

**DIVERSITY AND TAXONOMIC STUDIES OF ACRIDOID
PESTS (ACRIDOIDEA: ORTHOPTERA) OF PULSES
FROM UTTAR PRADESH, INDIA**

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ABSTRACT: In the present study insect pest complexes on pulses has been observed and their association with host plant was investigated. The pest species infesting different parts of this legume plant were foliage, flower, pod and leaf. The status of these pests has been determined depending upon the rate of their feeding and extent of damages caused by them. Pulses are important food crops due to their high protein and essential amino acid content. Like many leguminous crops, pulses play a key role in crop rotation due to their ability to fix nitrogen. India is largest producer of pulses in the world with 25 per cent share in global production. Grasshoppers consume flower buds and especially early pods that results in yield loss and a delay in maturity due to delayed pod set. Adults and nymphs feed on green plant material, creating holes on leaves and pods pose the greatest threat to pulse production. All the seventy districts of Uttar Pradesh have been surveyed to collect the acridoid pests of pulses. Fourteen species representing fourteen genera of grasshoppers have been recorded belonging to three families, six subfamilies and two tribes.

KEY WORDS: Pulses, Pests, Diversity, Acridoid, Uttar Pradesh.

Orthoptera is one of the largest orders of insect which includes both short horned (Caelifera) and long horned grasshoppers (Ensifera). Acridoidea is one of the most important out of four superfamilies of Caelifera which comprises five families out of which Acrididae, Catantopidae and Pyrgomorphidae are widely distributed in India. Grasshoppers are of great economic importance, because they constitute an important group of pests and pose a constant threat to cereal crops, pulses, vegetables, orchards, grassland and forest plantations all over the world. India is largest producer of pulses in the world with 25 per cent share in global production and has achieved the record production of 18.09 million tons during 2010-11. Chickpea, pigeon pea, mungbean, urdbean, lentil, and fieldpea are important pulses crop contributing 39 per cent, 21 per cent, 11 per cent, 10 per cent, 7 per cent and 5 per cent to the total production of pulses in the country. Pulses attacked and infested by an array of insect pests causing injuries to the seedling stage, vegetative stage, flowering stage, pod formation stage, pod filling stage, pod maturity stage of this leguminous plant. This association of the pests with host plant is called pest-host interaction, which is species rich place attracting a large number of natural enemies mostly assigning at higher trophic levels of the food chain. Considerable study has been done on the pests attacking and infesting pigeon pea in different regions of the India (Prabhakar & Roy, 2008).

Bhowmik (1985), Tandon (1975, 1976), Shishodia (1987, 1997, 1999), Tandon & Shishodia (1969-1989), Usmani & Shafee (1980-1990), Kumar & Virktamath (1991a,b), Murlirangan & Srinivasan (1992), Hazra et al. (1993), Priya & Narendran (2003), Kulkarni & Shishodia (2004, 2005) and Usmani (2006) have

contributed works on the taxonomy of this group. More recently, Tandon & Khera (1978), Julka et al. (1982), and Dey & Hazra (2003) have done work on the taxonomy as well as on the ecology of this group. Usmani et al. (2010) described thirty three species of locusts and grasshoppers from Western Uttar Pradesh. The objective of the present study is to record the Acridoid pests attacking pulses of Uttar Pradesh.

Uttar Pradesh is the fifth largest and most populous state located in the north-central part of India. Uttar Pradesh is bounded by Nepal on the North, Utrakhhand on the north-east, Himachal Pradesh on the north-west, Haryana on the west, Rajasthan on the south-west, Madhya Pradesh on the south and south-west, and Bihar on the east. Situated between 23°52'N and 31°28'N latitudes and 77°3' and 84°39'E longitudes. The climate of Uttar Pradesh varies from Temperate in Eastern Uttar Pradesh to Extreme in Western UP. Therefore it is extremely difficult to categorize it a particular climatic frame. Nevertheless, summers are very hot and winters are bit chilly. Summer season persists from April to August. The daytime temperature remains very high and usually touches around 45°C in Western Uttar Pradesh where as it remains around 42°C in Eastern Uttar Pradesh. Winters in Uttar Pradesh are a lot cooler chilly with temperature getting as low as 2 to 4°C across the state. Approximate average annual rainfall in the state is around 65-70 centimeters.

