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# Multivariate and an Ordination Approach to Classify the Attractiveness of the Plant Species in Pastoral Lands

**Fazel Amiri[1]* and Abdul Rashid Mohamed Shariff[2]**

*[1]Department of Natural Resources, Faculty of Engineering, Islamic Azad University, Bushehr Branch, Iran*
*[2]Department of Biological and Agricultural Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia*

## ABSTRACT

To identify the foraging plants by honeybees and determine apicultural potential, a sample collection of species was carried out with the commencement of rangeland plants at 6 different stations in the Freidan summer rangelands during 2010. Attractive index (AI) of each plant was determined by direct observations based on the average number of bees visiting and the length of time that each bee spents on the flowers. By using ordinate method, the AI data were classified into four main groups. The most import vegetation families utilized by the bees in the area were Compositae Labiatae, Umbeliferae, Cruciferae, Gramineae, Liliaceae and Caryophyllaceae. The results of the assessment carried out on the plant diversity showed that between 88 plant species, 70 species were utilized by the bees. These species were unpalatable for grazing animals and were dominant in degraded rangelands. The Class I group comprised of *Papaver dubium, Onobrychys sativa, Astragalus gossipianus, Thymus kotschyanus, Eryngium billardieri, Echinops cephalotes* and *Alhagi camelorum*. The Class II group comprised of *Eremurus persicus, Peganum harmala, Astragalus sp., Centaurea sp., Scariola orientalis, Medicago lupulina, Ferula gummosa* and *Mentah longifolia*. The Classes III and IV comprised of the species, *Euphorbia, Tragopagon caricifolius, Centaurea, Salvia sp, Acantholimon erinaceum, Convolvulus arvensis, Achillea falcate* and *Cynodon dactylon*. The results indicated that the more extensive uses of the pollen of these plants by the honeybees were associated with the higher attractiveness of the flowers and the presence of more nutritive materials in the pollen and nectar.

*Keywords:* Multivariate, Cluster analysis, Attractive index (AI), beekeeping, *Apis mellifera persica*

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*E-mail addresses*:
amiri_fazel@yahoo.com (Fazel Amiri),
rashidsnml@gmail.com (Abdul Rashid Mohamed Shariff)
* Corresponding author

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## INTRODUCTION

To utilize the natural resource capabilities for apicultural purposes, there is a need for precise and comprehensive information regarding the attractiveness of plant species in order to raise and keep honeybees. The existence of plants with high pollen and nectar producing potential in semi-arid rangeland will enable employment of these species for bee keeping as one of the multiple aspects of rangeland use. Thus, their development based on native knowledge is an important strategy to create new employment and compensate for the income decline among ranchers due to the recommended decrease in livestock pressure to be applied to rangelands.

Recognition of favorite bee plants, their dispersion areas, determination of the attractiveness of plant species, as well as phenology (especially during flowering period) is important planning tools for the protection and prevention of rangeland destruction and beekeeping development (Amiri & Mohamed Shariff, 2012). Since there is close interaction between bees and flowering plants, it is necessary to identify and study plants used by honeybees and be aware of their biological needs in order to raise them (Abou-Shaara, 2013). Therefore, detailed knowledge is necessary to achieve maximum production in bee keeping (Abou-Shaara *et al*., 2013).

Lack of attractiveness of plants would indicate lack of apicultural capacity of the rangelands. Hence, the study on the nectar and pollen producing potential of plants in an area is important to determine bee keeping effectiveness. In this respect, Ghalechnia (2006) studied the summer rangelands of Mazandaran province and noted that the most nectar bearing species were from the Leguminosae, Labiatae, Compositae and Rosaceae families. In the Markazi province, Asadi *et al*. (2004) reported 139 plant species from among 32 plant families, while Nazarian *et al*. (2006) identified 186 genera with 301 plant species used by honeybees among 54 plant families and specified their attractiveness. In the summer rangelands to the east of Mazandaran, Razaghi Kamrodi (2009) introduced plant species from the Labiatae, Compositae, Leguminosae, Rosaceae, and Cruciferae families. In the Tarobar basin area, Sabaghi *et al*. (2006) named the more important families as Compositae, Labiatae, Rosaceae, Leguminosae, Cruciferae, Umbelliferae, Scrophulariaceae and Plumbaginaceae. In Esfahan province, however, Faghih *et al*. (2005) attached greater importance to Papilionaceae, Compositae, Labiatae and Umbelliferae families. This was due to the existence of flowers bearing a great deal of pollen and the special characteristics of compounds in the pollen and nectar of the flowers. In Far province, Karimi and Jafari (2009) also noted that Compositae, Papilionaceae, Labiatae, Rosaceae, Umbelliferae and Cruciferae families are important families. In Mazandaran province, Akbarzadh and Razaghikamrodi (2006) identified 123 species from 22 families and 68 genera based on nectar and pollen bearing potential of the plant species. Coffey and Breen (1997) identified 76 nectar and

