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# Floral Visitors and Relative Abundance of Honey Bee Species on Dragon Fruit (*Hylocereus* spp. : Fam. Cactaceae)

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**ABSTRACT**

Fourteen species of floral visitors including *Apis* and non-*Apis* species were recorded at different flowering phases of *H. undatus* and *H. polyrhizus* during 2021-22. Out of which seven species from Hymenoptera included four species of honey bees, *Apis dorsata* F., *A. cerana* F., *A. mellifera* L. and *A. florea* F. belonging to Apidae were regular diurnal flower visitors. The *Ropalidia marginata* P. (Vespidae) was a diurnal occasional visitor and *Camponotus compressus* F. and *Tapinoma melanocephala* F. (Formicidae) were regular diurnal flower visitors. *Tirumala* sp. (Lepidoptera: Nymphalidae) was an occasional, diurnal visitor. Of the six species of Coleoptera, one each belonging to Chrysomelidae (*Colasposoma* sp.), Coccinellidae (*Coccinella transversalis* F.), Meloidae (*Mylabris pustulata* Thun.), Scarabidae (*Popillia schizonycha* A.) and Curculionidae (*Myllocerus viridanus* F.) were occasional visitors, while *Carpophilus* sp. (Nitidulidae) was a nocturnal visitor of both the types of dragon fruit. Irrespective of different phases of flowering, overall composition of *A. mellifera* was maximum, followed by *A. cerana, A. florea* and *A. dorsata* on both the types of dragon fruit. The native Indian honey bee, *Apis cerana* visited maximum overall mean number of flowers as compared to other species of honey bees. Comparison of quantity of pollen produced by single flower in two types of dragon fruit with that of quantity of fully loaded corbicular pollen of *Apis* species of honey bees revealed that pollen of single flower accommodated maximum number of *A. florea,* followed by *A. cerana, A. mellifera* and *A. dorsata*, if individual forager from *Apis* species was allowed to forage on a single flower.

*Keywords* : Floral visitors, Relative abundance, Nectar, Pollen foragers

DRAGON fruit, *Hylocerus* spp. is an exotic fruit crop belonging to the family Cactaceae, native to Central and South American rainforests. It has been well established as a new crop in various tropical countries due to its precocious yielding ability and its acceptability in the market. Dragon fruit has been introduced to India during late 1990s. In India, it is cultivated in Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Orissa, West Bengal, Andhra pradesh and Andaman and Nicobar Islands in a small area of less than 400 ha (Karunakaran *et al.,* 2019).

At the onset of flowering, 3-5 spherical buttons emerge from the stem margins and 2-3 of these may develop into flower buds in about 13 days. The light green cylindrical flower buds reach about 28 cm after 17 days when anthesis occurs. The flowers are hermaphrodite and extremely showy. They are whitish pink in some types, very fragrant, nocturnal and bell shaped. The flower opens rapidly, starting between 6.30 - 7.00 pm and opening of the flower is completed at about 10.00 pm. Around 2.00 pm, the flower closes after pollination and thereafter the flower begins to

wilt. The petals close completely by daybreak (Gunasena *et al*., 2006).

Pollination is essential in fruit production of the dragon fruit. As the flowers open in the night, bats and hawk moths in the natural range pollinate the flowers. In many countries where the crop is grown as a new crop, pollination is poor due to the lack of natural pollinators. Hence, hand pollination has been suggested to increase fruit set. Under Sri Lankan conditions, *Apis cerana* F., *Apis florea* F. and *Apis dorsata* F. were effectively pollinate the dragon fruit during the early morning hours (Pushpakumara *et al*., 2005).

The studies on four cactus species *viz*., *Notocactus polyacanthu* Link & Otto*, N. sellowi* Link & Otto*, N. sucineus* Link & Otto and *Gymnocalycium denudatum* (Link & Otto) Pfeiff. ex Mittler. found that *Arhysosage cactorum* Moure (Andrenidae), *Sarocolletes rugata* Moure & Urban, (Colletidae) and *Ancyloscelis fiebrigi* Brethes (Anthophoridae), specialized solitary bees are the most effective pollinators of *Notocactus* and *Gymnocalycium*. Various species of Notocacteae share the same main pollinators. Polylectic and social bees contribute little to the pollination of the cactus species examined in the Serra do Sudeste, Rino Grande do Sul, Brazil (Schlindwein and Wittmann, 1995).

## Material and Methods

Observations on different species of floral visitors, their abundance, composition and diversity were recorded to recognize the most efficient pollinator species during the dragon fruit flowering period of 2021-22 in the farmer's field at Suradenupura, Yelahanka (Tq.), Bengaluru Urban.

### *Apis* and Non-*Apis* Floral Visitors

All the *Apis* and non-*Apis* floral visitors including crepuscular and nocturnal visitors of dragon fruit at different phases of its flowering were collected through visual scanning and sweep net sampling technique (Belavadi and Ganeshaiah, 2013).

### Visual Counting of Floral Visitors

*Ad-libitum* sampling of floral visitors for a sampling time of five minutes at hourly intervals was followed. All the floral visitors including nocturnal visitors of dragon fruit flower per sampling time were counted and recorded. The observations on species of floral visitors and number of each species per sample were recorded starting from 0600 to 1800 hrs. at hourly intervals for a period of 5 min in each hour. This was done to record variations in species composition and their abundance if any, at different time intervals of the day. The crepuscular and nocturnal visitors of dragon fruit flowers were recorded through time-lapse camera and by visual observations. The observations were repeated at different phases of flowering. Among the insect floral visitors, the most frequently visiting species and type of floral resource (nectar/ pollen) they collected was recognized during these observations for drawing further interpretations on their foraging behaviour (Belavadi and Ganeshaiah, 2013).

### Nectar and Pollen Foraging Floral Visitors

The nectar and pollen foraging floral visitors were recorded during different phases of dragon fruit flowering. Four flowers from four directions of plant were randomly selected, tagged and labelled. Nectar and pollen collecting bees were observed for five minutes at hourly intervals from 0600-1900 hrs of the day and the honeybee species alighting were counted. The bee species collecting pollen from the flower along with pollen load in their hind legs were treated as pollen foragers and the bee species collecting the nectar from the flower without pollen load in their hind leg were treated as nectar foragers. The observations on the pollen and nectar collecting bees were expressed as number of pollen or nectar gatherers per 5 minutes per four flowers (n=4).

