



**Lepidopteran floral visitors as documented at an agro-ecosystem near Bikaner,
Rajasthan, India**

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Abstract

Insects visit flowers for nectar and pollen and in turn act as pollinators. Amongst pollinators, key role is played by lepidopteran insects. Ideally, pollination investigations are necessary in each general locality where crop is grown and the present study was therefore planned to study the diversity and rhythmicity of lepidopteran insects visiting different crops in an agro-ecosystem at Bikaner. The crops cultivated in the field during the study period comprised of ornamental plant marigold (Compositae or Asteraceae), cucumber, bottle gourd, ridged gourd, pumpkin (Cucurbitaceae), coriander (Umbelliferae or Apiaceae), mustard (Brassicaceae) and brinjal (Solanaceae). In all 14 lepidopteran representatives of 10 families were documented to visit different flowers during the course of study.

Introduction

Insects visit flowers for nectar and pollen and in turn act as pollinators. Amongst pollinators, key role is played by lepidopteran insects. Pollination, a fortunate by-product of insects that are nectar feeding and pollen collecting, is essential to the continued existence of many plants. When insects reach for the sweet juice of flowers that they need for food, they walk all over the flower parts, actively and passively collecting pollen and transporting it to other plants. Estimates suggest that approximately 73 per cent of the world's cultivated crops are pollinated by some varieties of bees, 19 per cent by flies, 6.5 per cent by bats, 5 per cent by wasps, 5 per cent by beetles, 4 per cent by birds and 4 per cent by butterflies, indicating that most of the plant species rely on insects for pollination (Real, 1983). In the tropics 90% of plants are dependent on animals or insects for pollination (Ingram et al., 1996).



According to the U.S. Department of Agriculture (U.S.D.A.), the world is facing an “impending pollination crisis”, in which both wild and managed pollinators are disappearing at alarming rates owing to habitat loss, pesticides poisoning, diseases and pests. Pimental et al. (1992) suggested that income from harvests could increase by an estimated \$ 400 million per year if pollinators were available in sufficient numbers. Richards (1993) estimated the value of pollination services for global agriculture at \$ 200 billion in the United States each year. The average yield of crops in India is much below optimum, one of the major reason for this is inadequate pollination, as per the studies by Partap&Partap (1997).

Kevan (1999) suggested pollinators are bio-indicators as individuals and population in that they can be used to monitor environmental stress brought about by introduced competitors, diseases, parasites, predators as well as by chemical and physical factors, particularly pesticides and habitat modification. Habitat loss and fragmentation and the toxic effects of pesticides and herbicides have led to the endangered status of pollinators. Different pollinators prefer different types of flowers. Studying the relationships between flowers and their pollinators is thus very useful to help maintain endangered species. The loss of a pollinator could cause the collapse of an ecosystem. Over the last few decades the perception has been growing among pollination biologists that pollinators have declined in numbers resulting in decreased seed and fruit set in the plants that they service. Threats to pollinators include habitat reduction, use of pesticides and other agrochemicals, invasive species, fungal, protozoan and bacterial diseases, modern agricultural practices etc. Looking into the importance of insect pollinators, agricultural practices must be designed to incorporate the protection and sustainable management of pollinators. A decline in pollinators can cause a decline in crop yields of various plants. It is, therefore essential to survey and collect insect species on various crop plants during their flowering periods, identify and conserve them, and explore their potentiality as crop pollinators.

Ideally, pollination investigations are necessary in each general locality where crop is grown and the present study was therefore planned to study the diversity and rhythmicity of lepidopteran insects visiting different crops in the crop field.



Material and method

The area under study falls in the Indian desert near Bikaner situated in western Rajasthan (23°3' to 20°13' N latitude and 69°30' to 78°17' C longitudes) along the international border. The agro-ecosystem Vallabh Garden Agriculture Farm, lies 10 km away from Bikaner, at Gharsisar village. It is a cropfield where seasonal crops are grown. The crops cultivated in the field during the study period comprised of ornamental plant marigold (Compositae or Asteraceae), cucumber, bottle gourd, ridged gourd, pumpkin (Cucurbitaceae), coriander (Umbelliferae or Apiaceae), mustard (Brassicaceae) and brinjal (Solanaceae). The flowering period of marigold was from October to April, of cucumber from April to August, of bottle gourd and ridged gourd from May to October, of coriander only for two months March and April, of mustard was during January to February, while, pumpkin and brinjal was during November and December.

The insect visitors to different flowering crops were surveyed and collected every week for an annual cycle (December to November). For the study, the field area was divided into five stations from where the insect visitors on flowers were collected. Sweep net was used for insect collection. The insects collected by the above method were transferred to killing bottles, killed and preserved. Large winged insects were put to dry preservation by pinning them in insect boxes, while smaller insects were preserved in 70% alcohol.

The insects were collected and visits were monitored during forenoon (7 a.m. to 12 noon) and afternoon (12 noon to 5 p.m.). When records of insects visiting crops like ridged gourd and bottle gourd were to be made the collection was done up to 7 p.m., as these flowers are in their full bloom during evening hours.

Visit of a particular insect species to a specific flower was documented and expressed as number of visits/man/h. The fauna was sorted out group wise and identifications were made following pertinent literature. Besides, the reference collection in the Department of Zoology, Govt. Dungar College, Bikaner, Rajasthan was also consulted.



Observation and result

This order includes moths, skippers and butterflies. These 'scale winged insects' possess a proboscis for feeding nectar from flowers along with which they also carry pollen and serve as important pollinators of several agricultural crops. Different crops were grown in the crop field throughout the year. As the study concentrated on insect pollinators, therefore, the flowering period in different crops was also recorded. The flower status whether solitary or in the form of inflorescence was noted. The colour and size of flowers were also documented. It was also noted that whether the flowers released scent or not (Table 1.). In all 14 lepidopteran representatives of 10 families were documented to visit different flowers during the course of study as follows:

Danaidae

Only one member *Danauschrysippus*, commonly known as the 'plain tiger' belonging to this family was reckoned from the agro-ecosystem during the present study. It was noted throughout the study period. Occurrence of *D. chrysippus* on flowers of different crops present in the Vallabh Garden Agriculture Farm is presented in Table2. Except for pumpkin the butterfly was observed to visit flowers of all the seven crops grown in the field.

The butterfly was found to visit marigold flowers most number of times (438 visit/m/h) in the month of November suggesting its high population during this period. A minimum of 5 visits /man/h were observed in the month of January. The butterfly frequently also visited flowers of other crops like coriander in the month of March and April, cucumber in the month of April to August, cucurbits (except pumpkin) during May to October and brinjal in the month of November. On all these crops the number of visits ranged between 6 to 35 visits /man/h (Fig.1.). It was found to visit the flowers more during forenoon as compared to afternoon (Table 3).

Lycaenidae

Lampidesboeticus was the only representative belonging to this family which was observed during the present study. Occurrence of *Lampidesboeticus* on the flowers of different crops



present in the Vallabh Garden Agriculture Farm has been presented in Table. 2. Except for February, March and September, it was observed during rest of the nine months.

Of the eight crops, it preferred to visit flowers of only three crops viz. marigold, cucumber and ridged gourd and was not at all observed on rest of the five crops (bottle gourd, pumpkin, brinjal, coriander, mustard) in the field during the study period. It was a frequent visitor.

