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Full Length Research Paper

A Study on Insect Visitors of Certain Cucurbit Vegetable Crops in an Agro- Ecosystem near Bikaner, Rajasthan, India

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ABSTRACT

Pollinators, including insects play a crucial role in reproduction of flowering plants and in the production of most fruits and vegetables. The relationship between pollinators and flowering plants is one of the mutually beneficial relationships in the natural world. Without the assistance of pollinators, most plants cannot reproduce. 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. Pollinators are also required for the successful proliferating communities and wildlife habitats. Estimates suggest that approximately 73 percent of the world's cultivated crops are pollinated by some varieties of bees, 19 percent by flies, 6.5 percent by bats, 5 percent by wasps, 5 percent by beetles, 4 percent by birds and 4 percent by butterflies, indicating that most of the plat species rely on insects for pollination. Looking into the importance of insect pollinators, agricultural practices should be designed to incorporate the protection and sustainable management of pollinators.

Key words: pollinators, flowering plants, Cucubitaceae, insects

1. INTRODUCTION

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.

The present study was therefore planned to observe and document insects visiting different vegetable crops belonging to family Cucurbitaceae, in an agro-ecosystem existing in the vicinity of Bikaner (Rajasthan, India) and to monitor some of their biological activities.

2. THE STUDY AREA

The state of Rajasthan is the largest state of Indian republic located between 23º3' to 20'13 N latitude and 69º30' to 78º17'C longitudes. The area under study falls in the Indian desert near Bikaner situated in Western Rajasthan along the international border. The agro-ecosystem *Vallabh Garden Agriculture Farm*, the area under study, lies 10 km away from Bikaner, at *Gharsisar* village. It is a crop field where seasonal crops are grown. It is irrigated by sewage water.

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3. METHODOLOGY

The crop field comprised of different crops but this study concentrated on insect visitors of Cucurbitaceae family only, which included cucumber, bottle gourd, ridged gourd and pumpkin. As the study was on 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 color and size of flowers were also documented. It was also noted that whether the flowers released scent or not. Visit of a particular species to a specific flower was documented and expressed as number of visits/man/h. The insect visitors to different flowering crops were surveyed and collected every week from December 2007 to November 2008. For the study, the field area was divided into five stations from where the insect visitors on flowers were collected. An indigenously designed cage net of 1mx1mx1m size and sweep net were 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 fauna were sorted out group-wise and help from the Section of Entomology, Department of Agriculture, Bikaner and Desert Regional Station of the Zoological Survey of India, Jodhpur was also taken for identification and for confirmation. Besides, the reference collection in the Department of Zoology, Dungar College was also consulted.

4. RESULTS

Hymenoptera

Apidae

This family comprising of the bees was the dominating family amongst hymenopterans represented by three species *viz*. *Apis mellifera, Xylocopa fenestrata and X. virginica.* Most number of visits was noted on flowers of *L. cylindrica* followed by *C. melo, L. siceraria* and *C. maxima*. In April and May it was noted in good numbers on *Cucumis melo* making 192 and 141 visits /man /h respectively. During the next four months the bee population showed a decline while, in October its population again increased and was noted on flowers of *Luffa cylindrica*, making 452 visits /man/h. The honeybee showed more foraging activity in the afternoon. *Xylocopa fenestrata* and *X. virginica* were the two carpenter bees observed during the present study from the agro-ecosystem. Although *X. fenestrata* was observed nearly throughout the study period as a frequent visitor, *X. virginica* was rarely observed. The visits of *X. fenestrata* on different flowers ranged from 1 to 266 visits /man/h. Most number of visits was noted on flowers of *L. cylindrica*, followed by *C. melo* and *C. maxima*. It was a major contributor to the bee family when the flowers of *Luffa cylindrica* were present in the crop field making 182 to 266 visits /man/h. It was intermittently documented. The visits of *X. virginica* ranged between 1 to 5 visits /man/ h only. It preferred *Luffa* flowers. *X. virginica* was found to show more foraging activity in the forenoon, while, *X. fenestrata* in the afternoon.

Vespidae

Two wasps observed to visit flowers of different crops during the present study were *Polistes carolina* and *Polistes sp. P. carolina* preferred flowers of *Luffa cylindrica* and *C. melo*. Of these, *Polistes*

sp. was reckoned nearly throughout the study period as a frequent visitor, while, *P. carolina* was observed from April to November only, as a rare visitor. In April, 18 visits/man/h on *Luffa*, in September and 14visits/man/h on *Lagenaria* were documented. Most number of visits was noted on *C. melo* followed by *L. siceraria* and *L. cylindrica*. While, *P. carolina* preferred to visit flowers more during forenoon, *Polistes sp.* showed this activity more during afternoon.

Megachilidae

Only one member, *Coelioxys capitatus* belonging to this family was reckoned during the present study visiting different flowers. It was a rare visitor. The number of visits ranged from 1 to 9 visits/man /h. The insects were found to visit flowers of *Cucumis*. As observed in small numbers not much difference in the time of the foraging activity could be adjudged. In April it was present in maximum numbers making 9 visits /man/h.

Scoliidae

Scolia specifica was only one wasp representative of this family documented from the crop field. It was observed nearly during all the months of study, although its number was high during May to October. Its most number of visits was noted on flowers of *L. cylindrica* followed by *L. siceraria*, *C. melo* and *C. maxima*. It was found to visit the flowers of *Luffa cylindrica* at 469 visits/man/ h and on flowers of *Lagenaria* at 292 visits/man/ h in the month of September when it was noticed in maximum number. These were also observed frequently on flowers of *Cucumis*. *S. specifica* preferred to visit flowers more during forenoon.

Sphecidae

The sole member belonging to this family documented from the study area was *Sphex sp.* Occurrence of *Sphex sp.* Except for February and October; it was noted during all other months. In July it was noticed in maximum number. Its visits on different flowers ranged from 1-14 visits/man/h. It was a frequent visitor on the crops. The wasp was found to prefer flowers of *Luffa* and *Cucumis*. It was not found to visit the flowers of *Lagenaria* at all. This wasp also showed more foraging activity during forenoon.

Ichneumonidae

Ichneumonid wasp *Xanthopimpla stemattor* was documented on flowers of *Lagenaria* and *Luffa*. It was intermittently observed during the study period. Although, the flowers of *L. cylindrica* were rarely visited by the wasp, it was found to make frequent visits to flowers of *L. siceraria*, the number ranging from 19 to 22 visits /man/h, especially during forenoon. Its maximum visits were observed in the month of September. *X. stemattor* was found to show more foraging activity in the forenoon as compared to afternoon. It was a frequent visitor on the crops. Its most number of visits was noted on *L. siceraria* followed by *L. cylindrica*.

