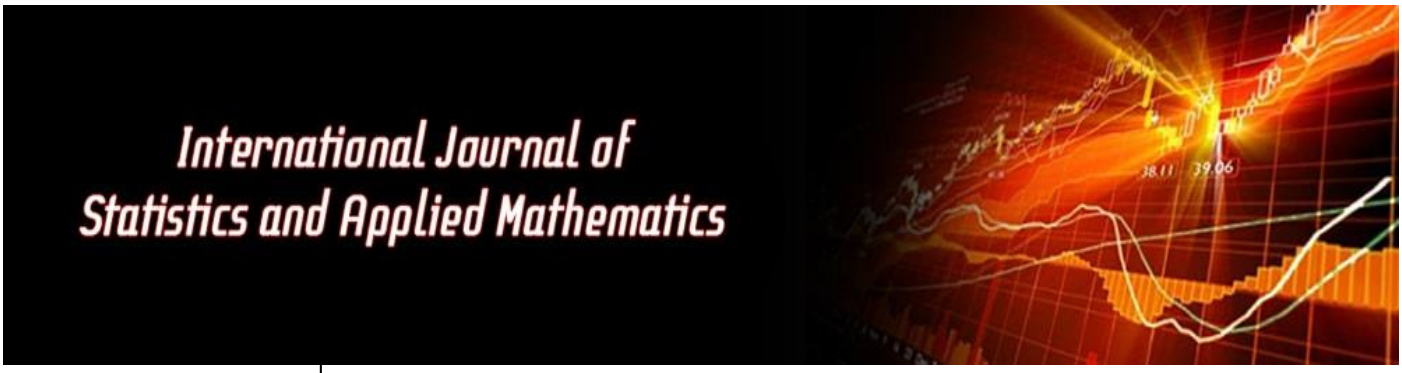
International Journal of Statistics and Applied Mathematics 2024; SP-9(1): 43-47



ISSN: 2456-1452
Maths 2024; SP-9(1): 43-47

https://www.mathsjournal.com
Received: 20-10-2023
Accepted: 18-11-2023

AP Prajapati
Ph.D., Scholar, Department of Entomology, NM College of Agriculture, Navsari Agricultural University, Dandi Road, Erugam, Navsari, Gujarat, India

JJ Patel
Associate Professor & Head, Department of Entomology, College of Agriculture, Navsari Agricultural University, Bharuch, Gujarat, India

NM Kachhadiya
Scientist (Plant Protection), KVK, Junagadh Agricultural University, Amreli, Gujarat, India

NP Trivedi
Associate Research Scientist, Department of Field Biology (R & D), Crystal Crop Protection Ltd., Anand, Gujarat, India

Corresponding Author:
AP Prajapati
Ph.D., Scholar, Department of Entomology, NM College of Agriculture, Navsari Agricultural University, Dandi Road, Erugam, Navsari, Gujarat, India

Biodiversity of insects and mites in organic farming system of bottle gourd [*Lagenaria siceraria* (Molina) Standley]

AP Prajapati, JJ Patel, NM Kachhadiya and NP Trivedi

DOI: https://doi.org/10.22271/maths.2024.v9.i1Sa.1545

Abstract
An inventory of 42 species of different insects and mites was made for the organic bottle gourd crop. A total of 42 species of insects and mites belonging to 35 families of the 12 orders *viz*. Hemiptera, Dermeptera, Mantodea, Odonata, Orthoptera, Coleoptera, Diptera, Hymenoptera, Lepidoptera, Neuroptera, Acarina and Araneae was observed on bottle gourd. Insects of the order Hemiptera were observed as the dominant group with 11 species and 10 families contributing to 27.5 per cent. Mite population was also observed in organic farming systems during the entire study period. A total of 5093 insects and mites from bottle gourd crop were observed during the summer 2020 and 2021. Order Hemiptera (36.66%) and Coleoptera (32.32%) were relatively more abundant on the organic farm compared to other orders. From Hemiptera, *Aphis gossypii* Glover was found most abundant with 9.28 per cent abundance followed by *Nesidiocoris* spp. with 10.72 per cent abundance and from order Coleoptera, *Aulacophora foveicollis* Lucas was the most abundant with 17.00 per cent abundance and found as very common species. Shannon's diversity index, species richness and species evenness of insect and mites of organic bottle gourd crops were recorded as 2.94, 10.57 and 0.80, respectively.

