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Identification of honey plants and their attractiveness to honeybee in Kandovan, Northwest of Iran

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Abstract. Kandovan region in the north west of Iran is used by bee keepers as an apiary to collect nectar and produce high quality honey. This study was carried out to survey plants foraged by honeybees (*Apis mellifera* L.) and to identify them in Kandovan (East-Azarbaijan, Iran). Identification of these plants can help us to know their flowering time and location, which could be recommended to the bee keepers for the emplacement of honeybee colonies for producing high quality and quantity honey in the bee hives. During 2007-2008 honeybee activities (nectar and pollen collecting) were surveyed two times weekly, within the radius of three km from the apiary. The results indicated that there were 22 families and 98 species of honey plants in this region. Among them, 16 species (16.32%) belonged to Fabaceae, 14 species (14.28%) to Asteraceae, eight species (8.16%) to Lamiaceae, seven species (7.14%) to Rosaceae, seven species (7.14%) to Apiaceae, six species (6.12%) to Brassicaceae, six species (6.12%) to Papaveraceae, six species (6.12%) to Scrophulariaceae and 28 to others. The life form of plant species was determined by using of Raunkier's life forms. They included 63.26% Hemicryptophytes, 17.34% Therophtytes, 6.12% Phanerophytes, 10.20% Chamaephytes, 3.06% Geophytes. Three species (3.09%) have high attractiveness, 60 species (61.85%) good attractiveness, three species (3.09%) middle attractiveness and 31 species (31.95%) weak attractiveness. Twenty one species (21.42%) were as nectar source, 33 species (33.67%) as pollen source and 44 species (44.89 %) as nectar and pollen source for honeybees.

Key words: Honeybee, Iran, Kandovan, Nectar and pollen Plants.

Introduction

There is a close relationship between honeybees and flowering plants. Nectar and pollen are critical for the survival and reproductive success of many beneficial insects (Hogg et al. 2011). Flowering plants produce nectar and pollen that lead to enforcing of honey bee population to increase of honey and other hive products. These plants have medicinal properties and are foraged by honeybees. Honeybees (*Apis mellifera* L.) pollinate garden and pasture plants as their foraging activities. This processing causes the plants generation to perpetuate and prevent soil erosion. By identification of honey plants, beekeepers recognize the place and time of establishing their apiaries and know the botanic origin of honey. On the other hand, farmers use bee hives for their crops pollination. Botanic origin of honey is one of the most important parameters of honey quality (Tucak & Perikic 2007). The honey obtained from different plants has different characteristics and applications, both in medicine and in food industry. A melissopalynological study on honey samples from north western provinces of Iran showed that a majority of pollen grains found in samples belonged to Asteraceae, Lamiaceae and Fabaceae families (Manafi 1994). Elmi (1999) identified the most important families that were used by honeybees in some areas of East-Azarbaijan province. Asteraceae, Fabaceae, Lamiaceae and Rosaceae were the major sources of pollen and nectar in Tehran province (Nazarian 1997). Fabaceae, Asteraceae, Lamiaceae and Brassicaceae families were more important plants used by honeybees in Isfahan province (Faghih 2005). These types of studies have been done in different area of Iran (Razaghi Kamroodi et al. 2004, Sabaghi et al. 2004, Karimi et al. 2008, Rastgar et al. 2008).

East-Azarbaijan province, particularly Kandovan due to suitable climate and plant diversity is taken into consideration by beekeepers. But our knowledge of species, phenology, distribution of honey plants in this area, is inadequate. Also there is not a logical equilibrium between pasture's capacity and number of established apiaries. To increase the honey production of honey bees, candidate insectary plants must be screened for traits that are appropriate for this beneficial insect. The aim of this survey was determination and introduction of important honey plants to beekeepers.

Materials and Methods

This survey was carried out in Kandovan region, northwest of Iran and in 55 km of south of Tabriz and 20 km East south of Osku. This region is placed between 47° 10' to 47° 20' longitude and 37° 42' to 37° 52' latitude. The lowest and the highest altitude were 1800 and 3000 meters, respectively.

Field studies

1. Collecting of honey plants

At first step, situations were determined in 1: 50000 topographic maps and honey plants were studied in 3 km from apiaries two days per week at morning, noon and evening. 35 apiary and from every apiary 70 colonies were surveyed. At least three samples from every plant were collected and were identified in the Herbarium of Agriculture Faculty of Tabriz University.