Lepidoptera

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. In all 12 *Lepidopteran* representatives of 9 families were documented to visit different flowers during the course of study which are as follows:

Danaidae

Only one member *Danaus chrysippus*, commonly known as the 'plain tiger' belonging to this family was reckoned from the agro ecosystem during the present study. It was noted through out the study period. Except for pumpkin, the butterfly was observed to visit flowers of all the other crops grown in the field. Its most number of visits was noted on flowers *L. cylindrica* followed by *C. melo*, *L. siceraria* and *C. maxima*. A minimum of 5 visits /man/h were observed in the month of January. The butterfly frequently visited flowers of crops like cucumber in the month of April to August, cucurbits (except pumpkin) during May to October. On all these crops the number of visits ranged between 6 to 35 visits /man/h. It was found to visit the flowers more during forenoon as compared to afternoon.

Lycaenidae

Lampides boeticus was the only representative belonging to this family which was observed during the present study. Except for February, March and September, it was observed during rest of the nine months. Of the various crops, it preferred to visit flowers of only cucumber and ridged gourd and was not at all observed on rest of the crops (bottle gourd, pumpkin) in the field during the study period cultivated. It was a frequent visitor. It was found to visit flowers of cucumber at the rate of 48 visits /man/h in the month of May. The flowers of ridged gourd were rarely visited (3-4 visits/man/h). It showed complete absence from the field during February, March and September. It preferred to visit the flowers more in the afternoon.

Nymphalidae

Vanessa cardui and *V. annabela* were the members belonging to this family and reckoned from the agro ecosystem during the present study. 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 cucumber flowers only. The visits of *V. annabela* ranged between 1 to 5 visits /man/h. It usually preferred to visit the flowers in the forenoon. The other nymphalid, *V. cardui* was found to visit only flowers of cucumber. It was a rare visitor making 1 visit/man/h. This butterfly also preferred to move about and visit flowers in the forenoon as did *V. annabela*.

Pieridae

This family comprising of yellow butterflies was represented by two species *viz*., *P. edusa* and *Catopsilia pomona*. *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. Its population too was found to be high during winter months of October and November. This butterfly preferred to visit the flowers more during forenoon. *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 also found to be active during forenoon.

Hesperidae

Only one skipper, *Hesperilla ornata* was noted from the study area. This butterfly was not observed during January to April. Most number of visits was noted on flowers of *C. melo*, *L. cylindrica*, followed by *L siceraria*. 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. *H. ornata* was found to visit the flowers more during forenoon.

Pyralidae

This family of moths was represented by two members, *viz*. *Margaronia indica* and *Hymenia fascialis* during the present study. *H. fascialis* was reckoned throughout the study period except in the month of February when it was not documented. It was a frequent visitor while *Margaronia* was a rare visitor. Most number of visits were noted on *L. siceraria*, *L. cylindrica*, followed by *C. melo* and *C. maxima*. 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 and cucumber. It was frequently also noted on flowers of pumpkin. It was found to visit flowers more during forenoon. 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. Most number of visits was noted on flowers of *C. melo*, *L. siceraria* and *L. cylindrica*l. 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 and bottle gourd. *M. indica* was found to visit the flowers during afternoon.

Arctiidae

Only one species, *Utethesia pulchella* belonging to this family was collected from the agro-ecosystem during the present study. 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. It was observed to visit flowers of bottle gourd and cucumber. *Utethesia pulchella* preferred to visit the flowers in forenoon. It was a frequent visitor.

Noctuidae

Agrotis ipsilon 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 was noted on *C. melo*, *L. siceraria* and *C. maxima*. 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. It was also found to visit flowers in forenoon.

Gelechiidae

This family was represented by *Pectinophora gossypiella* which was reckoned throughout the study period except for winter months of January and February. 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 and cucumber. *P. gossypiella* was found to visit the flowers more during forenoon as compared to afternoon.

Diptera

The two winged insects comprising of true flies belong to this order which possess sponging and lapping type of mouth parts. Most of the flies survive on honeydew, nectar or exudates of various plants and animals, and decomposing organic matter. The *dipterans* noted to visit flowers of various crops cultivated

in the agro-ecosystem studied belonged to the following families:

Culicidae
Culex pipiens was the only member belonging to this family found to visit the flowers and reckoned throughout the study period except in the month of September. These occurred in large numbers during November and December. *C. pipiens* was observed on the flowers of *C. maxima* followed by, *Cucumis* and *Lagenaria*. It was not recorded from the flowers of *Luffa*. It was a rare visitor. Its maximum visits of 14v/m/h on *C. maxima* were noted during December. It preferred to visit the flowers in the forenoon.

Muscidae
This family was represented by *Musca domestica* and was reckoned throughout the study period. Maximum of 166 visits /man/h by *M. domestica* were noted on flowers of *Lagenaria* in the month of October. It was a frequent visitor. This was the month when it was present in maximum numbers. This *Dipteran*, although recorded on flowers of *Cucumis* and *Luffa*, was found to prefer *Lagenaria*. The flies preferred to visit the flowers in the forenoon.

Syrphidae
The member belonging to this family collected during the present study was *Eristalis sp.* which was noticed throughout the study period except in the month of November. Its maximum number of visits on various flowers was noted in the month of April. It was a frequent visitor. It was found to visit the flowers of *Lagenaria*, *Luffa* and *Cucumis*. It showed preference towards cucumber on which 80 visits/man/ h was documented in the month of April. It was noticed to visit the flowers in forenoon as compared to afternoon.

Tephritidae
The fly belonging to this family documented during the present study was *Dacus cucurbitae* which was collected throughout the study period except November. It was observed to visit flowers of cucumber, ridged and bottle gourd. It showed slightly more preference towards *Luffa* flowers on which 15 visits /man/h) was recorded in the month of September. It was also noticed to visit the flowers in forenoon.

Tabanidae
Tabanus sp. was the member belonging to this family which was observed in the agro-ecosystem.. It was present throughout the study period in good numbers and was noted on flowers of *Cucumis*, *Lagenaria* and *Luffa*. It preferred the flowers of *Luffa*, but was never documented on the flowers of *C. maxima*. In both forenoon and afternoon it was noticed in almost equal numbers.

Sarcophagidae
Only one member *Sarcophoga bravicornis* belonging to this family was reckoned during the present study visiting the flowers of *Cucumis*, *Lagenaria* and *Luffa*. The number of visits ranged from 1 to 13/man/h. In October it was present in maximum numbers. It was not observed in the month of November, December, February and April. This dipteran preferred to visit the flowers more during forenoon.

Coleoptera
The *coleopteran*s bearing 'sheathed wings' or 'elytra' are the insects commonly known as beetles and are found in almost all habitats, interacting with their ecosystem in several ways. This group was represented by only one family during the present study:

Coccinellidae
Only two insects belonging to order *Coleoptera* were observed on flowers of different crops in the agro-ecosystem studied, both belonged to family Coccinellidae. These were *Coccinella septempunctata* and *Menochilus sexmaculatus*. *C. septempunctata* was documented more frequently as compared to *Menochilus sexmaculatus* which was rarely observed. The former was noted on flowers of cucumber and pumpkin. Both the beetles were not documented on flowers of *Lagenaria* and *Luffa*. These were found more during forenoon as compared to afternoon.

