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Kavinilavu M
Ph.D Scholar, Department of Agricultural Entomology, TNAU, Coimbatore, Tamil Nadu, India

Vishnupriya R
Professor, Department of Agricultural Entomology, TNAU, Coimbatore, Tamil Nadu, India

Chitra N
Associate Professor, Department of Agricultural Entomology, TNAU, Coimbatore, Tamil Nadu, India

Correspondence
Kavinilavu M
Ph.D Scholar, Department of Agricultural Entomology, TNAU, Coimbatore, Tamil Nadu, India

Coleopteran diversity in bhendi ecosystem, *Abelmoschus esculentus* L. (Moench)

Kavinilavu M, Vishnupriya R and Chitra N

Abstract
An extensive survey was conducted to understand the species diversity of coleopterans in bhendi (*Abelmoschus esculentus*) ecosystem. The present study was carried out at four locations like Perur, Thondamuthur, Narasipuram and TNAU, Coimbatore during August 2107 to April 2018. Coleopteran insects were collected using seven different methods *viz., insitu* count, sweep net, yellow pan trap, pheromone trap, yellow sticky trap, light trap and pitfall trap. In total 12,653 individuals of coleopterans were collected in which 13 different families and 51 species were identified. Among the 51 species, 29 species were herbivores, 16 species were predators, five species were visitors, and one scavenger species was recorded. From that, it has concluded that predator and herbivore ratio was 1:1. Insect collection was made at different crop stages from sowing to harvest of bhendi. Among these, vegetative stage mostly preferred by coccinellids (0.48%) followed by *Myllocerus* spp. (0.38%) and flowering stage was most affected by the coleopterans including the three major families *viz.,* Cetonidae (0.007%), Anthicidae (0.226%) and Meloidae (0.047%). The relative abundance of coleopteran species in bhendi ecosystem were *Myllocerus* spp. (Curculionidae) (1.10%) followed by *Mylabris pustulata* Thunberg (0.91%), *Aulacophora foveicollis* Lucas (0.42%), and *Oxycetonia versicolor* Fabricius (0.22%). The Simpson's diversity Index (SDI), Shannon-Wiener index (H'**)**, species richness (D**)**, and evenness index (E1**)** were computed for all four locations. The coleopteran diversity was high in Perur region (0.08036, 3.283, 5.173 and 0.889, respectively) followed by TNAU, Coimbatore region (0.07656, 3.236, 4.624 and 0.8633, respectively). The present study will provide information on grading the insects while carrying management practices and decrease the cost of crop protection practices.

Keywords: Bhendi, coleoptera, diversity, survey

Introduction
Bhendi, *Abelmoschus esculentus* L. (Moench), is an important vegetable crop grown under garden land conditions in tropical and sub-tropical parts of the world. Recent estimates reveal that in India, it is cultivated in an area of 501 thousand ha, with a production of 5972 thousand metric tonnes and productivity of 11.5 MT ha^{-1} during 2016-17. In Tamil Nadu, it is cultivated in an area of 8000 ha, with a production and productivity of 56.67 thousand metric tonnes and 7.10 metric tones ha^{-1} (https://www.indiastat.com). Coleoptera is a largest order serve in all the ways like pests, predators, bio indicators, weed killers, scavengers and pollinators, but majorly known for its infestation on plants at field and storage. Beetles are not only pests but can also be beneficial, usually by controlling the pest population. One of the best examples is the Coccinellids. Both the larvae and adults are found feeding on aphid, scale insects and mealybugs.

Conservation biological control is one important approach to support the natural enemy populations in agro ecosystem. Mixed cropping and intercropping methods are said to be favorable to natural enemies by providing breeding grounds, pollen and nectar to adult natural enemies. Due to intensification in agriculture, changes in structure of the cultivable lands, long term use of pesticides and fertilizers for past 50 years, there has been considerable changes in diversity of arthropods relevant to a particular crop ecosystem (Disney, 1999) [4].

Coleopteran diversity plays an important role in enhancing crop yield. Therefore, present study was contemplated to compare the diversity of coleopteran in bhendi. There should be a continuous monitoring and documentation of the arthropod diversity to know about the present status of their population and distribution which affect the crop yield due to sudden outbreak of herbivores in absence of natural enemies.

Materials and methods

The present investigation was carried out to study the arthropod biodiversity, seasonal incidence of arthopods in bhendi ecosystem during September 2017 to April 2018 at different regions of Coimbatore.

