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Diversity of hemipteran insect fauna and their relative abundance in pigeonpea, *Cajanus cajan* (L.) Millsp

Atanu Sen**Abstract**

The study on the hemipteran insect fauna associated with pigeonpea and their relative abundance was carried out at Chiplima, Odisha, India during 2019-20. A total of 18 hemipteran insect taxa belonging to 11 insect families were documented from the pigeonpea ecosystem during the study. Among them, nine taxa viz., *Megacopta cribraria* Fabricius, *Otinotus oneratus* (Walker), *Clavigralla gibbosa* (Spinola), *Clavigralla scutellaris* (Westwood), *Aphis craccivora* Koch, *Piezodorus hybneri* (Gmelin), *Nezara viridula* (Lin.), *Empoasca kerri* Pruthi, *Riptortus linearis* (Fab.) were most abundant in pigeonpea ecosystem. They were observed in vegetative to reproductive stages of the crop and mostly abundant in November and December. Among miridae family, two insects namely *Poppiocapsidea* (=Creontiades) *biseratense* (Distant) and *Eurystylus bellevoeyi* (Reuter) were first time observed in pigeonpea in Odisha and under lygaeidae family, *Graptostethus servus* (Fabricius) was first time appeared as pest of pigeonpea. All the hemipteran insects' incidence was negatively correlated with temperature and rainfall whereas positively correlated with morning relative humidity. Regression analysis showed that minimum temperature significantly contributed more than 40% variation to the high population built up of the insects belonging to plataspidae, coreidae, membracidae, cicadellidae and pentatomidae families.

Keywords: Abundance, diversity, pigeonpea ecosystem, hemipteran insects, weather factors

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the important pulse crop and grown in semi-arid, tropical and subtropical regions of the world. Although maximum crop is produced in South Asia, it is also widely cultivated in Africa and parts of Latin America^[14]. It is an erect, woody, perennial shrub but most commonly grown as an annual crop. Its seed contains high quality protein and are consumed in various ways i.e. green seed eaten as fresh whereas dried seed used for making different curry recipe. Cultivation of this crop has many other beneficial roles i.e., nitrogen-enhancement in soil by fixing that, tolerance to drought, leaves and stem used as fodder and increase the soil organic matter by incorporation of leaves and stem in soil.

Although India is the largest producer almost 75 per cent of global production of pigeonpea^[24] but its production is heavily affected by the infestation of various Insect pests. It has been reported that more than 250 species of insect belonging to 8 orders and 61 families attack pigeonpea crop at various stages of its growth^[10]. Among the different insect orders, lepidopteran, hemipteran, dipteran and coleopteran insects causes maximum damage to pigeonpea crop. Among hemipteran insects pod sucking bugs causes enormous damage to pigeonpea crops^[18]. It is reported that seed damage due to pod-sucking bugs in Kenya, Malawi, Tanzania, and Uganda ranged from 3 to 32% and in India, combined losses due to *Clavigralla gibbosa* and *C. scutellaris* often exceed 50%^[12, 21].

Although maximum research paper deals with the lepidopteran^[2, 15] and some hemipteran i.e. pod bug mainly *Clavigralla gibbosa*, aphid and leaf hopper insect but information regarding overall hemipteran insect fauna and their relative abundance is scanty in literature. For this, an attempt was made to document the diversity of hemipteran insect fauna, their abundance and influence of various weather parameters on their incidence in pigeonpea at west central table land zone of Odisha, India.

Materials and Methods**Experimental Site**

The study was conducted in the experimental farm of Regional Research and Technology

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Transfer Station (OUAT), Chiplima, Sambalpur, Odisha, during 2019-20. The Station is situated at 20°21' N latitude and 80°55'E longitude in Dhankauda block of Sambalpur district under west central table land zone of Odisha, India at an altitude of 178.8 m above MSL. The climate of the area is warm sub humid.