Neuroptera
This order includes lacewings, ant lions, dobson flies, alder flies and snake flies are insects which have 'nerve wings'. In most cases the adults of these insects are predators, the non-predatory species usually feed on nectar, pollen and honeydew. Insect species belonging to the following family was collected during the present study:

Chrysopidae
Chrysopa sp. was the only member belonging to this family which was seen to visit flowers of only on *Cucumis*. This insect was not documented from June to November. It was a rare visitor. It was generally found to visit flowers during forenoon.

Hemiptera
This order comprising of true bugs possessing a beak for sucking the sap and bearing 'hemi elytra' are quite distinctive and during the present study the following families were documented:

Pentatomidae
Only one species belonging to family Pentatomidae were observed to visit flowers of various crops in the agro-ecosystem studied *viz*., *Nezara viridula*. Its visits were noted on only flowers of *C. melo*. The number of visits of *N. viridula* ranged from 1-16 visits /man/ h. Its maximum number was noticed in April. The number of visits was observed to be more during forenoon. Flowers of *Lagenaria*, *Luffa*, and *Cucurbita* were not at all visited by both of the insects as observed during the present study. It was a rare visitor to the crops.

Pyrrhocoridae
This family was also represented by two species *viz*. *Dysdercus cingulatus and D. koengii*. *D. cingulatus* was reckoned throughout the study period and was as a frequent visitor noted on nearly flowers of all the crops. Most number of visits was noted on *C. melo* followed by *L. siceraria* and *L. cylindrica*. Its number of visits on various flowers *viz*. *Cucumis*, *Lagenaria* and *Luffa*, ranged from 1-30 visits/man/h. Its maximum visits were noted during the month of June on flowers of *Cucumis* melo (30 visits /man/h). Not much difference in the time of visit was observed with respect to this insect species. *D. koengii* was documented during December to May. It was a rare visitor. Rarely, it was also seen to visit flowers of *Cucumis*. It was generally found to visit the flowers more during forenoon.

Orthoptera
These 'straight winged' insects include grasshoppers, crickets and locusts which are generally phytophagous, many being omnivorous.

Acrididae
This family was represented by two insects' *viz*. *Ochrilidia sp.* and *Chrotogonus sp. Ochrilidia* was frequently noted from March to November, while, *Chrotogonus sp.* was intermittently noted during the study

period. *Ochrilidia sp.* was documented on flowers of *Cucumis*, *Luffa* and *Cucurbita*. *Chrotogonus sp.* was observed only on *Cucumis*. Both the *acridids* were never seen to visit flowers of *Lagenaria*. *Ochrilidia sp.* was noted as a rare visitor. Maximum visits of *Chrotogonus* (5 visits/man /h) on flowers of *Cucumis* were noted in August. These were noted on the flowers mostly during forenoon.

Odonata

Dragon flies and damsel flies bearing 'strong teeth' are predacious insects which belong to this order. The *odonates* documented during the present study belonged to the following families:

Libellulidae

Only one dragon fly *Pantala flavescens* was observed to visit flowers present in the agro-ecosystem studied. It was documented throughout the period of study. The number of visits ranged from 1 to 40/man/ h on different flowers. These were also seen to visit the flowers mostly in the forenoon.

Coenagrionidae

This family was represented by only *Argiocnemis femina*. The adults were seen from April to October and their number of visits ranged from 1 to 7/man/ h on different flowers. Its maximum number was noticed in the month of April. They visited flowers of *Cucumis* and *Lagenaria*, although *Luffa* flowers were also in their full bloom showing their preference. It was a rare visitor. These were also reckoned more during forenoon.

Crops and their insect visitors

Cucumber (*Cucumis* melo)

Cucumber, belonging to family Cucrubitaceae, commonly known as 'kakri' or 'tar', was one of the major crops grown in the agro-ecosystem studied. The flowering season of the crop was from April to August. The flowers were solitary, yellow in color and scentless. Male and female flowers bloom separately and therefore are cross-pollinated. Out of the total 36 insects documented during the period of study, 34 insects belonging to eight orders were found to visit cucumber flowers.

All the insect representatives belonging to order Neuroptera, Orthoptera and Odonata which were documented during the present study visited the flowers of *Cucumis*; while 85.71% of *Lepidopteran* and dipteran, 75% of hemipteran, 70% of *hymenopteran* and 50% of *coleopteran* insects visited them.

Seven species belonging to order *Hymenoptera* were observed to visit the flowers of *Cucumis* which included *Sphex sp.*, *Polistes sp.*, *A. mellifera*, *X. fenestrata* (17.85% each), *S. specifica* and *C. capitatus* (10.71% each) and *P. carolina* (7.14%). The lepidopterans were the major forms found to visit the flowers of cucumber during the present study. In all twelve *Lepidopteran* species were noted which included *V. annabela*, *C. pomona*, *U. pulchella*, *L. boeticus*, *H. fascialis* each contributing 12.19%, followed by *P. gossypiella* (9.75%), *H. ornata* and *D. chrysippus* (7.31% each), *M. indica*, *Pieris edusa* (4.87% each), *A. ipsilon* and *V. cardui* (2.43% each). Six dipteran forms which were frequently seen to visit the flowers of cucumber during the present study were Sarcophaga carnaria which contributed to only 10.71 %, while, the others which included *C. pipiens*, *Eristalis sp.*, *Tabanus sp.*, *D. Cucurbitae* and *M. domestica* each contributed to 17.85% of the total population. Only one member belonging to order *Coleoptera* and *Neuroptera* each were documented on the flowers of *Cucumis* which were *C. septempunctata* and *Chrysopa sp.* respectively. Among

hemipterans, *D. cingulatus* was the major form visiting cucumber flowers contributing to 55.55% followed by *N. viridula* (33.33%) *and D. koengii* (11.12%). *Orthopterans* were represented by two species *Ochrilidia sp.* contibuting to 55.55% and *Chrotogonus sp.* sharing 44.45% while, between *odonates A. femina* was major visitor (66.66 %) as compared to *P. flavescens* (33.34).

Bottle gourd (*Lagenaria* siceraria)

Bottle gourd commonly known as 'Lauki' or 'Gheeya' was another major summer crops cultivated in the field during April to October, flowering period being May onwards. *Lagenaria* siceraria also has stalked flowers, which are monoecious, solitary, scentless and creamy or white in color and are cross-pollinated as presented in Table 1. Of the total number of insect species documented during the present study, only 66% were found to visit the flowers of bottle gourd.

Insects belonging to order Coleoptera, Neuroptera and Orthoptera were never recorded on flowers of *L. siceraria* during the present study, while, the visits of *odonates* was 100% followed by *dipterans* (85.71 %), lepidopterans (71.42 %), hymenopterans (40 %) and *hemipterans* (25 %).