Table 1: List of experimental sites with crop diversification

S. No	Places	Crop diversification
1.	Perur	Main crop – Bhendi; Adjacent crops – Brinjal, Chilli; Border crop – Castor.
2.	Thondamuthur	Main crop – Bhendi; Intercrop – Marigold; Border crop – Maize.
3.	Narasipuram	Main crop – Bhendi; Intercrop – Coriander; Border crop – Maize; Adjacent crops – Lablab.
4.	AC & RI	Main crop – Bhendi; Adjacent crops – Cotton, Redgram; Border crop – Castor, Marigold.

a. Sampling methods

The coleopteran present in bhendi crop were collected using seven different methods *viz.*, *insitu* count, sweep net, yellow pan trap, pheromone trap, light trap, yellow sticky trap and pitfall trap. Collection has been carried out at different crop stages of bhendi ecosystem. Insect fauna were collected in the early hours of the day (6-8 hours) at weekly intervals (Hassan *et al*., 1995). The collected insects were expressed in terms of number/plant. For coleoptera, grubs and adults were recorded and expressed as number/plant.

b. Preservation and identification

The collected insects killed, Pinned, mounted and labelled insects were kept in the insect boxes for proper identification. Soft-bodied insects were preserved in 70 per cent ethyl alcohol. The dried specimens were mounted on pointed triangular cards and studied under a Stemi (Zeiss) 2000-C and Photographed under Leica M 205-A stereo zoom microscopes and identified through conventional taxonomic techniques by following the keys. All species were identified to the lowest possible taxon. Insects were identified by the expert of Biosystematics and from the repository collection of Insect museum TNAU, Coimbatore and insect catalogs.

c. 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), and Shannon-Wiener index. 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. Species richness was calculated for the three sites using the Margalef index 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'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.

d. Statistical analysis

The statistical test ANOVA was also used to check whether there was any significant difference in the collections from three sites. All these statistical analyses were done using Microsoft Excel 2016 version and Agres software version 3.01.

Results and Discussion

The insects were collected at weekly intervals and were identified to an extent of possible taxons (family, genus and species levels) along with their functional role. A total of 12,653 individuals of coleopterans were collected in which 13 different families and 51 species were identified. Among the families, the highest numbers of species were observed in coccinellids (12 species) (Table 2). It was also reported that, 6 species and 4 genera of coccinellids beetles were the main defenders in bhendi ecosystem (Vasconcelos *et al.*, 2008) [5]. Similar results were reported by Latif *et al*. (2009) [6] stated that, Coleoptera was the most important order of predatory insects under 3 different families such as Coccinellidae, Carabidae and Staphylinidae.

Insect collection was made at different crop stages from sowing to harvest of bhendi. In this sowing to plant establishment stage, the occurrence of ground dwelling coleopteran insects were more abundant *viz.*, Carabidae (21), Staphylinidae (17). In vegetative stage, commonly observed families were Buprestidae (1), Chrysomelidae (54), Coccinellidae (61), Staphylinidae (31), Curculionidae (49). During Flower initiation stage, totally 7 families were reported. They are Buprestidae (5), Chrysomelidae (79), Coccinellidae (93), Staphylinidae (25), Curculionidae (52), Scutelleridae (5), Elateridae (2). During flowering stage, a coleoptera families (8) was more than others. The number of Cetonidae and Meloidae were 43 and 589 were more abundant in this stage when compared with other stages. In fruit set and harvesting stages, totally 5 and 3 families were reported respectively. Among these, vegetative stage mostly preferred by coccinellids (0.48%) followed by *Myllocerus* spp. (0.38%) and flowering stage was most affected by the coleopterans including the three major families *viz*., Cetonidae (0.007%), Anthicidae (0.226%) and Meloidae (0.047%). Similarly, blister beetle was found to be abundance during the flowering stage of bhendi (Pal and Sarkar, 2009) [7]. Total number of insects highest during flowering stage (6999) followed by fruit set (2757) and flower initiation stage (2261) (Table 3 and Figure 2).

Letourneau and Bothwell (2008) [8] reported that intercrops/mixed crops attract natural enemies by providing shade, nectar and pollen. At Thondamuthur, the maize grown as border crop harboured coccinellids and rove beetles. In Perur, bhendi raised along with adjacent crops like brinjal and chilli and border crop as castor had higher incidence of ash weevil. Since castor was grown here as border crop, more blister beetles and predators. In AC & RI, Coimbatore, castor and marigold was grown as border crop and adjacent crops were cotton and redgram. Due to the effect of the adjacent crops like cotton and redgram, the blister beetle population

was high. Sangha and Mavi (1995) [9] also noticed *M. pustulata* as the major pest in bhendi when malvaceous crops were grown in adjacent fields. Mulching with paddy straw contributed to harbouring of ground dwelling insects like ground beetles and rove beetles (Table 1).