Sampling methods and identification

Observations on the incidence of hemipteran insects were recorded on 20 randomly selected plants in pesticide free plot at weekly interval from the ICPL-87119 (Asha) cultivated plots. The observations were taken 20 days after germination to full maturity stage and samplings of the hemipteran insects were conducted during that period to determine their species composition. The samples were collected by adopting the methods of sweeping net. Sweeping were done between 7.30 a.m. to 11.30 a.m. from pigeonpea field during their growth period. Observations of leafhoppers (nymph and adult) were recorded on three leaves per plant viz., each from upper, middle and lower leaves. Observations on stink bug (nymph and adult), pod bugs (nymph and adult), mealybug, tree hoppers, mirid bugs were recorded on per plant basis^[3]. For recording aphid population, 10 cm of central shoot and two side shoots of each plant were taken and counted the number of aphids confined there. Then hemipteran insects were identified using available keys and guides from the various references^[1, 4-8, 14, 16, 20, 22]. The data on various abiotic factors during the crop growing period were taken from the meteorological observatory located in the RRTTS, Chiplima, Sambalpur.

Statistical analysis

Numbers of different hemipteran insects were pooled over months (September to March) to know the abundance of different insects in pigeonpea. One way Analysis of Variance (ANOVA) test was followed to find out the difference in the population of different hemipteran insects in different months and significant differences were determined by using Tukey's Honest Significant Difference (HSD) test at probability level $P < 0.05$ and the influence of various abiotic factors on the incidence of hemipteran insect pests of pigeonpea were analyzed by correlation and regression analysis was done by using SPSS 16 statistical package.

Results and Discussion

Incidence of hemipteran insect fauna

The outcome of the present study revealed that the pigeonpea crop ecosystem acting as a depot of hemipteran insect fauna. A total of 18 hemipteran insect taxa belonging to 11 insect families were documented from the pigeonpea ecosystem studied at west central table land zone of Odisha (Table 1). Among them, nine taxa viz., *Megacopta cribraria* Fabricius, *Otinotus oneratus* (Walker), *Clavigralla gibbosa* (Spinola), *C. scutellaris* (Westwood), *Aphis craccivora* Koch, *Piezodorus hybneri* (Gmelin), *Nezara viridula* (Lin.), *Empoasca kerri* Pruthi, *Riptortus linearis* (Fab.) were most abundant in pigeonpea ecosystem. They were mainly observed in vegetative to reproductive stages of the crop. A higher species richness of hemipteran insect were observed in December (Table 2, 3, 4 and Figure 1-20).

Insect belonging different families which were observed in pigeonpea ecosystem at west central table land zone of Odisha are given below

Plataspidae

Megacopta cribraria Fabricius adults are light brown to olive green in colour with dark punctuation and 3-6 mm in length. Scutellum enlarged in size, covering forewings and most of the abdomen. They feed on tender pigeonpea leaves, stems, flowers and pods. The feeding site turns into white patches and later turns into brownish in colour. It infested pigeonpea plant from October onwards and maximum infestation observed in December month. The average population was 1.2 insects/plant in December ($F=5.334$, $df=6$, $p<0.05$) (Table 3).

Cicadellidae

Empoasca kerri Pruthi are small yellowish green insect, vertex is flat and smaller than the pronotum. Forewings are long, narrow, semi transparent and light green in colour. They suck the sap from the lower and upper parts of the leaflets and buds. The leaf hopper or jassid was first observed in November month and peak infestation occurred in December. The average population of this insect was 3.325 insects per plant in December ($F=6.60$, $df=6$, $p<0.05$) (Table 3).