It was found to visit marigold flowers most number of times at the rate of 88 visits /man/h in the month of October, followed by flowers of cucumber at the rate of 48 visits /man/h in the month of May. The flowers of ridged gourd belonging to Cucubitaceae were rarely visited (3-4 visits/man/h).

It highest number of visits to a flower was recorded in the month of October (88 visits/man/h) and lowest (2 visit/man/h) in the month of January, both on marigold. It showed complete absence from the field during February, March and September (Fig.2.). It preferred to visit the flowers more in the afternoon (Table3.).

Nymphalidae

V. annabela and *Vanessa cardui* were the members belonging to this family and reckoned from the agro ecosystem during the present study. Occurrence of *V. annabela* on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented in Table 2. As *V. annabela* was observed throughout the year it was found to visit all the crops, while, *V. cardui* was observed intermittently for six months and was noted to visit marigold and cucumber flowers only. Among crops, *V. annabela* preferred marigold flowers to which it was a frequent visitor. Its maximum visits of 19 visits /man/h were observed in the month of November and it was the month when it was noticed in maximum numbers while on rest of the flowers the visits ranged between 1 to 5 visits /man/h (Fig.3). It usually preferred to visit the flowers in the forenoon (Table 3.).

The other nymphalid, *V. cardui* was found to visit only two flowers viz. marigold and cucumber as presented in Table 2. It was a rare visitor. This butterfly also preferred marigold as compared to cucumber which was obvious by the number of visits



(10visits/man/h) during April and 8 visits /man/h in November, while on cucumber it was recorded to be only 1 visit/man/h (Fig.4). This butterfly also preferred to move about and visit flowers in the forenoon as did *V. annabela*(Table 3.).

Papilionidae

Only one papilionid butterfly *Papiliopolyxenes*was recorded during the present study, that too only during two months March and December. Occurrence of *P. polyxenes*on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented inTable 2. It was a rare butterfly which visited marigold and brinjal flowersat the rate of 1 visit/man/h (Fig. 5.) and observed only during forenoon (Table 3.). No visits were observed on coriander flowers which were also in their bloom during the same period.

Pieridae

This family comprising of yellow butterflies was represented by three species viz. *P. brassicae*, *P. edusa* and *Catopsiliapomona*. *C. pomona* was noted throughout the study period, although in small numbers. Further, it was found to visit flowers of all the crops during the study period. It also showed a slight preference towards flowers of *Tagetes*on which its maximum visits of 9 visits /man/h were recorded in the month of November. Occurrence of *C. pomona*on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented inTable 2. Its population too was found to be high during winter months of October and November (Fig. 6.). This butterfly preferred to visit the flowers more during forenoon (Table 3.). *P. edusa* showed a different trend and was documented from April to January, with maximum number of 28 visits /man/h in the month of November. It was found to visit all the flower during the study period, showing preference towards flowers of marigold. It was not seen on flowers of mustard (Fig. 7.). Occurrence of *P. edusa*on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented in Table 2. *Pierisbrassicae*,another pieridwas rarely documented and noted from October to March. Occurrence of *P. brassicae*on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented in Table 2. Maximum number of 9 visits /man/h was noted in the month of October. It was



observed mostly on flowers of *Tagetes* and *Brassica* very rarely found on flowers of coriander and brinjal. It was never found to visit the flowers of *Cucumis*, *Lagenaria*, *Luffa*, *Brassica* and *Cucurbita*(Fig. 8.).Both these butterflies were also found to be active during forenoon (Table 3.).

Hesperiidae

Only one skipper, *Hesperillaornata* was noted from the study area. Occurrence of *H. ornata* on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented in Table 2. This butterfly was not observed during January to April when the field comprised mostly of marigold, coriander, mustard, pumpkin and brinjal crops. Most number of visits was noted on flowers of *C. melo*, *L. cylindrical*, followed by *L. siceraria* and *T. erecta* as presented in Fig. 9. It made its appearance from May onwards up to December and was found to visit flowers of bottle gourd and ridged gourd showing preference towards the latter.

During July and August when the flowers of cucumber were in their full bloom the skipper showed greatest preference towards them visiting these flowers at the rate of 26 and 39 visits/man/h respectively during the two months. In August it was noticed in maximum number. In November when the agro-ecosystem did not comprise of either the crops of bottle gourd, ridged gourd and cucumber the skipper was seen to visit marigold flowers. Although during this period, pumpkin and brinjal were also present in the field but no visits of the skipper were recorded on them. *Hesperillaornata* was found to visit the flowers more during forenoon (Table 3.).

Pyralidae

This family of moths was represented by two members, viz. *Margaroniaindica* and *Hymenia fascialis* during the present study. *Hymenia fascialis* was reckoned throughout the study period except in the month of February when it was not documented. Occurrence of *H. fascialis* on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented in Table 2. It was a frequent visitor, while, *Margaronia* was a rare visitor. Most number of visits was noted on *L. siceraria*, *L. cylindrica*, followed by *C.*



melo, *T. erecta*, *C. maxima*, *S. melongana* and *C. sativum* and have been presented in Fig. 11. Its number of visits ranged from 5 to 207 visits /man/h on different flowers present in the agro-ecosystem. It was mostly found on flowers of bottle gourd, ridged gourd, cucumber and marigold. It was frequently also noted on flowers of coriander, pumpkin and brinjal. It was found to visit flowers more during forenoon (Table 3.). The moth was noticed in large numbers in the month of October.

M. indica, in general was hardly observed from November to April and showed its appearance from May and continued to appear till October. Occurrence of *M. indica* on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented in Fig. 10. Most number of visits was noted on flowers of *C.melo*, *L.siceraria*, *L.cylindrica* and *T.erecta* which have been presented in Table 2. Its maximum number of visits was noted during August (20 visits /man/h). Its order of preference towards the flowers was cucumber followed by ridged gourd, marigold and bottle gourd. *M. indicawas* found to visit the flowers during afternoon (Table 3.).

Arctiidae

Only one species, *Utethesiapulchella* belonging to this family was collected from the agro-ecosystem during the present study. Occurrence of *U. pulchella* on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented in Table 2. It was documented throughout the study period except during November. Its number of visits ranged from one in February to 101 visits /man/h in April. The flowers of *Coriandrumsativum* were greatly preferred by this insect, although it was also observed to visit flowers of bottle gourd, cucumber and marigold as presented in Fig. 12. *Utethesiapulchella* preferred to visit the flowers in forenoon (Table 3.). It was a frequent visitor.

Noctuidae

Agrotisipsilon belonging to family Noctuidae was yet another moth observed on flowers of different crops located in the agro- ecosystem during the present study. It was a rare visitor. Most number of visits were noted on *C. melo*, *L. siceraria*, *C. maxima*, *S. melongana* *C. sativum* and *T. erecta*. Occurrence of *A. ipsilon* on the flowers of different



crops present in the Vallabh Garden Agriculture Farm has been presented in Table 2. This moth although showed its appearance from March to November was found in very few numbers. The number of visits ranged from 1 to 4 visits /man/h concentrating mostly on flowers of bottle gourd (Fig. 13). It was also found to visit flowers in forenoon (Table 3.).