pollen bearing plant species in Ireland. In Ghana, Amoako (1997) studied 399 plant species from 59 families and introduced 255 pollen and nectar bearing species. Freitas (1994) identified 62 plant species used by honeybees by analyzing pollen samples in the Caatinga area of Brazil. Shahid (1992) studied the attractiveness of 178 plant species from 45 plant families and reported that the most important plant families in the frontier province of northwest of Pakistan are Compositae, Rosaceae, Leguminosae and Labiatae. Maskey (1992) reported that the most important plant families in Kathmandu are Rosaceae and Cruciferae. In Nepal, Verma and Attri (2008) identified 31 plant species and specified their attractiveness to honeybees. There is a wealth of literature on the apicultural capacity of many species of plants. However, little is known on the nature and apicultural capacity of plant species in the rangelands of Freidan, which is located in the north-west of Isfahan Province. Hence, the aim of this study was to identify the diversity of plant species of the area and suggest suitable strategies to enhance apicultural capacity of the rangelands. The study also aimed to identify the diversity of the plant species in terms of their pollen and nectar bearing potential and determine the attractiveness of the species to *Apis mellifera persica* bees.

## MATERIALS AND METHODS

### *Study Area*

The study area included 6 different stations in the Freidan rangelands in the north-west of Isfahan Province (50º, 00´-50º, 12´E and 32º, 56´-33º, 48´N) covering a 25,221 ha