The flowers of bottle gourd were visited by only four hymenopterans *viz*., *S. specifica* (31.57 %), *A. mellifera* (26.31 %), *X. sexmaculatus* and *Polistes sp.* (21.05 % each). Ten *Lepidopteran* species which were seen to visit the flowers of bottle gourd included *U. pulchella*, *H. fascialis*, *P. gossypiella*, *M. indica* and *C. pomona* (11.76 % each), *A. ipsilon* (9.80 %), *P. edusa*, *D. chrysippus*, *Hesperilla ornata*. and *V. annabela* (7.84% each). Among *dipterans* all the six species were documented on flowers of *L. siceraria*. These included *Eristalis sp*., *Tabanus sp*., *M. domestica* and *Sarcophaga bravicornis* (19.35 % each), *C. pipiens* (12.90 %) and *D. cucurbitae* (9.67 %). Only one hemipteran, *D. cingulatus* was observed to visit the flowers of bottle gourd. Both the odonates, namely *A. femina* and *P. flavescens* (50 % each) were noted to visit the flowers of *L. siceraria*. During the present study 23 insects belonging to Hymenoptera, Lepidoptera, Diptera, Hemiptera and Odonata were found to visit the flowers of bottle gourd while, insects belonging to orders Coleoptera, Neuroptera and Orthoptera were never recorded on flowers of *L. siceraria*.

One of the frequent visitors to the flowers of cucumber during the present study were, the dipterans, which included *C. pipiens*, *Eristalis, Tabanus*, *D. cucurbitae* and *M. domestica*. Although, all the forms were documented throughout the flowering period, *Eristalis*, *M. domestica* and *Tabanus* were major visitors. *D. cucurbitae* was one of the visitors to the flowers of cucumber making 2–7 visits / man / h.

Only one *coleopteran*, *C. septempunctata* was rarely documented on the flowers of *Cucumis* during the present study.

Chrysopa was the only *neuropteran* collected very rarely collected from the flowers of *Cucumis* during the present study.

Of the three hemipteran species documented during the present study *viz*. *D. cingulatus*, *D. koengii* and *N. viridula*, the first one was frequently noted on flowers of *C. melo*, while, the other two forms were very rarely observed.

The two *orthopterans viz*. *Ochrilidia* and *Chrotogonus* and two *odonates* namely *A. femina* and *P. flavescens* were all rare forms visiting flowers of cucumber.

Ridged gourd (*Luffa cylindrica*)

Yet another major cucurbit crop cultivated in the agro-ecosystem studied was *Luffa cylindrica*, commonly known as ridged gourd. The flowering started

May onwards and continued up to October, during which various insects visited them. The flowers are solitary, yellow in color, scentless and although both male and female flowers are present on the same plant, cross-pollination takes place.

Of the total number of insects documented during the present study, only 25 were observed to visit the flowers of *Luffa*. Insects belonging to order Coleoptera and Neuroptera were not recorded, while, the insects belonging to other orders were hymenopterans (80%), *dipterans* (71.42%), lepidopterans (64.28%), *odonates* and *orthopterans* (50% each) and hemipteran (25%).

S. specifica, *A. mellifera*, *P. carolina*, *X. fenestrata* (15 % each), *X. virginica*, *Sphex sp.*, *Xanthopimpla stemmator* and *Polistes sp.* (10 % each) were the eight hymenopterans species found to visit the flowers of ridged gourd during the present study. Nine *Lepidopteran* species which were observed on flowers of *Luffa*, were *D. chrysippus*, *H. fascialis*, *P. gossypiella*, *M. indica*, *H. ornata*, *V. annabela*, *C. pomona* (12 % each), *L. boeticus* and *P. edusa* (8% each). The *dipterans* were represented by *M. domestica*, *Eristalis sp.* (25 % each) and *Sarcophaga bravicornis*, *D. cucurbitae* and *Tabanus sp.* (16.66 % each), visiting the flowers of ridged gourd. Only one *hemipteran* observed was *D. cingulatus*, one *orthopteran Ochrilidia sp.* and one odonate *P. flavescens* was noted on the flowers of this vegetable crop. Of the total number of insects documented during the present study, only 25 were observed to visit the flowers of *Luffa*. Insects belonging to orders *Hymenoptera*, *Lepidoptera*, *Diptera*, Orthoptera, *Hemiptera* and *Odonata* were recorded, while, *Coleoptera* and *Neuroptera* were not noted on these flowers.

Pumpkin (*Cucurbita maxima*)

Pumpkin, *Cucurbita maxima*, in India called 'Sitaphal', 'Halwa Kaddu' or 'Kashiphal', was also cultivated in the crop field. The flowering period of this crop was observed for two months that is November and December. The flowers were the largest of all the flowers and were solitary, yellow colored scentless and cross-pollinated.

Only one fourth of the total number of insects documented, were found to visit the flowers of pumpkin during the present study. The insects belonging to Neuroptera, Hemiptera and Odonata were never reckoned from these flowers while Orthoptera and Coleoptera contributed 50% each, followed by Lepidoptera 35.71%, Hymenoptera 20% and Diptera 14.28%.

Only two hymenopterans *viz*. *S. specifica* (66.66 %) and *A. mellifera* (33.34%) visited the flowers of *C. maxima*.

The *Lepidopteran* fauna which was found to visit pumpkin flowers included *P. edusa*, *H. fascialis*, *A. ipsilon*, *V. annabela*, *C. pomona* (20 % each). Only one dipteran observed was *C. pipiens*, one *coleopteran*, *M. sexmaculatus* and one orthopteran *Ochrilidia sp.* was observed on the flowers of this crop.

In all, eleven insects belonging to five orders *viz*. Hymenoptera, Lepidoptera, Diptera, Coleoptera and Orthoptera were found to visit the flowers of pumpkin, while, *neuropterans*, *hemipterans* and *odonates* were not observed on them during the present study.

5. DISCUSSION

The present findings get support from the work of Thapa (2006) who also reported *A. mellifera*, *A. cerena*, *A. dorsata*, *Xylocopa*, *V. orientalis*, *V. magnifica* and *Sphex* as insect pollinators of cucumber. According to Hodges & Baxendale (2007), cucumber flowers are exclusively pollinated by honeybees and other insect

pollinators. During the present observations also it was found that *A. mellifera* visited *Cucumis* flowers most number of times (192 visits / man / h), especially in the month of April, while, all other *hymenopteran* visitors were rarely found on these flowers. Goodwell & Thompson (2007) suggested *A. mellifera* to be a better pollinator than *Bombus impatiens*. Honeybees have also been observed as pollinators of *C. melo* by Carrillo et al. (2007). According to Cervancia & Bargonha (2000) also, the most common flower visitors of cucumber were *Xylocopa chorna*, *X. philippinensis*, *Megachile afrita* and *A. dorsata*.

During the present study twelve *Lepidopteran* species were documented on the flowers of *C. melo* which included *V. annabela*, *V. cardui*, *C. pomona*, *P. edusa*, *D. chrysippus*, *U. pulchella*, *L. boeticus*, *M. indica*, *H. fascialis*, *H. ornata*, *P. gossypiella* and *A. ipsilon*. Of these, *H. fascialis* was the major visitor followed by *L. boetius*, both visiting the flowers quite frequently during May to August. The other *Lepidopteran* species which were quite often documented mostly during July and August were *M. indica* and *H. ornata*, while rests of the species were rarely observed to visit flowers of *C. melo*. Earlier Thapa (2006) also reported Presis butterfly, skipper *Pleopidas methias* and *Papilio machon* as insect pollinators of this plant.