### Shannon Wiener Diversity Index

The frequency of visits by each species of floral visitor was recorded to identify the most abundant species effecting dragon fruit pollination. Pollinator count data was used to compute Shannon-Wiener index of diversity (H) by using the following formula:

$$H = \sum Pi \times \ln Pi$$

wherein,

'H' is the Shannon-Wiener index of diversity.

'Pi' is the proportion of the $i^{th}$ species of visitor.

**Pollen Output Per Flower**

The sepals and petals of fully matured five floral buds of both dragon fruit types were removed before anther dehiscence. The floral buds were covered with plastic covers. After the complete anther dehiscence, flowers were shaken for the collection of the pollen in the plastic covers. The study was conducted both in the field as well as in the laboratory. The weight difference between the cover with pollen and the empty cover was treated as pollen yield per flower. It was expressed as grams of pollen grains per flower.

**Pollen Load Carrying Capacity of Honey Bees**

The pollen load carrying capacity of *A. cerana, A. mellifera* and were determined by capturing the returning forager bees with pollen load in their corbicula at hive entrance by using sweep net. The pollen collected by 10 bees of the test colony were removed by using forceps and weighed. The body weight of bees was also recorded. Similarly, in *Apis dorsata* F. and *Apis florea* F. the pollen forager fully packed with pollen in their corbicula on the dragon fruit flowers were captured by using glass vials and pollen loads were removed and weighed. The mean weight of pollen carried by bees was expressed in mg per bee.

## Results and Discussion

***Apis* and Non-*Apis* Floral Visitors of Dragon Fruit**

Totally fourteen species of floral visitors which included *Apis* and non-*Apis* species were recorded at different flowering phases of *Hylocereus undatus* and *Hylocereus polyrhizus* during 2021-22. Out of which seven species from Hymenoptera *viz., Apis dorsata* F., *Apis cerana* F., *Apis mellifera* L. and *Apis florea* F. belonging to Apidae were regular diurnal flower visitors. These findings are supported by the reports of Pushpakumara *et al.* (2005) who stated that *Apis cerana* F., *Apis florea* F. and *Apis dorsata* F. were the most likely pollinators of *H. undatus* and *H. polyrhizus* in Bulath sinhala, Sri Lanka. Similarly, Muniz *et al.* (2019) recorded the visitation of *A. mellifera* on *H. undatus* and *H. polyrhizus* at North eastern Brazil. The wasp *Ropalidia marginata* P. under Fam. Vespidae was a diurnal occasional visitor, whereas *Camponotus compressus* F. and *Tapinoma melanocephalum* F. belonging to Formicidae were regular diurnal flower visitors. Muniz *et al.* (2019) witnessed the visitation of ants and wasps on *Hylocereus undatus* and *Hylocereus polyrhizus* at North eastern Brazil. The *Tirumala* sp. from Lepidoptera which belonged to Family Nymphalidae is an occasional and diurnal flower visitor. Six species from Coleoptera, one each belonging to Chrysomelidae (*Colasposoma* sp.), Coccinellidae (*Coccinella transversalis* F.), Meloidae (*Mylabris pustulata* Thun.), Scarabidae (*Popillia schizonycha* A.), Curculionidae (*Mylloceru sviridanus* F.) were found as occasional visitors, whereas *Carpophilus* sp. from Nitidulidae was a regular nocturnal visitor (Table 1). On the contrary to the present findings on the nocturnal visitors, many earlier studies (Muniz *et al.,* 2019; Locatelli *et al.,* 1997 and Rocha *et al.,* 2019) conducted in the place of origin of this crop showed that *Pilosocereus* species was pollinated by bats and moths, but no such non-insect pollinators could be observed in the present study (Sajjanar & Eswarappa, 2015 and Moulya *et al.,* 2023).

The honey bees, *Apis dorsata*, *Apis cerana*, *Apis mellifera* and *Apis florea* collected nectar from sepals of unopened flower bud and pollen from fully opened flowers. Among honey bees, *Apis dorsata* (05:40-11:00 hrs) was the first visitor of the flower followed by *A. cerana* (06:00- 11:30 hrs), *A. mellifera* (06:00- 12:00 hrs) and *A. florea* (06:00-11:30 hrs), whereas from non-*Apis* species, *Camponotus compressus* (0600-1800 hrs) and *Tapinoma melano cephalum* (0600-1800 hrs) were the first visitors which collected nectar from the sepals of unopened floral

**Table 1**

**Floral visitors of dragon fruit types, *Hylocereus undatus* and *Hylocereus polyrhizus* during flowering period of 2021 - 22**

| Order | Family | Scientific name | Visiting status | | Forage collected | Foraging period |
|---|---|---|---|---|---|---|
| | | | *H. undatus* | *H. polyrhizus* | | |
| Hymenoptera | Apidae | *Apis dorsata* Fab. | Regular | Regular | P+N | 05:40-11:00 hrs |
| | | *Apis cerana* Fab.(yellow & black strain) | Regular | Regular | P+N | 06:00- 11:30 hrs |
| | | *Apis florea* Fab. | Regular | Regular | P+N | 08:00- 12:00 hrs |
| | | *Apis mellifera* L. | Regular | Regular | P+N | 06:00-11:30 hrs |
| | Vespidae | *Ropalidia marginata* P. | Occasional | Occasional | N | 08:00-18:00 hrs |
| | Formicidae | *Camponotus compressus* F. | Regular | Regular | N | 06:00-18:00 hrs |
| | | *Tapinoma melanocephalum* F. | Regular | Regular | N | 06:00-18:00 hrs |
| Lepidoptera | Nymphalidae | *Tirumala* sp. | Occasional | Occasional | N | 07:00-08:00 hrs |
| Coleoptera | Chrysomelidae | *Colasposoma* sp. | Occasional | Occasional | P | 7:30-09:00 hrs |
| | Coccinellidae | *Coccinella transversalis* F. | Occasional | Occasional | P | 08:00-10:00 hrs |
| | Meloidae | *Mylabris pustulata*Thun. | Occasional | Occasional | P | 07:00-09:00 hrs |
| | Scarabidae | *Popillia schizonycha* A. | Occasional | Occasional | P | 07:00-09:00 hrs |
| | Curculionidae | *Myllocerus viridanus* F. | Occasional | Occasional | p | 07:30-10:00 hrs |
| | Nitidulidae | *Carpophilus* sp. | Regular | Regular | P | 02:00-12:00 hrs |

*Note* : P: pollen; N: nectar

bud, followed by *Tirumala* sp. (07:00-08:00 hrs), which collected the nectar from sepals of just opened flower. However. *Mylabris pustulata* (07:00-09:00 hrs), *Popillia schizonycha* (07:00-09:00 hrs), *Colasposoma* sp. (7:30-09:00 hrs), *Myllocerus viridanus* (07:30-10:00 hrs) and *Coccinella transversalis* (08:00-10:00 hrs) collected the pollen from opened flower. The *Ropalidia marginata* (0800-1800 hrs) foraged on the nectar from the sepals of unopened floral bud. The *Carpophilus* sp. was the only nocturnal visitor which foraged on the pollen from 02:00-12:00 hrs (Table 1).