MATERIALS AND METHODS

The crop was observed from seedling stage till the harvest for the incidence of acridoid pests during 2010 and 2011. Authors collected 671 specimens of adult grasshoppers of both sexes from various districts of Uttar Pradesh. Grasshoppers collected through sweeping net and hand picking method and killed using bottle having ethyl acetate. For the purpose of correct identification and photography the grasshoppers are stretched on Stretching Board, pinned and labeled and examined under stereo microscope and later kept in store boxes and cabinets for further studies. For detailed study of genitalia permanent slide were prepared and drawn it with the help of Camera Lucida. Morphometry has been done with the help of Vernier Calliper and then mean and standard deviation calculated. Diversity also made by using formula provided by Shannon-Wiener (1963).

$$H = \pi \log 2\pi$$

Where

H = Diversity index

Pi = n_i/N is the probability of an individual to belong to a species.

n_i = Number of individuals of each species in the sample.

N = Total number of individuals of all species in the samples.

Diversity indices were calculated by using SPECDIV program.

RESULTS

Our survey revealed the presence of total of 671 specimens of Acridoidea representing 14 species (Table 1.) belonging to three families, six subfamilies and two tribes collected from pulse crop field of Uttar Pradesh. It is first report though no previous information is available on acridoid pest of pulses from Uttar Pradesh, therefore, it is desirable to take up a detailed study on the succession of insect pest complexes of pulses under the agro-climatic conditions prevailing in

Uttar Pradesh. Shanower & Romeis (1999) studied pests of pigeonpea, Mandal et al. (2009) studied the pests on pigeonpea of Bihar, Mandal & Roy (2010) studied pests on chick pea of Bihar and Srilaxmi & Paul (2010) studied pest of pigeon pea in Karnataka but no one has described any acridoid fauna as a pest of pulses. Agrawal et al., monitored the pest of pulses in eastern and central Uttar Pradesh but did not describe any acridoid fauna as a pest of pulses. Kumar & Nath (2003) described pest on medium-late variety of pigeon pea Bahar at Varanasi, Lateef & Reed (1983), Reddy et al. (1998), Sekhar et al. (1991) and, Singh & Singh (1978) also studied pest of pigeonpea from different regions of India without describing any grasshopper pest in pulses. Even in Manipur not a single species of grasshopper has been mentioned in pulses by Subharani & Singh (2004).

DISCUSSION

Maximum number of species has been recorded from pigeonpea *i.e.* 9 (64.28%), followed by mungbean *i.e.* 7 (50%), urdbean, chickpea, fieldpea *i.e.* 5 (35.71%) whereas minimum number recorded from lentil *i.e.* 2 (14.28%) (Table. 2, Fig.1 & 2). Shannon Index value of 2.63 indicates moderate diversity of grasshopper pest in pulse crops of Uttar Pradesh. The grasshopper is an annual species in which each generation lasts for just one year and there is no overlap between generations. Grasshoppers have chewing mouthparts that tear away plant tissue commonly thought of as foliage feeders, but will also feed on flowers, fruits, seed heads, stems, and essentially all above ground plant parts. Often fence rows and roadsides adjacent to crops serve as the major sources of grasshoppers; as the vegetation dries up in such areas, grasshoppers that hatched and matured there move into adjacent crops. Moderate diversity shows it is minor pest but heavy infestation may result to a major pest. So it is a basic need to find out these pests and its control measure to save the most important sources of protein *i.e.* pulses.

Taxonomic account

Chrotogonus trachypterus (Blanchard, 1836)

Diagnostic characters: Body brown, rugose and tuberculate; head short and broad; antennae pronotum short, broad with small tubercles; sternum yellowish; tegmina reaching near to the tip of abdomen, covered with numerous prominent nodules, wings nearly as long as the tegmen; hind femur as long as the abdomen; abdomen brown above, pale beneath, without darkish spots, but with darkish tinge.

<i>Chrotogonus trachypterus</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean \pm SD	
			Male	Female
Body	13.91- 15.48	20.98- 24.22	14.53 \pm 0.63	21.68 \pm 1.42
Pronotum	3.05- 3.46	4.12- 4.77	3.26 \pm 0.14	4.43 \pm 0.23
Tegmina	9.56- 10.78	11.94- 13.80	9.96 \pm 0.49	12.83 \pm 0.71
Hind Femur	6.71- 8.05	8.72- 9.68	7.22 \pm 0.63	9.162 \pm 0.39

Attractomorpha crenulata (Fabricius, 1793)

Diagnostic characters: It can easily be identified on the bases of fastigium of vertex somewhat longer, tegmina comparatively longer, wings purple coloured at base. Smooth membranous area on the posterior part of the lateral pronotal lobe. The size and colour of species are extremely variable.