D. cucurbitae was one of the visitors to the flowers of cucumber making 2–7 visits / man / h, which is supported by the earlier report of Thapa (2006) who has also found this fruit fly to be a pollinator, while, *Bactrocera Cucurbitae* another dipteran has been reported to be a major pest of *C. melo* by Dhillon (2005). Earlier Thapa (2006) reported pumpkin beetle *Aulacphora foveicollis* and pollen beetle *Chiloloba acuta* besides lady beetles *Coccinella* as insect pollinators of cucumber.

No other records of *neuropterans*, *hemipterans*, *orthopterans* and *odonates* as visitors of cucumber flowers are available in the literature referred.

The flowers were visited by four *Hymenopteran* species *viz*. *A. mellifera*, *X. sexmaculatus*, *Polistes sp.* and *S. specifica*. Earlier Morimoto et al. (2004) also observed honeybee *A. mellifera* as active flower visitors of *L. siceraria* in Kenya which is in support of the present findings. Fomekong et al. (2008) also reported *A. mellifera* to be a pollinator of cucurbitaceous plant. *A. mellifera* as a dominant species visiting flowers of Cucurbitaceae was also reported by Rust et al. (2003). In all, 43 species of bees were collected from the flowers of *E. elaterium* a member of Cucuritaceae, of which 33 bee species were found to carry pollen. The present findings also get support from the findings of Valdivia & Niemeyer (2006) who also documented *A. mellifera* and *Polistes buyssoni* to visit flowers of cucurbit *Escallonia myrtoidea*. Besides these, 16 other *hymenopteran* species were reported to visit these flowers by them. While studying the pollination ecology of *Citrullus lanatus* a cucurbit, Njorage et al. (2004) found that this species depends heavily on *A. mellifera* for pollination. Other pollinators identified were *Xylocopa* bees, *halicted* bees and *hypotrigona* bees which corroborate the present findings.

Lepidopteran species which were found to visit the flowers of bottle gourd during the present study included *C. pomona*, *P. edusa*, *D. chryhippus*, *V. annabela*, *U. pulchella*, *H. fascialis*, P. gossypiella, *M. indica*, *A. ipsilon* and *H. ornate*. Srivastava (2000) also reported two lepidopterans, hawk and pyrillid moth as pollinators of cucurbits. Six *Lepidopteran* species were documented by Valdivia & Niemyer (2006) to visit flowers of

cucurbit *E. myrtoidea* including a *nymphalid*, *V. carye*. Thapa (2006) reported only one *Lepidopteran Lampides boeticus* to visit the flowers of *L. siceraria*.

Six *dipterans* were documented on the flowers of *L. siceraria* which included *Eristalis sp*., *Tabanus sp*., *M. domestica*, *C. pipiens*, *D. cucurbitae* and *Sarcophaga bravicornis*. In earlier studies Fomekong et al. (2008) recorded only two *dipterans* including *D. bivitattus* and Kabir et al. (1991) also found that the flowers of bottle gourd attracted *Dacus* fruit fly, which support the present findings wherein *Dacus* was documented. Thapa (2006) also reported only one *syrphid* fly *Syrphus* on flowers of *L. siceraria*. Six dipteran species were reported to visit the flowers of *C. mortoidea* by Valdivia & Niemeyer (2006). These included members belonging to family Syrphidae and Tabanidae which is in conformation with the present study during which the members belonging these two families were documented on flowers of bottle gourd. Baskaran & Eswaran (2004) cited *M. domestica* to be a pollinator of cucurbit *Momordica charantia*. Njorage et al. (2004) identified flies as pollinator of *Citrullus lanatus,* a cucurbit crop, which corroborate the present findings.

D. cingulatus was the only hemipteran observed on flowers of bottle gourd during the present study. Srivastava (2000) also reported bug to pollinate *L. siceraria*, while, in another study conducted on entomofauna, Fomekong et al. (2008) reported twelve hemipteran species as floral visitors of cucurbit plant *Cucumeropsis mannii* which included *D. voelkersi*.

Two odonates, namely *A. femina* and *P. flavescens* were noted as rare visitors on the flowers of *L. siceraria*. No earlier records of *odonates* on flowers of bottle gourd are available in the literature cited.

The present findings are in conformation with the studies done by Agarwal & Rastogi (2008) who also noticed hymenopterans on the flowers of *Luffa cylindrica*. Singh et al. (2000) also recorded members belonging to family Braconidae on cucurbit plant *Luffa cylindrica*. The members of Formicidae on *Luffa* were documented by Okoli et al. (2008). Thapa (2006) reported hymenopterans like bumble bee *Bombus*, golden wasp *Vespa magnifica* and oriental wasp *Vespa orientalis* as pollinators of sponge gourd. Earlier Baskaran & Eswaran (2004) also observed *Apis dorsata* and *A. florea* as pollinators of another gourd *Momordica charantia* which corroborate the present findings.

According to Valdivia & Niemeyer (2006) some cucurbits exhibit floral traits associated with pollination by diurnal butterflies, however, flowers remain open during the night and thus, may also be pollinated by nocturnal moths. During the present study also butterflies as well as moths were documented on the flowers of *Luffa*. Butterflies were also noted as pollinators of a gourd by Baskaran & Eswaran (2004). Thapa (2006) reported lemon butterfly (*Papilio machon*), yellow butterfly (*Therias sp*.), cabbage butterfly (*Pieris brassicae*) and castor butterfly (*Ergolis merione*) as pollinators of sponge gourd which corroborate the present findings. Earlier Srivastava (2000) noted the *hawk* moth as pollinator of *Luffa* acutangula.

M. domestica, *Eristalis sp*., *Sarcophaga bravicornis*, *D. cucurbitae* and *Tabanus sp.* were the *dipterans* recorded on the flowers of *Luffa* during the present study which gets support from the reports of Kabir et al. (1991) who also recorded fruit fly on the flowers of ridged gourd. Thapa (2006) also reported fruit fly *Bactrocera sp*. and Tabanid fly *Tabanus sp.* as pollinators of sponge gourd.

One hemipteran *D. cingulatus* was documented on the flowers of ridged gourd during the present study. Earlier, an oligophagous pentatomid bug *Coridius obscurus* was noted as an egg parasitoid on *Luffa cylindrica* by Senrayan & Annadurai (1991).

One orthopteran, *Ochrilidia sp.* and *P. flavescens* an odonate were noted on the flowers of ridged gourd during the present study as a rare form. No earlier reports on Orthoptera and Odonata visiting flowers of ridged gourd are available in the literature referred.

