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Foraging Behaviour of Different Honeybees on Sunflower – A Comparative Study

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Sunflower is a bee loving crop. The foraging behaviour of *Apis dorsata* L. was studied in comparison with Indian bee (*A. cerana* indica) and stingless bee (Trigona sp.) on this crop. A.dorsata outnumbered the other two bee species on capitulum after anther dehiscence during all the three stages of blooming. *A. dorsata* population varied at different hours of the day showing a bimodal distribution. The foragers were active from 10.00 to 11.00 am in the forenoon and 2.00 to 3.00 pm in the afternoon. Foraging behaviour showed distinct variation according to the floral reward collected. *A.dorsata* alone was found to tap the nectar fully due to its longer lapping tongue. Exclusive pollen collectors were rare. Majority of the foragers collected both pollen and nectar. Exclusive nectar foragers intentionally discarded the pollen load before final take off. Rains adversely affected the time of commencement and cessation of foraging. Among all the bee species studied, *A.dorsata* was the best pollinator of sunflower based on pollinator efficiency index. Wild honey bees like *A.dorsata* have to be conserved in crop ecosystem where planned pollination with hive bees is not in vogue.

Key words: *Apis dorsata*, *Apis cerana indica,* pollinator, honey bees, *Helianthus annuus*

Sunflower is essentially a cross-pollinated crop and it requires the assistance of bees for pollination success. The most predominant insect pollinators observed on sunflower are bees. Rock bees, *Apis dorsata* F., European bee, *Apis mellifera* L., Indian bee, *Apis cerana indica* F. and stingless bees, *Trigona sp* are the common bees attracted to sunflower. *A.dorsata* plays a crucial role in enhancing the productivity of sunflower. It also plays an important role in hybrid seed production in sunflower (Mohana Rao *et al.,* 1995). *A.dorsata* is equally attracted to both varieties and hybrids in large number. Foraging behaviour of *A.dorsata* on sunflower has not been studied thoroughly. Hence, a comparative study was taken up to understand the foraging behaviour and pollinating efficiency of *A.dorsata*. These two traits were compared with that of the common hive bee, *A.cerana indica* and stingless bee, *Trigona* sp commonly attracted to sunflower.

Materials and Methods

Field investigations were carried out during winter (August to November, 2012) in Tamil Nadu Agricultural University, Coimbatore to study the foraging behaviour of *A.dorsata* on two sunflower varieties *viz.,* Morden and CO5. Observations were recorded on the abundance of the above three bee species during initial, peak and final stages of flowering which lasted for ten days. Bee population was monitored on 25 randomly selected heads by visual scanning from 6.00 am to 6.00 pm at hourly interval to work out the peak foraging period. Foraging activity of the bee species was studied by making *in situ* observations and photography. Time of initiation and cessation of foraging of each bee species were recorded on a clear sunny day and a rainy day. Pollinator efficiency index (PEI) were worked out for the three bee species by multiplying the number of bees at the peak period of activity with the number of loose pollen grains sticking on the body of each bee species.

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Results and Discussion

A.dorsata was the most dominant pollinator found on sunflower on both the varieties on number basis during final stage of flowering. However, *Trigona* sp was the dominant pollinator during intial and peak stages of flowering (Fig.1). The stingless bee activity was mainly restricted to the unopened disc florets found at the centre of the capitulum for collecting resinous fluid oozing out from these florets until anther dehiscence. The population of *A.dorsata* outnumbered the other two bee species after anther dehiscence in all the three stages of blooming. The secretion of resinous fluid decreased at the end of the blooming period, which substantially reduced the stingless bee population during the final blooming stage (Fig.1). Availability of nest congregations near the experimental field was the major reason for dominance of *A.dorsata* during various phases of blooming of sunflower. *A.dorsata* was the most common wild honeybee visiting

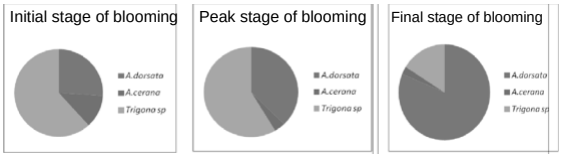

Fig.1. Relative abundance of bee pollinators on sunflower during three stages of blooming during winter 2012

sunflower in places where commercial bee keeping with hive bees was not in vogue. *A.dorsata* has been the most widely distributed wild honey bee species in India. It had been reported as the dominant visitor of sunflower in Maharashtra (Nadre *et al.,* 1996), Rajasthan (Swaminathan and Baradwaj, 1982), Karnataka (Bhat and Jagdish, 1995) and Andhra Pradesh (Rajasri *et al.,* 2012).