**Foraging Behaviour of *Apis* Species of Honey Bees on *Hylocereus undatus* and *Hylocereus polyrhizus***

The foraging behaviour of major floral visitors under *Apis* species of honey bees *viz., A. dorsata, A. cerana, A. mellifera* and *A. florea* were documented during seven flowering phases in *H. undatus* and eight flowering phases in *H. polyrhizus*.

**Relative Abundance and Shanon-Wiener Diversity Index (H) of Pollen Foragers of Honey Bee Species on Two Dragon Fruit Types during different Phase of Flowering**

**First Phase of Flowering in *H. undatus* and *H. polyrhizus***

Pollen foraging activity of *A. dorsata*, *A. cerana* and *A. mellifera* was observed from 0600-1200 hrs, whereas *A. florea* foraged the pollen from 0800-1200 hrs on both types of dragon fruit with the exception of *A. dorsata* which stopped the foraging activity at 1000 to 1100 hrs on *H. polyrhizus*.

On *H. undatus,* peak activity of pollen foragers of *A. cerana* (17/5min. /4fl.) and *A. mellifera* (16/5min. /4fl.) was observed during 0600-0700 hrs. whereas, in case of pollen foragers of *A. dorsata* (9/5min./4fl.) and *A. florea (*32/5min./4fl.), the peak was recorded during 0700-0900 hrs and 1000-1100 hrs, respectively. The diversity was low during morning 0600 to 0700

**TABLE 2**

**Relative abundance (No./5 min/4 flowers) and Shanon - Wiener diversity index (H) of pollen foragers of *Apis* species on dragon fruit types, *Hylocereus undatus* (white flesh) and *H. polyrhizus* (pink flesh) during 1st phase of flowering (06.05.2022 - 10.05.2022)**

| *Apis* species | *Hylocereus undatus* | | | | | | *Hylocereus polyrhizus* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time (hrs) | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' |
| 0600-0700 | 3.00 | 17.00 | 16.00 | - | 36.00 | 0.92 | 2.00 | 27.00 | 11.00 | - | 40.00 | 0.77 |
| 0700-0800 | 9.00 | 15.00 | 14.00 | - | 38.00 | 1.07 | 11.00 | 26.00 | 9.00 | - | 46.00 | 0.98 |
| 0800-0900 | 9.00 | 16.00 | 14.00 | 10.00 | 49.00 | 1.35 | 7.00 | 18.00 | 9.00 | 8.00 | 42.00 | 1.30 |
| 0900-1000 | 6.00 | 11.00 | 11.00 | 25.00 | 53.00 | 1.25 | 5.00 | 15.00 | 10.00 | 16.00 | 46.00 | 1.30 |
| 1000-1100 | 5.00 | 11.00 | 8.00 | 32.00 | 56.00 | 1.13 | 2.00 | 11.00 | 10.00 | 25.00 | 48.00 | 1.13 |
| 1100-1200 | 5.00 | 9.00 | 6.00 | 23.00 | 43.00 | 1.18 | - | 7.00 | 6.00 | 25.00 | 38.00 | 0.87 |
| Total | 37.00 | 79.00 | 69.00 | 90.00 | 275.00 | - | 27.00 | 104.00 | 55.00 | 74.00 | 260.00 | - |
| Mean±SD | 6.17 ± 2.4 | 13.17 ± 3.25 | 11.5 ± 3.8 | 22.5 ± 9.18 | - | - | 5.40 ± 3.78 | 17.33 ± 8.01 | 9.17 ± 1.72 | 18.50 ± 81.8 | - | - |
| Composition of individual visitors (%) | 13.45 | 28.73 | 25.09 | 32.73 | 100.00 | - | 10.38 | 40.00 | 21.15 | 28.46 | 100.00 | - |

*Note* : *A. d: Apis dorsata; A.c: Apis cerana; A.m: Apis mellifera; A.f: Apis florea*

hrs. (0.92) and it reached maximum at 0800-0900 hrs (1.35) and thereafter it declined to 1.18 at 1100-1200 hrs. The total abundance and composition of *A. florea* (90 and 32.73%) was maximum, followed by *A. cerana* (79 and 28.73%), *A. mellifera* (69 and 25.09 %) and lowest (37 and 13.45%) was in case of *A. dorsata* (Table 2).

The peak in pollen foragers of *A. cerana* (27/5min./ 4fl.) and *A. mellifera* (11/5min./4fl.) was observed during 0600-0700 hrs, whereas in case of pollen foragers of *A. dorsata* (11/5min./4fl.) and *A. florea (*32/5min./4fl.), the peak was recorded during 0700-0800 hrs and 1000-1200 hrs, respectively. The diversity was low during morning 0600 to 0700 hrs (0.77) and it reached maximum at 0800-1000 hrs (1.30), thereafter it declined to 0.87 at 1100-1200 hrs. The total abundance and composition of *Apis cerana* (104 and 40%) was maximum, followed by *A. florea* (74 and 28.46%), *A. mellifera* (55 and 21.15%) and lowest (27 and 10.38%) was in case of *A. dorsata* on *Hylocereus polyrhizus* (Table 2).

**Second Phase of Flowering in *H. undatus* and *H. polyrhizus***

Pollen foraging activity of *A. dorsata*, *A. cerana* and *A. mellifera* were observed from 0600-1200 hrs, whereas *A. florea* foraged the pollen from 0800-1200 hrs on both types of dragon fruit with the exception of *A. dorsata* which stopped the foraging activity during 1000 to 1100 hrs on *Hylocereus polyrhizus*.