Keywords: Biodiversity, hymenoptera, diptera, lepidoptera, hemiptera, coleoptera, organic, bottle gourd

Introduction
The term "Biodiversity", where 'bio' refers to life and 'diversity' the variety of life forms was coined by Walter G. Rosen during the "National Forum on Biodiversity" held in Washington DC from 21st – 24th September 1986 (Sarkar and Margules, 2002) [8]. Biodiversity is also referred to as "Biological diversity" which means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; including diversity within species, between species and of ecosystems (Anon., 1992) [9]. The bottle gourd [*Lagenaria siceraria* (Molina) Standley] producing major countries in the world are India, Sri Lanka, Indonesia, Malaysia, Philippines, China, Hong Kong, Tropical Africa, Columbia and Brazil. India is the second largest producer of bottle gourd in the world after China. It is extensively grown in India (U. P., Punjab, Gujarat, Assam, Rajasthan, Tamil Nadu, and Karnataka). Bottle gourd [*L. siceraria*] also known as Calabash, is one of the most important cucurbitaceous vegetable crops grown in both rainy and summer seasons. It is also known as the white flower gourd. It is originated in Africa and now grown in most of the world. It is variously called *alabu* in Sanskrit, *kaddu*, *lauki*, and *tumri* in Hindi, *sorakaya* in Telugu, *shorakkai* in Tamil, *sorekayi* and halagumbala in Kannada, *lau* in Bengali and Assamese, and *ghiya* in Punjabi (Sivaraj and Pandravada, 2005). In Gujarat, it is known as *Dudhi*. In India, it is cultivated in about 155 thousand ha area with a production of 2573 thousand MT (Anon., 2021) [10]. The unripe fruits of bottle gourd are eaten as vegetables and the matured dried fruits are used for making storage jars, utensils and musical instruments (Dhatt and Khosa, 2015) [11]. The 100 g fruits of bottle gourd contain 96.1 g water, 2.5 g carbohydrates, 0.6g fibers,
0.5 g minerals, 0.2 g protein and 0.1g fats edible parts. It is also used as medicinal values and used as a cardio-tonic, aphrodisiac, hepatoprotective, analgesic, anti- inflammatory, expectorant, diuretic and antioxidant agent (Dhatt and Khosa, 2015) [11].

Assessment of faunal biodiversity in the agroecosystem provides a base for developing practical and cost-effective preservation and monitoring programme and also aims at obtaining maximum information regarding the distribution of component species and their habitats (Kim, 1993) [12]. Information on the diversity of insects and mites in a particular farming system is a prerequisite, which helps in designing a successful pest management strategy. However, no systematic efforts have been made to observe the diversity of insects and mites, their seasonal abundance in relation to weather factors and crop phenological stages in organic farming systems. Such information on bottle gourd is lacking in south Gujarat. Therefore, the proposed study based on the biodiversity of insects in organic farming systems of bottle gourd pests was undertaken at the certified organic farming unit, Navsari Agricultural University, Navsari during the summer seasons of 2020 and 2021 on bottle gourd.

Materials and Methods

For the study of the biodiversity of insects and mites in the organic farming system of bottle gourd, the crop was sown at Organic Farming Unit, ACHF, Navsari Agricultural University, Navsari, Gujarat in the year 2019-20 and 2020-21. The collection of various diurnal and nocturnal insects and mites was made from bottle gourd fields during both years.