Membracidae

Otinotus oneratus (Walker) and *Leptocentrus taurus* (Fabricius) were observed in pigeonpea at west central table land zone of Odisha. Adults of *L. taurus* are black in colour, eyes were subglobose, reddish brown and 6-8 mm in length, and have horn-like projections on the thorax and a black long protrusion elevated from near base passing beyond 5th apical cell. Adults of *O. oneratus* are grayish brown in colour with hemispherical reddish brown eyes and 4.5-6.75 in length, posterior process of median carina slender gradually tapering from base to apex, apex acute, passing well beyond the abdomen. During peak period of activity 10-25 bugs per twig were observed. They excrete honeydew, a sugary substance that attracts black ants, *Camponotus compressus* (Fab.). Among these insects, *O. oneratus* were more abundant than *L. taurus*. They were first noticed in October month and peak infestation reached in December. Their average population was 3.175 insects per plant in December ($F=2.865$, $df=6$, $p<0.05$) (Table 2).

Pentatomidae

Among pentatomidae, *Piezodorus hybneri* (Gmelin), *Plautia crossota* (Dallas) and *Nezara viridula* (Lin.) were observed in pigeonpea ecosystem. Adults of *P. hybneri* are pale olive greenish yellow in colour, transverse stripe on pronotum, dorsal site has uniformly coarse black punctata. In case of *P. crossota* adult, head, pronotum and scutellum are uniformly green in colour, apex of scutellum pale white and hemelytra except membrane reddish brown in colour. *N. viridula* Adults are green in color, two basal angle of scutellum with black spot and three white spots on scutellum and small black dots are present along the sides of the abdomen. Within these, *P. hybneri* and *N. viridula* were more abundant than *P. crossota*. They were first recorded in November month and peak infestation observed in December ($F=8.271$, $df=6$, $p<0.05$). Their population in December (0.625 insect per plant) was significantly different from other months (Table 2).

Coreidae

Clavigralla bugs are brown-gray in colour. *C. scutellaris* (Westwood) were more robust than *C. gibbosa* (Spinola), lateral angle produced into acute black spines. Both the adults

and nymphs penetrate the pod wall by their piercing mouthparts and suck the sap from the developing seeds. Damaged seeds become shriveled, and develop dark patches. They were first noticed in September and major activity was from November to January. Nymphs are sluggish in nature and form colonies on pods and leaves. Their average population was 1.90 insect per plant in December ($F=4.549$, $df=6$, $p<0.05$) (Table 2).

Alydidae

Both *Riptortus linearis* (Fab.) and *R. pedestris* (Fab.) were found in pigeonpea ecosystem. *R. linearis* are slender dark cinnamon brown in colour with broad longitudinal yellow band, posterior femora with a ventrolateral row of spines. *R. pedestris* are dark brown in colour, tips of antennal 1, 2 and 3rd segments brownish. They sucked the plant sap from leaves, shoots and developing pods. They were first appeared in September and maximum population observed in October to November. Their average population was 0.825 in November ($F=4.915$, $df=6$, $p<0.05$) (Table 2).

Aphididae

Green aphid, *Myzus persicae* (Sulzer) are yellowish green in colour. Siphunculi are medium in length and little swollen at the tips. The adults and nymphs sucked the plant sap from tender shoots, buds, tender pods and leaves. Their infestation started from October and activity remains till December but their population was not significantly different between the months ($F=1.736$, $df=6$, $p=0.127$) (Table 3).

Black aphid, *Aphis craccivora* Koch are dark brown in colour and dorsal site has black shiny carapace. It feeds on the tender parts of the plant including tender shoots, buds, pods and leaves and honey dew. They excreted honeydew which attracts black ants, *Camponotus compressus* (Fab.). They were first appeared in November and peak activity was in January. Their population in January was significantly differ with other months and average population was 67.525 insect per plant ($F=5.633$, $df=6$, $p<0.05$) (Table 3).

Miridae

Among miridae two taxa namely *Poppiocapsidea* (= *Creontiades*) *biseratense* (Distant), *Eurystylus bellevoeyi* (Reuter) were observed in pigeonpea field feeding on the tender flower buds and developing pods. Adult *E. bellevoeyi* are brownish grey in colour, wing cuneus pale, anterior angle and apex red in colour. Adult *P. biseratense* are elongate ovate in shape, orange in colour and large central basal stripe present to pronotum. Within these, *E. bellevoeyi* were more abundant than the other and their population were higher in November and December with an average population of 0.375 insect per plant and that was significantly different with other months ($F=19.84$, $df=6$, $p<0.05$) (Table 4).