During the survey made for 32 weeks, a total number of 12,653 individuals were recorded from the field survey comprising of 29 species were herbivores, 16 species were predators, five species were visitors, and one scavenger species was recorded. Among the 29 species of herbivores, the relative abundance of coleopteran species in bhendi ecosystem were *Myllocerus* spp. (Curculionidae) (1.10%) followed by *Mylabris pustulata* Thunberg (0.91%), *Aulacophora foveicollis* Lucas (0.42%), and *Oxycetonia versicolor* Fabricius (0.22%) (Table 4). Based on the functional role, the relative abundance of coleopteran species was maximum in herbivore community (46.41) followed by predator community (42.59), tourists (9.70) and scavengers (1.28). Nair *et al.* (2017) [10] reported number of the blister beetle (*Mylabris pustulata*) was relatively more abundant in bhendi field (Figure 1)

From the Table 5, the Simpson's index of diversity is highest for Narasipuram (0.074), followed by Thondamuthur (0.073). This means the diversity is more in Narasipuram. A similar trend was observed for the Shannon-Wiener Index (*H'*) and Margalef index. From the values of Shannon- Wiener Index (*H'*) for the four regions, it was observed that the Perur was very rich in species with a richness value of 3.28 followed by TNAU, Coimbatore (3.236), Thondamuthur (3.145) and Narasipuram (3.117). The values of Margalef index for the four regions revealed that maximum diversity (5.173) accounted for the Perur followed by TNAU, Coimbatore (4.624). The species evenness is a measure of the even distribution of the species. The Pielou's evenness value (*E1*) for the sites clearly indicate that the Perur showed maximum evenness pattern with evenness index value (0.88) followed by TNAU, Coimbatore which showed a value of 0.86. The least evenness observed in Thondamuthur region (0.83). Crowder *et al.* (2010) [11] have documented high Evenness of predatory insects in organic farms.

Table 2: Inventory of Coleoptera in bhendi ecosystem

Family	Scientific name	Functional role
Buprestidae	*Trachys* sp.	Tourist
	Agrilus acutus Thunberg	Herbivore
Carabidae	*Scarites mahratta* Andrewes	Predator
	Pheropsophus bimaculatus	Predator
	Ophionea indica Thunberg	Predator
	Undetermined	Predator
Scarabaeidae	*Onthophagus laevigatus* Fabricius	Scavenger
	Oniticellus cinctus Fabricius	Tourist
Cicindellidae	*Chlaenius bimaculatus* Macleay	Predator
Cetonidae	*Oxycetonia versicolor* Fabricius	Herbivore
	Popillia lucida Newman	Herbivore
	Protaetia alboguttata Vigors	Herbivore
	Glycyphana napalensis Kraatz	Herbivore
	Heterorrhina nigritaris Hope	Tourist
Zygogrammatidae	*Zygogramma bicolorata* Pallister	Tourist
Chrysomelidae	*Aulacophora foveicollis* Lucas	Herbivore
	Aulacophora intermedia Jacoby	Herbivore
	Aulacophora indica Gmelin	Herbivore
	Cryptocephalus schestedti Fabricius	Tourist
	Cryptocephalus sp.	Herbivore
	Altica cyanea Weber	Herbivore
	Chetocnema sp.	Herbivore
	Diapromorpha turcica Fabricius	Herbivore
Coccinellidae	*Brumoides suturalis* Fabricius	Predator
	Anegleis cardoni Weise	Predator
	Cheilomenes sexmaculata Fabricius	Predator
	Coccinella transversalis Fabricius	Predator
	Harmonia octomaculata Fabricius	Predator
	Illeis cincta Fabricius	Predator
	Micraspis discolor Fabricius	Predator
	Propylea dissecta Mulsant	Predator
	Cryptolaemus montrouzieri	Predator
	Scymnus fuscatus Boheman	Predator
	Unidentified sp.	Predator
	Undetermined	Predator
Anthicidae	*Anthelephila* sp.	Tourist
	Notoxus sp.	Tourist
Curculionidae	*Alcidodes affaber* Aurivillius	Herbivore
	Alcidodes bubo Fabricius	Herbivore
	Acythopeus sp.	Herbivore
	Myllocerus viridanus	Herbivore
	Myllocerus discolour	Herbivore
	Myllocerus maculosus	Herbivore