Sampling Procedure

The diurnal and nocturnal insects and mites on bottle gourd were collected at fortnightly intervals on 25 randomly selected plants (5 plants/spot in "W" shape) of middle rows, leaving the border row plants in organic farming systems by visual observation and plant inspection method as suggested by Southwood, 1978. The Nocturnal insects were observed at eight O'clock evening time. The insect-like pumpkin beetles was found active at day and night but its higher activity was seen at night, hence it was recorded as nocturnal insects. The above-ground insect species were trapped in sweep nets (32 cm dia. and 70 cm long) and monitored. Five sweeps were done and fortnightly data on the number of individuals of each species obtained by net sweeping was used to formulate the biodiversity of insects.

The counts on pollinators were made using Ad-libitum sampling of flower visitors for a sampling time of ten minutes with a time interval of 60 min. All insects visiting flowers per sampling time were counted and recorded. Observations were recorded on the species of insects visiting the flowers and the numbers of each species per sample at different times of the day throughout the flowering period of selected crops in the organic farming systems. The population of sucking pests was visually recorded on three leaves (top, middle and bottom leaves).

The insects and mites collected by various methods were brought to the laboratory and killed by placing a small cotton swab dipped in ethyl acetate or chloroform inside the polythene bags. The identification of the collected specimens from the organic farming system was confirmed taxonomically. The data were used to calculate species abundance, species richness, and evenness; Shannon and Weaver diversity index for each taxonomic order in organic fields.

Statistical Analysis

Species diversity: Shannon and Wiener diversity index (H') is the most popular and widely used index in community ecology. It is the average degree of 'Uncertainty' and if this average 'uncertainty' increases as the number of species increase and the distribution of individuals among the species also become even. Insect and mite diversity in the organic farming systems was assessed using Shannon and Weaver diversity formula and is as under:

$H = \sum pi\ log2\ pi$ (Shannon and Weiner, 1963)

Where,

H = Diversity index Pi = ni /N

Pi= Proportion of individuals of i^{th} species

Ni = Number of individuals of each species in the sample

N = Total number of individuals of all species in the sample

Species evenness: How equally abundant the species are? There are many measures of evenness proposed. One of the most common approaches has been to scale one of the heterogeneity measures such as the Shannon and Weaver diversity measure, relative to its maximum theoretical value when each species in the sample was represented by the same number of individuals. It was calculated by the following formula

$$J = \frac{H}{log\gamma S}$$ …….. (Pielou, 1969) [13]

Where,

H = Shannon and Weaver diversity

S = The number of species in the community.

Species Richness: In order to assess how the diversity of the population is distributed or organised among the particular species, this index was calculated.

$$R = \frac{S\text{-}1}{log\gamma N}$$ …….. (Margalef, 1958) [14]

Where,

S = The total number of species collected and

N = The total number of individuals in all the species

Relative Abundance: The relative abundance of different species was calculated in terms of percentage.

$$\%\ \text{Relative abundance (RA)} = \frac{n}{N} \times 100$$

Where,

n = Total number of individuals of species 'a' N = Total number of individuals of all species

Results and Discussion

A total of 5093 insects and mite individuals belonging to 11 insect orders, 34 families and 41 insect species as well as one mite order, one family which includes one mite species were recorded during the entire study period (2020 and 2021) on bottle gourd crop in organic farming systems. Out of these, the insect order Hemiptera was observed to be the dominant group with 11 species, 10 families contributing to 27.50 per cent of the total species diversity. Lepidoptera occupied the second place with six species under five families contributing to 15 per cent of the species diversity followed by Coleoptera with six species under three families containing 15 per cent, Hymenoptera with six species under five families with 10 per

cent, Orthoptera with three species under two families and 7.50 per cent, Diptera with two species under two families and five per cent, Odonata and Araneae with two species each under one family with five per cent biodiversity and Mantodea, Neuroptera and Dermeptera with one species under one family containing 2.50 per cent and mite order Acarina with one species under one family contributing 2.50 per cent of the total biodiversity of the total insect and mite faunal diversity (Table 4.1, Fig. 1 and 2).