2. Kind of honeybee foraging activity (gathering of pollen or nectar)

For recording the honeybee activity on the plant, the flowers that were visited by honey bees were observed. The number of honeybees (*Apis mellifera* L.) on the flowers was recorded in fifteen minutes. Then, it was recorded honeybee activities (collecting of pollen and nectar), locality (characteristic of region, collection place and elevation) and number of hives and distance of apiaries. Pollen or nectar collection was determined by direct observation of honeybees' activity. When the honeybee tries to collect the nectar by proboscis in nectary of flower, this plant is considered as nectar source for honeybee. In contrast, when honey bee collects and transfers pollen from stigma to pollen kit on its hind legs, this plant is considered as pollen source. If honeybee accomplished both of these activities, this plant species is recorded as pollen and nectar source.

All of the researches were done from early spring until late summer in 2007-2008. The plants were grouped based on the number of the bees

attracted to them, hives number and distance from apiary (Asadi et al. 2001). For drawing of dendrogram, data were analyzed by SPSS software and using of clustering method. The plant species with Euclidian distance of 2.5 were divided into four groups (low, mean, good and high attractiveness). Average of 57 (and further) visits per fifteen minutes was considered for high attractiveness, 50 visits for good attractiveness, 37 visits for mean attractiveness and 29 (and less) visits for low attractiveness.

Laboratory studies

After plant collection, samples were identified using Birang (1989-1993), Davis (1998), Ghahraman (1975-2000), Mauseth (2003), Mobayen (1980-1999), Mozaffarian (1994), Parsa (1986), Rechinger (1973) and Townsend and Gust (1963-2001). The life form of plant species was determined by using of Raunkier's life forms (Raunkier 1934). Mauseth (2003) grouped plants in five parts:

- Hemichryphtophyte, plants that have their buds located at the surface of the soil, protected by leaf and stem bases, many grasses and rosette plants.
- Therophtyte, annual herbal plants that grow in spring and pass stress conditions as seeds.
- Chamaephyte, herbal or small shrubby plants that are lower than 25 cm in length and their buds are located above ground, but low enough not to be exposed to strong winds.
- Phanerophyte, trees and large shrubs that have their buds located high, on shoots at least 25 to 30 cm above ground.
- Geophyte, cryptophytic plants that have their buds underground on rhizomes, bulbs, corms (Mauseth et al. 1998).

Life form of each plant species is a constant character and can be affected by environmental climate. Determination of plant life forms can help us to recognize kind of climate in each region. For example high percent of Hemicryptophytes in a region suggests that the climate of that region is temperate and semi-dry. Existence of different climates in a region can cause to find different life form plants in the same area and then increases apicultural period with different honey resources.

Results

Results of field and laboratory studies showed that there were 98 species belonging to 22 families and 66 genera that were being foraged by honeybees in this region (Table 1). Among plants that were identified, 16 species (16.32%) belonged to Fabaceae, 14 species (14.28%) Asteraceae, eight species (8.16%) Lamiaceae, seven species (7.14%) Rosaceae, seven species (7.14%) Apiaceae, six species (6.12%) Brassicaceae, six species (6.12%) Papaveraceae, six species (6.12%) Scrophulariaceae (Fig.1). *Asyneuma pulchellum* (Fisch & Mey.) was reported for the first time as honey plant in East-Azarbaijan. From the point of view of the life form, 63.26% species were Hemicryptophytes, 17.34% species were

Table 1. Plant species and their life form in study area
(He= Hemicryptophytes, Ph= Phanerophytes, Th= Therophtytes , Ch= Chamaephytes, Ge= Geophytes).

