADDY

Discussion

In the organically managed site, during Phase I and Phase II cropping seasons, Family Lycosidae and Araneidae were the most diverse families. The Hunting spider guild contributed to 66.66% of the species diversity and the web builders spiders comprised about 33.33%. Oraze et al (1988), Sigsgaard (2000); Barrion et al (1999); Okuma et al (1978); Ishijima (2004); Sebastian et al (2005) have reported the dominance and diversity of Lycosidae and Araneidae in the flooded rice fields in Temperate, Tropical and Semi tropical region of the world. These have modified their habitats or adapted to live in rice agroecosystems in a better way as compared to the other spider families. In terms of density of the spider families during the initial stage Family Lycosidae were the dominant in both phase I and Phase II cropping seasons. Sahu et al, (1996); Sigsgaard, (2000) showed that Lycosidae are the early colonizers of the paddy fields.

Family Linyphiidae was found in high density during the phase II, this buildup of Linyphiids is due to their ballooning behaviour by which they arrive in large numbers (Oraze et al, 1988) when the fields are initially flooded. During the Vegetative stage of the crop Lycosidae represented about 30% of the total spider abundance in both the cropping seasons. Oxyopidae and Araneidae were the other two families which were abundant during this stage. It is seen that the crop architecture becomes more complex in the vegetative stage of the crop during this stage hills of the paddy crop come in contact with each other. This provides sufficient cover for the Lynx spiders (Oxyopidae) and adequate sites for web attachment and web support for the Orb web spiders (Araneidae) and Space web spiders to build their webs.

During the Earhead formation stage and earhead maturation stage of the crop the percentage composition of the Lycosidae becomes less than Araneidae. This is due to the increased structural complexity of the crop which promotes the buildup of population Web building spiders. The decrease in the population of Lycosidae can be due to a variety of factors one of them is the availability of light in the bottom strata. The light penetration decreases due to the growth of the paddy crop and the bottom of the rice field remains dark. As Lycosids are ground hunting diurnal spiders, these spiders may find later stage of the paddy as less favourable habitat for foraging. However during the earlier stages of the crop there are many gaps in between the hills of the paddy for light penetration which promotes the colonization of lycosids during the early cropping stages.

The rainfall is another factor which determines the ground dwelling spider assemblages like those of *Agelenopsis aperata* (Richert, 1974). Since the period of their decrease coincides with the increased rainfall, it may be argued that the interaction among abiotic factors like rainfall and light availability does contribute to the temporal distribution of the ground dwelling spider families. During the earhead maturation stage of the crop (November) the rainfall is less and the population of Lycosids increases .The percentage composition of the spiders during the Earhead maturation stage (November) showed that the steep decline in the population of the Orb Weavers both Araneidae and Tetragnathidae showing that the phase of the crop where the water logged condition is absent. Such dry habitat seems to be less favourable for the colonization of the Orb Weavers showing that rainfall and water logging decreases the density and diversity of lycosids however a minimum amount of soil humidity is required for the lycosid survival. At the same time the above factors promotes the diversity as well as density of Orb web builders like Araneidae and Tetragnathidae.

Correlation with abiotic factors like Temperature, Humidity, and Soil Temperature showed no significant impact on the spider abundance in the rice fields. Rypstra (1986) has shown a very slight correlation between temperature and web building spider density in tropical forests. But I couldn't find any significant correlation between the temperature and the spider abundance in paddy. Thus microclimatic moisture and temperature are not the determining factors for the change in Lycosidae and Araneidae abundance. But rainfall may be one of the determining factors for the abundance and distributions of the ground dwelling spiders (Richert 1974) the duration and the intensity of the light might be other factors which may affect the distribution of the diurnal hunting spiders. In the present study however we did not quantify the light intensity. According to Dondale and Binns (1977) rainfall and cumulative temperature of any area determine the variance in the number of spiders captured. Rushton et al, (1987) found that the wetness of the habitat as determinant of spider community structure. However the environmental factors were found to have a lesser impact on the spider density and diversity in the field. Hence in the absence of any strong correlation between spider abundance and climatic factors, it is possible that the crop architecture and the prey availability are some of the factors which influence the spider diversity and abundance.

During the post monsoon season there is a progressive buildup of Lycosidae. The Family Tetragnathidae shows similar pattern of abundance like that of family Araneidae. The only difference is the abundance and the representative species in the family Tetragnathidae is comparatively lower that the Family Araneidae. Oxyopidae were abundant in the Earhead maturation stage of the crop as the dry blades of the paddy provide camouflage for Oxyopids.