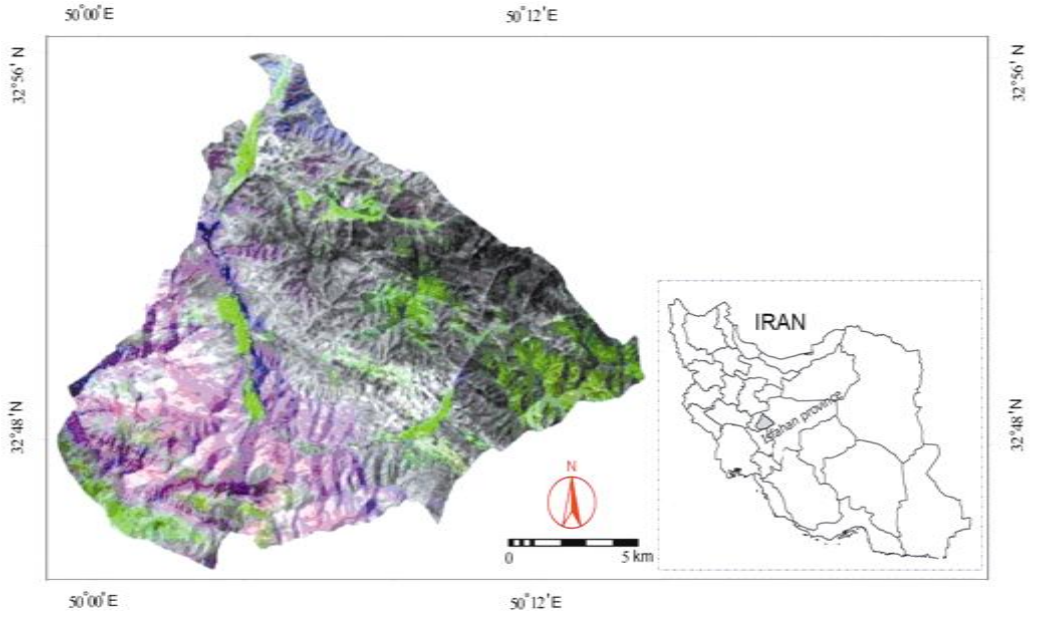


Fig.1: Location of the study area

plain. The average altitude of this region is 2828 meters above sea level (see Fig.1). It has semi-arid climate with an average annual rainfall of 452 mm $yr^{-1}$. Rainfall mainly occurs in the autumn and winter. The mean annual temperature is about 10 degrees Celsius. About 86.62% (21666 hectares) of the study area are rangelands, which include 10 vegetation types.

*Sampling Methods*

A quantitative survey of the vegetation was carried out during May and June 2010. The survey included the concentration of honeybee colonies. The survey was carried out with the aid of 1:20,000 and 1:50,000 scale maps.

*Vegetation Types and Identification of Diversity of the Plant Species*

A random-systematic sampling method was used to sample the diversity of plant species in each vegetation type (Potts *et al*., 2009). In each vegetation type, two 200 meter transects were made along and perpendicular to the slope (Fig.2). Along each transect, one square meter (1 $m^2$) of the sampling areas was marked at 20 meter intervals and plant characteristics within the sampling areas were determined. The

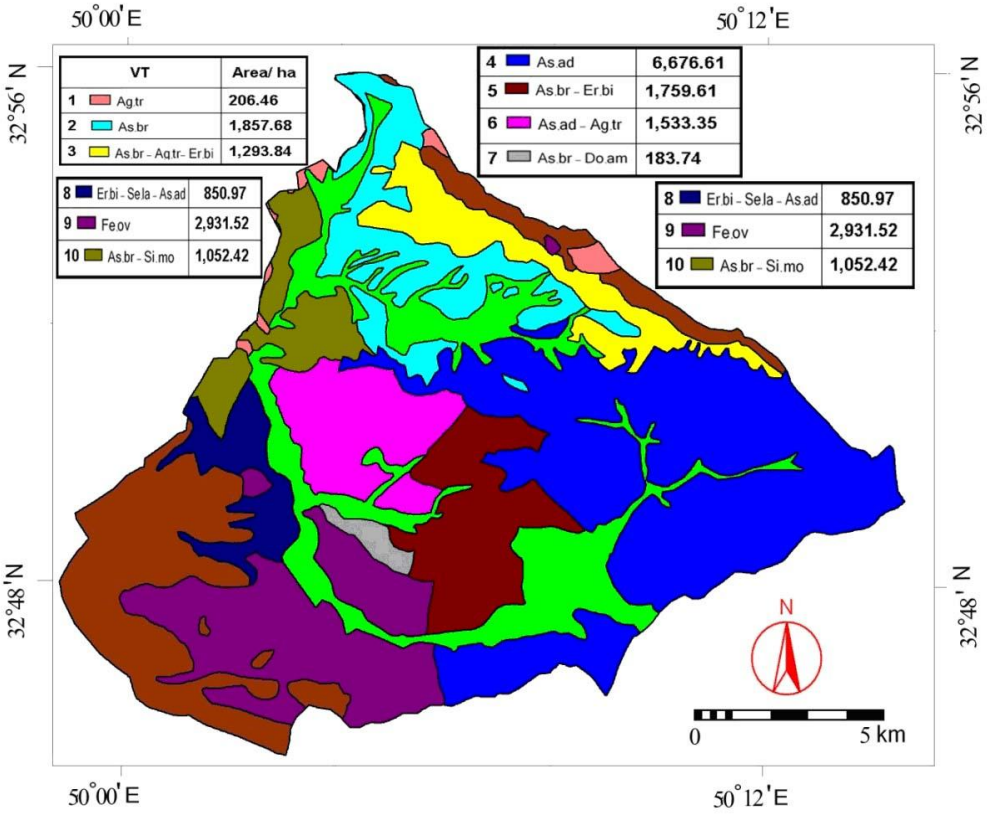


Fig.2: Vegetation type mapping of Freidan summer rangelands

presence or absence and cover percentages of nectar and pollen producing plants within the sampled plots were also determined (Ebeling *et al*., 2008). The plants were identified by comparing them with available herbarium samples, published information and were based on interviews with local bee keepers (Asadi *et al*., 2004; Afzali, 2006; Faghih *et al*., 2005; Nazarian *et al*., 2006; Amoako, 1997; Coffey & Breen, 1997).

