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Research Article

Crop Hosts and Pollination Potential of the Red Dwarf Honey Bee (*Apis florea* F.) in the Semi-arid Environment of North West India

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Abstract

Background and Objective: The red dwarf honey bee (*Apis florea*, Fabricius) is indigenous to semi-arid tropical environments of several parts of Asia and some parts of Africa. This species is also one of the important natural and wild pollinators of these regions. Therefore, knowledge on the crop hosts and pollination potential of this honey bee is important and this study was planned to get this information. **Materials and Methods:** A record of the crop plants visited by this honey bee during the year round was maintained. Pollination potential of this honey bee was ascertained on the basis of its foraging behavior and abundance of the foragers on the crop plants in the study area. **Results:** Red dwarf honey bee visited some 38 crop plants for pollen and/or nectar and acted as an important pollinator of more than 35 crops in the semi-arid environment of northwest India. **Conclusion:** Red dwarf honey bee has an excellent pollination potential for more than 35 crops of semi-arid environment of northwest India. On the basis of its pollination service, this honey bee needs vigorous conservation efforts.

Key words: Red dwarf honey bee, *Apis florea*, semi-arid environment, excellent pollination potential, foraging, pollination

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INTRODUCTION

Honey bees play a vital role in the pollination of plants^{1,2} and conservation of floral diversity³. Three honey bee species are indigenous to India. These include the giant honey bee (*Apis dorsata* F.), the little or dwarf honey bee (*Apis florea* F.) and the Indian hive bee (*Apis cerana indica* F.). The exotic honey bee (*Apis mellifera* L.) was also introduced in 1962 and has now been successfully established in India. *Apis cerana* suffered a great loss due to the spread of a deadly Thai Sac Brood virus and now has exceptionally small number of colonies in the country. The colonies of the giant honey bee (*Apis dorsata*) too are declining⁴ and efforts for its conservation are under consideration⁵.

The red dwarf honey bee (*Apis florea* F.) occupies a wide variety of habitats including semi-deserts, subtropical steppes, savannas and tropical rainforests. This honey bee is distributed from southeast Asia to the Far East⁶⁻⁹, extending to Pakistan, Afghanistan, Iran¹⁰, coastal areas of southern Iraq, Oman, Yemen, Sudan¹¹, Central Saudi Arabia⁷, around Aqaba in Jordan^{9,12,13}, Eilat in Israel⁹ and Djibouti¹⁴.

Earlier reports revealed the crop hosts of *Apis mellifera*¹⁵ and *Apis dorsata*⁴ in the semi-arid environment of northwestern region of India. Earlier reports also revealed that *Apis florea* is among the major visitors of some plants of this region; e.g., some oil seed, vegetable and condiment plants^{1,16}, pigeon pea, (*Cajanus cajan*)¹⁷, sunflower (*Helianthus annuus* L.)¹⁸, cauliflower (*Brassica oleracea* var. botrytis)¹⁹, carrot (*Daucus carota* L.)^{20,21}, coriander (*Coriandrum sativum* L.)²², fennel (*Foeniculum vulgare* L.)^{21,23}, Cucumber (*Cucumis sativus* L.)²⁴, Praecitrullus (*Praecitrullus fistulosus*)²⁵, wanga (*Cucumis melo*.sp. melo)²⁶, Onion (*Allium cepa* L.)^{21,27}, sarpagandha (*Rauvolfia serpentina*)²⁸ and European plum (*Prunus domestica* L.)²⁹. However, this report is not exhaustive. This study was aimed at exploring the crop hosts and pollination potential of red dwarf honey bee in the semi-arid environment of northwest India.