During 2020, total number of 2627 individuals belonging to 12 orders and 35 families were recorded at the organic bottle gourd farm. Organic farm showed higher species richness of natural enemies as compared to phytophagous species. Species evenness (J) is a measure of how equally abundant the species are. The species evenness was 0.79 for organic bottle gourd farming systems (Table 4.1). Species richness index R (Margalef) was (10.57) Shannon and Wiener diversity index (H') was (2.91) in organic bottle gourd (Table 4.1). Total number of 2466 individuals belonging to 12 orders and 35 families comprising of 42 species were recorded at the organic bottle gourd farm during 2021. Higher species evenness was recorded at the organic farm (0.80) (Table 4.1).

The data based on the species richness index (R) indicated a higher value (10.57) in the organic farming system of bottle gourd. This indicates that organic farms support higher species richness. Shannon and Wiener diversity index (H') of organic farming systems was 2.97 indicating higher diversification of species on organic bottle gourd farm (Table 4.1).

In the present investigation, 5093 individuals belonging to 12 orders and 35 families comprising of 42 species of insects were observed in the organic farming system (Table 4.1). This finding is in line with the result of Patra *et al.* (2016) who recorded 41 insect species comprising of 11 Coleopteran, 13 Hemipteran, three Orthopteran, one Dipteran, one Thysanopteran, 11 Lepidopteran and one Hymenopteran insect in vegetables. They also recorded natural enemies comprising of eight coccinellid beetles, one yellow wasp, one predatory bug, two unidentified parasitoids and a few unidentified spiders. Similarly, Nair *et al.* (2017) recorded 64 insect pests belonging to seven orders and 32 families. Amongst them, nine species were recorded as major, 30 as minor and the remaining 25 were recorded as negligible pests which supports the present findings. Singh and Chauhan (2014) [6] recorded a total of 32 species in 15 genera and seven families in 16 different vegetables and ornamental crops.

Table 1: Insect and mites diversity of organic bottle gourd system

Sr. No.	Order	Family	Scientific name	Number		
				2020	2021	Total
1.	Hemiptera	Aleyrodidae	*Bemisia tabaci* Gennadius	86	72	158
		Alydidae	*Riptortis pedestris* Fabricius	42	58	100
		Aphididae	*Aphis gossypii* Glover	217	253	470
		Cicadellidae	*Empoasca kerri* Pruthi	87	80	167
		Lygaeidae	*Geocoris tricolor* Fabricius	16	11	27
			Lygaeus hospes Fabricius	09	09	18
		Miridae	*Nesidiocoris* spp.	289	254	543
		Pyrrhocoridae	*Dysdercus cingulatus* Fabricius	12	10	22
		Plataspididae	*Coptosoma cribraria* Fabricius	108	117	225
		Pentatomidae	*Nezara virudula* Linnaeus	67	51	118
		Reduvidae	*Rhynocoris fuscipes* Fabricius	04	05	09
2.	Dermaptera	Labiduridae	*Labidura riparia* (Pallas)	08	12	20
3.	Mantodea	Mantidae	*Mantis religiosa* Couple	03	02	05
4.	Odonata	Libullelidae	*Pantala flavescens* (Fabricius)	07	06	13
			Orthetrum sabina (Drury)	06	04	10
5.	Orthoptera	Pyrgomorphidae	*Atractomorpha crenulata* Fabricius	11	09	20
		Gryllidae	*Oecanthus indicus* (Saussure)	21	17	38
			Gryllus sp.	34	23	57
6.	Coleoptera	Chrysomelidae	*Aulacophora foveicollis* Lucas	483	378	861
			Aulacophora intermedia Jacoby	17	21	38
		Coccinellidae	*Coccinella transversalis* Fabricius	47	58	105
			Cheilomenes sexmaculata Fabricius	111	121	232
			Illeis cincta Fabricius	06	04	10
		Nitidulidae	*Haptones* spp.	213	178	391
7.	Diptera	Agromyzidae	*Liriomyza trifoli* Burgess	18	12	30
		Tephritidae	*Bactrecra (Dacus) cucurbitae* (Coquillet)	184	201	385
8.	Hymenoptera	Apidae	*Apis dorsata* Fabricius	97	89	186
			Apis cerana indica Fabricius	27	31	58
		Formicidae	*Camponotus compressus* Fabricius	74	67	141
		Ichneumonidae	*Ichneumonidae* spp.	02	04	06
		Megachilidae	*Megachile (Eutricharaea) hera* (Bingham, 1897)	07	08	15
		Xylocopidae	*Xylocopa fenestrata* (Fabricius, 1798)	09	05	14
9.	Lepidoptera	Noctuidae	*Helicoverpa armigera* Hubner	23	20	43
		Pterophoridae	*Sphenarches anisodactylus*	19	22	41
		Crambidae	*Diaphania indica* Saunders	09	11	20
			Spoladea recurvallis Fabricius	03	07	10
		Nymphalidae	*Danaus chrysippus* Linnaeus	11	15	26
		Pieridae	*Eurema hecabe* Linnaeus	14	12	26
10.	Neuroptera	Chrysopidae	*Chrysoperla carnea* Stephens	10	08	18
11.	Acarina	Tetranychidae	*Tetranychus urticae* Koch	198	164	362