No.	Species	Family	Life form	Rate of honeybee activity on plant				Honeybee activities		
				Weak	Mean	Good	Excellent	Nectar	Pollen	Both
1	*Achillea bibersteinii* Afan	Asteraceae	He			×			×	
2	*Achillea millefolium* L.	Asteraceae	He			×			×	
3	*Acroptilon repens* (L.) DC.	Asteraceae	He			×		×		
4	*Alcea flavovirens* Boiss.& Buhse	Malvaceae	He			×			×	
5	*Alkanna orientalis* (L.) Boiss.	Boraginaceae	He	×						×
6	*Amygdalus communis* L.	Rosaceae	Ph			×			×	
7	*Anchusa italica* Retz.	Boraginaceae	He			×				×
8	*Anthemis altissima* L.	Asteraceae	Th	×						×
9	*Armeniaca vulgaris* Lam.	Rosaceae	Ph			×				×
10	*Astragalus (Adiaspastus) aureus* Willd.	Fabaceae	Ch	×				×		
11	*Astragalus basineri* Trautv.	Fabaceae	He	×				×		
12	*Astragalus (Onobrychium) effusus* Bunge	Fabaceae	He			×		×		
13	*Astragalus paralipomenus* Bunge , Mem	Fabaceae	Ch	×				×		
14	*Astragalus (Brachycalyx) caspicus* Bieb.	Fabaceae	Ch			×		×		
15	*Astragalus microcephalus* Willd.	Fabaceae	Ch	×				×		
16	*Astragalus (Adiaspastus) strictifolius*	Fabaceae	He	×				×		
17	*Astragalus (Hymenostegis) lagopoides* Lam.	Fabaceae	Ch			×		×		
18	*Asyneuma pulchellum* (Fisch & Mey.) Bornm	Campanulaceae	He			×			×	
19	*Brassica elongata* Ehrh.	Brassicaceae	He			×				×
20	*Campanula glomerata* L.	Campanulaceae	He			×			×	
21	*Campanula rapunculoides* L.	Campanulaceae	He			×			×	
22	*Carduus onopordioides* Fisch & M.B.	Asteraceae	He			×				×
23	*Centaurea depressa* M.B.	Asteraceae	Th			×				×
24	*Centaurea ochrocephala* Wagenitz	Asteraceae	He			×				×
25	*Centaurea virgata* Lam.	Asteraceae	He	×						×
26	*Ceratocephalus falcata* (L.)Pres.	Ranunculaceae	Th			×			×	
27	*Cerinthe minor* L.	Boraginaceae	He			×				×
28	*Chaerophyllum aureum* L.	Apiaceae	He	×						×
29	*Chaerophyllum bulbosum* L.	Apiaceae	He			×				×
30	*Cirsium arvense* (L.) Scop.	Asteraceae	He	×						×
31	*Cirsium echinus* (M.B.) Hard-Mzt.	Asteraceae	He			×				×
32	*Cirsium lappaceum* M.B.	Asteraceae	He			×				×
33	*Convolvulus arvensis* L.	Convolvulaceae	He			×				×
34	*Coronilla varia* L.	Fabaceae	He			×				×
35	*Cousinia canescens* DC.	Asteraceae	He	×				×		

Table 1. (continued).