MATERIALS AND METHODS

This study was carried out at the main campus (in an area of about 9 km²) of CCS Haryana Agricultural University, Hisar (Haryana, India). A record of different crop plants visited by the foragers of the red dwarf honey bee (*Apis florea* F.) was maintained through the year round. To ascertain whether this honey bee acted as a pollinator or a non-pollinator of the flowers of a reference crops it visited, the foraging behavior of its visitors on that crop was studied following Robinson³⁰, Sihag^{31,32} and Sihag and Shivrana³³. While visiting the

flowers of a crop plant, if the foragers of this honey bee worked from the top of the flower, such foragers virtually came in contact with the reproductive organs (anthers and stigma) of the flowers (Fig. 1). These foragers gathered pollen in each foraging effort/visit and transferred it during the subsequent visits to the succeeding flowers. These foragers were designated as pollinators of the reference crop. However, if the foragers of this honey bee worked from the side of the flower to steal nectar only and did not come in contact with the reproductive organs of the flower, then this honey bee was characterized as a non-pollinator (nectar thief) of the reference crop (Fig. 2). Furthermore, on the basis of pollen and



Fig. 1: *Apis florea* foraging from the top/front of the flower of *Zilla spinosa* to collect pollen and nectar
(Photo: Gideon Pisanty; Source: https://en.wikipedia.org/wiki/Apis_florea#/media/File:Apis_florea_worker_1.jpg)



Fig. 2: *Apis florea* foraging from the side/base of the flower of cauliflower to collect/thieve nectar

nectar presentation by the plant and collection by the foragers of this honey bee, the plants were characterized as pollen and or nectar sources^{4,15}. The crops which are grown in several thousand hectares in this region were designated as the "major crops," whereas those crops which are grown in a few hundred hectares were designated as the "minor crops." Likewise, if the population of the foragers of this honey bee during the peak foraging hours (between 1200 and 1400 h on winter flowering and 0800-1000 h on summer flowering crops) on the reference crop was >8 bees m^{-2} , it was designated as a "frequent" visitor, if it was 5-8 bees m^{-2} , it was designated as the "moderate" visitor and if it was <5 bees m^{-2} , it was designated as the "occasional" visitor of that crop plant⁴. On these grounds, the importance of this honey bee as the pollinator of crops of semi-arid region of northwestern India was determined.

RESULTS

Crop hosts and their flowering periods: On the basis of the crop area, of the 38 crops mentioned here, only 4 were major crops in this region which were grown in several thousand hectares, all other were minor crops as these are grown only in a few hundred hectares. December-February is the winter of this region when crops of the Cruciferae family were in blooms; raya (the leafy mustard) is the major crop representing an excellent floral pollen and nectar source of this honey bee. Other crops grown in the region are Chick pea (a good pollen source), Coriander (a good pollen source) and Fenugreek (an excellent pollen and nectar source). Winter is followed by small spring (March) and early summer (April). Many minor crops are host of this honey bee during these seasons. Some fruit plants e.g., Aonla, lemon, Kinnow, peach, plum and guava come in blooms during this period which are rich sources of pollen and nectar for this honey bee. Besides these, onion, lentil, beseem and sunflower are also very rich sources of pollen and nectar for this honey bee. May-July were the months of peak summer in this region. This season witnessed a very high ambient temperature. Some of the crops of early summer keep flowering during May, Pearl millet, sorghum and many cucurbits are the other sources of pollen and nectar for this honey bee. August and September represent the late summer when rice and cotton are the major crops and cucurbits and some crops of peak summer keep flowering and act as floral hosts of dwarf honey bee in this region. During October-November, toria crop make a good source of pollen and nectar. The flowering period of all

these crops staggers almost throughout the year thus providing year round forage to this honey bee in this region (Table 1).