The abundance of *A.dorsata* varied from dawn to dusk. A bimodal visitation was observed (Fig. 2). The morning peak and evening peak of visitation occurred during 10.00-11.00 am and 2.00-3.00 pm respectively. Among these two peaks, the morning

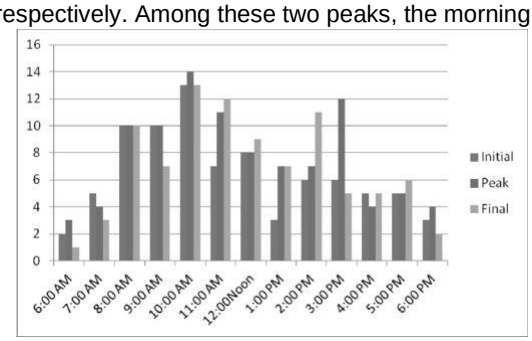

Fig. 2. Abundance of *A.dorsata* on sunflower at different hours of the day during three stages of blooming during winter 2012

peak was the highest one. The morning peak occurred after the pollen dehiscence and release which usually occurred around 7.00 am at the study site. Extension of styles occurred around 3.00 pm. Elongation of style and subsequent protrusion of stigma outside the anther tube pushed off the pollen grains adhering to the interior parts of anther tube. This resulted in sustained pollen availability during evening hours which lured the bees again for pollen collection resulting in a second peak. Satyanarayana and Seetharam (1982) observed a forenoon peak at 10.30 am and an afternoon peak at 4.30 pm for *A.dorsata* on hybrid sunflower. This earlier finding supports our present finding.

A.dorsata foragers collected either pollen or nectar or both from sunflower. Nectar foragers were less active on disc florets. The body of nectar forager became nearly vertical while sipping the nectar accumulated in the corolla tube. Both lapping tongue and distal end of head were inserted into floret found in male or female phase. The gaster assumed an upright position during this process. It also got expanded due to nectar intake inside the crop. After nectar collection from a capitulum, it flew to a nearby capitulum for further nectar collection. Before departure from each head, nectar forager cleaned its body by using legs to discard the pollen grains adhering to its body (Plate 1). Forager collecting both nectar and pollen during the same foraging trip did not discard pollen but loaded pollen in its corbicula (Plate 2). Of all the native honey bees, *A.dorsata* was highly efficient in totally tapping the secreted nectar due to its longer tongue length (Bhat

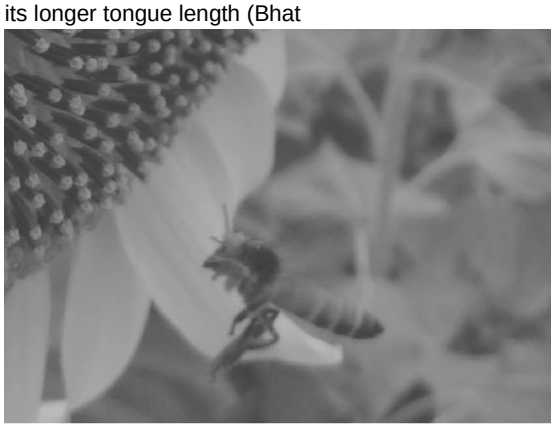

Plate 1. Nectar foraging *A.dorsata* discarding pollen grains from its body during hovering flight

Plate 2. Nectar and pollen foraging *A.dorsata* loading pollen in corbicula during hovering flight

Plate 3. *A.dorsata* forager with pollen grains all over its body

and Jagdish, 1995) . During this act pollen grains stuck to facial region of the forager and were brought in close contact with stigmatic surface resulting in pollination.