12.	Araneae	Araneidae	*Argiope anasuja*(Thorell)	08	19	27
		Oxyopidae	*Oxyopes birmanicus* (Thorell)	10	18	28
No. of species (S)				42	42	42
No. of Families				35	35	35
No. of orders				12	12	12
N				2627*	2466*	5093*
J				0.79	0.80	0.80
R				10.57	10.57	10.57
H				2.91	2.97	2.94

Note:
S- No. of species, N- Total no. of individuals in all species, J- Species evenness,
R- Species Richness, H- Shannon-Wiener index
*Number of individuals per 300 plants and 12 sampling dates, Mites recorded on 4cm^2 leaf area

Relative Abundance (%) of Insect and Mites in Organic Bottle Gourd System

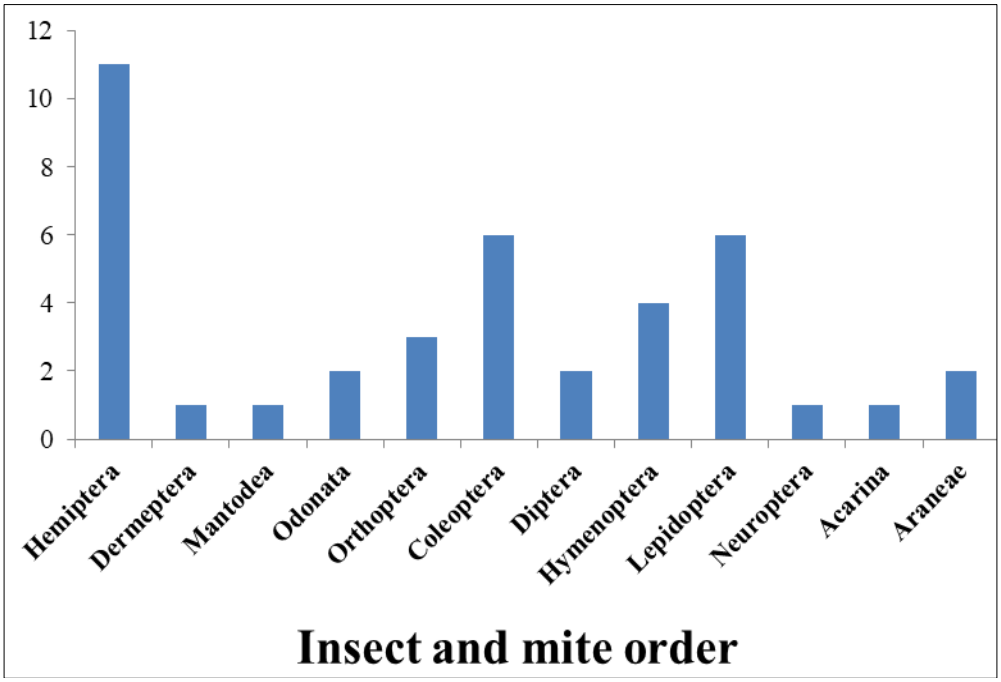


Fig 1: Overall species composition under different insect and mite orders

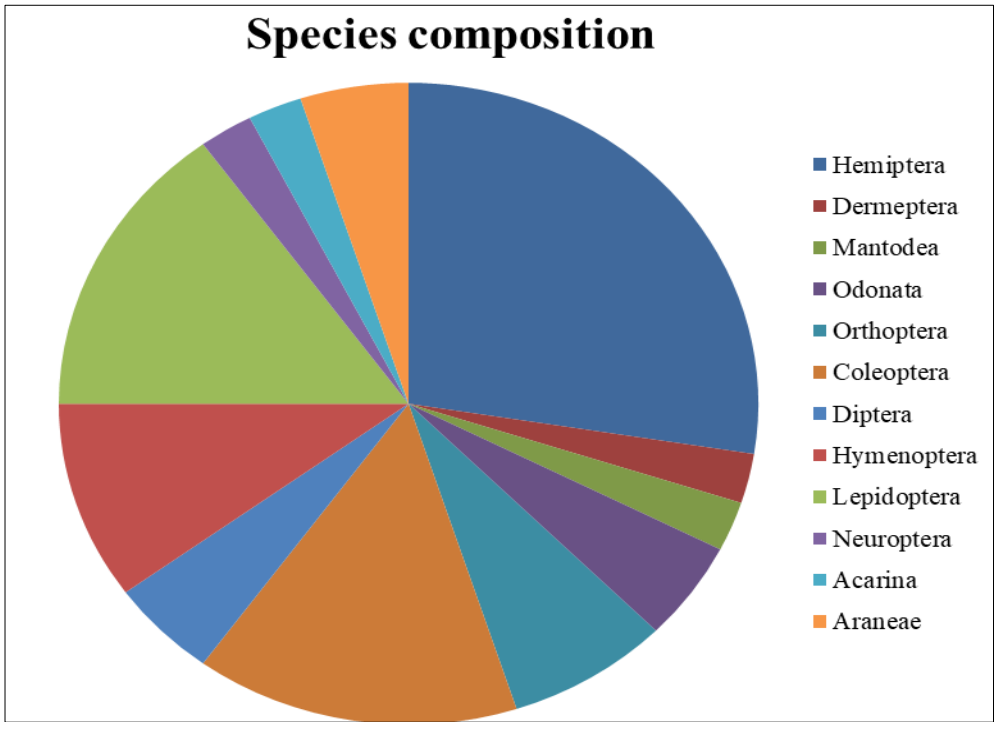


Fig 2: Per cent composition of different species under insect and mite orders

In contradiction to the results of the current investigation, Chitra and Soundararajan (2011) [2] recorded 127 insect species under 113 genera, 59 families and 11 orders in the vegetable ecosystem. Amongst the insect orders, Coleoptera was the most diverse (31 species) insect order followed by Hemiptera (27 species), Lepidoptera (19 species), Orthoptera (15 species), Hymenoptera (14 species), Odonata (7 species), Dictyoptera six species), Diptera (4 species), Neuroptera (2 species), Ephemeroptera and Isoptera (1 species each).

Srilaxmi and Paul (2010) [7] have recorded a total of 1056 insects belonging to six orders and 16 families of Lepidoptera, Hemiptera, Coleoptera, Homoptera and Diptera in the organic ecosystem at Gulbarga, Karnataka.

In the present investigation, the organic bottle gourd farming system recorded higher species richness (42 species), species abundance (5093) species evenness (0.80), species richness index (10.57) and Shannon diversity index (H=2.94), (Table 4.1). Bengtsson *et al.* (2005) [1], Hole *et al.* (2005) [3] studied the biodiversity of natural enemies and phytophagous insects in organic farming systems in the Sacramento Valley and subsequently found higher richness (61 species) in organic samples.