On *H. undatus,* peak in pollen foragers of *A. cerana* (19/5min./4fl.) and *A. mellifera* (22/5min./4fl.) was observed during 0600-0700 hr, whereas in case of pollen foragers of *A. dorsata* (11/5min./4fl.) and *A. florea* (27/5min./4fl.), the peak was recorded during 0800-0900 hrs and 1000-1100 hrs, respectively. The diversity was low during morning 0600 to 0700 hrs (0.89) and it reached maximum at 0800-0900 hrs (1.36) there afterwards it declined to 1.20 at 1000-1200 hrs. The total abundance and composition of *A. mellifera* (81 and 29.24%) was maximum followed by *A. cerana* (79 and 28.52%), *A. florea* (77 and 27.80 %) and it was lowest (40 and 14.44%) with *A. dorsata* (Table 3).

The peak activity of pollen foragers of *A. cerana* (29/5min./4fl.) and *A. mellifera* (18/5min./4fl.) was observed during 0700-0800 hrs on *H. polyrhizus*, whereas in case of pollen foragers of *A. dorsata* (8/5min./4fl.) and *A. florea* (27/5min./4fl.), the peak was recorded during 0700-0900 hrs and 1000-1200 hrs, respectively. The diversity of pollen foragers was low during morning 0600 to 0700 hrs (0.84) and

**TABLE 3**

**Relative abundance (No. /5 min/4 flowers) and Shanon-Wiener diversity index (H) of pollen foragers of *Apis* species on dragon fruit types, *Hylocereus undatus* (white flesh) and *H. polyrhizus* (pink flesh) during 2nd phase of flowering (27.05.2022-31.05.2022)**

| *Apis* species | *Hylocereus undatus* | | | | | | *Hylocereus polyrhizus* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time (hrs) | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' |
| 0600-0700 | 3.00 | 19.00 | 22.00 | - | 44.00 | 0.89 | 2.00 | 22.00 | 15.00 | - | 39.00 | 0.84 |
| 0700-0800 | 10.00 | 18.00 | 17.00 | - | 45.00 | 1.06 | 8.00 | 29.00 | 18.00 | - | 55.00 | 0.98 |
| 0800-0900 | 11.00 | 12.00 | 14.00 | 8.00 | 44.00 | 1.36 | 8.00 | 19.00 | 12.00 | 8.00 | 47.00 | 1.31 |
| 0900-1000 | 6.00 | 11.00 | 14.00 | 16.00 | 47.00 | 1.33 | 6.00 | 16.00 | 12.00 | 13.00 | 47.00 | 1.33 |
| 1000-1100 | 7.00 | 11.00 | 9.00 | 27.00 | 51.00 | 1.20 | 2.00 | 12.00 | 10.00 | 22.00 | 46.00 | 1.17 |
| 1100-1200 | 3.00 | 8.00 | 5.00 | 26.00 | 46.00 | 1.20 | - | 7.00 | 7.00 | 27.00 | 41.00 | 0.87 |
| Total | 40.00 | 79.00 | 81.00 | 77.00 | 277.00 | - | 26.00 | 105.00 | 74.00 | 70.00 | 275.00 | - |
| Mean±SD | 6.66 ± 3.38 | 13.16 ± 4.35 | 13.5 ± 5.95 | 19.25 ± 9 | - | - | 5.2 ± 3.03 | 17.5 ± 7.7 | 12.33 ± 3.82 | 17.5 ± 8.6 | - | - |
| Composition of individual visitors (%) | 14.44 | 28.52 | 29.24 | 27.80 | 100.00 | - | 9.45 | 38.18 | 26.91 | 25.45 | 100.00 | - |

reached maximum at 0900-1000 hrs (1.33), there afterwards declined to 0.87 at 1100-1200 hrs. The total abundance and composition of *Apis cerana* (105 and 38.18%) which was maximum followed by that of *A. mellifera* (74 and 26.91%), *A. florea* (70 and 25.45%) and the lowest (26 and 9.45%) in case of *A. dorsata* (Table 3).

**Third Phase of Flowering in *Hylocereus undatus* and *Hylocereus polyrhizus***

Pollen foraging activity of *Apis dorsata*, *A. cerana* and *A. mellifera* were observed from 0600-1200 hrs, whereas *A. florea* foraged the pollen from 0800-1200 hrs on both types of dragon fruit with the exception of *Apis dorsata* which stopped the foraging activity at 1000 to 1100 hrs on *Hylocereus polyrhizus*.

On *Hylocereus undatus,* peak in pollen foragers of *A. dorsata* (7/5min./4fl) and *A. cerana* (10/5min. /4fl.) was observed during 0800-0900 hr, whereas in case of pollen foragers *A. mellifera* (12/5min. /4fl.) and *A. florea* (14/5min. /4fl.), the peak was recorded during 0700-0800 and 1000-1100 hrs, respectively. The pollinator diversity was low during morning 0600 to 0700 hrs (0.86) and gradually reached maximum at 1100-1200 hrs (1.35). The total abundance and composition of *Apis mellifera* (54 and 31.58%) was maximum, followed by *A. cerana* (49 and 28.65 %), *A. florea* (39 and 22.81%) and lowest (29 and 16.96 %) in case of *A. dorsata* (Table 4).

The peak in pollen foragers of *A. dorsata* (7/5min. / 4fl.) and *A. mellifera* (12/5min./4fl.) was observed during 0800-0900 hr, whereas in case of pollen foragers of *A. cerana* (12/5min./4fl.) and *A. florea* (27/5min./4fl.), the peak was recorded during 0700-0800 hrs and 1000-1100 hrs, respectively. The diversity was low during morning 0600 to 0700 hrs (0.97) and reached maximum at 0800-0900 hrs (1.31) there after declined 1.03 at 1100-1200 hrs. The total abundance and composition of *Apis florea* (62 and 32.98%) was maximum followed by *A. mellifera* (52 and 28.72%), *A. cerana* (50 and 26.60%) and the lowest (22 and 11.70%) in case of *A. dorsata* on *Hylocereus polyrhizus* (Table 4).

**Fourth Phase of Flowering in *Hylocereus undatus* and *Hylocereus polyrhizus***

Pollen foraging activity of *A. dorsata*, *A. cerana* and *A. mellifera* were observed from 0600-1200 hrs, whereas *A. florea* foraged the pollen from 0800-1200 hrs on both types of dragon fruit, with the exception of *A. dorsata* which stopped the foraging activity at 1000 to 1100 hrs on *Hylocereus polyrhizus*.