Gelechiidae

This family was represented by *Pectinophoragossypiella* which was reckoned throughout the study period except for winter months of January and February. Occurrence of *P. gossypiella* on the flowers of different crops present in the Vallabh Garden Agriculture Farm has been presented in Table 2. Its maximum visits of 73 visits /man/h were recorded during September on flowers of bottle gourd. It was a frequent visitor throughout the year. Besides this crop, it was observed on flowers of ridged gourd, cucumber, marigold and coriander as resented in Fig. 14. *P. gossypiella* was found to visit the flowers more during forenoon as compared to afternoon (Table 3.).

Discussion

Among lepidopterans, *Danauschrysisippus* (Danaiidae), *Lampidesboeticus* (Lycaenidae), *Vanessa annabela* and *V. cardui* (Nymphalidae), *Papiliopolyxenes* (Papilionidae), *Catopsiliapomona*, *Pierisedusa* and *P. brassicae* (Pieridae) were the butterfly species, skipper *Hesperillaornata* (Hesperiidae) and moths *Utehesiapulchella* (Arctiidae), *Pectinophoragossypiella* (Gelechiidae), *Agrotisipsilon* (Noctuidae), *Hymenia fascialis* and *Margaroniaindica* (Pylalidae) were observed visiting flowers of various crops during the present study.

Butterfly *D. chrysisippus* was one of the major floral visitors which was observed throughout the study period in good numbers. It was found to visit flowers of all the crops cultivated in the agricultural farm and it showed preference towards heads of *Tagetes erecta* on which its visits ranged from 5 to 438 / man / h. Among cucurbits flowers of *Luffa* were the most preferred, while, flowers of *C. maxima* were not visited at all by the butterfly. It visited *S. melongena* flowers at the rate of 35 visits / man / h during November and *B. campestris* flowers at the rate of 5 visits / man / h in February. Its peak population



was observed in the month of November and lowest in the month of January. During March, April and October also it was noted in large numbers. The present findings are in accordance with the earlier reports of Macior (1975) who also reported butterfly as important pollinator of *Delphinium*. *Danaus* pollinator of *Satyrium* was observed by Johnson (1997), as pollinator of Asteraceae and representing nearly 75% of all visitors by Mani & Sarvanan (1999), of milkweed by Ivey et al. (2003), of *Wedeliacalendulaceae* by Mitra et al. (2004), of *Justicia* by Seikh (2005), of *Woodfordia floribunda* by Soloman & Rao (2005), of Teak flowers by Tangmitcharoen et al. (2006). *D. plexippus* as a floral visitor of brinjal has also been reported by Thapa (2006). *Danaus* pollinator of *Strobilanthes consanguinea* was suggested by Anitha & Prasad (2007). *D. chrysippus* was recorded to transport some pollen of *Acacia*, by Martin (1993). Earlier Bhuyan et al. (2005) observed highest frequency of visits by *Danaus genutia* on flower of *Crotalaria juncea*, *Nerium oleander*, *Barleria cristata*, *Bauhinia porporea* to be 31.9, 13.2, 11.6 and 9.2 during 10 to 12 a.m. and 33.8, 13.6, 13.0 and 11.6 during 11 to 12 a.m. respectively.

Lampides boeticus was observed throughout the study period except February, March and September during the present study. It was found to prefer flowers of marigold, followed by cucumber and ridged gourd. It was not documented on bottle gourd, pumpkin, coriander, mustard and brinjal, but earlier Thapa (2006) reported this species to visit flowers of *L. siceraria*, *B. campestris* and *S. melongena*. Visitation rate of *Lampides* was noted from 2 to 88 / man / h. Highest 88 visits / man / h was noticed on *Tagetes*, followed by 48 visits / man / h on *Cucumis* and from 2–4 visits / man / h on *Luffa*.

Of the two nymphalids, *V. annabel* was documented throughout the study period while, *V. cardui* was intermittently documented. While *V. annabela* was noticed visiting flowers of all the crops cultivated in the agro-ecosystem, *V. cardui* preferred visiting only marigold heads. Its highest population was documented in the month of November and minimum in January and June. The present findings get support from the earlier works of Valdivia & Niemyer (2006) who documented six lepidopteran species including a nymphalid *V. carye* to visit flowers of cucurbit *E. myrtoidea*. *Vanessa cardui* was also collected by Hawkeswood (1985) from the flowers of *Acacia bidwillii*. *V. atlanta* and *V. cardui* as



pollinators of *Delphinium* was reported by Macior (1975). Nymphalids as pollinators of *Acacia* were noted by Stone et al. (2003). Tangmitcharoenet al. (2006) documented nymphalids as floral visitors of teak flowers. Visitation rate of *V. annabela* were noticed from 1 to 19 / man / h on the flowers of different crops. Both these butterflies showed their preference towards *Tagetes* which was obvious by the most number of visits on them. One of the very rare species noticed during the present study was *Papiliopolyxenes*, a lone member of Papilionidae which was documented in the month of March on *Tagetes capitulum* (1 visit / man /h) and once on the flowers of *S. melongena* (1 visit / man / h) in the month of December. This is in conformation with the earlier reports of Thapa (2006) who also suggested *Papilio sp.* as floral visitor of cucumber, ridged gourd and brinjal. *Papiliopolytes* as pollinator of *Wedeliacalendulacea* has also been reported by Mitra et al. (2004), *Papilioglaucas*, *P. philenor* and *P. troylusas* as pollinators of *Delphinium* by Macior (1975), *P. glaucas* and *P. polyxenes* as pollinators of milkweed by Robert et al. (1994) and Ivey et al. (2003), *Papilio sp.* as pollinator of *Dipterocarpus obtusifolius* by Ghazoul (1997), of *Acacia* by Stone et al. (2003), *P. demoleus* as floral visitors of *Justicia* by Sheikh (2005) and papilionid as potential pollinators of teak flowers by Tangmitcharoenet al. (2006).

Catopsilia pomona, *P. edusa* and *P. brassicae* were the three pierids collected from the study area, while *C. pomona* was documented throughout the study period, *P. edusa* was found intermittently and *P. brassicae* only for a short period from October to April. All the three were found to prefer the flowers of *Tagetes* and their maximum numbers was also noted on them ranging from 9–22 visits/man/h. *C. pomona* and *P. edusa* were found to be more in the month of November. While, *C. pomona* visited flowers of all the crops cultivated in the field, *P. edusa* did not visit *B. campestris* and *P. brassicae* was not observed on flowers of cucurbit crops. Earlier, *P. rapae* as nectar consumer of *Lantana* flowers has been reported by Almet et al. (1989), of *Acacia* by Tybirk (1993), of *Dipterocarpus obtusifolius* by Ghazoul (1997), of buck wheat by Goodman et al. (2001), of milkweed by Ivey et al. (2003). Pierids as floral visitors of *Acacia* were observed by Stone et al. (2003). Sheikh (2005) observed *P. brassicae* to visit inflorescence of *Justicia*. Pierid



as floral visitors of teak flowers have also been reported by Tangmitcharoenet al. (2006). Thapa (2006) reported *Pierisbrassicae* visiting flowers of cucumber and brinjal and Bruysnaet al. (2008) observed them on flowers of *Brassica nigra* and support the present findings. Lee & Snow (1998) observed that *P. rapae* preferred to visit *Raphanus* population which had yellow flowers as compared to its hybrids which had white or pale pink flowers. Mani & Sarvanan (1999), Evans et al. (2003) reported butterflies as important pollinators of Asteraceae flowers. Reddi & Reddi (1983) observed insect foragers including *Catopsiliacrocaleas* pollinators of *Jatropha gossypifolia* (Euphorbiaceae). *C. pomona* was noticed to make 1–9 visits / man /h on flowers of different crops. Its visitation was seen intermittently on the flowers of cultivated crops and peak visitation (9/man/h) was observed in November on the flowers of *Tagetes*. *P. edusa* was found to visit the flowers at the rate of 1–22 visits / man / h and peak visitation of this insect was also noticed in the month of November on the flowers of *Tagetes*. Peak visitation of *Pierisbrassicae* was also noticed on the flowers of *Tagetes* but it was documented in the month of October.