*Flowering Period*

The flowering periods of plants were recorded from start to finish during weekly field visits to the area. Plant communities with at least 10 to 20% of dominant flowering pattern were determined.

*Attractiveness Index of Plant Species*

The attractiveness of plants for honeybees were determined in field observations by recording the number of visiting bees, and the time bees settle on each species during the flowering period (Rastgar *et al*., 2007). At 100 to 1000 meter intervals, honeybee colonies were counted and recorded in the relevant forms. The number of visitor bees on each species was counted within a square meter area during 10 minutes. The honeybee settlement period of each species was measured using a stopwatch. The attractiveness of the species was determined as follows:

The average time and number of honeybees settling on each plant was divided by the total time and number of bees settling on all plants, and multiplied by 100, respectively. The two indices were added up and the mean was considered as the attractiveness index (AI) of each plant species.

$$AI = \frac{R_n + R_t}{2} \quad (1)$$

where AI is the attractiveness index, $R_n$ and $R_t$ are the average time and number of honeybees settling on each plant, respectively.

*Data Analysis*

Multivariate analysis was performed using SPSS® software, with XlStat an add-in package of Microsoft Excel 2010. Agglomerative hierarchical clustering (AHC) and Gap statistic (Gs) were used to identify differences between the classes and to cluster the samples with similar coefficients. AHC was undertaken according to the Ward-algorithmic method. Results are presented in a dendrogram where steps in the hierarchical clustering solution and values of distances between clusters (squared Euclidean distance) are represented. Thus, species having excellent attractiveness (Group, I), species with good attractiveness (Group II), species having average attractiveness (Group III), and species with weak attractiveness (Group IV) were separately classified into the distinct groups. The attractiveness index (AI) of each plant species was classified into four levels as in Table 1.

TABLE 1
The Score of each species based on AI index

| Range | Class |
|---|---|
| 5 | I |
| 4 | II |
| 3 | III |
| 1 | IV |

## RESULTS

The results of assessment of plant diversity showed that out of 88 plant species belonging to 29 families existing in the area, 70 species were of interest to honeybees. Among the identified plants, 14 species belonging to the Leguminosae and 11 and 13 species of Compositae and Labiatae families, respectively, were preferred by the honeybees, while Gramineae and Umbelliferae had 5 and 7 species that were preferred by honeybees, followed by Caryophyllaceae with 4 species and Cruciferae and Liliaceae families with 3 species each. Among the identified plant species preferred by honeybees, 16 species (22.8%) belonged to the "excellent" attractiveness group, 23 species (32.8%) were of "good" attractiveness, 22 species (31.4%) with "average" attractiveness, and 8 species (11.4%) had "weak" attractiveness. Floristic listing of species used by honeybees, including the flowering period and the plant attractiveness for bees is presented in Table 2. The results of the cluster analysis showed 65% similarity level. Based on the two characteristics, the honeybee settling time and the number of visits by bees, all the plant species were classified into the four general groups (see Fig.3A and 3B).

### *Species with Excellent Attractiveness (Group I)*

In this group, *Papaver dubium* species had the most number of visitor bees, and the longest bee settling time, with an average of 26 visitors lasting about 234 seconds on average, with a $DA_{Index}$ equal to 130. The main reason for the high index value is the flowering period of this species, which is from late April to the middle of June. The lowest attractiveness was observed for *Alyssum linifolium* and *Alhagi camelorum* species with attractiveness indices of 69.7 and 72.2, respectively. The average number of bees visiting *Astragalus camelorum* species was 14 and the settlement time was 125.2 seconds. *Astragalus camelorum*, *Astragalus linifolium*, Bellevalia sp., *Astragalus lycioides*, *Onobrychys melanotricum*, *Echinops cephalotes*, *Stachys acerosa*, *Phlomis persica*, *Astragalus adsendence*, *Astragalus parroaianus*, *Eryngium billardieri*, *Thymus kotschyanus*, *Stachys inflate*, *Astragalus gossipianus*, *Onobrychys sativa* and *Papaver dubium* had a similarity level of 65% and were placed in one class (Fig.2; Fig.3a). The common aspects between these species are the number of visitor honeybees and the high rate of settlement time for each plant species. Based on the similarity characteristics of the species with each other (80%), four subgroups are distinguishable (Fig.3b).

