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Diversity of Harmful and Beneficial Insect Fauna in Pigeonpea [*Cajanus cajan* (L.)] Ecosystem in Tamil Nadu, India

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A B S T R A C T

The study of biodiversity associated with agro ecosystem is of significance for agro ecologist and conservation biologist, since the maintenance of biological diversity is essential for productive and ecologically sustainable agriculture. Field experiment was conducted to inventorize the insect fauna in pigeon pea ecosystem from February 2015 to July 2015. A total of 77 different species of insects belonging to 45 families under 10 orders were collected. Of the 77 species recorded, 53 species were harmful and 24 were beneficial. The Simpson's index of Diversity was the highest for beneficial insects (0.94) and for harmful insects it was (0.93). Similar trend was observed in Shannon-Wiener index also for beneficial and harmful insects with values of 3.12 and 3.00, respectively. The values of Margalef index for the beneficial and harmful insects revealed that maximum richness (6.35) was accounted for harmful insects followed by beneficial insects (5.32). The species evenness was maximum for beneficial insects (0.55), whereas for the harmful insects it was (0.45).

Introduction

Pigeon pea (*Cajanus cajan* (L.) Mill Sp.) is one of the most important and widely cultivated pulse crop in India. Pest menace on Pigeon pea has assumed serious proportions, even to the extent of suicidal deaths of farmers. It is attacked by a large number of insects at all stages of growth *i.e.,* seedling to harvest stage and as per a conservative estimate, losses due to these insect pests may vary from 27% to even 100%. Among the various constraints for low productivity in pigeon pea crop, the infestation of insect pests is the main contributor. There are several reports indicating that pigeon pea is attacked by different insect pests from different parts of the country and other countries, as well (Singh and Singh, 1991; Rao *et al.,* 2002; Akhilesh and Parasnath, 2003). Information on pest complex in particular agro climatic condition is a prerequisite, which helps in designing a successful pest management strategy. Information pertaining to diversity and seasonal occurrence of pests on this crop is of significance in effective pest management practices. Arthropods are important components of ecosystems occupying vital positions in food webs, dynamics of populations and communities. They play

various roles in ecosystems acting as herbivores, predators, decomposers, parasitoids and pollinators. Population ecologists discussed diversity of arthropods in two aspects, species richness i.e., the number of species in a set of sample and equitability e.g., the number of individuals of each species in a sample (Disney, 1999). There are evidences that species rich ecosystems are more stable than species-poor ecosystems. It is now established that arthropod predators suppress the pest populations (Chang and Kareiva, 1999 and Synmondson *et al.,* 2002). In view of scant information on diversity of insects on pigeon pea ecosystem the present study was undertaken.

Materials and Methods

Experimental site

Field experiment was conducted in 30 X 40 m2 plots to inventorize the insect fauna in pigeon pea ecosystem from February 2015 to July 2015 at New area of Tamil Nadu Agricultural University. The variety Co (Rg) 7 was cultivated. The agronomic practices were carried out as per the crop production guide of the University, Coimbatore. Insect fauna was collected using different methods of collection *viz.*, active searching and net sweeping.

Active searching

It was done in the early morning or evening hours. The site was searched for a total of two hours per week. The population of sucking pests was visually recorded.

Net sweeping

It is very effective for the collection of flying and jumping insects. Sweeping of vegetation was as random as possible from ground level to the height of the crop. The nets used in systematic sweeping of the ground level were made of thick cotton cloth with a diameter of 30 cm at the mouth and a bag length of 60 cm.

Identification of arthropods

The collected arthropods were sorted out based on taxon. Soft bodied insects were preserved in 70 per cent ethyl alcohol in glass vials. Other arthropods were card mounted or pinned. The preserved specimens were photographed and identified based on the taxonomic characters. All arthropod species were identified to the lowest possible taxon. Insects were identified by comparing with the specimens in the Department of Agricultural Entomology, Tamil Nadu Agricultural University.

Measurement of diversity

Relative density of the species was calculated by the formula, Relative Density (%) = (Number of individuals of one species / Number of individuals of all species) X 100. Species or alpha diversity of the sites was quantified using Simpson's diversity Index (SDI), (Simpson, 1949) and Shannon-Wiener index (Shannon, 1949). SDI is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. SDI is calculated using the formula, $D = \Sigma n\ (n-1)/\ N(N-1)$ where n=total number of organisms of a particular species and N=total number of organisms of all species. Subtracting the value of Simpson's index from 1, gives Simpson's Index of Diversity (SID). The value of the index ranges from 0 to 1, the greater the value the greater the sample diversity. Shannon-Wiener index (H') is another diversity index and is given as follows: $H' = -\ \Sigma\ Pi\ \ln(Pi)$, where $Pi = S\ /\ N$; S=number of individuals of one species, N=total number of all individuals in the sample, ln=logarithm to base e. The higher the value of H', the higher the diversity.