Hesperilla ornata, belonging to family Hesperidae, the members of which are commonly known as skippers, was documented from May to December during the present study. Its peak population was noted in the month of August. The skipper was found to prefer the flowers of cucumber followed by ridged gourd, marigold and bottle gourd. It was not documented on flowers of pumpkin, coriander, mustard and brinjal. Earlier, Tangmitcharoenet al. (2006) also suggested skippers as potential pollinators of teak flowers. The present findings also get support from the observations made by Martin (1993), who reported skippers as active feeders visiting flowers and carrying pollen. Another skipper as pollinator of cucumber was reported by Thapa (2006). Morimoto et al. (2003) reported skipper butterfly as major visitor of *Lagenariasiceraria*. Visitation rate of skipper *H. ornata* was noted from lowest 1 visit /man/h on *Tagetes* to highest 39 visits /man/h on the flowers of *Cucumis*. On flowers of *Lagenaria* and *Luffa* it was noted intermittently.

Another lepidopteran belonging to family Arctiidae was *Utethesiapulchella* which was reckoned throughout the study period except in the month of November. It was noted in



large numbers during April. This is in conformation with the studies done by Dhas (2007) who also found the insect to be active throughout the year being maximum during April. Similar findings have also been furnished by the Agricultural department in their Progress Report (ARSSW, 1998, 2001). The moth was found to prefer coriander flowers the most, followed by marigold, bottle gourd and cucumber. It was not documented on ridged gourd, pumpkin, mustard and brinjal. Martin (1993) observed *Utethesia* to also occasionally visit flowers. Its visitation rate was noted from 1 to 65 visits /man/h during the present study. Its maximum visits of 65 / man /h were noticed on coriander flowers followed by *Tagetes* flowers.

Lepidopteran family Gelechiidae was represented ed by *P. gossypiella* which was also documented throughout the study period except in the month of January and February. Its population was found to be maximum in the month of September. Katiyar (1982) suggested the population of this insect was profoundly influenced by different agro-climatic conditions. He further suggested that warm but not excessively hot weather, cloudiness and frequent light rains were conducive for rapid multiplication of this insect, which was true during the present study also. *P. gossypiella* was found to prefer *L. siceraria* flowers, followed by *L. cylindrica* and *Tagetes*. The flowers of *C. melo* and *C. sativum* were also visited occasionally, while those of *C. maxima*, *B. campestris* and *S. melongena* were not. Johnson (1997) also suggested *Pectinophora* as pollinator of South African species of *Satyrium* and Radford et al. (1979) found *P. gossypiella* to visit flowering head of sunflower. Maximum visitation of *P. gossypiella* was 63 visits /man/h on the flowers of *L. siceraria* in the month of September, followed by 44 visits /man/h on the flowers of *Tagetes* in the month of November.

Agrotisipsilon belonging to family Noctuidae, was a rare moth documented mostly on the flowers of *L. siceraria* and it occurred during March to November in the agricultural field. *Agrotis* was noted as the pollinator of *Dipterocarpusobtusifolius* by Ghazoul (1997). This noctuid moth is the primary pollination vector at night and accounted for 60% of pollen transfer. Highest visits of *Agrotis* were 4/man/h in the month of March on the flowers of *Tagetes*.



Pyralids *Hymenia fascialis* and *Margaroniaindica* were observed to visit the flowers of various crops during the present study. *Hymenia fascialis* was one of the major forms documented during the present study. It was observed throughout the study period except in the month of February. Its population was found to increase May onwards and remained quite high up to December. A similar trend was also noted by Dhas (2007) in the same region. *Margaroniaindica* was documented from May to October in more or less the same numbers. It was observed on flowers of *Tagetes*, *C. melo*, *L. siceraria* and *L. cylindrica* among which, *L. cylindrica* seemed to be the most preferred one. Highest visitation of 110 visits /man/h of *Hymenia* was noticed on *L. siceraria* in the month of October. It was observed intermittently on flowers of different crops. Peak visitation of *Margaronia* was noticed as 20 visits /man/h on the flowers of cucumber and lowest of 1 visit /man/h on the flowers of *Tagetes* in the month of December. Lepidopterans were noted as pollinators of an umbelliferous plant carrot by Ahmed & Aslam (2002) and on the heads of *Mikania* by Cerana (2004).

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Table 1. Floral characteristics of different crops cultivated in Vallabh Garden Agriculture Farm, Bikaner during the study period

Crop	Botanical Name	Family	Inflorescence	Scent	Colour	Self or Cross pollination
Marigold	<i>Tagetes erecta</i>	Compositae/Asteraceae	Head or Capitulum	Scented	Yellowish orange	Self/Cross
Cucumber	<i>Cucumis melo</i>	Cucurbitaceae	Solitary	Scentless	Yellow	Cross
Bottle gourd	<i>Lagenaria siceraria</i>	Cucurbitaceae	Solitary	Scentless	White or Creamish	Cross
Ridged gourd	<i>Luffa cylindrica</i>	Cucurbitaceae	Solitary	Scentless	Yellow	Cross
Pumpkin	<i>Cucurbita maxima</i>	Cucurbitaceae	Solitary	Scentless	Yellow	Cross
Coriander	<i>Coriandrum sativum</i>	Umbelliferae/Apiaceae	Compound umbel	Aromatic	Pinkish White	Self/Cross
Mustard	<i>Brassica campestris</i>	Brassicaceae	Corymbose raceme	Aromatic	Yellow	Self/Cross
Brinjal	<i>Solanum melongena</i>	Solanaceae	Solitary	Scentless	Purple	Cross



Table 3. Insect visitation during different time of the day

Sr. No.	Insect	Forenoon	Afternoon
1.	<i>Danauschrysippus</i>	++	+
2.	<i>Lampidesboeticus</i>	+	++
3.	<i>Vanessa annabela</i>	++	+
4.	<i>Vanessa cardui</i>	++	+
5.	<i>Papiliopolyxenes</i>	++	+
6.	<i>Catopsiliapomona</i>	++	+
7.	<i>Pierisedusa</i>	++	+
8.	<i>Pierisbrassicae</i>	++	++
9.	<i>Hesperillaornata</i>	++	+
10.	<i>Utethesiapulchella</i>	++	+
11.	<i>Pectinophoragossypiella</i>	++	+
12.	<i>Agrotisipsilon</i>	++	+
13.	<i>Hymenia fascialis</i>	++	+
14.	<i>Margaroniaindica</i>	+	++