No.	Species	Family	Life form	Rate of honeybee activity on plant				Honeybee activities		
				Weak	Mean	Good	Excellent	Nectar	Pollen	Both
36	*Crataegus meyeri* A. Pojark.	Rosaceae	Ph			×				×
37	*Delphinium speciosum* M.B.	Ranunculaceae	He			×			×	
38	*Echinops pungens* Trautv.	Asteraceae	He			×		×		
39	*Eryngium billarderi* F.Delar.	Apiaceae	He		×					×
40	*Eryngium caeruleum* M.B.	Apiaceae	Th		×					×
41	*Erysimum strictiisiliquum* N.Busch.	Brassicaceae	He			×				×
42	*Erysimum subulatum* J.Gay	Brassicaceae	He			×				×
43	*Euphorbia boissieriana* (Woron) Prokh.	Euphorbiaceae	He			×		×		
44	*Euphorbia heteradenia* Jaub & Spach.	Euphorbiaceae	He			×		×		
45	*Fumaria vaillantii* Loisel.	Fumariaceae	Th		×			×		
46	*Gagea confusa* A.Terr.	Liliaceae	Ge			×				×
47	*Gagea dubia* A.Terr.	Liliaceae	Ge			×				×
48	*Heracleum anisactis* Boiss & Hohen.	Apiaceae	He						×	
49	*Hyoscyamus niger* L.	Solanaceae	Th			×			×	
50	*Isatis cappadocica* Desv.	Brassicaceae	He			×			×	
51	*Juglans regia* L.	Juglandaceae	Ph			×			×	
52	*Lotus corniculatus* L.	Fabaceae	He	×						×
53	*Malus domestica* Borkh.	Rosaceae	Ph			×				×
54	*Malva neglecta* Wallr.	Malvaceae	He			×			×	
55	*Medicago sativa* L.	Fabaceae	He	×						×
56	*Melilotus officinalis* (L.) Lam.	Fabaceae	Th			×			×	
57	*Mentha longifolia* (L.) Desr.	Lamiaceae	He			×				×
58	*Muscari neglectum* Guss.	Lamiaceae	Ge			×		×		
59	*Nepeta speciosa* Boiss. & Noe	Lamiaceae	He	×						×
60	*Noaea mucronata* (Forsk.) Aschers. & Schweinf.	Chenopodiaceae	Ch			×			×	
61	*Onobrychis cornuata* (L.) Desv.	Fabaceae	Ch	×						×
62	*Papaver fagax* Poiret	Papaveraceae	He			×			×	
63	*Papaver bracteatum* Lindl.	Papaveraceae	He	×					×	
64	*Papaver macrostomum* Boiss. & Huet ex Boiss.	Papaveraceae	Th			×			×	
65	*Papaver orientale* L.	Papaveraceae	He	×					×	
66	*Papaver lasiothrix* Fedde	Papaveraceae	He	×					×	
67	*Pimpinella saxifraga* L.	Apiaceae	He	×					×	
68	*Plantago lanceolata* L.	Plantaginaceae	He			×			×	
69	*Prunus domestica* L.	Rosaceae	Ph			×			×	
70	*Ranunculus arvensis* L.	Ranunculaceae	Th			×				×
71	*Ranunculus scleratus* L.	Ranunculaceae	Th		×					×
72	*Ranunculus sahendicus* Boiss. &Buhse.	Ranunculaceae	He			×				×
73	*Reseda lutea* L.	Resedaceae	Th			×			×	
74	*Roemeria refracta* DC.	Papaveraceae	Th			×			×	
75	*Rosa damascena* Mill.	Rosaceae	Ch			×			×	
76	*Salvia sahendica* Boiss. & Buhse.	Lamiaceae	He	×						×
77	*Salvia verticillata* L.	Lamiaceae	He			×				×
78	*Sanguisorba minor* Scop.	Rosaceae	He			×				×
79	*Scrophularia zuvandica* Grossh.	Scrophulariaceae	He	×					×	
80	*Sisymbrium loeselii* L.	Brassicaceae	Th			×				×
81	*Taraxacum syriacum* Boiss.	Asteraceae	He	×						×
82	*Teucrium orientale* L.	Lamiaceae	He			×		×		
83	*Teucrium polium* L.	Lamiaceae	He	×				×		
84	*Thlaspi perfoliatum* L.	Brassicaceae	Th			×			×	
85	*Thymus kotschyanus* Boiss.&.Hohen.	Lamiaceae	Ch	×				×		
86	*Trifolium pratense* L.	Fabaceae	He			×		×		
87	*Trifolium repens* L.	Fabaceae	He				×	×		
88	*Trifolium tumens* Stev.ex M.B.	Fabaceae	He	×				×		
89	*Verbascum speciosum* Schrad.	Scrophulariaceae	He			×				×
90	*Veronica anagalis- aquatica* L.	Scrophulariaceae	He	×						×
91	*Veronica ceratocarpa* C.A.Mey.	Scrophulariaceae	Th			×			×	
92	*Veronica hederifolia* L.	Scrophulariaceae	Th			×			×	
93	*Veronica orientalis* Miller	Scruphulariaceae	He	×						×
94	*Vicia canescens* Labill.	Fabaceae	He	×						×
95	*Viola odorata* L.	Violaceae	He			×				×
96	*Viola tricolor* L.	Violaceae	Th			×				×
97	*Ziziphora clinopodioides* Lam.	Lamiaceae	Ch				×			×
98	*Zosima absintifolia* (Vent.) Link.	Apiaceae	He				×		×	

Therophytes, 6.12% species were Phanerophytes, 10.20% species were Chamaephytes, 3.06% species were Geophyte (Fig. 2). Three species (3.09%) had high attractiveness, 60 species (61.85%) good attractiveness, three species (3.09%) middle attractiveness and 31 species (31.95%) weak attractiveness for honeybees (Fig. 4). *Trifolium repens* L., *Zosima absintifolia* (Vent.) Link, *Ziziphora clinopodioides* Lam. had high attractiveness and *Fumaria vaillantii* Loisel., *Eryngium caeruleum* M.B. and *Ranunculus scleratus* L. had mean attractiveness (Fig. 5). Twenty one species (21.42%) were as nectar

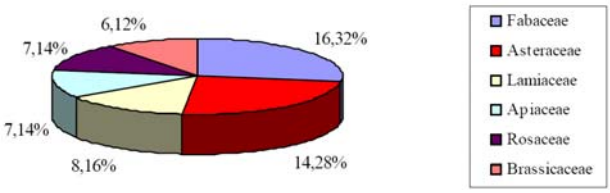

Figure 1. Important families used by honeybees in Kandovan.