<i>Attractomorpha crenulata</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	22.59- 24.67	33.63- 35.66	23.56 ± 0.87	33.84 ± 1.28
Pronotum	4.06 - 4.87	5.80 - 6.92	4.54 ± 0.32	6.30 ± 0.53
Tegmina	15.99 - 17.53	21.88- 25.35	16.81 ± 0.61	23.61 ± 1.35
Hind Femur	8.82 - 9.86	12.18- 13.19	9.24 ± 0.40	12.68 ± 0.44

***Oxya velox* (Fabricius, 1787)**

Diagnostic characters: Antennae as long as length of head and pronotum together. Interocular distance as wide as frontal ridge at median sulcus. Posterior margin of metazona of pronotum is sharply pointed and angular. Posterior ventral basalvalvular sclerites of ovipositor without any well defined spines on its lower inner margin. Median pair of spines on posterior margin of subgenital plate set wider apart. Male cercus conical with subacute apex. Supra-anal plate rounded triangular posterior portion.

<i>Oxya velox</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	21.35 - 22.32	25.56 - 26.86	21.9 ± 0.41	26.06 ± 0.52
Pronotum	5.68 - 6.21	6.2 - 6.75	5.88 ± 0.31	6.57 ± 0.21
Tegmina	18.5 - 19.4	22.52 - 23.45	18.91 ± 0.34	23.22 ± 0.23
Hind Femur	13.54 - 14.24	16.56 - 17.48	13.85 ± 0.32	17.06 ± 0.41

***Eyreprocnemis alacris alacris* (Serville, 1838)**

Diagnostic characters: Having bluish grey hind tibia with two whitish signs at the base and reddish apex and tarsus, male cercus gradually narrowing towards apex incurved and down curved. Fastigium of vertex round, frontal ridge with characteristic dark brown markings on lateral carinae, prosternal process cylindrical and antero-posteriorly compressed. Elytra and wings fully developed, elytra with numerous brown spots, bluish grey hind tibiae.

<i>Eyreprocnemis alacris</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	30.50-33.10	34.88-38.98	31.67 ± 1.20	34.34 ± 3.08
Pronotum	5.73-6.59	6.96-7.02	6.23 ± 0.36	6.71 ± 0.32
Tegmina	25.81-27.64	28.67-29.96	27.10 ± 1.21	27.87 ± 1.46
Hind Femur	16.87-19.11	21.43-21.83	18.00 ± 0.95	20.76 ± 0.83

***Catantops erubescens* (Walker, 1870)**

Diagnostic characters: Body large, wings orange red at base. Wings brightly coloured. Frontal ridge flat or slightly depressed. Prosternal process cylindrical or slightly antero-posteriorly compressed with rounded apex. Male cercus longer with apex rounded.

<i>Catantops erubescens</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	30.16- 31.27	36.34 - 40.99	30.62 ± 0.43	38.56 ± 2.0
Pronotum	5.3- 5.81	6.59 - 8.32	5.61 ± 0.21	7.21 ± 0.66
Tegmina	22.25 - 23.4	28.31 - 31.38	22.75± 0.45	29.48 ± 1.82
Hind Femur	13.25 - 14.05	15.6 - 18.76	13.75 ± 0.33	17.14 ± 1.27

***Aiolopus simulatrix* (Walker, 1870)**

Diagnostic characters: It can easily be distinguished by its broad hind femur which is longer than hind tibia and by the form of frontal ridge and pronotum. The species is variable in general coloration, size, relative length of tegmina and width of hind femur.

<i>Ailopus simulatrix</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	15.44-18.02	20.64-27.81	16.49 ± 1.21	24.02 ± 2.78
Pronotum	2.62-3.47	3.84-4.88	3.07 ± 0.36	4.27 ± 0.39
Tegmina	16.33-19.82	21.83-26.65	17.51 ± 1.45	24.02 ± 2.02
Hind Femur	9.02-11.29	11.77-14.76	9.72 ± 0.90	13.25 ± 1.19

***Acrotylus humbertianus* (Saussure, 1884)**

Diagnostic characters: Body pubescent, tip of vertex conical, concave, pronotum finely carinate. Wings hyaline, yellow at the base. Prozona with two fuscusfascia. The lateral margins white below. Radial area with a semilunar fuscus fascia, posterior femora fascinate.