Pollination potential of the red dwarf honey bee in the semi-arid environment of Northwest India: The red dwarf honey bee (*Apis florea*) was found to visit the flowers of all the 38 crops for pollen and/or nectar in the semi-arid environment of north west India (Table 1, Fig. 1-6). On alfalfa (*Medicago sativa*) and pigeon pea (*Cajanus cajan*) the foragers of this honey bee were the side workers/nectar thieves and did not act as pollinators. On all other crops mentioned here, the field workers of this honey bee were invariably top/front foragers and transferred pollen in each foraging attempt thus always acted as pollinators. Coriander (*Coriandrum sativum*) and other umbelliferous crops (fennel, cumin and carrot) and onion and sunflower



Fig. 3: *Apis florea* foraging from the top/front of the flower of lemon to collect pollen



Fig. 4: *Apis florea* foraging from the top/front of the flower of turnip to collect pollen and nectar

Table 1: Crop hosts and pollination potential of the red dwarf honey bee in the semiarid environment of north west India

Crop host	Area	Flowering time	Source	Activity
Pigeon pea (<i>Cajanus cajan</i> (L.) Millsp.)	m	Sep-Oct	P, N	nt, o
Toria (<i>Brassica campestris</i> L. var. toria)	m	Oct-Nov	P, N	p, f
Leafy mustard (<i>Brassica juncea</i> Czern. and Coss)	M	Dec-Feb	P, N	p, f
Chinese cabbage (<i>Brassica chinensis</i> L. D.)	m	Dec-Feb	P, N	p, f
Rape (<i>Brassica napus</i> L.)	m	Dec-Feb	P, N	p, f
Cauliflower (<i>Brassica oleracea</i> L. var. botrytis)	m	Dec-Feb	P, N	p, f
Radish (<i>Raphanus sativus</i> L.)	m	Dec-Feb	P, N	p, f
Turnip (<i>Brassica rapa</i> L.)	m	Dec-Feb	P, N	p, f
Salad rocket (<i>Eruca sativa</i> Mill.)	m	Dec-Mar	P, N	p, f
Chick pea (<i>Cicer arietinum</i> L.)	m	Dec-Feb	P, N	p, f
Coriander (<i>Coriandrum sativum</i> L.)	m	Feb-Mar	P	p, l
Fenugreek (<i>Trigonella foenum-graecum</i> L.)	m	Feb-Mar	P, N	p, f
Lemon (<i>Citrus limon</i> (L.) Burm. f.)	m	March	P, N	p, f
Kinnow (<i>Citrus nobilis</i> × <i>Citrus deliciosa</i>)	m	March	P, N	p, f
Peach (<i>Prunus persica</i> (L.) Stokes)	m	March	P, N	p, f
Onion (<i>Allium cepa</i> L.)	m	Mar-Apr	P, N	p, f
Aonla (<i>Embllica officinalis</i> Gaertn.)	m	Mar-Apr	P, N	p, f
Lentil (<i>Lens culinaris</i> Medikus)	m	Mar-Apr	P, N	p, f
Sun flower (<i>Helianthus annuus</i> L.)	m	Mar-May	P, N	p, f
Berseem/clover (<i>Trifolium alexandrinum</i> L.)	m	Mar-May	P, N	p, f
Alfalfa (<i>Medicago sativa</i> L.)	m	Mar-Oct	P, N	nt, f
Guava (<i>Psidium guajava</i> L.)	m	Apr-May	P, N	p, f
Bottle gourd (<i>Lagenaria siceraria</i> (Molina) Standl.)	m	Mar-Nov	P, N	p, f
Ribbed gourd (<i>Luffa acutangula</i> (L.) Roxb.)	m	Mar-Nov	P, N	p, f
Bath sponge (<i>Luffa cylindrica</i> L.)	m	Mar-Nov	P, N	p, f
Bitter gourd (<i>Momordica charantia</i> L.)	m	Mar-Nov	P, N	p, f
Apple gourd (<i>Praecitrullus fistulosus</i> (Stocks) Pangalo)	m	Mar-Nov	P, N	p, f
Muskmelon (<i>Cucumis melo</i> L.)	m	Mar-Nov	P, N	p, f
Watermelon (<i>Citrullus lanatus</i> var. (Thunb.))	m	Mar-Nov	P, N	p, f
Summer squash (<i>Cucurbita pepo</i> L.)	m	Mar-Nov	P, N	p, f
Kheera (<i>Cucumis sativus</i> L.)	m	Mar-Nov	P, N	p, f
Pumpkin (<i>Cucurbita moschata</i> Duchesne ex Poir.)	m	Mar-Nov	P, N	p, f
Petha (<i>Benincasa hispida</i> (Thunb.) Cogn)	m	Mar-Nov	P, N	p, f
Pearl millet (<i>Pennisetum typhoides</i>)	M	May-Aug	P	p, f
Rice (<i>Oryza sativa</i>)	M	Aug-Sep	P	p, f
Sorghum (<i>Sorghum bicolor</i> (L.) Moench)	m	May-Aug	P	p, f
Cotton (<i>Gossypium hirsutum</i>)	M	Aug-Sep	P	p, f
Cluster bean (<i>Cyamopsis tetragonoloba</i> (L.) Taub.)	m	July-Aug	P, N	p, f