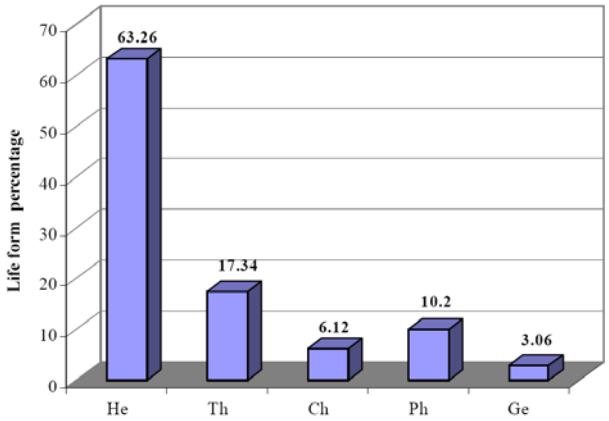

Figure 2. Life form of plants used by honeybee in Kandovan (He= Hemicryphtophyte, Th= Therophytes, Ch= Chamaephytes, Ph= Phanerophytes, Ge= Geophyte).

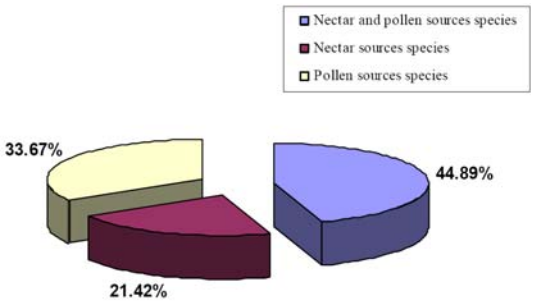

Figure 3. Percentage of nectar and pollen sources plant species.

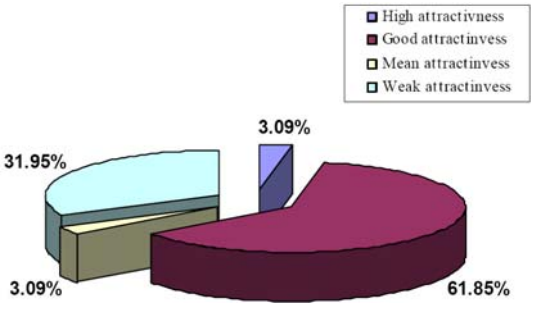

Figure 4. Percentage of plants attractiveness for honeybees in Kandovan.

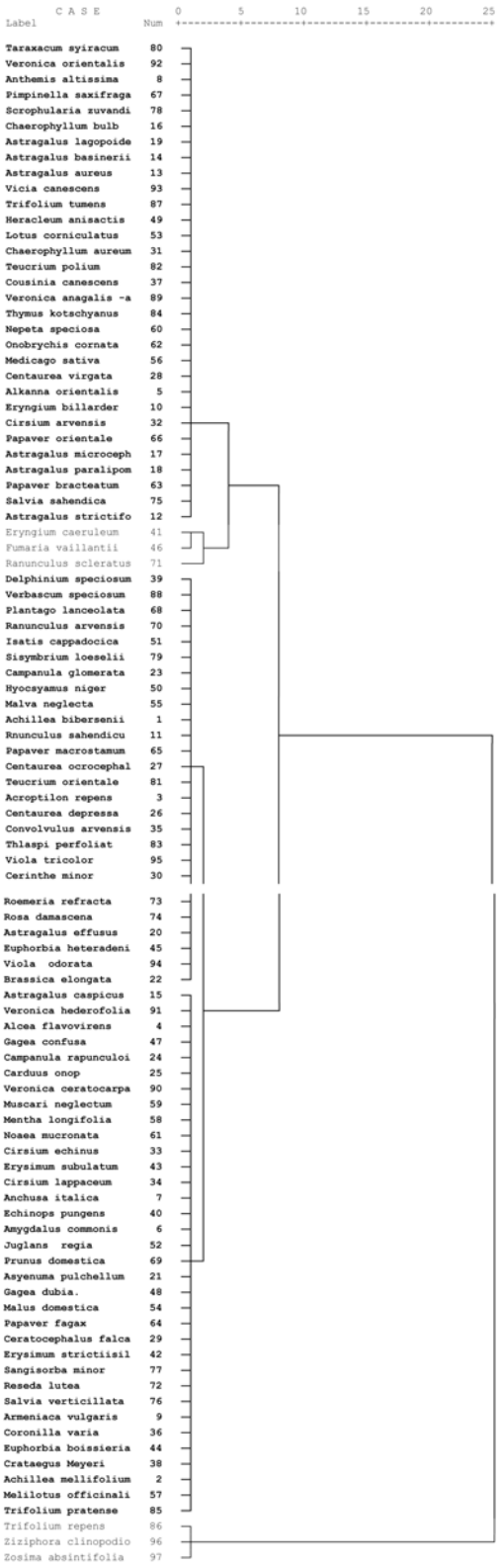

Figure 5. Dendrogram of plants' classification based on different levels of attractiveness (Dendrogram using Average Linkage (Between Groups). Rescaled Distance Cluster Combine).