Conclusion

From the present investigation it can be concluded that

- Insect like fruit fly [*Bactrocera cucurbitae* Coq.], red pumpkin beetle [*Aulacophora foveicollis* (Lucas)], black pumpkin beetle [*Aulacophora foveicollis* (Fabricius)], pumpkin caterpillar [*Margaroria indica* (Saunders)], American serpentine leaf miner [*Liriomyza trifolii* (Burgess)], bottle gourd moth [*Sphenarches anisodactylus* (Walker)], aphids [*Aphis* spp.], dudhi bugs [*Nesidiocoris tenuis* Reut.] are key pests, causing substantial loss every year in organic bottle gourd.
- An inventory of 108 insects and mites of bottle gourd is prepared in an organized manner. 16 species of insect of bottle gourd are noticed as a new record from Gujarat that updated the checklist of Gujarat.

References

1. Bengtsson J, Ahnstrom J, Weibull AC. The effects of organic agriculture on biodiversity and abundance: A Metaanalysis. Journal of Applied Ecology. 2005;42:261-269.
2. Chitra N, Soundararajan RP. Insect diversity in pigeon pea ecosystem in Tamil Nadu. Indian Journal of Entomology. 2011;73(4):349-356.
3. Hole DG, Perkins AJ, Wilson JD, Alexander IH, Grice PV, Evans AD. Does organic farming benefit biodiversity? Biological Conservation. 2005;122:113-130.
4. Nair N, Thangjam B, Bhattacharjee T, Debnath M. Species composition of Dacine fruit flies (Diptera: Tephritidae: Dacinae: Dacini) associated with cucurbits in Tripura, a North Eastern state of India. Journal of Entomology and Zoology Studies. 2017;5(3):330-335.
5. Patra S, Firake DM, Azad NS, Thakur, Roy A. Insect pest complex and crop losses in pigeon pea in medium altitude hill of Meghalaya, The Bioscan. 2016;11(1):297-300.
6. Singh DK, Chauhan U. Diversity of mite (Acari) fauna associated with vegetables and ornamental plants in Midhill conditions of Himachal Pradesh, India. Journal of Biological Control. 2014;28:75-80.
7. Srilaxmi K, Paul R. Diversity of insect pest of pigeon pea (*Cajanus cajan* L. Mill Sp.) and their succession in relation to crop phenology in Gulbarga, Karnataka. The Ecoscan. 2010;4(4):273-276.
8. Sarkar S, Margules C. Operationalizing biodiversity for conservation planning. Journal of biosciences. 2002 Jul;27:299-308.
9. Añon VV, Aymard A, Gobin YP, Casasco A, Rüffenacht D, Khayata MH, Abizanda E, Redondo A, Merland JJ. Balloon occlusion of the internal carotid artery in 40 cases of giant intracavernous aneurysm: technical aspects, cerebral monitoring, and results. Neuroradiology. 1992 May;34:245-51.
10. Bier-Laning C, Cramer JD, Roy S, Palmieri PA, Amin A, Anon JM, Bonilla-Asalde CA, Bradley PJ, Chaturvedi P, Cognetti DM, Dias F. Tracheostomy during the COVID-19 pandemic: comparison of international perioperative care protocols and practices in 26 countries. Otolaryngology–Head and Neck Surgery. 2021 Jun;164(6):1136-47.
11. Khosa JS, Dhatt AS. Genetic diversity for morphological and biochemical traits in bulb onion. Indian Journal of Horticulture. 2015;72(1):143-6.
12. Kim KC. Biodiversity, conservation and inventory: why insects matter. Biodiversity & Conservation. 1993 Jun;2:191-214.
13. Pielou E. Association tests versus homogeneity tests: their use in subdividing quadrats into groups. Vegetatio. 1969 Jan;18:4-18.
14. Margalef R. Trophic typology versus biotic typology, as exemplified in the regional limnology of northern Spain; c1958.