	Myllocerus subfasciatus	Herbivore
	Undetermined	Tourist
	Unidentified sp.	Herbivore
Meloidae	*Hycleus thunbergi* Billberg	Herbivore
	Hycleus balteata Pallas	Herbivore
	Hycleus pustulata Thunberg	Herbivore
Staphylinidae	*Paederus fuscipes* Curtis	Predator
Elateridae	*Melanotus fuscus* Candeze	Tourist
Total	51 – Species ; 13 – Families	

Note: Undetermined/ Unidentified - indicates species not identified

Table 3: The major coleopteran that colonised/visited the bhendi field during different stages/phases of the crop

S. No.	Crop stage	Major arthropods
1.	Sowing to Plant establishment	Carabidae (121), Staphylinidae (317)
2.	Vegetative stage	Buprestidae (130), Chrysomelidae (218), Coccinellidae (735), Staphylinidae (137), Curculionidae (169), Carabidae (209)
3.	Flower initiation	Buprestidae (14), Chrysomelidae (719), Coccinellidae (826), Staphylinidae (205), Curculionidae (420), Carabidae (45), Elateridae (32)
4.	Flowering	Buprestidae (62), Chrysomelidae (869), Coccinellidae (1534), Curculionidae (759), Anthicidae (1431), Elateridae (12), Cetonidae (443), Meloidae (1889)
5.	Fruit set	Chrysomelidae (268), Coccinellidae (389), Curculionidae (346), Anthicidae (265), Meloidae (1489)
6.	Harvesting stage	Coccinellidae (265), Curculionidae (249), Meloidae (700)

Table 4: Relative abundance of herbivore fauna (Coleoptera) in bhendi ecosystem

S. No	Arthropod species	Nos.	Relative abundance (%)
1	*Oxycetonia versicolor* Fabricius	59	0.22
2	*Popillia lucida* Newman	13	0.05
3	*Glycyphana napalensis* Kraatz	10	0.04
4	*Aulacophora foveicollis* Lucas	115	0.42
5	*Aulacophora intermedia* Jacoby	9	0.03
6	*Alcidodes affaber* Aurivillius	54	0.20
7	*Alcidodes bubo* Fabricius	7	0.03
8	*Myllocerus* sp.	300	1.10
9	Unidentified sp.	7	0.03
10	*Hycleus sp.*	60	0.22
11	*Mylabris pustulata* Thunberg	250	0.91
	Total	884	

Table 5: Diversity indices of coleoptera in four region of Coimbatore

Regions	Simpson's Index	Shannon-Wiener Index	Margalef index	Pielou's index
Perur	0.05036	3.283	5.173	0.889
Thondamuthur	0.07364	3.145	4.544	0.8392
Narasipuram	0.074	3.117	4.451	0.842
TNAU, Coimbatore	0.06056	3.236	4.624	0.8633