The hymenopterans visiting the flowers of pumpkin were *S. specifica* and *A. mellifera*. Earlier most of the authorities have considered honeybees to play a major role in pollination of *Cucurbita*, which include the works of Pammel & Bach (1894), Jones & Rosa (1928), Jones & Emsweller (1934), Thompson et al. (1955), Whitaker & Davis (1962), Battaglini (1969), Langridge (1952), Nevkryta (1953), Robinson (1952), Sandulac (1959), Verdieva & Ismalilova (1960) and Wolfenbarger (1962), while, Michel Bacher et al. (1964) and Hurd (1966) gave credit to both honeybees as well as wild bees and thus support the present findings. Alan & Bradley (1966) have also considered bumble bees, carpenter bees, squash bees and honeybees including *A. mellifera* as natural pollinators of pumpkin. Canto Aquliar & Parra – Ptavla (2000) evaluated the pollination efficiency of *Peponapis limitaris* and *A. mellifera* in *Cucurbita moschata* in Mexico and found that *P. limitaris* to be more efficient than *A. mellifera*. Thapa (2006) has also reported *A. cerena* and *Helophilus trivittatus* as insect visitors of *C. maxima* which corroborate the present findings. Agbagwa et al., (2007) also considered *A. mellifera* to play an essential role in pollination of *C. moschata* in Nigeria.

The *Lepidopteran* species, which were found to visit pumpkin flowers during the present study, included *P. edusa*, *V. annabela*, *C. pomona*, *H. fasicalis* and *A. ipsilon*. Although no earlier records of *Lepidopteran* visitors on *C. maxima* are available, nevertheless, Srivastava (2000) and Valdivia & Niemyer (2006) have reported lepidopterans including hawk and pyrillid moth and nymphalid butterfly *V. carye* respectively to visit cucurbit flowers.

Only one dipteran *C. pipiens* was observed on flowers of pumpkin during the present study, while, earlier Thapa (2006) reported syrphid fly *Syrphus sp*., robber fly *Asilus sp*., fruit fly *Bactrocera sp*. and house fly *Musca domestica* to visit the flowers of *C. maxima*.

Menochilus sexmaculatus was the only *coleopteran* species which was documented from the flowers of *C. maxima*. Lady beetle *Coccinella sp*. has been reported by Thapa (2006) as floral visitor of *C. maxima*.

Only one orthopteran, *Ochrilidia sp.* was observed on the flowers of this crop. No earlier records of *orthopterans* on flowers of *C. maxima* are available in the literature referred.

Decline in pollinator populations due to various reasons would have significant ecological as well as economic impact and therefore it becomes imperative to protect and enhance floral visitors of agricultural crops. The present study reveals various insects visiting some plants belonging to family Cucurbitaceae only and emphasizes the importance of natural pollinators in agriculture.

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7. TABLES

Table 1: Floral characteristics of different crops cultivated in *Vallabh Garden Agriculture Farm*, Bikaner, India

Crop	Botanical Name	Family	Inflorescence	Scent	Color	Self or Cross pollination
Cucumber	*Cucumis melo*	*Cucurbita*ceae	Solitary	Scentless	Yellow	Cross
Bottle gourd	*Lagenaria siceraria*	*Cucurbita*ceae	Solitary	Scentless	White or Creamish	Cross
Ridged gourd	*Luffa cylindrica*	*Cucurbita*ceae	Solitary	Scentless	Yellow	Cross
Pumpkin	*Cucurbita maxima*	*Cucurbita*ceae	Solitary	Scentless	Yellow	Cross

Table 2: Insect visitors on flowers of different crops in *Vallabh Garden Agriculture Farm*, Bikaner, India (2008-2009)

Insect visitors	***Cucumis melo*** **(Cucumber)**	***Lagenaria siceraria*** **(Bottle gourd)**	***Luffa cylindrica*** **(Ridged gourd)**	***Cucurbita maxima*** **(Pumpkin)**
HYMENOPTERA				
Family: Apidae				
Apis mellifera Linnaeus	+++	+	+++	++
Xylocopa fenestrata Fabricius	+	-	+++++	-
X. virginica Linnaeus	-	-	+	-

Insect visitors	***Cucumis melo*** **(Cucumber)**	***Lagenaria siceraria*** **(Bottle gourd)**	***Luffa cylindrica*** ***(*****Ridged gourd*****)***	***Cucurbita maxima*** **(Pumpkin)**
Family: Vespidae				
Polistes carolina Linnaeus	+	-	+	-
Polistes sp.	+	++	++	-
Family: Megachilidae				
Coelioxys capitatus Fabricius	+	-	-	-
Family: ***Scoliidae***				
Scolia specifica Smith	++	+++	++++	+
Family: **Sphecidae**				
Sphex sp.	+	-	+	-
Family: Ichneumonidae				
Xanthopimpla stemattor Thunberg	-	++	+	-
LEPIDOPTERA				
Family: Danaidae				
Danaus chrysippus Linnaeus	+	+	++	-
Family: Lycaenidae				
Lampides boeticus Linnaeus	++	-	+	-

Family: Nymphalidae				
Vanessa annabela Field	+	+	+	+
V. cardui Linnaeus	+	-	-	-
Family: Pieridae				
Catopsilia pomona Cramer	+	+	+	+
Pieris edusa Fabricius	+	+	+	+
Family: Hesperiidae				
Hesperilla ornata Leach	++	+	++	-
Family: Arctiidae				
Utetheisia pulchella Linnaeus	+	+	-	-
Family: Gelechiidae				
Pectinophora gossypiella Saunders	+	++	++	-
Family: *Noctuidae*				
Agrotis ipsilon Hufnage	+	+	-	+
Family: Pyralidae				
Hymenia fascialis Cramer	++	+++	+++	+
Margaronia indica Saunders	+	+	+	-

DIPTERA				
Family: Culicidae				
Culex pipiens Gemeine	+	+	-	++
Family: Muscidae				
Musca domestica Linnaeus	++	++	++	-
Family: Syrphidae				
Eristalis sp.	++	+	++	-
Family: Tephritidae				
Dacus cucurbitae Coquillett	+	+	++	-
Family: Tabanidae				
Tabanus sp.	++	+	++	-
Family: *Sarcophagidae*				
Sarcophaga bravicornis Linnaeus	+	+	+	-
COLEOPTERA				
Family: Coccinellidae				
Coccinella septempunctata Linnaeus	+	-	-	+
NEUROPTERA				
Family: Chrysopidae				
Chrysopa sp.	+	-	-	-

HEMIPTERA				
Family: Pentatomidae				
Nezara viridula Linnaeus	+	-	-	-
Family: Pyrrhocoridae				
Dysdercus cingulatus Fabricius	++	+	+	-
D. koengii Fabricius	+	-	-	-
ORTHOPTERA				
Family: Acrididae				
Ochrilidia sp.	+	-	+	+
Chrotogonus sp.	+	-	-	-
ODONATA				
Family: *Libellulidae*				
Pantala flavescens Fabricius	+	+	+	-
Family: Coenagrionidae				
Agriocnemis femina Brauer	+	+	-	-

Number of visits/h: 0-10 = +, 10-50 = ++, 50-100 = +++, 100-200 = ++++.