Pyrrhocoridae

The insect observed in pigeonpea ecosystem within this family was *Dysdercus cingulatus* (Fab.). They are reddish in colour, scutellum and legs are blakish, abdomen stripped with creamy white lines. The adults and nymph sucked cell sap from the leaves and developing pods of the plant. From the table 4 it is found that maximum incidence of *D. cingulatus* was in November with an average population of 0.125 insect per plant ($F=9.30$, $df=6$, $p<0.05$) (Table 4).

Pseudococcidae

Among Pseudococcidae, the mealybug *Cocciidohystrix insolita* (Green) was first observed in pigeonpea in November

at Chiplima and remained till January. They sucked the plant sap from the tender shoots, buds and leaves. Their average population was 0.225 in November ($F=4.54$, $df=6$, $p<0.05$) (Table 4).

Lygaeidae

The insect visited pigeonpea under lygaeidae family was *Graptostethus servus* (Fabricious). Adults are pale red in colour, large black spot on the lateral area of each sternal segment. They sucked the sap from the developing pods. They were first noticed in October and maximum population were found in November with an average population of 0.15 insect per plant ($F=3.66$, $df=6$, $p<0.05$) (Table 4).

Effect of weather factors on hemipteran incidence

From the association between various abiotic factors and insect pests incidence in pigeonpea, it is observed that all the hemipteran insect attacking pigeopea were negatively correlated with maximum as well as minimum temperature and rainfall whereas positively correlated with morning relative humidity (Table 5). Among various weather factors, minimum temperature significantly contributed more than 50% variance of insect pests belonging to membracidae, cicadellidae and coreidae families. Whereas, morning relative humidity significantly contributed more than 25% variance of insect pests comes under plataspidae, coreidae, pentatomidae, miridae and lygaeidae families. In case of aphididae insects, maximum temperature attributed 56.7% variance to their incidence in pigeonpea crop ecosystem (Table 6).

The study revealed that, occurrence of hemipteran insect pest's started during vegetative stage and gradually increased to reach its peak during reproductive stage of the crop. Whereas month wise, major activity of the hemipteran insects were observed in November and December months. Among the various families, Coreidae, Plataspidae, Aphididae families of hemipteran insect were most prevalent in pigeonpea ecosystem in west central table land zone of Odisha. Among these, pod sucking bug, *Clavigralla* were most abundant and serious in reproductive phase and our result agrees with the observation of Shanower *et al.* [18] and Henry *et al.* [9]. In our study, it was found that highest number of insect genus (3) belongs to Pentatomidae family followed by Aphididae, Membracidae and miridae with 2 genuses each. Three genus of pentatomid bugs namely *Piezodorus hybneri*, *Plautia crossota* and *Nezara viridula* were first time recorded from pigeonpea ecosystem from this zone. Previously Seni [17] reported the infestation of *P. crossota* on chilli, *Capsicum frutescens* L. from here. Regarding aphid infestation an interesting fact came into light. It is observed that green aphid infestation occurred early but after black aphid arrival they disappeared from the pigeonpea ecosystem. This may be due to competition present between them. Another important outcome of our study was seed bug, *Graptostethus servus* was first time recorded from pigeonpea. Among miridae insect, both the insects namely *Poppiocapsidea* (= *Creontiades*) *biseratense* and *Eurystylus bellevoeyi* were first time observed in pigeonpea in Odisha. Previous studies reported that *C. biseratense* caused a lot of damage to cotton crop in some parts of India and assumed the status of major pest whereas *E. bellevoeyi* caused notable damage to sorghum [19, 23]. Nair *et al.* [13] studied the insect pest complex on pigeonpea (variety: UPAS 120) and recorded a total of 64 insect pests belonging to 7 orders and 32 families on pigeonpea in Tripura and also found that maximum number of species were belongs to

