Differential floral attractiveness as a determinant of foraging decision in honeybees

Pollinator–plant interactions have co-evolved as reciprocal selective factors shaping their behaviour, physiology and ecology. In the course of evolution, there has been competition between plants for pollinators, and pollinators for plants[1,2]. Of the several crops that require cross-pollination, fruit trees face severe pollination problems because of their short flowering periods and competition from other plants simultaneously in bloom. Most of the fruit trees are highly self-incompatible and depend upon cross-pollinating insects for significant fruit production[3,4].

Studies were conducted at Udheywalla (32°39′13″N lat., 74°48′16″E long., 300 m asl), about 5 km away from Jammu city, to determine the pollinating insects visiting peach, plum and pear flowers during February–March 2008. Surprisingly, a weed commonly known as 'kurthaharl' (*Lepidagathus incurva*; Acanthaceae) that grows near the fruit trees, proved detrimental to their pollination and attracted a large number of bees. The relative abundance of bees on the flowers of different fruit trees such as peach, plum and pear was assessed using the method suggested by Abrol[5], with some modifications. Bee abundance was recorded from the beginning to the end of flowering. For this purpose, 15 branches were marked in five trees and the number of bees visiting each were counted for 5 min with 1 h interval in the period beginning from 0800 to 1800 h. For every hour, the 5 min average value was used as an index of foraging intensity. The foraging rates were determined using a chronometer with 0.01 s accuracy. The time spent by a bee gathering nectar was recorded using the chronometer. The number of flowers visited by an individual and the time taken to do so were also recorded, following their movements as long as possible. Based on data obtained from five such observations, the number of flowers visited per minute was calculated. Simultaneously, the relative abundance of bees visiting *L. incurva* was recorded from the commencement of flowering till the petal-fall. For this purpose, five plots, each measuring 1×1 m were selected randomly in the field and the number of bees of each species visiting these plots was recorded for 5 min at hourly intervals from each side of the plot using visual counting method. The mean of these five observations constituted the reading for each hour. The number of flowers visited per minute was recorded using the same method. To determine the nectar sugar concentration in the flowers of both, the fruit trees and the weed, the flowers were bagged with synthetic nylon nettings to exclude all nectarivorous insects. The nectar from these flowers was sampled with the help of microcapillary pipettes at an interval of 2 h throughout the day. The volume of nectar was measured with the help of 5λ pipettes and its sugar concentration was determined with hand refractometer (Erma-type, Japanese make).

The studies revealed that honeybees, *Apis dorsata* F., *Apis mellifera* Linn., *Apis cerana* F. and *Apis florea* F. were the most abundant flower visitors and comprised more than 80% of the total flower-visiting insects. Interestingly, the simultaneously growing weed attracted a large number of bees (23.0 ± 1.64 million/ha) compared to flowers of fruit trees such as peach, plum and pear (3.8 ± 0.61 million/ha). This may be attributed to the fact that the weed (*L. incurva*) had a long flowering period (February–May) compared to the fruit trees February and March). Furthermore, the weed had a high flowering density (51.0 ± 2.2 million flowers/ha) compared to the fruit trees (17.6 ± 1.81 million flowers/ha). The differences in flowering density and foraging populations between the weed and the fruit trees were significant ($P < 0.05$). The differential attraction of bees may also be due to the higher concentration of nectar sugars in the weed ($48.4 \pm 2.20\%$; $n = 20$) compared to that in peach ($32.6 \pm 1.68\%$; $n = 20$), plum ($28.0 \pm 1.14\%$; $n = 20$), and pear ($22.8 \pm 1.09\%$; $n = 20$) flowers. Further, the foraging rates of honeybees, *A. mellifera*, *A. cerana*, *A. dorsata* and *A. florea* (24.87 ± 2.84; 23.06 ± 1.96; 18.60 ± 1.88 and 4.76 ± 0.80 flowers/min respectively) were much higher on weed flowers compared to those on fruit trees (3.39 ± 0.08; 3.06 ± 0.60; 3.60 ± 0.48 and 1.82 ± 0.11 flowers/min respectively). This clearly shows that bees could harvest more energy per unit time from weed flowers than from fruit trees. In earlier studies, competition between the target plants and weeds has also been demonstrated[5–7]. Bees are generally attracted to flowers that are available in large numbers and are more rewarding in terms of energy[7–12]. It is, therefore, concluded that this weed, though a good bee floral source, competes with fruit trees for effective pollination and significant fruit production. Hence it should be removed during the period when the fruit trees are in flowering and require pollination.

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D. P. ABROL

Division of Entomology,
Sher-e-Kashmir University of Agricultural Sciences and Technology,
Faculty of Agriculture,
Chatha Jammu 180 009, India
e-mail: dharam_abrol@rediffmail.com