On *H. undatus,* peak in pollen foragers of *A. cerana* (30/5min. /4fl.) and *A. mellifera* (37/5min. /4fl.) was

**TABLE 4**

**Relative abundance (No. /5 min/4 flowers) and Shanon-Wiener diversity index (H) of pollen foragers of *Apis* species on dragon fruit types, *Hylocereus undatus* (white flesh) and *H. polyrhizus* (pink flesh) during 3rd phase of flowering (09.06.2022-12.06.2022)**

| *Apis* species | *Hylocereus undatus* | | | | | | *Hylocereus polyrhizus* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time (hrs) | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' |
| 0600-0700 | 1.00 | 9.00 | 9.00 | - | 19.00 | 0.86 | 2.00 | 7.00 | 8.00 | - | 17.00 | 0.97 |
| 0700-0800 | 6.00 | 9.00 | 12.00 | - | 27.00 | 1.06 | 6.00 | 12.00 | 11.00 | - | 29.00 | 1.05 |
| 0800-0900 | 7.00 | 10.00 | 12.00 | 5.00 | 34.00 | 1.33 | 7.00 | 8.00 | 12.00 | 9.00 | 36.00 | 1.36 |
| 0900-1000 | 5.00 | 9.00 | 9.00 | 13.00 | 36.00 | 1.33 | 5.00 | 9.00 | 8.00 | 15.00 | 37.00 | 1.31 |
| 1000-1100 | 6.00 | 8.00 | 7.00 | 14.00 | 35.00 | 1.32 | 2.00 | 8.00 | 10.00 | 27.00 | 47.00 | 1.08 |
| 1100-1200 | 4.00 | 4.00 | 5.00 | 7.00 | 20.00 | 1.35 | - | 6.00 | 5.00 | 11.00 | 22.00 | 1.03 |
| Total | 29.00 | 49.00 | 54.00 | 39.00 | 171.00 | - | 22.00 | 50.00 | 54.00 | 62.00 | 188.00 | - |
| Mean±SD | 4.83 ± 2.13 | 8.16 ± 2.13 | 9 ± 2.75 | 9.75 ± 4.42 | - | - | 4.4 ± 2.3 | 8.33 ± 2.06 | 9 ± 2.52 | 15.5 ± 8.06 | - | - |
| Composition of individual visitors (%) | 16.96 | 28.65 | 31.58 | 22.81 | 100.00 | - | 11.70 | 26.60 | 28.72 | 32.98 | 100.00 | - |

*Note* : *A. d: Apis dorsata; A.c: Apis cerana; A.m: Apis mellifera; A.f: Apis florea*

observed during 0800-0900 hr, whereas in case of pollen foragers of *A. dorsata* (7/5min./4fl.) and *A. florea* (11/5min./4fl.), the peak was recorded during 0700-0900 hrs and 1000-1100 hrs, respectively. The diversity was low during morning 0600 to 0700 bhrs (1.00) and reached maximum at 1000-1100 hrs (1.19) thereafter declined to 1.17 at 1100-1200 hrs. The total abundance and composition of *Apis mellifera* (98 and 44.50%) was maximum followed by *A. cerana* (81 and 36.50%), *A. florea* (23 and 10.40 %) and lowest (20 and 9%) with *A. dorsata* (Table 5).

The peak in pollen foragers of *A. dorsata* (8/5min./4fl.), *A. cerana* (40/5min./4fl.) and *A. mellifera* (48/5min./4fl.) was observed during 0700-0800 hrs, whereas in case of pollen foragers of *A. florea* (6/5min./4fl.), the peak was recorded during 0900-1000 hrs. The diversity was low during morning 0600 to 0700

**TABLE 5**

**Relative abundance (No. /5 min/4 flowers) and Shanon-Wiener diversity index (H) of pollen foragers of *Apis* species on dragon fruit types, *Hylocereus undatus* (white flesh) and *H. polyrhizus* (pink flesh) during 4th phase of flowering (27.06.2021-01.07.2021)**

| *Apis* species | *Hylocereus undatus* | | | | | | *Hylocereus polyrhizus* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time (hrs) | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' |
| 0600-0700 | 4.00 | 6.00 | 10.00 | - | 20.00 | 1.00 | 3.00 | 17.00 | 18.00 | - | 38.00 | 0.90 |
| 0700-0800 | 7.00 | 10.00 | 12.00 | - | 29.00 | 1.07 | 8.00 | 40.00 | 48.00 | - | 96.00 | 0.91 |
| 0800-0900 | 4.00 | 30.00 | 37.00 | 3.00 | 74.00 | 1.02 | 7.00 | 24.00 | 32.00 | 3.00 | 66.00 | 1.19 |
| 0900-1000 | 2.00 | 17.00 | 24.00 | 6.00 | 49.00 | 1.10 | 3.00 | 11.00 | 16.00 | 6.00 | 36.00 | 1.22 |
| 1000-1100 | 2.00 | 13.00 | 11.00 | 11.00 | 37.00 | 1.19 | 2.00 | 5.00 | 12.00 | 5.00 | 24.00 | 1.07 |
| 1100-1200 | 1.00 | 5.00 | 4.00 | 3.00 | 13.00 | 1.17 | - | 3.00 | 7.00 | 2.00 | 12.00 | 0.96 |
| Total | 20.00 | 81.00 | 98.00 | 23.00 | 222.00 | - | 23.00 | 100.00 | 133.00 | 16.00 | 272.00 | - |
| Mean±SD | 3.33 ± 2.16 | 13.5 ± 9.22 | 16.33 ± 12.04 | 5.75 ± 3.77 | - | - | 4.6 ± 2.70 | 16.66 ± 13.8 | 22.16 ± 15.18 | 4 ± 1.82 | - | - |
| Composition of individual visitors (%) | 9.00 | 36.50 | 44.50 | 10.40 | 100 | - | 8.46 | 36.76 | 48.90 | 5.88 | 100.00 | - |

*Note: A. d: Apis dorsata; A. c: Apis cerana; A. m: Apis mellifera; A. f: Apis florea*

hrs (0.90) and it reached maximum at 0900-1000 hrs (1.22), thereafter it declined to 0.96 during 1100-1200 hrs. The total abundance and composition of *A. mellifera* (133 and 48.90%) was maximum, followed by that of *A. cerana* (100 and 36.76%), *A. dorsata* (23 and 8.46%) and lowest (16 and 5.88 %) was in case of *A. florea* on *Hylocereus polyrhizus* (Table 5).