Order Hemiptera (13 families with 29 species) followed by Lepidoptera (10 families with 25 species) and Coleoptera (5 families with 6 species). Lingaraju & Biradar ^[11] surveyed various pigeonpea growing areas in Karnataka, India for understanding the abundance of sucking pests and found that leaf hopper and pod bugs were abundant in the visited areas. Yadav *et al.* ^[24] studied the insect pests associated with pigeonpea in western Uttar Pradesh, India and found that under hemipteran insect, *Empoasca kerri*, *Bemisia tabaci*, *Aphis craccivora*, *Oxyrachis tarandus*, *Clavigralla gibbosa*, *Riptortus* spp., *Nezara viridula* infested the pigeonpea but in this study instead of *O. tarandus*, *Otinotus oneratus* and *Leptocentrus Taurus* were present in pigeonpea ecosystem. Abundance of different hemipteran insects in pigeonpea crop ecosystem is dependent on the prevailing weather condition in

the particular region. In this study, it is found that their incidence was negatively correlated with temperature (both maximum and minimum) and rainfall whereas positively correlated with morning relative humidity. Some of the observation is also in accordance with the findings of Bijewar *et al.* ^[3] who observed that maximum and minimum temperature had negatively correlated with *Clavigralla gibbosa* pest population belongs to coreidae family. Similarly, Sharma & Lopez ^[19] observed that *E. bellevoeyi* populations were positively correlated with relative humidity in sorghum. Regression analysis showed that minimum temperature significantly contributed more than 40% variation to the high population built up of the insects belonging to plataspidae, coreidae, membracidae, cicadellidae and pentatomidae families.

Table 1: List of Hemipteran insect with their families found in pigeonpea ecosystem at chiplima, Sambalpur, Odisha

Family	Insects name
Membracidae	<i>Otinotus oneratus</i> (Walker) <i>Leptocentrus taurus</i> (Fabricius)
Cicadellidae	<i>Empoasca kerri</i> Pruthi
Plataspidae	<i>Megacopta cribraria</i> Fabricius
Pentatomidae	<i>Nezara viridula</i> (Lin.) <i>Piezodorus hybneri</i> (Gmelin) <i>Plautia crossota</i> (Dallas)
Coreidae	<i>Clavigralla gibbosa</i> (Spinola) and <i>Clavigralla scutellaris</i> (Westwood)
Alydidae	<i>Riptortus pedestris</i> (Fabricius) <i>Riptortus linearis</i> (Fabricius)
Lygaeidae	<i>Graptostethus servus</i> (Fabricius)
Miridae	<i>Poppiocapsidea</i> (= <i>Creontiades</i>) <i>biseratense</i> (Distant) <i>Eurystylus bellevoeyi</i> (Reuter)
Aphididae	<i>Myzus persicae</i> (Sulzer) <i>Aphis craccivora</i> Koch
Pyrrhocoridae	<i>Dysdercus cingulatus</i> (Fab.)
Pseudococcidae	<i>Cocciidohystrix insolita</i> (Green)

Table 2: Incidence of different hemipteran insect families* in pigeonpea during 2019-20

Month	Coreidae	Membracidae	Alydidae	Pentatomidae
2019				
Sep.	0.025 ^b	0.00 ^b	0.125 ^b	0.00 ^b
Oct.	0.400 ^b	0.04 ^b	0.260 ^b	0.00 ^b
Nov.	0.850 ^{ab}	0.575 ^{ab}	0.825 ^a	0.05 ^b
Dec.	1.900 ^a	3.175 ^a	0.375 ^{ab}	0.625 ^a
2020				
Jan.	0.725 ^{ab}	1.975 ^{ab}	0.150 ^b	0.200 ^b
Feb.	0.375 ^b	0.925 ^{ab}	0.125 ^b	0.025 ^b
March	0.075 ^b	0.250 ^{ab}	0.000 ^b	0.000 ^b

*Mean number of insects in a family per plant.