+ = 1 to 10 visits/m/h

++ = 11 to 50 visits/m/h

+++ = 50 and above visits/m/h

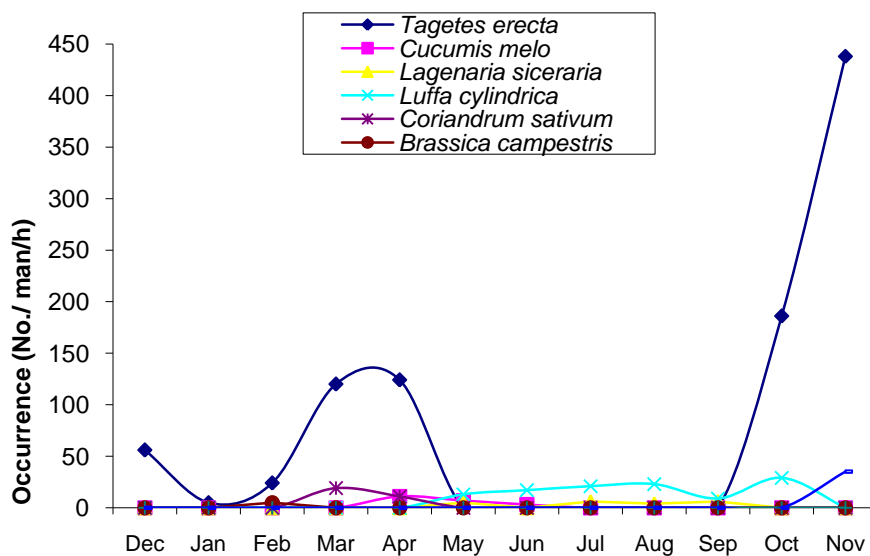


Fig.1 Occurrence (No./man/h) of *Danauschrysippus*

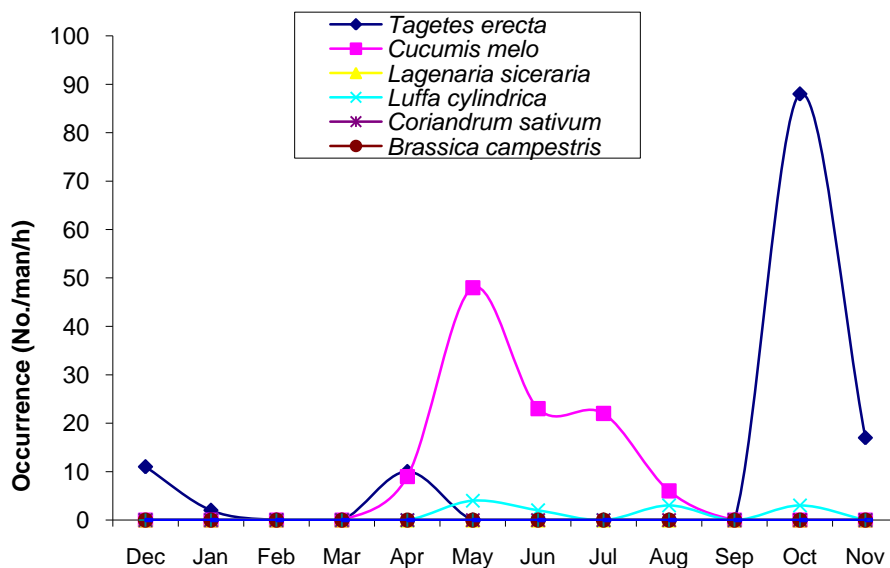


Fig. 2 Occurrence (No./man/h) of *Lampidesboeticus*

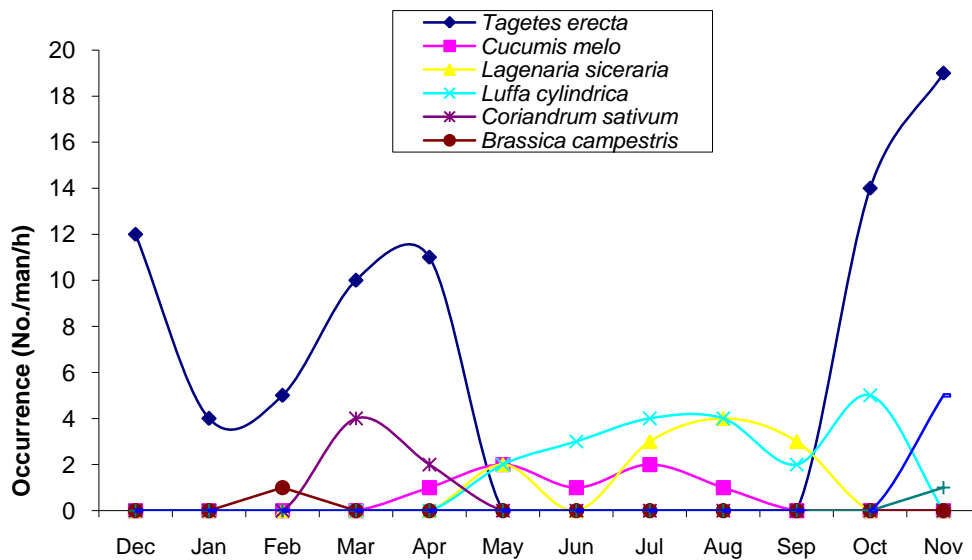


Fig. 3. Occurrence (No./man/h) of *Vanessa annabella*

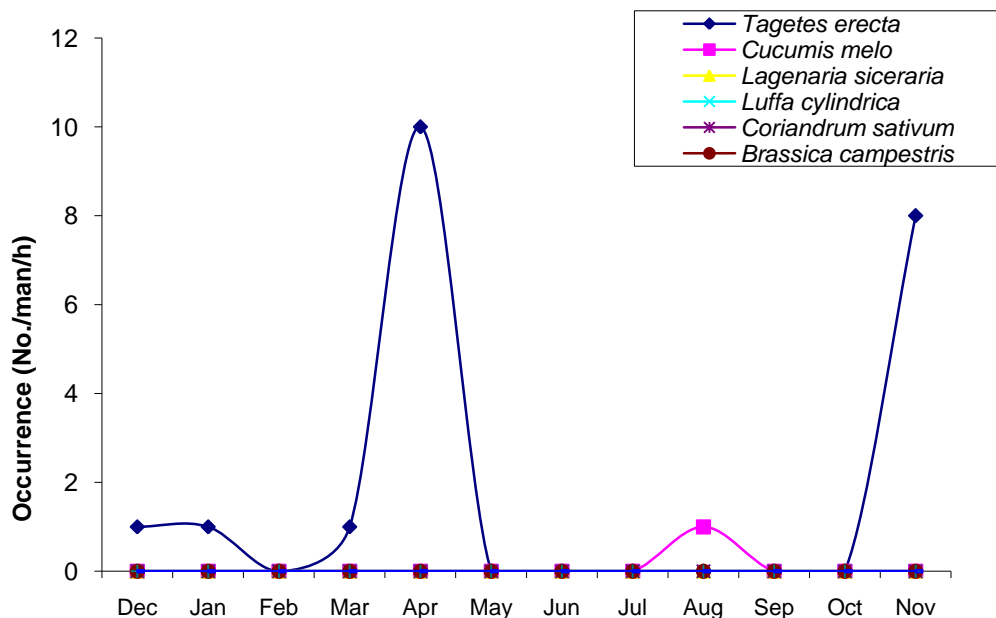


Fig. 4. Occurrence (No./man/h) of *Vanessa cardui*

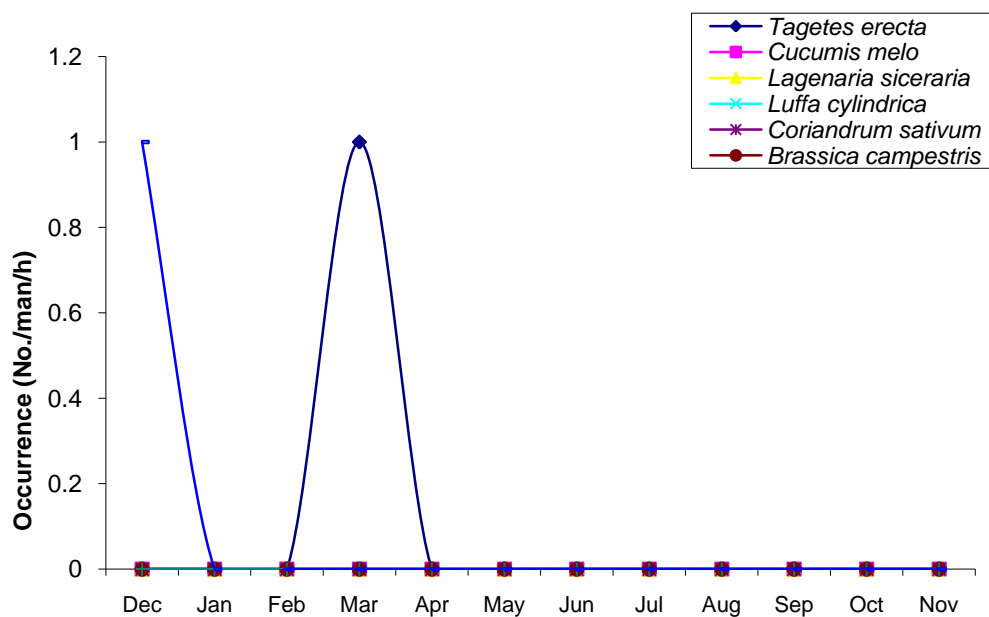


Fig. 5. Occurrence (No./man/h) of *Papiliopolyxenes*

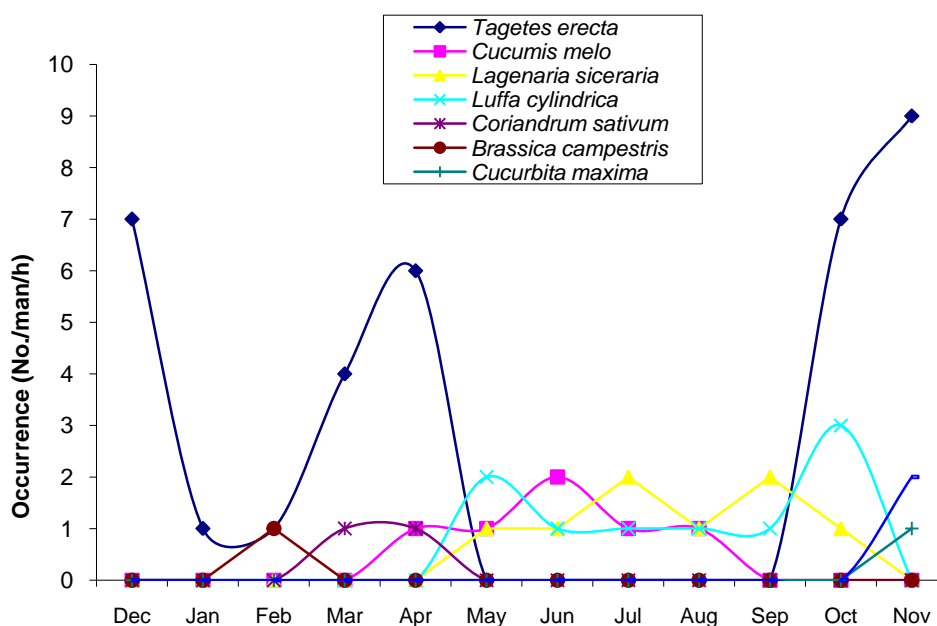


Fig. 6. Occurrence (No./man/h) of *Catopsiliapomona*



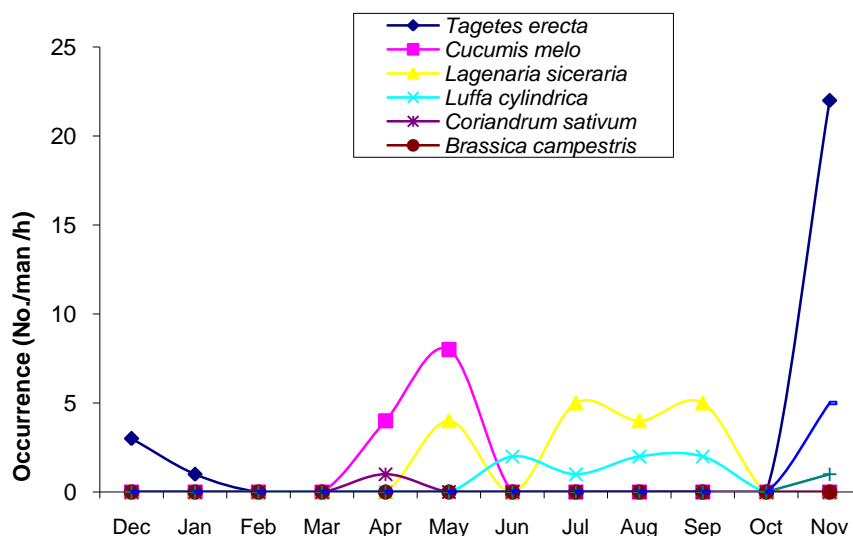


Fig. 7. Occurrence (No./man/h) of *Pierisedusa*

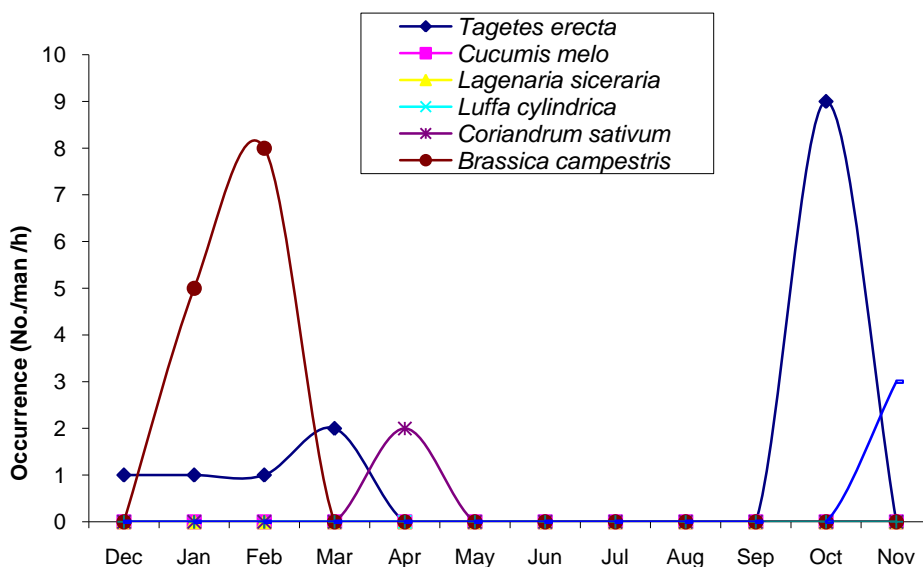


Fig. 8. Occurrence (No./man/h) of *Pierisbrassicae*

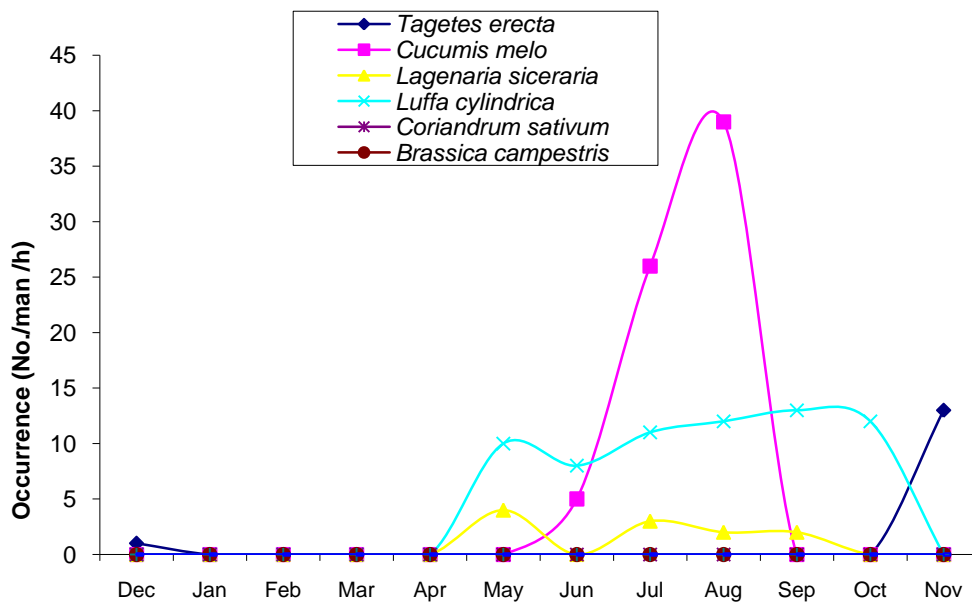