**Fifth Phase of Flowering in *Hylocereus undatus* and *Hylocereus polyrhizus***

Pollen foraging activity of *Apis dorsata*, *A. cerana* and *A. mellifera* were observed from 0600-1200 hrs, whereas *A. florea* foraged for the pollen from 0800-1200 hrs on both types of dragon fruit with the exception of *A. dorsata* which stopped the foraging activity during 1000 to 1100 hrs on *Hylocereus polyrhizus*.

On *Hylocereus undatus,* peak in pollen foragers of *A. dorsata* (7/5min./4fl.), *A. cerana* (19/5min./4fl.) and *A. mellifera* (24/5min./4fl.) was observed during 0700-0800hr, whereas in case of pollen foragers of *A. florea* (13/5min. /4fl.), the peak was recorded during 0900-1000 hrs. The lowest (0.93) and highest (1.28) diversity was recorded during 0600 to 0700 hrs and 1000-1100 hrs, respectively. The total abundance and composition of *A. mellifera* (77 and 42.31%) was maximum, followed by *A. cerana* (57 and 31.32%), *A. florea* (28 and 15.38%) and lowest (20 and 10.99%) was in case of *A. dorsata* (Table 6).

The peak in pollen foragers of *A. dorsata* (10/5min./4fl.), *A. cerana* (23/5min./4fl.) and *A. mellifera* (31/5min./4fl.) was observed during 0700-0800 hr, whereas in case of pollen foragers of *A. florea* (6/5min./4fl.), it was recorded during 1000-1100 hrs. The lowest (0.96) and highest (1.24) diversity was recorded during 0600 to 0700 hrs and 0900-1000 hrs, respectively. The total abundance and composition of *A. mellifera* (98 and 43.36%) was maximum, followed by *A. cerana* (85 and 37.61%), *A. dorsata* (26 and 11.5%) and lowest (17 and 7.52%) was in case of *A. florea* on *Hylocereus polyrhizus* (Table 6).

**Sixth Phase of Flowering in *Hylocereus undatus* and *Hylocereus polyrhizus***

Pollen foraging activity of *Apis dorsata*, *A. cerana* and *A. mellifera* were observed from 0600-1200 hrs, whereas *A. florea* foraged the pollen from 0800-1200 hrs on both types of dragon fruit with the exception of *A. dorsata,* which stopped the foraging activity at 1000 to 1100 hrs on *Hylocereus polyrhizus*.

**Table 6**

**Relative abundance (No. /5 min/4 flowers) and Shanon-Wiener diversity index (H) of pollen foragers of *Apis* species on dragon fruit types, *H. undatus* (white flesh) and *H. polyrhizus* (pink flesh) during 5th phase of flowering (19.07.2021-23.07.2021)**

| *Apis* species | *Hylocereus undatus* | | | | | | *Hylocereus polyrhizus* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time (hrs) | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' |
| 0600-0700 | 2.00 | 8.00 | 11.00 | - | 21.00 | 0.93 | 3.00 | 11.00 | 12.00 | - | 26.00 | 0.96 |
| 0700-0800 | 7.00 | 19.00 | 24.00 | - | 50.00 | 0.99 | 10.00 | 23.00 | 31.00 | - | 64.00 | 1.00 |
| 0800-0900 | 5.00 | 15.00 | 16.00 | 4.00 | 40.00 | 1.22 | 7.00 | 19.00 | 24.00 | 3.00 | 53.00 | 1.15 |
| 0900-1000 | 3.00 | 7.00 | 13.00 | 13.00 | 36.00 | 1.26 | 5.00 | 14.00 | 17.00 | 5.00 | 41.00 | 1.24 |
| 1000-1100 | 2.00 | 5.00 | 8.00 | 7.00 | 22.00 | 1.28 | 1.00 | 11.00 | 9.00 | 6.00 | 27.00 | 1.18 |
| 1100-1200 | 1.00 | 3.00 | 5.00 | 4.00 | 13.00 | 1.26 | - | 7.00 | 5.00 | 3.00 | 15.00 | 1.04 |
| Total | 20.00 | 57.00 | 77.00 | 28.00 | 182.00 | - | 26.00 | 85.00 | 98.00 | 17.00 | 226.00 | - |
| Mean±SD | 3.33 ± 2.25 | 9.5 ± 6.18 | 12.83 ± 6.7 | 7 ± 4.24 | - | - | 5.2 ± 3.5 | 14.16 ± 5.8 | 16.33 ± 9.75 | 4.25 ± 1.5 | - | - |
| Composition of individual visitors (%) | 10.99 | 31.32 | 42.31 | 15.38 | 100.00 | - | 11.50 | 37.61 | 43.36 | 7.52 | 100.00 | - |

*Note* : *A. d: Apis dorsata; A. c: Apis cerana; A. m: Apis mellifera; A. f: Apis florea*

**TABLE 7**

**Relative abundance (No. /5 min/4 flowers) and Shanon-Wiener diversity index (H) of pollen foragers of *Apis* species on dragon fruit types, *Hylocereus undatus* (white flesh) and *H. polyrhizus* (pink flesh) during 6th phase of flowering (02.08.2021-06.08.2021)**

| *Apis* species | *Hylocereus undatus* | | | | | | *Hylocereus polyrhizus* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time (hrs) | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' |
| 0600-0700 | 4.00 | 7.00 | 4.00 | - | 15.00 | 1.06 | 4.00 | 7.00 | 7.00 | - | 18.00 | 1.06 |
| 0700-0800 | 7.00 | 15.00 | 17.00 | - | 39.00 | 1.03 | 8.00 | 9.00 | 10.00 | - | 27.00 | 1.09 |
| 0800-0900 | 5.00 | 7.00 | 15.00 | 5.00 | 32.00 | 1.26 | 5.00 | 10.00 | 9.00 | 2.00 | 26.00 | 1.24 |
| 0900-1000 | 2.00 | 6.00 | 11.00 | 15.00 | 34.00 | 1.19 | 3.00 | 7.00 | 10.00 | 5.00 | 25.00 | 1.29 |
| 1000-1100 | 2.00 | 5.00 | 7.00 | 8.00 | 22.00 | 1.28 | 1.00 | 5.00 | 7.00 | 5.00 | 18.00 | 1.23 |
| 1100-1200 | 1.00 | 2.00 | 3.00 | 3.00 | 9.00 | 1.31 | - | 2.00 | 3.00 | 2.00 | 7.00 | 1.07 |
| Total | 21.00 | 42.00 | 57.00 | 31.00 | 151.00 | - | 21.00 | 40.00 | 46.00 | 14.00 | 121.00 | - |
| Mean±SD | 3.5 ± 2.25 | 7 ± 4.33 | 9.5 ± 5.78 | 7.75 ± 5.25 | - | - | 4.2 ± 2.6 | 6.66 ± 2.8 | 7.66 ± 2.6 | 3.5 ± 1.73 | - | - |
| Composition of individual visitors (%) | 13.91 | 27.81 | 37.75 | 20.53 | 100.00 | - | 17.36 | 33.06 | 38.02 | 11.57 | 100.00 | - |