Mean in each column with different alphabets indicate a significant difference in their abundance in different months ($P < 0.05$, ANOVA, Tukeys HSD)

Table 3: Incidence of different hemipteran insect families* in pigeonpea during 2019-20

Month	Plataspidae	Cicadellidae	Aphididae	
			green	black
2019				
Sep.	0.00 ^b	0.000 ^b	0.00 ^a	0.00 ^b
Oct.	0.14 ^b	0.000 ^b	0.14 ^a	0.00 ^b
Nov.	0.475 ^{ab}	0.325 ^b	8.45 ^a	0.075 ^b
Dec.	1.200 ^a	3.325 ^a	2.50 ^a	9.95 ^b
2020				
Jan.	0.25 ^b	1.825 ^{ab}	0.00 ^a	67.525 ^a
Feb.	0.35 ^b	1.000 ^b	0.00 ^a	24.575 ^{ab}
March	0.075 ^b	0.350 ^b	0.00 ^a	0.450 ^b

*Mean number of insects in a family per plant.

Mean in each column with different alphabets indicate a significant difference in their abundance in different months ($P < 0.05$, ANOVA, Tukeys HSD)

Table 4: Incidence of different hemipteran insect families in pigeonpea during 2019-20

Month	Miridae	Pyrrhocoridae	Pseudococcidae	Lygaeidae
2019				
Sep.	0.00 ^b	0.000 ^c	0.00 ^b	0.00 ^b
Oct.	0.04 ^b	0.000 ^c	0.00 ^b	0.04 ^{ab}
Nov.	0.375 ^a	0.20 ^a	0.225 ^a	0.15 ^a
Dec.	0.375 ^a	0.125 ^{ab}	0.100 ^{ab}	0.075 ^{ab}
2020				
Jan.	0.05 ^b	0.025 ^b	0.025 ^b	0.025 ^b
Feb.	0.00 ^b	0.00 ^c	0.00 ^b	0.00 ^b
March	0.00 ^b	0.00 ^c	0.00 ^b	0.00 ^b

*Mean number of insects in a family per plant.

Mean in each column with different alphabets indicate a significant difference in their abundance in different months ($P < 0.05$, ANOVA, Tukeys HSD)

Table 5: Correlation between hemipteran insect population in pigeonpea and various abiotic factors

Insect family	Correlation coefficient (r)			
	Max. Temp.	Min. Temp.	MRH#	RF
Plataspidae	-0.392*	-0.701**	0.511**	-0.297
Coreidae	-0.448**	-0.778**	0.646**	-0.361*
Alydidae	-0.375*	-0.476**	0.455**	-0.342
Membracidae	-0.523**	-0.799**	0.463**	-0.298
Cicadellidae	-0.407*	-0.708**	0.404*	-0.269
Pentatomidae	-0.291	-0.641**	0.587**	-0.202
Aphididae	-0.753**	-0.617**	0.022	-0.242
Miridae	-0.356*	-0.574**	0.563**	-0.226
Pyrrhocoridae	-0.379*	-0.529**	0.476**	-0.209
Pseudococcidae	-0.325	-0.428*	0.355*	-0.169
Lygaeidae	-0.386*	-0.444**	0.529**	-0.246

*-Significant ($p < 0.05$), **-Highly significant ($p < 0.01$), #MRH: Morning Relative Humidity, RF: Rainfall

Table 6: Regression analysis of hemipteran pigeonpea insect pests incidence against different abiotic factors during 2019-20