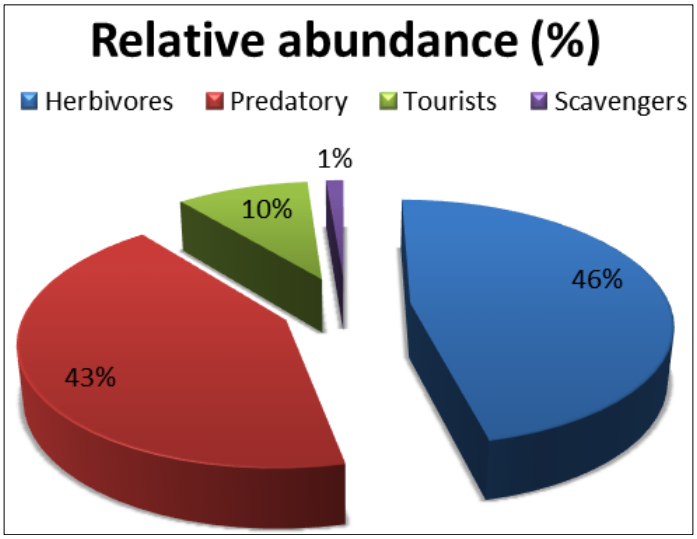

Fig 1: Relative abundance of coleoptera in bhendi ecosystem

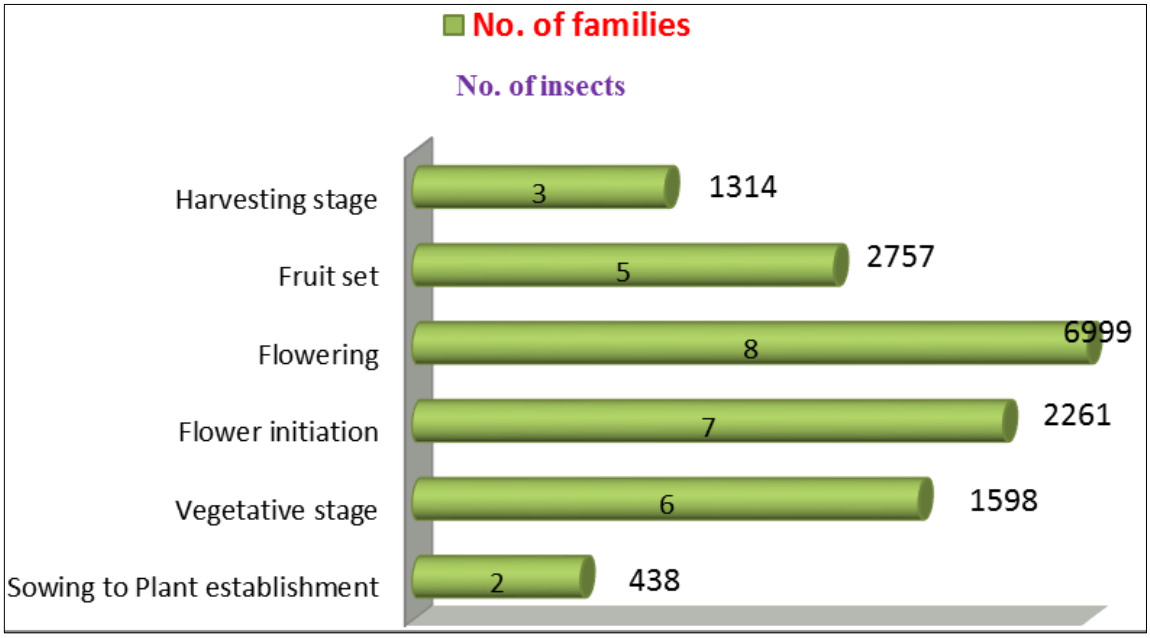

Fig 2: Coleoptera colonised during different stages of the crop

Conclusion

This study reveals the diversity of coleopteran of four different regions of Coimbatore, where the Perur region is the most diverse and the Narasipuram region being the least. From that, it has concluded that predator and herbivore ratio was 1:1. The results clearly indicated that crop diversification increased the natural enemy population and also helped in reducing the insect pest population in bhendi. Thus, the ecological engineering approaches could help in sustainable insect pest management in bhendi.

References

1. Chakraborty A, Kumar K, Chitra N. Computation of insects biodiversity in bhendi ecosystem. The Bioscan. 2014; 9(4):1405-1409.
2. Simpson EH. Measurement of diversity. Nature. 1949; 163:688-696.
3. Smith HA, McSorley R. Intercropping and pest management: A review of major concepts. American Entomologist. 2000; 46(3):154-161.
4. Disney R. Insect biodiversity and the demise of alpha taxonomy. Antenna-London-Royal Entomological Society. 1999; 23:84-88.
5. Vasconcelos S, Suzuki D, Barbosa F, Iannuzzi L. Short-term survey of Coccinellidae (Coleoptera) on okra in the semi-arid region of Pernambuco. Biociencias. 2008; 16(2):154-156.
6. Latif M, Rahman M, Islam M, Nuruddin M. Survey of arthropod biodiversity in the brinjal field. Journal of Entomology. 2009; 6(1):28-34.
7. Pal S, Sarkar I. Pests infesting ornamental plants in hilly region of West Bengal. The Journal of Plant Protection Sciences. 2009; 1(1):98-101.
8. Letourneau DK, Bothwell SG. Comparison of organic and conventional farms: challenging ecologists to make biodiversity functional. Frontiers in Ecology and the Environment. 2008; 6(8):430-438.
9. Sangha H, Mavi G. Seasonal activity and host-range of blister beetle, *Mylabris phalerata* (Pallas). Journal of Insect Science. 1995; 8:106-107.
10. Nair *et al*. Insect pest complex of Pigeon pea (*Cajanus cajan*) in agro ecosystem of Tripura, NE India. Journal of Entomology and Zoology Studies. 2017; 5(4):765-771.
11. Crowder DW, Northfield TD, Strand MR, Snyder WE. Organic agriculture promotes evenness and natural pest control. Nature. 2010; 466(7302):109.