The individual spider species comprising more than 10 % of the total catch in the cropping seasons were taken up for population dynamics study. Araneidae and Tetragnathidae were the two families which were abundant in both the years. Genera *Argiope and Cytrophora* of the Family Araneidae were present during the earhead maturation stage of the crop and were absent during the other stages of the crop. *Neoscona theis* was present throughout the cropping season. *Tetragnatha mandibulata* was present in the both the season from the Vegetative stage (September) till the end of the cropping season. While in the Phase II *Cytrophora cicatrosa* showed a more uniform trend from September to October. As the dominant spiders found in the paddy are Orb web weavers which require structural support for building their web. The young and transplanted paddy doesn't support or provide adequate attachments sites for the orb weavers. Thus with the growth in vegetation we find the buildup of web weavers and their dominance in the earhead formation stage of the crop.

According to Uetz (1991), the physical structure of environment has an important influence on the habitat preferences of the spider species and composition of spider communities. Greenstone (1984) has shown that there is a strong positive correlation between vegetation tip height and diversity of web building spiders. The density and diversity of spider communities is found to be highly correlated with the crop architecture (Gunnarsson, 1990; Uetz et al, 1991; Baur et al 1996, Pianka, 1978). It is known that with the progress of cropping stage the structural complexity of paddy increases and also the spatial heterogeneity appears with the appearance of weeds in the field. According to Greenstone (1984) spatial heterogeneity determines the diversity of Orb weavers. Thus the diversity and abundance of orb weavers is determined by a combination of vegetational complexity, vegetational diversity and prey abundance (Rypstra, 1986).

In the Phase II, Three species of Lycosids, *Oxyopes shweta* from Family Oxyopidae and *Chieracanthium melanostoma* from the Family Clubionidae were the dominant hunting spiders. The population of *Oxyopes shweta* reaches its peak density during September (Earhead formation) and in October (Earhead maturation stage). Their abundance is positively correlated with moisture levels in their microhabitat. Lynx spiders (Oxyopidae) are found in very high numbers in Alfalfa ecosystem, where the microclimatic humidity exceeds 90% (Personal observation). *Chieracanthium melanostoma* also shows max abundance during the earhead formation stage. Of the three species of Lycosids *Pardosa birmanica* is the most abundant. The spider could be found through out the cropping season in paddy. It is also the dominant spider reported in the cotton agroecosystem (Sebastian et al, 2001; Siliwal, 2000).

The species number shows that it is in the month of October (Earhead maturation stage) that the maximum number of spider species are found in phase I it was 24 and in phase II it was 20. According to Way and Heong (1994), there is a temporal and spatial variation of arthropods in rice fields. The irrigated rice fields represent an agroecosystems with high gamma diversity (Channa and Amarasinghe, 2003)

The Shannon –Weiner (H) showed maximum value in the both cropping season in the month of October with the values of 2.8485 ± 0.009 for Phase II and 2.7621 ± 0.009 for Phase I. It is known that the value of H is sensitive to the changes in the number of rare species and for any ecological study its values are always between 1.5 - 3.5 and rarely exceeds 4.0. (Southwood and Henderson 2000). The value of Simpson index of diversity (D) was maximum for November in Phase II and in October for Phase I. According to hill 1973, fisher alpha is very similar to the inverse Simpson index (1/D), the value of which is highest for November in Phase II (15.177). Renyi Diversity ordering was undertaken for the Phase II data as the peak values of the Simpson and Shannon index were for different months.

Berger- Parker dominance index was maximal for the young transplanted paddy as very few spiders (5 species in Phase I and 14 In Phase II) were present in the field and among them the proportional abundance also varied. In terms of evenness the earhead maturation stage (October) in both the years showed maximal value. Thus in terms of diversity and evenness, the Earhead maturation stage reported a diverse assemblage of spiders and the relative abundance of individual spider species were also similar. Margalef d index is similar to the evenness index (Q) (Southwood and Henderson, 2003). The value of Margalef d for Phase I and Phase II was maximal October ; 4.585 for Phase I and 5.3109 for Phase II .The Rank abundance of spiders shows that about 8 species contributed to the majority in terms of the number in Phase I and around 14 species contributed for Phase II respectively.

The correlation between the crop architecture and the composition of the spider fauna is not very tight in the agroecosystems. Agricultural fields usually experience as extensive disturbance in the form of farm management practices like weeding, pesticidal spray and harvesting of the crop etc. In such condition, there is non equilibrium in the spider community and the community needs itself to be reestablished every year. During reestablishment of the spider community every year there is a slight difference in the composition of species from the previous years Culin and Yeargan (1983). Family Linyphiidae shows initially high abundance this is due to the ballooning (Oraze et al, 1988) and emigration behaviour is also seen in the case of Therrididae.