Table.1 Inventory of insects in pigeonpea ecosystem

S. No.	Insect (Order: Family: Scientific Name)	Role
1.	**Odonata**: Libullelidae: *Crocothemis servillia*	Beneficial
2.	**Odonata**: Libullelidae: *Pantala falvescens*	Beneficial
3.	**Dictyoptera**: Mantidae: *Mantis religiosa*	Beneficial
4.	**Isoptera**: Termitidae:*Odontotermes* sp.	Harmful
5.	**Orthoptera**: Acrididae: *Acrida exaltata*	Harmful
6.	**Orthoptera**: Acrididae: *Neothacris simulans*	Harmful
7.	**Hemiptera**: Aleyrodidae: *Bemisia tabaci*	Harmful
8.	**Hemiptera**: Alydidae: *Leptocoris oratorius*	Harmful
9.	**Hemiptera**: Coreidae: *Anoplecnemis phasiana*	Harmful
10.	**Hemiptera**: Coreidae: *Clavigrella gibbosa*	Harmful
11.	**Hemiptera**: Coreidae: *Clavigrella horrens*	Harmful
12.	**Hemiptera**: Coreidae: *Cletus punctiger*	Harmful
13.	**Hemiptera**: Coreidae: *Riptortus pedestris*	Harmful
14.	**Hemiptera**: Cicadellidae: *Empoasca kerri*	Harmful
15.	**Hemiptera**: Coccidae: *Ceroplastes cajani*	Harmful
16.	**Hemiptera**: Eurybrachidae: *Eurybrachis tomentosus*	Harmful
17.	**Hemiptera**: Pentatomidae: *Coptosoma cribrarium*	Harmful
18.	**Hemiptera**: Pentatomidae: *Dolycoris indiucs*	Harmful
19.	**Hemiptera**: Pentatomidae: *Nezara virudula*	Harmful
20.	**Hemiptera**: Pyrrhocoreidae: *Dysdercus* sp.	Harmful
21.	**Hemiptera**: Pseudococcidae: *Ferrisia virigata*	Harmful
22.	**Hemiptera**: Reduviidae: *Rhnocoris* sp.	Beneficial
23.	**Diptera**: Agromyzidae: *Melanoagromyza obtusa*	Harmful
24.	**Coleoptera**: Bruchidae: *Callosobruchis analis*	Harmful
25.	**Coleoptera**: Bruchidae: *Callosobruchis chinensis*	Harmful
26.	**Coleoptera**: Bruchidae: *Callosobruchis maculatus*	Harmful
27.	**Coleoptera**: Buprestidae: *Sphenoptera* sp.	Harmful
28.	**Coleoptera**: Carabidae: *Ophionea nigrofasciata*	Beneficial
29.	**Coleoptera**: Cassididae: *Cassida circumdata*	Harmful
30.	**Coleoptera**: Cetonidae: *Oxycetonia albopunctata*	Harmful
31.	**Coleoptera**: Cetonidae: *Oxycetonia versicolor*	Harmful
32.	**Coleoptera**: Chrysomelidae: *Aulocophora foveicollis*	Harmful
33.	**Coleoptera**: Coccinellidae: *Coccinella transversalis*	Beneficial
34.	**Coleoptera**: Coccinellidae: *Epilachna vigintioctopunctata*	Beneficial
35.	**Coleoptera**: Coccinellidae: *Harmonia octomaculata*	Beneficial
36.	**Coleoptera**: Coccinellidae: *Menochilus sexmaculatus*	Beneficial
37.	**Coleoptera**: Coccinellidae: *Micraspis discolor*	Beneficial