Fig. 9. Occurrence (No./man/h) of *Hesperillaornata*

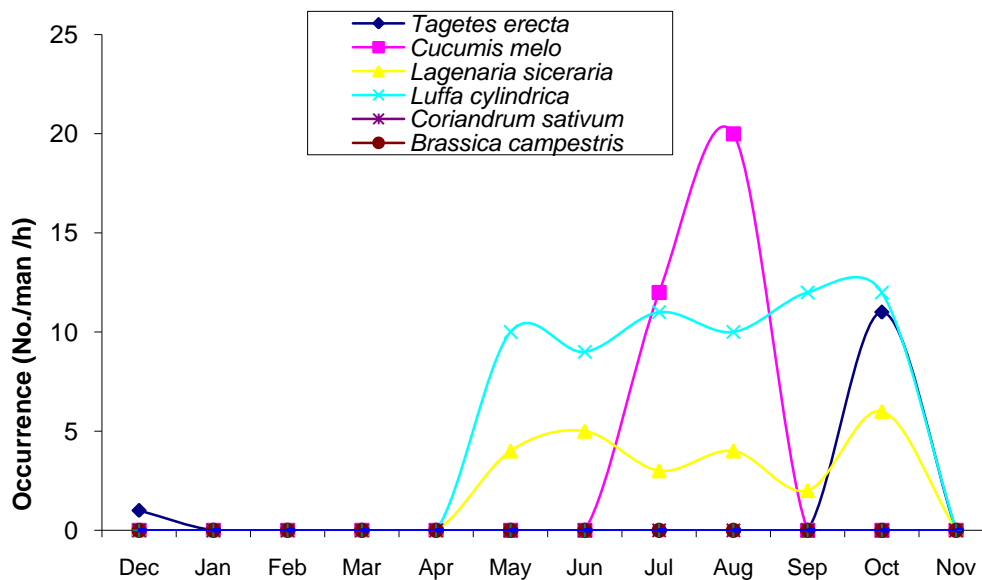


Fig. 10. Occurrence (No./man/h) of *Margaroniaindica*

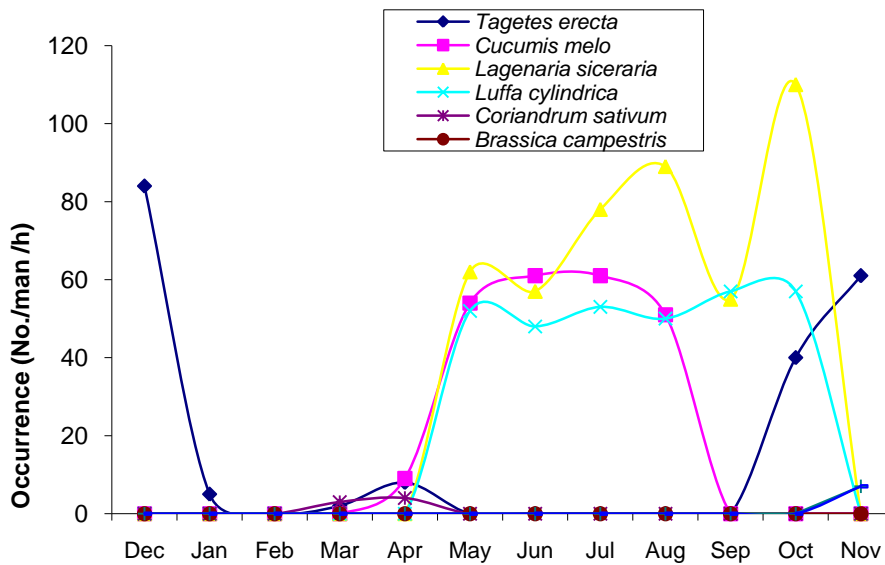


Fig. 11. Occurrence (No./man/h) of *Hymenia fascialis*

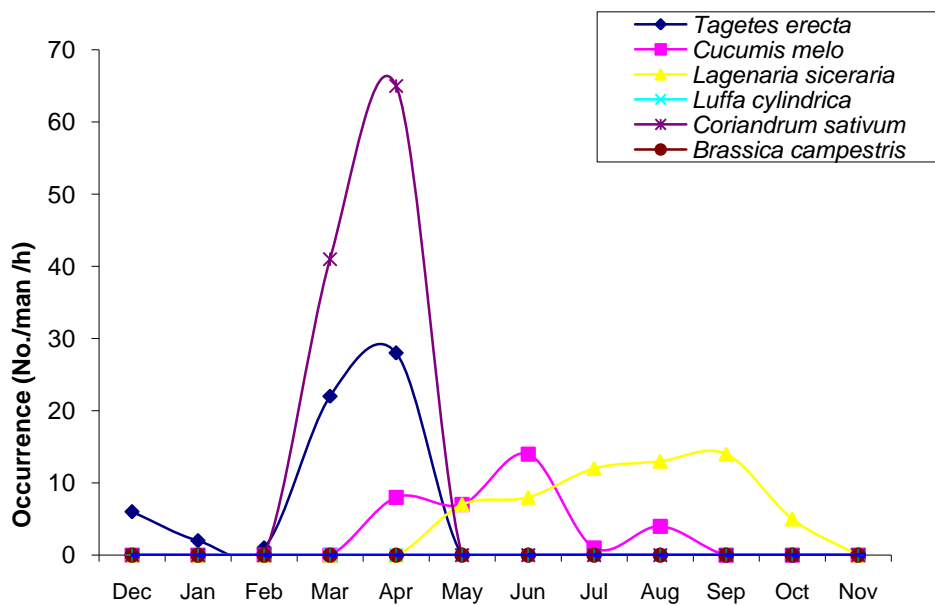


Fig. 12. Occurrence (No./man/h) of *Utethesiapulchella*

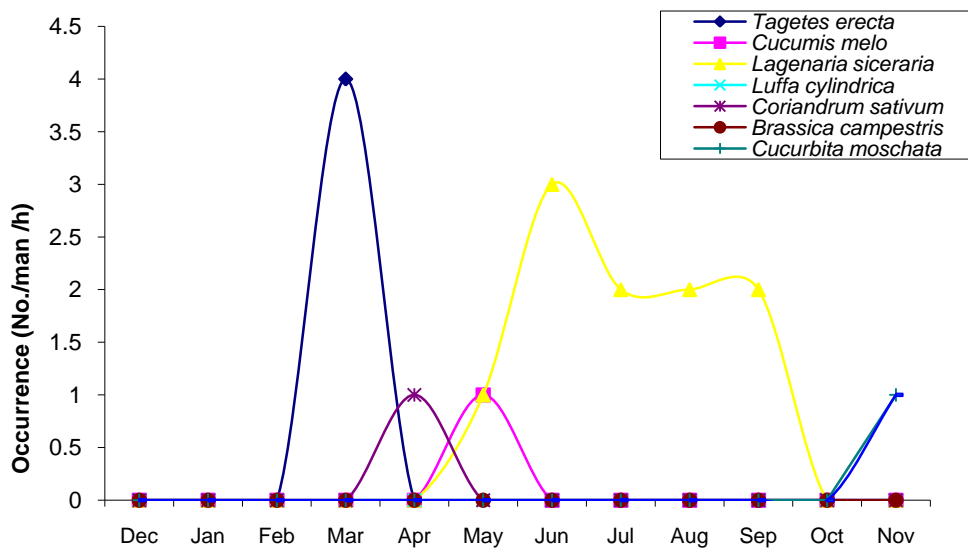


Fig. 13. Occurrence (No./man/h) of *Agrotisipsilon*

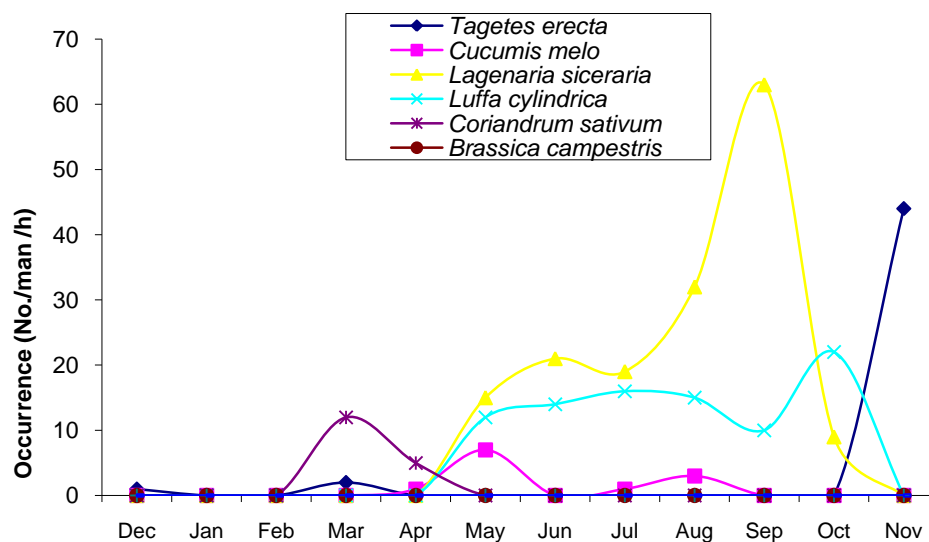


Fig. 14. Occurrence (No./man/h) of *Pectinophoragossypiella*



Table 2. Insect visitors on flowers of different crops in Vallabh Garden Agriculture Farm, Bikaner

Insect visitors	<i>Tagetes erecta</i> (marigold)	<i>Cucumis melo</i> (cucumber)	<i>Lagenaria siceraria</i> (bottle gourd)	<i>Luffa cylindrica</i> (ridged gourd)	<i>Cucurbita maxima</i> (pumpkin)	<i>Coriandrum sativum</i> (coriander)	<i>Brassica campestris</i> (mustard)	<i>Solanum melongena</i> (brinjal)