In the Conventionally managed field during Phase I of the study the amount of pesticide spray was restricted to herbicides and fungicides, during the early season of the crop while in the Phase II the application of the pesticides was in the months of September and November. The correlation between the pesticide spray and the spider diversity showed that immediately following the pesticide spray the density and diversity of the weavers and hunters decreases drastically.

In the conventionally managed site, during both the study phases the families Lycosidae, Araneidae and Salticidae represented the most diverse families. These families constitute the major share of the spiders in paddy grown in

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various regions of the world , they are have reported to be the diverse families by Ishijima (2004) , Okuma (1978); Oraze et al (1988); Sigsgaard (2000), Channa and Amarasinghe, (2003), Kumar et al (1996).

With respect to the family density of the spiders in paddy during the two phases it was found that four families of spiders namely Araneidae, Tetragnathidae, Lycosidae and Therrididae were found at higher densities throughout the season. During the transplanting stage and the vegetative stage of the crop the population of the hunting spiders belonging to family Lycosidae was higher. During the later stages the population of Araneidae and Tetragnathidae were the dominant spider fauna in the field. Other families of spiders were also found in the fields but their relative contribution in terms of the density and diversity was very less and hence were not included for the population dynamics studies, however they may be contributing effectively to the biological control of insect pests.

In terms of the percentage composition of the spider families in the cropping season it was found that in Phase I of the study the population of lycosidae was highest comprising about 63.88% and 31.4% during first two months after transplanting of the paddy. However in Phase II the composition of Lycosidae was lower than the earlier season and was represented by less than 10%of the total fauna throughout the cropping season. The lycosid population showed a declining trend from the start of the cropping season till the harvesting of the crop.

Jumping spider assemblages were found during the later stage of the cropping season in both the Phases in the conventionally managed feilds. From the Earhead formation stage in September to Harvesting of the crop, Salticidae comprised 20% of the spider fauna found in the field. During the later stages of the crop the population of leaf hoppers increased in number and it was seen that the majority of the Salticids were found along the stem region of the crop usually inhabited by the plant hoppers. It is seen that the buildup of the jumping spider's density is in response to the increase in the hopper density. Several scientists have shown that Lycosids are efficient predators of the leaf hoppers in paddy Kenmore et al (1984); Oraze and Grigarick (1989).

Araneidae comprised of the maximum density in the later half of the cropping stages, this is due to the lack or scarcity of the web sites in initial stages of the crop. With the growth of the plant the available web sites increases in number, Greenstone, (1986) ; Rypstra et al, (1999) ; Richert, (1974) , have found that the orb weaver diversity is a result of the function of the increase in the structural diversity of the plant, which in the case of the monocots is during the later stages of the life cycle. During Phase I Araenidae were found at maximum density in September (post monsoon phase) representing the earhead formation stage. In Phase II during the same time Araneidae population was almost half of what was found in Phase I. This was a result of the pesticide spray in September, showing that the Araeneidae either leave the field as a result of spray or they are killed by the chemicals.

The other orb weaver belonging to Tetragnathidae, increased in number during the month of September in both the phases of the crop. In the Phase I the orb weaver's density was almost uniformly throughout the season from the earhead formation stage till the harvesting of the crop. However in Phase II, the percentage composition of the family increased after the pesticide spray, from 38.63% to 61.29%. The buildup of the population of weavers immediately after disturbance has been found in several agroecosystems. This was due to the boundary effect, since field margins get a very low input of chemical insecticides and the floral diversity is higher, hence it is seen that the margins conserve the spider population during the spray periods. There is immigration of spiders into the fields from the margins after the spray of the pesticides (Alderweirldt (1989); Kromp and Steinberger, (1992); Toth et al 1996).

The Lynx spiders were found during the early stages of the crop and I have found that the population of the lynx spiders has a strong positive correlation with the microclimatic humidity in the pigeonpea agroecosystem. In Paddy field the populations of the spiders was higher during the early stages coinciding with the monsoon season. During the later stages of the crop, no Oxyopids were seen and they were found prior to the harvesting of the crop. These spiders have been found to be abundant along the field margins (personal observation). Therridids (comb footed spiders), comprise a relative major share of the spiders in phase I with 20% density throughout the cropping season. However, Therririds were not found in the phase II. Other spider families comprised very low percentage of the spiders.