38.	**Coleoptera**: Meloidea: *Hycleus pustulatus*	Harmful
39.	**Coleoptera**: Meloidea: *Hycleus orientalis*	Harmful
40.	**Coleoptera**: Meloidea: *Hycleus phalerata*	Harmful
41.	**Coleoptera**: Meloidea: *Hycleus thunbergii*	Harmful
42.	**Coleoptera**: Curculionidae: *Alicidodes collaris*	Harmful
43.	**Coleoptera**: Curculionidae: *Myllocerus viridanus*	Harmful
44.	**Coleoptera**: Staphylinidae: *Paederus fuscipes*	Harmful
45.	**Neuroptera**: Chrysopidae: *Chrysopa* sp.	Beneficial
46.	**Hymenoptera**: Apidae: *Apis cerana indica*	Beneficial
47.	**Hymenoptera**: Apidae: *Apis dorsata*	Beneficial
48.	**Hymenoptera**: Apidae: *Apis florea*	Beneficial
49.	**Hymenoptera**: Braconidae: *Myosoma chinensis.*	Beneficial
50.	**Hymenoptera**: Chalcididae: *Brachymeria*sp.	Beneficial
51.	**Hymenoptera**: Eurytomidae: *Eurytoma* sp.	Beneficial
52.	**Hymenoptera**: Formicidae: *Componotus* sp.	Beneficial
53.	**Hymenoptera**: Megachilidae: *Megachile* sp.	Harmful
54.	**Hymenoptera**: Vespidae: *Sceliphron* sp.	Beneficial
55.	**Hymenoptera**: Ichneumonidae: *Charops* sp.	Beneficial
56.	**Hymenoptera**: Ichneumonidae: *Isotima* sp.	Beneficial
57.	**Hymenoptera**: Ichneumonidae: *Trathala* sp.	Beneficial
58.	**Hymenoptera**: Ichneumonidae: *Xanthopimpla* sp.	Beneficial
59.	**Hymenoptera**: Torymidae: *Podagrion* sp.	Beneficial
60.	**Lepidoptera**: Erebidae: *Amsacta albistriga*	Harmful
61.	**Lepidoptera**: Erebidae: *Olepa ricini*	Harmful
62.	**Lepidoptera**: Erebidae: *Euproctis fraterna*	Harmful
63.	**Lepidoptera**: Gelechiidae: *Aproarema modicella*	Harmful
64.	**Lepidoptera**: Noctuidae: *Helicoverpa armigera*	Harmful
65.	**Lepidoptera**: Noctuidae: *Plusia* sp.	Harmful
66.	**Lepidoptera**: Noctudidae: *Spodoptera litura*	Harmful
67.	**Lepidoptera**: Papilionidae: *Papilio polytes*	Harmful
68.	**Lepidoptera**: Pieridae: *Eurema hecabe*	Harmful
69.	**Lepidoptera**: Lycaenidae: *Euchrysops cnejus*	Harmful
70.	**Lepidoptera**: Lycaenidae: *Lampides boeticus*	Harmful
71.	**Lepidoptera**: Notodontidae: *Neostaurpus alternus*	Harmful
72.	**Lepidoptera**: Pterophoridae: *Exelastis atomosa*	Harmful
73.	**Lepidoptera**: Pterophoridae: *Sphenarches* sp.	Harmful
74.	**Lepidoptera**: Crambidae: *Etiella zinckinella*	Harmful
75.	**Lepidoptera**: Crambidae: *Maruca vitrata*	Harmful
76.	**Lepidoptera**: Sphingidae: *Acherontia styx*	Harmful
77.	**Lepidoptera**: Sphingidae: *Cephanodes* sp.	Harmful

Species richness was calculated for the three sites using the Margalef index (Margalef, 1958) which is given as Margalef Index, $\alpha=(S-1)/ln(N)$; S=total number of species, N=total number of individuals in the sample. Species evenness was calculated using the Pielou's Evenness Index (*E1*) (Pielou, 1966) Pielou's Evenness Index, $E1=H'/ln(S)$; H'=Shannon-Wiener diversity index, S=total number of species in the sample. As species richness and evenness increase, diversity also increases (Magurran, 1988). Beta diversity is a measure of how different (or similar) ranges of habitats are in terms of the variety of species found in them (Magurran, 1988).

Results and Discussion

77 different species of insects belonging to 45 families under 10 orders were collected. Of the 77 species recorded, 53 species were harmful and 24 were beneficial. An inventory of insects that were collected from the pigeon pea ecosystem is enlisted in Table 1. It was found that the harmful insects (68.83%) were abundant than beneficial insects (31.16%). The Simpson's index of Diversity was the highest for beneficial insects (0.94) and for harmful insects it was (0.93). Similar trend was observed in Shannon-Wiener index also for beneficial and harmful insects with values of 3.12 and 3.00, respectively. The values of Margalef index for the beneficial and harmful insects revealed that maximum richness (6.35) was accounted for harmful insects followed by beneficial insects (5.32). The species evenness was maximum for beneficial insects (0.55), whereas for the harmful insects it was (0.45). From the present study it was found that Coleoptera is the most diverse insect order in pigeon pea ecosystem followed by Lepidoptera.

Globally 349 species of insects have been observed feeding on pigeon pea of which 191 species have been reported from India (Lateef and Reed, 1990). The most serious pests are those that attack the reproductive structures including buds, flowers and pods (Shanower *et al.,* 1999). The field infestation of bruchids *Callosobruchus* spp. was observed in the present study. Earlier field infestation of *C. chinensis* and *C. maculatus* was reported in pigeon pea (Shiv, 1987) and per cent infestation of pulse beetle on pigeon pea varieties varied from 1.2 to 10.2 per cent with a mean of 5.15 per cent on pod basis and percentage seed infestation on seed basis from 0.4 to 4.8 (Bindra and Jokhmola, 1967). Several natural enemies were recorded in the present study.

More than 60 species of arthropods were recorded as predators of *Helicoverpa armigera* in India (Romeis and Shanower, 1996). The predators and parasitods have been summarized for the key insects pest in pigeonpea such as *Helicoverpa armigera* (Sithanantham *et al.,* 2005), *Maruca vitrata* (Sharma *et al.,* 1998), *Melanoagromy zaobtusa* (Shanower *et al.,* 1998). Around 97 species of parasitods have been recorded on different insect pest occurring in pigeon pea (Rabindra *et al.,* 2004). The disappearance of eggs of *H. armigera* (Romeis and Shanower, 1996) and *Maruca vitrata* had been suggested due to predators. Paucity of information on the key natural enemies and their impact under field conditions need to be addressed with a view to provide basis for selecting candidate for augmentation and conservation (Sithanantham *et al.,* 2005).

This study increased the information and knowledge available on the biodiversity of insects in pigeon pea ecosystem. This information will be help in future for species specific work and for launching conservation strategies and pest management programmes in pigeon pea ecosystem.

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