*Note* : *A. d: Apis dorsata; A. c: Apis cerana; A. m: Apis mellifera; A. f: Apis florea*

On *Hylocereus undatus*, peak in pollen foragers activity of *A. dorsata* (7/5min. /4fl.), *A. cerana* (15/5min./4fl.) and *A. mellifera* (17/5min./4fl.) was observed during 0700-0800 hr, whereas peak activity of *A. florea* (15/5min./4fl.) was recorded during 0900-1000 hrs. The lowest (1.03) and highest (1.31) diversity was recorded during 0700 to 0800 hrs and 1100-1200 hrs, respectively. The total abundance and composition of *A. mellifera* (57 and 37.75%) was maximum, followed by *A. cerana* (42 and 27.81%), *A. florea* (31 and 20.53%) and lowest (21 and 13.91%) was in case of *A. dorsata* on *Hylocereus undatus* (Table 7).

The peak in pollen foragers of *A. dorsata* (8/5min./4fl.) and *A. mellifera* (10/5min./4fl.) was observed during 0700-0800 hr, whereas in case of pollen foragers of *A. cerana* (10/5min./4fl.) and *A. florea* (5/5min./4fl.), the peak was recorded during 0800-0900 hrs and 0900-1100 hrs, respectively. The lowest diversity was recorded during 0600 to 0700 hrs (1.06) and the highest was recorded during 0900-1000 hrs (1.29). The total abundance and composition of *A. mellifera* (46 and 38.02%) was maximum, followed by *A. cerana* (40 and 33.06%), *A. dorsata* (21 and 17.36%) and lowest (14 and 11.57%) in case of *A. florea* on *Hylocereus polyrhizus* (Table 7).

**Seventh Phase of Flowering in *Hylocereus undatus* and *Hylocereus polyrhizus***

Pollen foraging activity of *Apis dorsata*, *A. cerana* and *A. mellifera* were observed from 0600-1200 hrs, whereas *A. florea* foraged the pollen from 0800-1200 hrs. on both types of dragon fruit with the exception of *A. dorsata,* which stopped the foraging activity during 1000 to 1100 hrs on *Hylocereus polyrhizus*.

On *Hylocereus undatus,* peak in pollen forager activity of *A. dorsata* (6/5min. /4fl.) and *A. mellifera* (17/5min. /4fl.) was observed during 0600-0800 hr and 0600-0700 hrs, respectively, whereas in case of pollen foragers of *A. cerana* (15/5min./4fl.) and *A. florea* (6/5min./4fl.), the peak was recorded during 0800-0900 hrs and 0900-1000 hrs, respectively. The lowest diversity (0.99) was recorded during 0600 to 0700 hrs and reached maximum (1.27) during 0900-1100 hrs. The total abundance and composition of *A.mellifera* (67 and 39.88%) was maximum, this was followed by *A. cerana* (63 and 37.50%), *A. dorsata* (22 and 13.10%) and lowest (16 and 9.52 %) in case of *A. florea* (Table 8).

The peak in pollen foragers of *A. dorsata* (8/5min./4fl.) and *A. mellifera* (39/5min./4fl.) was observed during 0700-0800 hr, whereas in case of pollen

**TABLE 8**

**Relative abundance (No. /5 min/4 flowers) and Shanon-Wiener diversity index (H) of pollen foragers of *Apis* species on dragon fruit types, *Hylocereus undatus* (white flesh) and *H. polyrhizus* (pink flesh) during 7th phase of flowering (04.09.2021-08.09.2021)**

| *Apis* species | *Hylocereus undatus* | | | | | | *Hylocereus polyrhizus* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time (hrs) | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' |
| 0600-0700 | 6.00 | 8.00 | 17.00 | - | 31.00 | 0.99 | 7.00 | 29.00 | 23.00 | - | 59.00 | 0.96 |
| 0700-0800 | 6.00 | 14.00 | 15.00 | - | 35.00 | 1.03 | 8.00 | 17.00 | 39.00 | - | 64.00 | 0.91 |
| 0800-0900 | 4.00 | 15.00 | 13.00 | 3.00 | 35.00 | 1.18 | 7.00 | 14.00 | 27.00 | 2.00 | 50.00 | 1.09 |
| 0900-1000 | 3.00 | 12.00 | 10.00 | 6.00 | 31.00 | 1.27 | 7.00 | 16.00 | 18.00 | 4.00 | 45.00 | 1.23 |
| 1000-1100 | 2.00 | 9.00 | 7.00 | 5.00 | 23.00 | 1.27 | 3.00 | 7.00 | 9.00 | 3.00 | 22.00 | 1.27 |
| 1100-1200 | 1.00 | 5.00 | 5.00 | 2.00 | 13.00 | 1.22 | - | 3.00 | 5.00 | 2.00 | 10.00 | 1.02 |
| Total | 22.00 | 63.00 | 67.00 | 16.00 | 168.00 | - | 32.00 | 86.00 | 121.00 | 11.00 | 250.00 | - |
| Mean±SD | 3.66 ± 2.06 | 10.5 ± 3.83 | 11.16 ± 4.6 | 4 ± 1.82 | - | - | 6.4 ± 1.94 | 14.3 ± 9.02 | 20.16 ± 12.4 | 2.75 ± 0.95 | - | - |
| Composition of individual visitors (%) | 13.10 | 37.50 | 39.88 | 9.52 | 100.00 | - | 12.80 | 34.40 | 48.40 | 4.40 | 100.00 | - |

*Note* : *A. d: Apis dorsata; A. c: Apis cerana; A. m: Apis mellifera; A. f: Apis florea*

foragers of *A. cerana* (29/5min./4fl.) and *A. florea* (4/5min./4fl.), the peak was recorded during 0600-0700 hrs and 0900-1100 hrs, respectively. The lowest diversity (0.91) was recorded during 0700-0800 hrs and highest (1.27) was recorded during 1000-1100 hrs. The total abundance and composition of *A. mellifera* (121and 48.40%) was maximum, followed by that of *A. cerana* (86 and 34.40%), *A. dorsata* (32 and 12.80%) and lowest (11 and 4.40 %) in case of *A. florea* on *Hylocereus polyrhizus* (Table 8).