Pollen forager actively walked on the head and gathered pollen using both fore legs and middle legs mainly from the disc florets which were in male phase. The pollen grains got stuck all over the body and in some foragers especially on the dorsal side of the thorax (nototribic). Pollen thus gathered was loaded to corbicula mainly during hovering flight. Sometimes pollen loading occurred while forager was clinging either to ray floret or sepal or petiole after pollen collection. The corbicular pollen load of pollen forager was larger in size. Further, the gaster of pollen forager did not show any enlargement since its honey stomach was not filled with nectar. Pollen forager swiftly flew up after pollen collection. It did not part with its pollen load before final departure. Foragers exclusively collecting pollen were rare. The floral handling time was more for nectar collection (90 sec) than pollen collection (30 sec).

Of all the native bees, *A.dorsata* is the largest honey bee species which forms a larger colony. Hence, there is a need for greater quantity of pollen to support the development of larger brood. Further, it hoarded a larger amount of honey in the nest. Sunflower crop served as an excellent source providing both nectar and pollen for *A.dorsata* throughout the blooming period. In a clear day, *A.dorsata* commenced foraging at 6.20 am and stopped their foraging activity at 6.55 pm. However, in a rainy day, commencement of foraging was delayed and it started only at 7.30 am and cessation occurred at 5.45 pm. Rain affected the activity *A.dorsata* negatively. Heavy rain not only affected flight but also reduced the availability of floral rewards. Bad weather conditions markedly affected foraging activity of *A.dorsata* on sunflower capitulum. Observations of Puskadija *et al.,* (2007) revealed that precipitation had negative impact on honey bee visits on sunflower which is in consonance with the present finding.

Table 1. Pollination Efficiency of bees in sunflower

Species	Floral handling time (min)	Loose pollen grains /insect (in lakhs)	Abundance at 8.00-9.00 am (No / head)	PEI ('000)
A.dorsata	1.5	1.66	0.45	75
A.cerana indica	2.2	0.83	0.31	26
Trigona sp.	3.5	0.22	0.87	19
SEd	0.68	0.08		
CD(.05)	1.90	0.16		

Floral handling time required for *A.dorsata* was only 1.5 minutes (Table 2) as these bees swiftly collected floral rewards. They could also visit several flowers in a shorter time, making them efficient pollen vectors. A huge quantity of loose pollen grains (1.66 lakhs) was found adhering to the branching hairs of its body. Since *A.dorsata* was the largest honey bee species, it could carry a larger load of pollen grains scattered all over its body (Plate 3). This particular trait also made *A.dorsata* the most effective pollinator as loose pollen grains alone could bring about pollination. Chances of pollination would be greater if more pollen grains were found on the body of a forager. Among the three bee species studied, loose pollen grains over the body and Pollinator Efficiency Index (PEI) were maximum in *A.dorsata* (Table 1). The present finding is in conformity with the earlier finding of Singh *et al.* (2000) who adjudged *A.dorsata,* as the most efficient pollinator in sunflower ecosystem because it had huge amount of loose pollen grains all over its body

Conclusion

Sunflower is an exotic crop introduced into India during early forties. Among the native bees, long tongued *A.dorsata* has been highly successful in utilizing this crop as an excellent pasturage offering both nectar and pollen. Of all the bees, *A.dorsata* was found to be the best pollinator of sunflower in improving the productivity. Hence, there exists an excellent mutualistic relationship between *A.dorsata* and sunflower. Wild bees especially *A.dorsata* play a crucial role in increasing sunflower yield wherever hive bees are not maintained commercially. Sunflower productivity is bound to decline sharply if wild honey bee population is absent or scanty in a locality. In such locations hive bees can be employed to ensure productivity. In addition, to conserve bees, caution has to be exercised whenever chemical plant protection steps are taken to suppress capitulum borer, *Helicoverpa armigera* (Hubner).

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