source, 33 species (33.67%) as pollen source and 44 species (44.89 %) as nectar and pollen sources for honeybees (Fig. 3). Correlation coefficient between number of bees and distance from apiary was 0.261. Regression coefficient of bee number on distance from apiary:

X = distance from apiary y = number of bees

y =34.664+.26 x

Test of regression correlation was significant (P< 0.01).

Discussion

Identification of nectar and pollen producer plants is very important for apiculture. Thus beekeepers should know the plant species in different regions and availability period. Results of this study showed that the most important plant species that are used by honey bees belong to Fabaceae, Asteraceae, Lamiaceae, Rosaceae. Asteraceae, Fabaceae, Lamiaceae were the most important families that were used by honeybees in Ardabil, Tehran, Isfahan, West and East-Azarbaijan (Table 2). Guillermina and Fagundez 2007 found that Asteraceae and Fabaceae were the best represented families in studied honeys. Therefore the most important species used by honeybees were from this three plant families in Iran as same as Argentine (Guillermina and Fagundez 2007). The highest percentage of life form was Hemicryptophyte in Kandovan, which indicates that the climate of this region is temperate and semi-dry. Eighty-one species were forbs, 62 species perennial forbs, 17 species annual forbs, two species biennial forbs. From all 98 species, six species were trees and 11 species shrubs.

In this project three plant species (3.09%) had high attractiveness, 60 species (61.85%) had good attractiveness, three species had (3.09%) mean attractiveness and 31 species (31.95%) had weak attractiveness. Among identified honey plants in Ardabil, eight (4.17%) species had high attractiveness, 41 (21.47%) species good attractiveness, 104 (54.45%) species mean attractiveness and 38 (19.91%) species weak attractiveness (Azimi and Nazarian 2007). In Tehran province 57 species had excellent attractiveness, 139 species had good attractiveness, 65 species had middle attractiveness and 40 species had weak attractiveness (Nazarian 1997). Different factors affect attractiveness of plants such as distribution, abundance and distance from the apiary (Ebadi and Ahmadi 2004, Heiling and Cheng 2006, Wignall et al. 2006). It seems that high distribution and abundance of these families in Kandovan, radial and bilateral symmetry of their flowers caused their attractiveness (Wignall et al. 2006). Nazarian (1997) in Tehran, Mosaddegh (1986) in Khozestan, Elmi in East-Azarbaijan and Verma (1992) in Nepal showed that the plants that were mostly used by honeybees were producers of nectar and pollen. In this project, most of the species were a source of both pollen and nectar (Fig. 3). The important plants that were a pollen source for honeybees in this region contain: *Papaver, Reseda, Heracleum, Plantago, Rosa* and *Ceratocephalus*. Also *Astragalus, Onobrychis, Salvia, Thymus* and *Cirsium* were the major sources of nectar for honey bees. Based on the results of this study, the floristic situation of the studied region is very suitable for beekeeping and the abundance of many nectar and pollen plants let beekeepers to establish many colonies in this region. Using the identified plants' flowering period, beekeepers can calculate when they could transport their colonies toward this region. Preparation of apicultural calendar for this region and determining of rangeland capacity for beekeeping can be proposed.

Table 2. Plant families' attractiveness for honeybees in some provinces of Iran.

Plant families	East Azarbijan	East Azarbijan	Isfahan	Tehran	Ardabil	West Azarbijan	East Azarbijan
Asteraceae	2	1*	2	1	1	2	1
Fabaceae	1	2	1	2	2	3	4
Lamiaceae	3	4	3	3	3	1	3
Rosaceae	4	5	5	4	5	4	2
Brassicaceae	5	3	4	5	4	5	5
Reference	Current study	Manafi (1994)	Faghih (2005)	Nazarian (1997)	Azimi & Nazarian (2007)	Mohsennegad et al. (2006)	Elmi (1999)

* The number 1,2,3,4, 5 indicates the degree of plants' importance in attractiveness.

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