LEPIDOPTERA								
Family : Danaidae								
<i>Danaus chrysippus</i> Linnaeus	++++	+	+	++	+	++	+	++
Family : Lycaenidae								
<i>Lampides boeticus</i> Linnaeus	++	++	-	+	-	-	-	-
Family : Nymphalidae								
<i>Vanessa annabella</i> Field	+	+	+	+	+	+	+	+
<i>Vanessa cardui</i> Linnaeus	+	+	-	-	-	-	-	-



Insect visitors	<i>Tagetes erecta</i> (marigold)	<i>Cucumis melo</i> (cucumber)	<i>Lagenaria siceraria</i> (bottle gourd)	<i>Luffa cylindrica</i> (ridged gourd)	<i>Cucurbita maxima</i> (pumpkin)	<i>Coriandrum sativum</i> (coriander)	<i>Brassica campestris</i> (mustard)	<i>Solanum melongena</i> (brinjal)
Family : Papilionidae								
<i>Papilio polyxenes</i> Fabricius	+	-	-	-	-	-	-	+
Family : Pieridae								
<i>Catopsilia pomona</i> Cramer	+	+	+	+	+	+	+	+
<i>Pieris edusa</i> Fabricius	+	+	+	+	+	+	-	+
<i>Pieris brassicae</i> Linnaeus	+	-	-	-	-	+	+	+
Family : Hesperidae								