M: Major crop of the region, m: Minor crop of the region, P: Pollen source, N: Nectar source, p: Foragers acted as pollinators, nt: Foragers acted as nectar thieves, f: Frequent visitor, o: Occasional visitor



Fig. 5: *Apis florea* foraging on the umbel of carrot to collect both pollen as well as nectar



Fig. 6: *Apis florea* foraging for pollen on the male flower of bath sponge

had very small florets which together formed a composite inflorescence. The foraging bees were found to rush on the umbels/floral head to get dusted with their pollen. These crops acted as excellent pollen sources for this honey bee. All other crops, however, are sources of both pollen and nectar. On all the crops mentioned here, at the time of peak foraging, the population of this honey bee was $>8 \text{ bees m}^{-2}$. Therefore, this honey bee is a frequent visitor of all these crops. These observations indicate that the red dwarf honey bee is an important pollinator of more than 35 crops of this region (Table 1).

DISCUSSION

In the semi-arid environment of northwest India, the red dwarf honey bee (*Apis florea*) visited some 38 locally grown crops and acted as an important pollinator of more than 35 of these crops (Table 1). In earlier studies too, this honey bee was identified as the most abundant flower visitor of many crop plants in the semi-arid environment of northwest India^{1,17-29}. In this part of India, the Indian hive bee (*Apis cerana*) is not indigenous and managed pollination with *Apis mellifera* has not yet practiced on large scale. In the absence of latter pollinators, the crop growers have to rely on the wild pollinators for pollination of their crops. This is the reason that this honey bee in northwest India as pollinator of crops has gained much greater importance as pollinator of crops than any other pollinators. Therefore, in recent years when there is great emphasis on increasing the crop production, conservation of this honey bee has gained much greater agro-ecological importance than any other times especially in the light of declining number of colonies of the giant honey bee (*Apis dorsata*) in this region⁴.

The present study provides interesting information about two important features of the red dwarf honey bee in the semi-arid environment of northwestern region of India. First, the foraging behavior of this honey bee qualifies it for an important pollinator of more than 35 crops of this region (Table 1). This information can be used for the utilization of this honey bee for pollination of local crops. Therefore, methods of its domestication, conservation and utilization as pollinator of crops must be devised when this honey bee is facing a severe threat of decline in its colony numbers and the foraging populations³⁴. Second, the colonies of the red dwarf honey bee stay in this region through the year round. This information can be used for scheduling the honey and bees wax harvest timings from the colonies and/or deserted combs of this honey bee.

CONCLUSION

The red dwarf honey bee is indigenous to southeast, south and western Asia and eastern part of Africa. This honey bee is an integral component of bee diversity in the semi-arid environments of its natural abode. It is a useful pollinator of many crops in this region. Viewing the importance of this honey bee in the agro-ecosystems of its natural abode, its conservation becomes highly desirable.

SIGNIFICANCE STATEMENT

The dwarf honey bee (*Apis florea*) is indigenous to many parts of Asia and Africa. This is a natural pollinator of more than 35 crops of its natural abode. Therefore, study of its plants and pollination potential gains great importance.

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