TABLE 2
Floristic list of species used by honeybees, flowering period and the plant attractiveness rate for bees in the study area

| No. | Scientific name | Family | Growth form | Flowering period | | Bee activity | | | Bee activity of the plant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Start | End | nectar | pollen | nectar and pollen | Exellent (I) | Good (II) | Moderate (III) | Weak (IV) |
| 1 | Acantholimon erinaceum | Plumbaginaceae | SH. | late June | Late July | * | | | | | | * |
| 2 | Acanthophyllum bracteatum | Caryophyllaceae | SH. | June | Early July | | | * | | | * | |
| 3 | Achillea falcate | Compositeae | PF. | | | | * | | | | | * |
| 4 | Aegilops sp | Gramineae | AF. | - | - | - | - | - | - | - | - | - |
| 5 | Agropyron trichophoum | Gramineae | PG. | - | - | - | - | - | - | - | - | - |
| 6 | Ajuga chamasistus | Labiatae | SH. | Early June | Early July | - | - | - | - | - | - | - |
| 7 | Alhagi camelorum Fisch. | Legominosae | PF. | late June | Early August | | | * | * | | | |
| 8 | Alyssum linifolium | Cruciferae | PF. | Mid May | late June | | | * | * | | | |
| 9 | Anthemis | Compositae | AF. | - | - | - | - | - | - | - | - | - |
| 10 | Artemisia aucheri | Compositae | SH. | - | - | - | - | - | - | - | - | - |
| 11 | Astragalus adsendence | Legominosae | BT. | Early July | Mid August | * | | | * | | | |
| 12 | Astragalus brachycalyx | Legominosae | SH. | Late May | Mid June | * | | | | * | | |
| 13 | Astragalus canesens | Legominosae | SH. | Late May | late June | * | | | | * | | |
| 14 | Astragalus cyclophylus | Legominosae | PF. | Late May | late June | * | | | | * | | |
| 15 | Astragalus gossipianus | Legominosae | SH. | Mid July | Early August | * | | | * | | | |
| 16 | Astragalus lycioides | Legominosae | SH. | Late May | Mid June | * | | | * | | | |
| 17 | Astragalus parroaianus | Legominosae | SH. | Mid June | Mid July | * | | | * | | | |
| 18 | Astragalus. sp | Legominosae | PF. | Mid July | Early August | * | | | | | * | |