The population dynamics of the numerically abundant spiders shows that the majority of the members are from Araeneidae , the representative genera being *Argiope , Neoscona ,Leucage and cytrophora* these orb web builders occupy the habitats from the months of September till November. *Tetragnatha mandibulata and Eucta javanus* are also numerically abundant in the paddy fields in both the seasons. Out of the three agricultural fields studied Family Tetragnathidae was found only in rice fields. The population of the Tetragnathidae is found to be affected by the crop architecture as well as with the presence of the relative humidity. They have been found only near, the riparian habitats (Bell et al, 1999), banana agroecosystems (Siliwal, 2000) and in the Paddy crop (Dolly Kumar and Shivakumar, 2004).*Tetragnatha and Eucta* have been reported in the banana field of Vadodara by earlier worker from our laboratory. The biocontrol potential of these spiders is very large and diverse as their orb webs are even larger than orb webs made by *Araneid* spiders. Their orb webs are made between two rows of paddy crops and also on the periphery. In the case of disturbance in the field, they will move from the centre of the web towards the rice plant. They have got long legs which they stretch on the inner side of the leaf blade, protecting them from predators and toxic insecticides. They are useful biocontrol agents feeding on major insect pests like hoppers, mosquitoes, adult lepidopterans etc which are capable of damaging the rice crop. The large size of the web helps them to catch wide range of insects.

The numerically dominant hunting spiders were Oxyopes shweta in both conventional and organic fields except for the phase II of the conventional field where the population of the hunters was very low. *Chieracathium melanostoma* was found in the organic fields while they were not observed in the conventional fields. A variety of Lycosid spiders were numerically abundant in the paddy field. In phase I *Hippasa mahabaleshwarensis* , *Evippa sohani* , *Lycosa poonanesis* were found in high numbers while in the organic fields the population of these spiders were high during both the phases of the study. This shows that these Lycosid spider species are more tolerant to the pesticide spray and have the means of escaping the spray by emigration from the field or by the immigration of newer Lycosids from the field margins. *Rhene decoratus* and *Phiddipus indicus* were found only at the conventionally managed field during the phase I of the study and in Phase II no salticid was found in higher numbers.

The species diversity of the spiders in both the cropping seasons shows that the species number of the spiders during the phase I increases from the start of the season (transplanting) and reaches its peak in earhead maturation stage of the crop (October) with 30 species. While in Phase II there is a progressive decrease in the species number from August (vegetative stage) till the harvesting stage of the crop. Thus it can be said that the progressive decrease in the species richness of the habitat is due to the increased intensity of disturbance which increases as a result of the pesticidal spray in the month of September.

The values of the Simpson index (D) and Shannon-Weiner index (H) shows that in the phase I of the study, month of October is the most diverse month both in terms of density and diversity of the habitat. In the Phase II of the study the values of H is higher for August while the value of D is higher for September, hence diversity ordering with Renyi index shows that the diversity of the month of August was higher as compared to September as the value of D and H for corresponding month in Phase I showed an increase in the diversity from August to September. The values of the Equitability index and Berger –Parker Dominance index for the two Phases shows that the as a result of the chemical spray the disturbance to the agroecosystem is very high so the value of Berger –parker dominance index was higher for the month of September in Phase II and the value of the Equitability index was the lowest for September. In the Phase I of the study the disturbance due to the spray of the pesticides was comparatively lower and hence the changes in the diversity confounded to a similar pattern found in the organic paddy field.

The diversity measures and community structure of the spiders in the paddy managed in two ways (conventional and Organic) shows that the impact of the pesticide on the diversity, density and the seasonal patterns of the spiders is huge. It is seen that the hunting spiders are the most affected as a result of the pesticide spray (Phase II conventional), similar results have been found in the other ecosystems having pesticides inputs Bostanian et al (1984); Pekar , (1999); Milickzy, (2000). In paddy field a heavy input of the pesticide has been known to reduce the diversity of the spiders as well as the density of the spiders in the field (Kim, 1992; Kawahara et al, 1971).

The seasonal pattern of the web builders and the density of the weavers are comparatively less affected by the spray of the chemical pesticides. As these web builders do not come in direct contact with the pesticide spray. It has been shown that the 3 dimensional webs of the weavers are the most tolerant to the chemicals. While orb weavers descend to the lower regions of the crop as a result of the spray. Later on when the effect of the chemical diminishes they again occupy their webs.

If the chemicals are used as a need based spray, the impact on natural enemies particularly spiders which are known to be highly susceptible to the chemical insecticides is lower. From the study we find that a need based spray of the chemical pesticide had little effect on the density and the fauna composition of the spiders. This shows that spiders can tolerate chemical insecticides to a certain extent. The conventional field receiving a need based spray of the chemical insecticides can be considered as an IPM field, which aims to reduce the pesticide input to need based spraying.

Hence spider assemblages can be conserved with the judicious use of the pesticides. As the pesticides will remain the main stay in the management of insect pests, however their share can be reduced by promoting the spider assemblages in the fields, via conservation of their habitats.