Table 3: Insect visitors (visits/m/h) of *Cucumis melo* as observed in *Vallabh Garden Agriculture Farm*, Bikaner, India (2008-2009)

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Apis mellifera					192	141	78	4	5			
Xylocopa fenestrata	-	-	-	-	4	3	2	1	3	-	-	-
X. virginica												
Polistes carolina	-	-	-	-	1	1	-	-	-	-	-	-
Polistes sp.	-	-	-	-	4	4	4	2	1	-	-	-
Coelioxys capitatus	-	-	-	-	9	-	1	-	3	-	-	-
Scolia specifica	-	-	-	-	-	1	-	17	80	-	-	-
Sphex sp.	-	-	-	-	1	3	6	10	7	-	-	-
Xanthopimpla stemattor	-	-	-	-	-	-	-	-	-	-	-	-
Danaus chrysippus	-	-	-	-	11	7	3	-	-	-	-	-
Lampides boeticus	-	-	-	-	9	48	23	22	6	-	-	-
Vanessa annabela	-	-	-	-	1	2	1	2	1	-	-	-
V. cardui	-	-	-	-	-	-	-	-	1	-	-	-
Catopsilia pomona	-	-	-	-	1	1	2	1	1	-	-	-
Pieris edusa	-	-	-	-	4	8	-	-	-	-	-	-
Hesperilla ornata	-	-	-	-	-	-	5	26	39	-	-	-
Utetheisia pulchella	-	-	-	-	8	7	14	1	4	-	-	-
Pectinophora gossypiella	-	-	-	-	1	7	-	1	3	-	-	-
Agrotis ipsilon	-	-	-	-	-	1	-	-	-	-	-	-
Hymenia fascialis	-	-	-	-	9	54	61	61	51	-	-	-
Margaronia indica	-	-	-	-	-	-	-	12	20	-	-	-
Culex pipiens	-	-	-	-	8	2	1	2	1	-	-	-
Musca domestica	-	-	-	-	6	21	28	30	22	-	-	-
Eristalis sp.	-	-	-	-	80	28	12	25	26	-	-	-

Dacus cucurbitae	-	-	-	-	2	3	3	7	2	-	-	-
Tabanus sp.	-	-	-	-	31	21	8	21	19	-	-	-
Sarcophaga bravicornis	-	-	-	-	-	-	3	3	8	-	-	-
Coccinella septempunctata	-	-	-	-	1	4	1	1	2	-	-	-
Chrysopa sp.	-	-	-	-	1	3	-	-	-	-	-	-
Nezara viridula					1		1		1			
Dysdercus cingulatus	-	-	-	-	2	4	30	14	2	-	-	-
D. koengii						1						
Ochrilidia sp.	-	-	-	-	1	2	3	1	1	-	-	-
Chrotogonus sp.	-	-	-	-	1	1	2	-	5	-	-	-
Pantala flavescens	-	-	-	-	1	-	-	-	2	-	-	-
Agriocnemis femina	-	-	-	-	1	3	3	-	1	-	-	-

Table 4: Insect visitors (visits/m/h) of *Lagenaria ciceraria* as observed in *Vallabh Garden Agriculture Farm*, Bikaner, India (2008-2009)

Crop	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
Apis mellifera	-	-	-	-	-	2	1	3	2	2	-	-
Xylocopa fenestrata	-	-	-	-	-	-	-	-	-	-		
X. virginica												
Polistes carolina	-	-	-	-	-	-	-	-	-	-	-	-
Polistes sp.	-	-	-	-	-	12	-	14	10	14	-	-
Coelioxys capitatus	-	-	-	-	-	-	-	-	-	-	-	-
Scolia specifica	-	-	-	-	-	48	69	36	102	292	30	-
Sphex sp.	-	-	-	-	-	-	-	-	-	-	-	-
Xanthopimpla stemattor	-	-	-	-	-	19	-	21	20	22	-	-
Danaus chrysippus	-	-	-	-	-	5	-	6	4	6	-	-
Lampides boeticus	-	-	-	-	-	-	-	-	-	-	-	-

Vanessa annabela	-	-	-	-	-	2	-	3	4	3	-	-
V. cardui	-	-	-	-	-	-	-	-	-	-	-	-
Catopsilia pomona	-	-	-	-	-	1	1	2	1	2	1	-
Pieris edusa	-	-	-	-	-	4	-	5	4	5	-	-
Hesperilla ornata	-	-	-	-	-	4	-	3	2	2	-	-
Utetheisia pulchella	-	-	-	-	-	7	8	12	13	14	5	-
Pectinophora gossypiella	-	-	-	-	-	15	21	19	32	63	9	-
Agrotis ipsilon	-	-	-	-	-	1	3	2	2	2	-	-
Hymenia fascialis	-	-	-	-	-	62	57	78	89	55	110	-
Margaronia indica	-	-	-	-	-	4	5	3	4	2	6	-
Culex pipiens	-	-	-	-	-	-	6	5	7	-	7	-
Musca domestica	-	-	-	-	-	22	21	24	25	28	166	-
Eristalis sp.	-	-	-	-	-	7	5	8	4	9	2	-
Dacus Cucurbitae	-	-	-	-	-	2	-	2	-	-	3	-
Tabanus sp.	-	-	-	-	-	6	5	7	6	7	5	-
Sarcophaga bravicornis	-	-	-	-	-	2	4	3	4	2	5	-
Coccinella septempunctata	-	-	-	-	-	-	-	-	-	-	-	-
Chrysopa sp.	-	-	-	-		-	-	-	-	-	-	-
Nezara viridula	-	-	-	-	-	-	-	-	-	-	-	-
Dysdercus cingulatus	-	-	-	-	-	8	1	6	9	10	1	-
D. koengii	-	-	-	-	-	-	-	-	-	-	-	-
Ochrilidia sp.	-	-	-	-	-	-	-	-	-	-	-	-
Chrotogonus sp.	-	-	-	-	-	-	-	-	-	-	-	-
Pantala flavescens	-	-	-	-	-	4	6	5	7	2	8	-
Agriocnemis femina	-	-	-	-	-	2	3	2	1	2	5	-

Table 5: Insect visitors (visits/m/h) of *Luffa cylindrica* as observed in *Vallabh Garden Agriculture Farm*, Bikaner, India (2008-2009)