<i>Acrotylus humbertianus</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	11.45- 12.85	13.8-14.1	12.1 ± 0.55	13.34 ± 0.68
Pronotum	5.2 - 5.96	5.8-6.74	5.6 ± 0.29	6.24 ± 0.37
Tegmina	18.35 - 19.21	20.1-21.3	18.81 ± 0.36	20.75 ± 0.43
Hind Femur	9.56- 10.20	10.3-11.5	9.75 ± 0.32	10.90 ± 0.47

***Gastrimargus africanus africanus* (Saussure, 1888)**

Diagnostic characters: Antennae filiform, as long as or shorter than head and pronotum together, fastigium of vertex slightly concave with weak median and well developed lateral carinulae, frontal ridge flat, pronotum tectiform, constricted in prozona, anteriorly projecting above vertex, median carina almost crest-shaped, crossed by posterior transverse sulcus only, lateral carinae absent.

<i>Gastrimargus africanus</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	24.38-27.10	39.11-41.70	25.54 ± 1.26	40.75 ± 1.07
Pronotum	5.71-6.25	8.75-10.09	6.01 ± 0.22	9.57 ± 0.49
Tegmina	25.21-27.83	37.14-40.26	26.19 ± 1.30	38.78 ± 1.12
Hind Femur	13.98-16.53	21.81-22.72	14.94 ± 1.21	22.24 ± 0.33

***Locusta migratoria* (Linnaeus, 1758)**

Diagnostic characters: Prosternal process absent, the slight yellow tinting of the wings and the black anal veins are distinctive features of the species. Occurs in green and brown form in the solitary phase.

<i>Locusta migratoria</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	23.78-25.65	34.71-36.24	24.25 ± 0.87	35.38 ± 0.81
Pronotum	6.64-7.34	8.78-9.61	6.87 ± 0.30	9.13 ± 0.34
Tegmina	25.22-26.64	35.86-39.41	25.61 ± 0.59	36.91 ± 1.46
Hind Femur	15.25-16.47	18.10-19.20	15.90 ± 0.43	18.71 ± 0.40

***Hieroglyphus nigrerepletus* (Bolivar, I. 1912)**

Diagnostic characters: Body medium to large; antennae filiform, longer than head and pronotum together, fastigium of vertex rounded or trapezoidal, flat, with obtuse lateral carinulae. Its Pronotum with sides markedly expanded in metazoan, dorsum with characteristic black pattern connecting all sulci by two irregular stripes. First and third sulci joined by a black band; posterior margin of pronotum obtuse angular.

<i>Hieroglyphus nigrorepletus</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	30.36- 34.51	40.01- 44.52	32.38 ± 1.79	42.42 ± 1.68
Pronotum	7.22- 8.05	8.72- 8.98	7.48 ± 0.35	8.83 ± 0.36
Tegmina	18.35-19.67	20.53-21.56	19.16 ± 0.56	21.12 ± 0.42
Hind Femur	17.30- 18.19	19.62- 21.78	17.62 ± 0.39	20.17 ± 0.93

***Spathosternum prasiniferum* (Walker, 1871)**

Diagnostic characters: Small, head conical, fastigium of vertex obtusely angular or parabolic. Filiform antennae, frontal ridge narrow and sulcated. Two broad blackish band or dark greenish band running behind the lower part of the eyes and below the lateral carinae of the pronotum which is banded above by a narrow pale yellow line and lateral carinae present, Prosternal process large, strongly, antero–posteriorly compressed, spatulated, inclined backwards.

<i>Spathosternum prasiniferum</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	14.3 – 14.86	18.58 – 19.35	14.57 ± 0.21	18.96 ± 0.33
Pronotum	3.6 – 3.9	4.5 – 4.9	3.75 ± 0.11	4.73 ± 0.16
Tegmina	11.5 – 12.2	13.5 – 14.2	11.85 ± 0.27	13.81 ± 0.29
Hind Femur	8.7 – 9.4	9.8 – 10.5	9.03 ± 0.28	10.21 ± 0.32

***Cyrtacanthacris tatarica tatarica* (Linnaeus, 1758)**

Diagnostic characters: Body large, integument slightly granulose and punctuate-dotted, antennae filiform, about as long as head and pronotum together, pronotum moderately tectiform and slightly constricted, crossed by three transverse sulci, median carina low, lateral carinae absent, prosternal process large, widened in middle and gradually narrowing towards subacute apex.