**Eighth Phase of Flowering in *Hylocereus polyrhizus***

The peak in pollen foragers of *A. cerana* (49/5min./4fl.) and *A. mellifera* (44/5min./4fl.) was observed during 0700-0800 hrs, whereas in case of pollen foragers of *A. dorsata* (16/5min./4fl.) and *A. florea* (8/5min./4fl.), the peak was recorded during 0800-0900 hrs and 0900-1000 hrs, respectively. The lowest diversity (0.92) was recorded during 0700 to 0800 hrs and it reached maximum (1.20) during 0900-1100 hrs. The total abundance and composition of *A. cerana* (138 and 41.69%) was maximum, followed by *A. mellifera* (137 and 41.39%), *A. dorsata* (39 and 11.78%) and lowest (17 and 5.14 %) in case of *A. florea* on *Hylocereus polyrhizus* (Table 9).

**Pollen Output and Pollen Carrying Capacity of *Apis* Species of Honeybees from the Flowers of *H. undatus* (White Flesh) and *H. Polyrhizus* (Pink Flesh)**

The field and laboratory estimation of pollen output per flower revealed that the *H. polyrhizus* (1980 ± 170 mg/flower) yielded good amount of pollen as compared to *H. undatus* (1950 ± 260 mg/flower). The pollen load weight varied significantly among *Apis* species from the flowers of two types of dragon fruit. Among *Apis* species, the maximum pollen load weight was recorded in *A. dorsata* (16.50 and 16.35 mg/bee), followed by *A. mellifera* (5.80 and 5.90 mg/bee), *A. cerana* (4.60 and 4.56 mg/bee) and lowest (3.20 and 3.34 mg/bee) was recorded in case of *A. florea* from the flowers of *H. undatus* and *H. polyrhizus* (Table 10).

The pollen output of *H. undatus* and pollen carrying capacity of *Apis* species revealed that the pollen produced by single flower accommodated maximum number of *A. florea* (609.37 bees/flower), followed by *A. cerana* (423.91 bees/flower), *A. mellifera* (336.20 bees/flower) and lowest number was in case of *A. dorsata* (118.18 bees/flower), if the individual forager from *Apis* species was allowed to forage on single flower *H. undatus*. However, the

**TABLE 9**

**Relative abundance (No. /5 min/4 flowers) and Shanon-Wiener diversity index (H) of pollen foragers of *Apis* species on dragon fruit type, *H. polyrhizus* (pink flesh) during 8th phase of flowering (15.10.2021-19.10.2021)**

| *Apis* spp. | *Hylocereus polyrhizus* | | | | | |
|---|---|---|---|---|---|---|
| Time (hrs) | *A. d* | *A.c* | *A.m* | *A.f* | Total | 'H' |
| 0600-0700 | 8.00 | 17.00 | 19.00 | - | 44.00 | 1.04 |
| 0700-0800 | 9.00 | 49.00 | 44.00 | - | 102.00 | 0.92 |
| 0800-0900 | 16.00 | 25.00 | 40.00 | 3.00 | 84.00 | 1.14 |
| 0900-1000 | 4.00 | 24.00 | 18.00 | 8.00 | 54.00 | 1.20 |
| 1000-1100 | 2.00 | 16.00 | 11.00 | 3.00 | 32.00 | 1.10 |
| 1100-1200 | - | 7.00 | 5.00 | 3.00 | 15.00 | 1.04 |
| Total | 39.00 | 138.00 | 137.00 | 17.00 | 331.00 | - |
| Mean±SD | 7.8 ± 5.4 | 23 ± 14 | 22 ± 15.7 | 4.25 ± 2.5 | - | - |
| Composition of individual visitors(%) | 11.78 | 41.69 | 41.39 | 5.14 | 100.00 | - |

**TABLE 10**

**Pollen output (mg/flower) and pollen carrying capacity of *Apis* species of honeybees (mg/bee) from the flowers of *Hylocereus undatus* and *H. polyrhizus* at Suradenupura, Bengaluru Urban during 2021-22**

| *Apis* species | *Hylocereus undatus* (white flesh) | | | *Hylocereus polyrhizus* (pink flesh) | | |
|---|---|---|---|---|---|---|
| | Pollen yield (mg/ flower) | Pollen load (mg/bee) | Estimated maximum No. of bees accommodated or forage/flower | Pollen yield (mg/ flower) | Pollen load (mg/bee) | Estimated maximum No. of bees accommodated or forage/flower |
| *A. dorsata* | 1950±260 | 16.50 [a] | 118.18 | 1980±170 | 16.35 [a] | 121.10 |
| *A. cerana* | | 4.60 [c] | 423.91 | | 4.56 [c] | 434.21 |
| *A. mellifera* | | 5.80 [b] | 336.20 | | 5.90 [b] | 335.59 |
| *A. florea* | | 3.20 [d] | 609.37 | | 3.34 [d] | 592.81 |
| Mean | - | 7.52 | - | - | 7.53 | - |
| S.Em | - | 0.13 | - | - | 0.25 | - |
| CD@5% | - | 0.40 | - | - | 0.80 | - |
| CV | - | 3.89 | - | - | 7.64 | - |

*Note* : Means followed by the same letter in a column do not differ significantly by DMRT

pollen produced by a single flower of *H. polyrhizus* accommodated maximum number of *A. florea* (592.81 bees/flower), followed by *A. cerana* (434.21 bees/ flower), *A. mellifera* (335.59 bees/flower) and lowest number was in case of *A. dorsata* (121.10 bees/ flower), if the individual forager from *Apis* species was allowed to forage on single flower of *H polyrhizus* (Table 10).

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