<i>Hesperilla ornata</i> Leach	+	++	+	++	-	-	-	-
Family : Arctiidae								
<i>Utetheisa pulchella</i> Linnaeus	+	+	+	-	-	+++	-	-



Insect visitors	<i>Tagetes erecta</i> (marigold)	<i>Cucumis melo</i> (cucumber)	<i>Lagenaria siceraria</i> (bottle gourd)	<i>Luffa cylindrica</i> (ridged gourd)	<i>Cucurbita maxima</i> (pumpkin)	<i>Coriandrum sativum</i> (coriander)	<i>Brassica campestris</i> (mustard)	<i>Solanum melongena</i> (brinjal)
Family : Gelechiidae								
<i>Pectinophora gossypiella</i> Saunders	+	+	++	++	-	+	-	-
Family : Pyralidae								
<i>Hymenia fascialis</i> Cramer	++	++	+++	+++	+	+	-	+
<i>Margarona indica</i> Saunders	+	+	+	+	-	-	-	-
Family : Noctuidae								
<i>Agrotis ipsilon</i> Hufnagel	+	+	+	-	+	+	-	+
(+ = 1~10 visits/m/h, ++ = 11~50 visits/m/h, +++ = 51~100 visits/m/h, ++++ = 100~200 visits/m/h, +++++ = 200~300 visits/m/h, ++++++ = 300 visits/m/h & above)								