<i>Cyrtacanthacris tatarica</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	44.35-49.87	53.66-65.41	46.19 ± 2.21	59.23 ± 5.64
Pronotum	9.45-10.53	11.94-12.64	9.89 ± 0.48	12.26 ± 0.27
Tegmina	37.35-40.51	48.84-53.26	39.22 ± 1.34	51.01 ± 1.57
Hind Femur	21.29-24.65	28.77-30.16	23.14 ± 1.42	29.46 ± 0.51

***Chondacris rosea* (De Geer, 1773)**

Diagnostic characters: Body of large size, integument strongly granulose, antennae filiform, longer than head and pronotum together, fastigium of vertex trapezoidal, frontal ridge slightly narrowed at apex, Pronotum tectiform, crossed by three transverse sulci, median carina raised, lateral carinae absent, Prosternal process large, strongly bent towards mesosternum, nearly touching it, mesosternal interspace open, lobes rectangular.

<i>Chondacris rosea</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean ± S.D.	
			Male	Female
Body	58.58-62.87	82.11-96.14	60.91 ± 1.56	91.39 ± 5.62
Pronotum	16.42-18.67	22.17-23.08	17.52 ± 0.80	22.11 ± 0.62
Tegmina	40.25-42.36	61.19-72.43	41.54 ± 0.84	68.61 ± 4.31
Hind Femur	24.65-26.24	38.55-44.03	25.46 ± 0.64	41.64 ± 2.00

***Schistocerca gregaria gregaria* (Forskal, 1775)**

Diagnostic characters: Body of large size, integument finely punctuate, antennae filiform, shorter than head and pronotum together, fastigium of vertex trapezoidal, with

shallow longitudinal depression, frontal ridge low, narrower than interocular distance, pronotum constricted, crossed by three transverse sulci, median carina low, sometimes indistinct in prozona, lateral carinae absent, metazona about as long as prozona, posterior margin rounded, prosternal process cylindrical, moderately bent towards mesosternum but not touching it.

<i>Schistocerca gregaria</i> (5 males + 5 females)				
Measurement (in mm)	Male	Female	Mean \pm S.D.	
			Male	Female
Body	43.24- 46.87	52.66-56.41	45.24 \pm 1.36	54.54 \pm 1.45
Pronotum	8.45-9.53	10.94-11.64	8.93 \pm 0.54	11.35 \pm 0.28
Tegmina	36.35-38.51	47.84-50.26	37.52 \pm 0.91	49.28 \pm 1.07
Hind Femur	20.22-22.65	27.77-29.16	21.56 \pm 1.01	28.46 \pm 0.58

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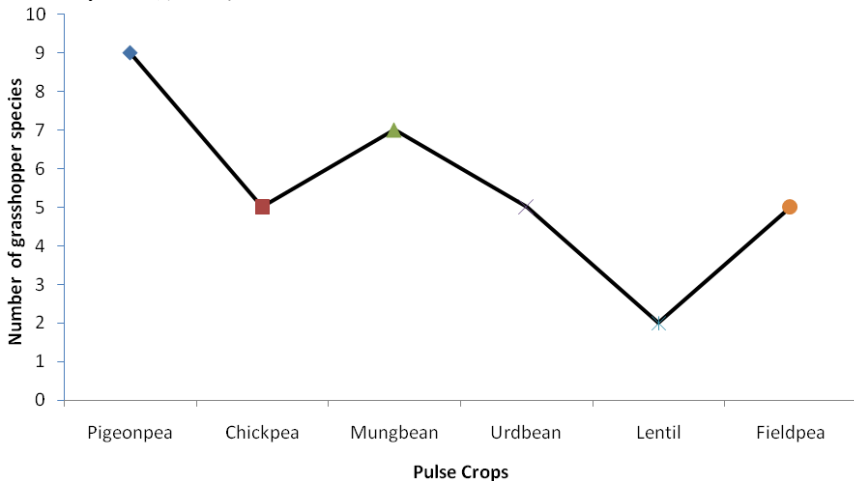


Figure 1. Number of grasshoppers species recorded in six major pulse crops.