	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Apis mellifera	-	-	-	-	-	5	7	2	8	4	452	-
Xylocopa fenestrata	-	-	-	-	-	182	194	246	259	266	184	-
X. virginica	-	-	-	-	-	3	3	-	2	4	-	-
Polistes carolina	-	-	-	-	-	2	3	1	5	1	6	-
Polistes sp.	-	-	-	-	-	15	11	13	-	18	-	-
Coelioxys capitatus	-	-	-	-	-	-	-	-	-	-	-	-
Scolia specifica	-	-	-	-	-	82	96	114	256	469	92	-
Sphex	-	-	-	-	-	12	-	13	13	14	-	-
Xanthopimpla stemattor	-	-	-	-	-	2	3	-	2	2	-	-
Danaus chrysippus	-	-	-	-	-	13	17	21	23	9	29	-
Lampides boeticus	-	-	-	-	-	4	2	-	3	-	3	-
Vanessa annabela	-	-	-	-	-	2	3	4	4	2	5	-
V. cardui	-	-	-	-	-	-	-	-	-	-	-	-
Catopsilia pomona	-	-	-	-	-	2	1	1	1	1	3	-
Pieris edusa	-	-	-	-	-	-	2	1	2	2	-	-
Hesperilla ornata	-	-	-	-	-	10	8	11	12	13	12	-
Utetheisia pulchella	-	-	-	-	-	-	-	-	-	-	-	-
Pectinophora gossypiella	-	-	-	-	-	12	14	16	15	10	22	-
Agrotis ipsilon	-	-	-	-	-	-	-	-	-	-	-	-
Hymenia fascialis	-	-	-	-	-	52	48	53	50	57	57	-
Margaronia indica	-	-	-	-	-	10	9	11	10	12	12	-
Culex pipiens	-	-	-	-	-	-	-	-	-	-	-	-
Musca domestica	-	-	-	-	-	22	20	18	24	26	19	-
Eristalis sp.	-	-	-	-	-	11	14	6	12	17	6	-

Dacus cucurbitae	-	-	-	-	-	8	9	-	12	15	-	-
Tabanus sp.	-	-	-	-	-	-	42	41	40	45	-	-
Sarcophaga bravicornis	-	-	-	-	-	3	2	-	3	3	-	-
Coccinella septempunctata	-	-	-	-	-	-	-	-	-	-	-	-
Chrysopa sp.	-	-	-	-	-	-	-	-	-	-	-	-
Nezara viridula	-	-	-	-	-	-	-	-	-	-	-	-
Dysdercus cingulatus	-	-	-	-	-	5	2	6	-	6	-	-
D. koengii	-	-	-	-	-	-	-	-	-	-	-	-
Ochrilidia sp.	-	-	-	-	-	2	3	1	-	-	3	-
Chrotogonus sp.	-	-	-	-	-	-	-	-	-	-	-	-
Pantala flavescens	-	-	-	-	-	2	-	3	2	-	3	-
Agriocnemis femina	-	-	-	-	-	-	-	-	-	-	-	-

Table 6: Insect visitors (visits/m/h) of *Cucurbita maxima* as observed in *Vallabh Garden Agriculture Farm*, Bikaner, India (2008-2009)

	Dec	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
Apis mellifera	-	-	-	-	-	-	-	-	-	-	-	17
Xylocopa fenestrata	-	-	-	-	-	-	-	-	-	-	-	-
X. virginica	-	-	-	-	-	-	-	-				
Polistes carolina	-	-	-	-	-	-	-	-	-	-	-	-
Polistes sp.	-	-	-	-	-	-	-	-	-	-	-	-
Coelioxys capitatus	-	-	-	-	-	-	-	-	-	-	-	-
Scolia specifica	6	-	-	-	-	-	-	-	-	-	-	2
Sphex sp.	-	-	-	-	-	-	-	-	-	-	-	-
Xanthopimpla stemattor	-	-	-	-	-	-	-	-	-	-	-	-
Danaus chrysippus	-	-	-	-	-	-	-	-	-	-	-	-
Lampides boeticus	-	-	-	-	-	-	-	-	-	-	-	-

Vanessa annabela	-	-	-	-	-	-	-	-	-	-	-	1
V. cardui	-	-	-	-	-	-	-	-	-	-	-	-
Catopsilia pomona	-	-	-	-	-	-	-	-	-	-	-	1
Pieris edusa	-	-	-	-	-	-	-	-	-	-	-	1
Hesperilla ornata	-	-	-	-	-	-	-	-	-	-	-	-
Utetheisia pulchella	-	-	-	-	-	-	-	-	-	-	-	-
Pectinophora gossypiella	-	-	-	-	-	-	-	-	-	-	-	-
Agrotis ipsilon	-	-	-	-	-	-	-	-	-	-	-	1
Hymenia fascialis	-	-	-	-	-	-	-	-	-	-	-	7
Margaronia indica	-	-	-	-	-	-	-	-	-	-	-	-
Culex pipiens	14	-	-	-	-	-	-	-	-	-	-	7
Musca domestica	-	-	-	-	-	-	-	-	-	-	-	-
Eristalis sp.	-	-	-	-	-	-	-	-	-	-	-	-
Dacus cucurbitae	-	-	-	-	-	-	-	-	-	-	-	-
Tabanus sp.	-	-	-	-	-	-	-	-	-	-	-	-
Sarcophaga bravicornis	-	-	-	-	-	-	-	-	-	-	-	-
Coccinella septempunctata	-	-	-	-	-	-	-	-	-	-	-	1
Chrysopa sp.	-	-	-	-	-	-	-	-	-	-	-	-
Nezara viridula	-	-	-	-	-	-	-	-	-	-	-	-
Dysdercus cingulatus	-	-	-	-	-	-	-	-	-	-	-	-
D. koengii	-	-	-	-	-	-	-	-	-	-	-	-
Ochrilidia sp.	-	-	-	-	-	-	-	-	-	-	-	1
Chrotogonus sp.	-	-	-	-	-	-	-	-	-	-	-	-
Pantala flavescens	-	-	-	-	-	-	-	-	-	-	-	-
Agriocnemis femina	-	-	-	-	-	-	-	-	-	-	-	-

Shaded area in Tables indicate flowering period

Table 7: Preferred time of visiting the flowers by different insects

Insect visitors	Forenoon	Afternoon
Apis mellifera Linnaeus		AN
Xylocopa fenestrata Fabricius		AN
X. virginica Linnaeus	FN	
Polistes carolina Linnaeus	FN	
Polistes sp.		AN
Coelioxys capitatus Fabricius	FN	AN
Scolia specifica Smith	FN	
Sphex sp.	FN	
Xanthopimpla stemattor Thunberg	FN	
Danaus chrysippus Linnaeus	FN	
Lampides boeticus Linnaeus		AN
Vanessa annabela Field	FN	
V. cardui Linnaeus	FN	
Catopsilia pomona Cramer	FN	
Pieris edusa Fabricius	FN	
Hesperilla ornata Leach	FN	
Utetheisia pulchella Linnaeus	FN	
Pectinophora gossypiella Saunders		AN
Hymenia fascialis Cramer	FN	
Margaronia indica Saunders		AN
Agrotis ipsilon Hufnagel	FN	
Culex pipiens Gemeine	FN	
Musca domestica Linnaeus	FN	
Eristalis sp.	FN	
Dacus cucurbitae Coquillett	FN	

Insect visitors	Forenoon	Afternoon
Tabanus sp.	FN	AN
Sarcophaga bravicornis Linnaeus	FN	
Coccinella septempunctata Linnaeus	FN	
Chrysopa sp.	FN	
Nezara viridula Linnaeus	FN	
Dysdercus cingulatus Fabricius	FN	
D. koengii Fabricius	FN	AN
Ochrilidia sp.	FN	
Chrotogonus sp.	FN	
Pantala flavescens Fabricius	FN	
Agriocnemis femina Brauer	FN	