Insect family	Variable*	R ²	p-value	Insect family	Variable*	R ²	p-value
Plataspidae	Max. Temp.	0.154 (15.4%)	0.024	Coreidae	Max. Temp.	0.200 (20.0%)	0.009
	Min. Temp.	0.492 (49.2%)	0.000		Min. Temp.	0.605 (60.5%)	0.000
	MRH%	0.261 (26.1%)	0.002		MRH%	0.417 (41.7%)	0.000
	Rainfall	0.088 (8.8%)	0.093		Rainfall	0.130 (13.0%)	0.039
Alydidae	Max. Temp.	0.140 (14.0%)	0.032	Membracidae	Max. Temp.	0.274 (27.4%)	0.002
	Min. Temp.	0.227 (22.7%)	0.005		Min. Temp.	0.639 (63.9%)	0.000
	MRH%	0.207 (20.7%)	0.008		MRH%	0.214 (21.4%)	0.007
	Rainfall	0.117 (11.7%)	0.052		Rainfall	0.089 (8.9%)	0.092
Cicadellidae	Max. Temp.	0.166 (16.6%)	0.019	Pentatomidae	Max. Temp.	0.085 (8.5%)	0.100
	Min. Temp.	0.502 (50.2%)	0.000		Min. Temp.	0.411 (41.1%)	0.000
	MRH%	0.163 (16.3%)	0.020		MRH%	0.345 (21.4%)	0.000
	Rainfall	0.072 (7.2%)	0.130		Rainfall	0.041 (4.1%)	0.260
Aphididae	Max. Temp.	0.567 (56.7%)	0.000	Miridae	Max. Temp.	0.126 (12.6%)	0.042
	Min. Temp.	0.381 (38.1%)	0.000		Min. Temp.	0.329 (32.9%)	0.000
	MRH%	0.000 (0.0%)	0.903		MRH%	0.317 (31.7%)	0.001
	Rainfall	0.059 (5.9%)	0.174		Rainfall	0.051 (5.1%)	0.205
Pyrrhocoridae	Max. Temp.	0.144 (14.4%)	0.030	Pseudococcidae	Max. Temp.	0.106 (10.6%)	0.065
	Min. Temp.	0.280 (28.0%)	0.002		Min. Temp.	0.184 (18.4%)	0.013
	MRH%	0.226 (22.6%)	0.005		MRH%	0.126 (12.6%)	0.043
	Rainfall	0.044 (4.4%)	0.243		Rainfall	0.028 (2.8%)	0.348
Lygaeidae	Max. Temp.	0.149 (14.9%)	0.026				
	Min. Temp.	0.197 (19.7%)	0.010				
	MRH%	0.280 (28.0%)	0.002				
	Rainfall	0.061 (6.1%)	0.167				

MRH: Morning Relative Humidity

Table 7: Monthly meteorological data of Chiplima, Sambalpur, Odisha from August 2019 to March, 2020

Year	Month	SMW	Mean Temperature		Mean MRH%	RF (mm)
			Max (°C)	Min (°C)		
2019	August	31-35	31.6	24.7	90.4	357.9
	September	36-39	33.0	23.5	87.1	116.5
	October	40-43	32.5	20.4	88.5	0
	November	44-48	28.8	14.3	90.4	0

	December	49-52	30.1	09.5	93.5	0
2020	January	01-04	26.9	10.7	88.6	0
	February	05-08	30.0	14.2	83.3	0
	March	09-13	32.1	20.26	83.35	0

SMW- Standard meteorological week, MRH – Morning Relative Humidity, RF – Rain Fall





Fig 1-20: 1, *Nezara viridula* 2, *Piezodorus hybneri* 3, *Plautia crossota* 4, *Dysdercus cingulatus* 5, *Eurystylus bellevoeyi* 6, *Poppiocapsidea biseratense* 7, *Megacopta cribraria* 8, *Aphis craccivora* 9, *Riptortus linearis* 10, *R. pedestris* 11, *Empoasca kerri* 12, *Graptostethus servus* 13 & 14, *Clavigralla gibbosa* and eggs 15 & 16, *C. scutellaris* and eggs 17, *Leptocentrus taurus* 18, *Otinotus oneratus* 19, *Coccidohystrich insolita* 20, *Myzus persicae*

Conclusion

Documenting this insect diversity is helpful in determining the pigeonpea crop ecosystem role in conserving diversity and the information generated from this study also help to understand the role of different abiotic factors on population build up. Beside this, this study may be useful for formulating suitable management practices in case of their heavy infestation.

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