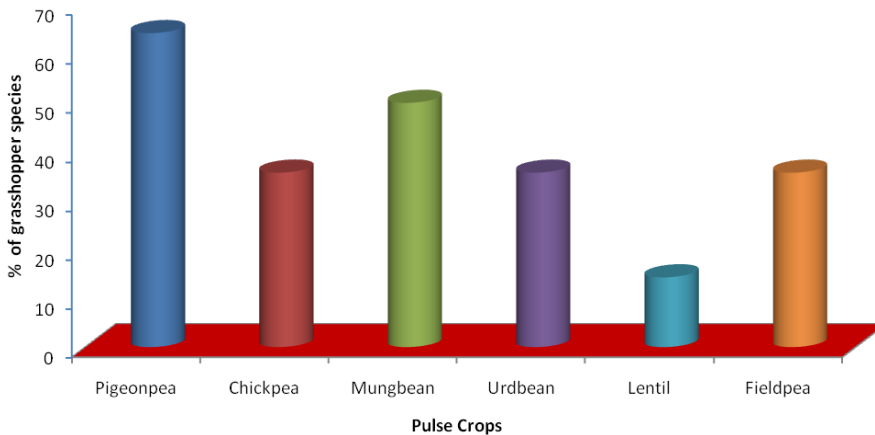


Figure 2. Percentage of grasshoppers species recorded in six major pulse crops.

Table 1. Grasshoppers species recorded from pulse crops of Uttar Pradesh.

S. No.	Grasshopper species	Host plant	Nature of damage	Number	Distribution
1.	<i>Chrotogonus traychypertus</i>	Mungbean, Urdbean, Chickpea, Fieldpea	Tender leaves, flowers and tender pods	40 ♂,36♀	Aligarh, Banda, Fatehpur, Azamgarh, Ghazipur,
2.	<i>Attractomorpha crenulata</i>	Mungbean, Urdbean, Chickpea, Fieldpea	Leaves	47 ♂,32♀	Aligarh, Azamgarh, Unnao, Kanpur,
3.	<i>Oxya velox</i>	Mungbean, Urdbean, Chickpea, Fieldpea	Leaves, Flower, Pod	43 ♂,38♀	Aligarh, Kanpur, Kannauj, Etawah
4.	<i>Eyprepocnemis alacris</i>	Pigeonpea	Tender leaves and growing tips	14 ♂,12♀	Jhansi, Jalaun, Banda
5.	<i>Catantops erubescens</i>	Mungbean, Pigeonpea	Tender leaves and growing tips	28 ♂,18♀	Aligarh, Jhansi, Banda, Lalitpur, Jalaun
6.	<i>Ailopus simulatrix</i>	Mungbean, Urdbean, Fieldpea, Lentil, Chickpea	Tender leaves and flowers	38 ♂,45♀	Aligarh, Ghazipur, Gorakhpur, Kanpur, Etawah, Jalaun,
7.	<i>Acrotylus humbertianus</i>	Pigeonpea	Leaves and flowers	10 ♂,7♀	Jalaun, Mahoba, Mau,Unnao
8.	<i>Gastrimargus africanus</i>	Pigeonpea	Tender leaves, flowers and tender pods	9 ♂,13♀	Aligarh, Hamirpur, Jalaun
9.	<i>Locusta migratoria</i>	Pigeonpea, Mungbean	Tender leaves, flowers and tender pods	13 ♂,11♀	Azamgarh, Aligarh, Allahabad, Ghazipur, Mau,
10.	<i>Hieroglyphus nigrorepletus</i>	Pigeonpea	Tender leaves, flowers and tender pods	11 ♂,10♀	Azamgarh, Allahabad, Ghazipur, Mau, Meerut, Saharanpur, Kanpur
11.	<i>Spathosternum prassiniferum</i>	Mungbean, Urdbean, Fieldpea, Chickpea, Lentil	Leaves	72 ♂,68♀	Aligarh, Azamgarh, Ghazipur, Kanpur, Etawah, Jalaun,
12.	<i>Cyrtacanthacris tatarica</i>	Pigeonpea	Feeds on leaves, Flowers	7 ♂,9♀	Azamgarh, Ghazipur, Kanpur, Etawah, Jalaun,
13.	<i>Chondacris rosea</i>	Pigeonpea	Leaves	6 ♂,7♀	Jalaun, Mahoba, Hamirpur, Kanpur
14.	<i>Schistocerca gregaria</i>	Pigeonpea	Tender leaves, flowers and tender pods	12 ♂,15♀	Allahabad, Azamgarh, Mirzapur, Kanpur, Hamirpur, Jalaun, Sultanpur
Total number of specimen- 671 Total number of species- 14 Shannon- Wiener Diversity Index- 2.63					

Table 2. Percentage of grasshopper species collected from pulses.

Host Plant	Number of species recorded	Percentage of species
Pigeonpea	9	64.28
Chickpea	5	35.71
Mungbean	7	50.00
Urdbean	5	35.71
Lentil	2	14.28
Fieldpea	5	35.71