*cont'd* Table 2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | Bellevalia sp | Liliaceae | PF. | May | Early June | * | | | * | | | | |
| 20 | Bieberstenia multifida | Geraniaceae | PF. | May | June | | * | | | | * | | |
| 21 | Bromus tomentellus | Gramineae | PG. | Early June | late June | - | - | - | - | - | - | - | |
| 22 | Caradaria draba | Cruciferae | PF. | Late May | Early July | | | * | | | * | | |
| 23 | Carex stenophylla | Cyperaceae | PF. | - | - | - | - | - | - | - | - | - | |
| 24 | Centaurea behen | Compositae | PF. | late June | Mid July | | | * | | * | | | |
| 25 | Centaurea virgata | Compositae | PF. | late June | Mid September | * | | | | * | | | |
| 26 | Convolvulus arvensis L. | Convollvulaceae | PF. | Early June | Late August | | | * | | | | * | |
| 27 | Cousinia bachtiarica | Compositae | PF. | Late June | Early August | - | - | - | | | | * | |
| 28 | Cousinia cylanderica | Compositae | PF. | Late June | Early August | | | * | | * | | | |
| 29 | Cynodon dactylon (L.) | Gramineae | PG. | June | July | | * | | | | | * | |
| 30 | Daphne macronata | Thymelaeaceae | BT. | Early July | MidJuly | | * | | | | * | | |
| 31 | Dianthus crinitus Sm. | Caryophyllaceae | AF. | Late June | Mid July | - | - | - | - | - | - | - | |
| 32 | Echinophora platyloba | Umbelliferae | PF. | Mid July | Late August | | * | | | | * | | |
| 33 | Echinops cephalotes DC. | Compositae | PF. | June | July | * | | | * | | | | |
| 34 | Eremostachys mocrophylla | Labiatae | PF. | Late May | Late June | | * | | | | | * | |
| 35 | Eremurus persicus | Liliaceae | PF. | Late May | Mid June | | * | | | * | | | |
| 36 | Eryngium billardieri | Umbelliferae | PF. | Mid July | late June | | | * | * | | | | |
| 37 | Euphorbia decipiens Boiss. | Euphorbiaceae | PF. | Mid May | Mid June | | | * | | | * | | |
| 38 | Euphorbia virgata | Euphorbiaceae | PF. | June | July | | * | | | | * | | |
| 39 | Euphorbia macroclada | Euphorbiaceae | PF. | Mid May | Mid June | * | | | | | * | | |
| 40 | Ferula gummosa Boiss. | Umbelliferae | PF. | Late May | Mid June | | | * | | * | | | |
| 41 | Ferula ovina | Umbelliferae | PF. | Early July | Late July | | | * | | | * | | |
| 42 | Festuca ovina | Gramineae | PG. | Early June | late June | - | - | - | - | - | - | - | |

*cont'd* Table 2

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | Gallium Verum L. | Rubiaceae | PF. | Early June | Mid August | | * | | | * | | |
| 44 | Geramium tuberosum | Geraniacae | PF. | Mid May | Mid June | | | * | | | * | |
| 45 | Gundelia tournefortii | Compositae | PF. | Late May | late June | | | * | | * | | |
| 46 | Iris s p | Iridaceae | PF. | June | July | | * | | | | | * |
| 47 | Isatis capadosica | Cruciferae | AF. | Early June | Early July | | | * | | | * | |
| 48 | Ixilirion tataricum | Amaryllidaceae | PF. | Mid May | Early June | | * | | | | * | |
| 49 | lactuca scarioloides | Compositae | PF. | Mid June | Early July | | | * | | | * | |
| 50 | Mathiola ovatifolia | Cruciferae | BF. | - | - | | * | | | | * | |
| 51 | Medicago lupulina L. | Leguminosae | PF. | Mid June | Early August | | | * | | * | | |
| 52 | Medicago sativa | Leguminosae | PF. | Mid June | Early August | | | * | | | | |
| 53 | Melica persica | Gramineae | PG. | Early June | Late June | - | - | - | - | - | - | - |
| 54 | Mentah longifolia | Labiatae | PF. | Mid June | Mid August | | | * | | * | | |
| 55 | Nepeta micranatha | Labiatae | PF. | June | July | | | * | | * | | |
| 56 | Noea mucronata | Chenopodiaceae | SH. | Early August | Late August | - | - | - | - | - | - | - |
| 57 | Onobrychys melanotricum | Legominosae | PF. | Late May | Mid June | | | * | * | | | |
| 58 | Onobrychys sativa | Legominosae | PF. | Late May | Early August | | | * | * | | | |
| 59 | Papaver dubium | Papaveraceae | AF. | Late May | Mid June | | * | | * | | | |
| 60 | Peganum harmala | Zygophyllaceae | PF. | May | July | | * | | | * | | |
| 61 | Phlomis olivieri | labiatae | PF. | June | July | | | * | | | * | |
| 62 | Phlomis persica | labiatae | PF. | Mid June | Late July | * | | | * | | | |
| 63 | Plantago major L. | Plantaginaceae | PF. | June | July | | * | | | * | | |
| 64 | Poa bulbosa | Gramineae | PG. | Mid May | Mid June | - | - | - | - | - | - | - |
| 65 | Ploygonum sp | Polygonaceae | AF. | Early July | Late July | - | - | - | - | - | - | - |
| 66 | Prangus ferulacea | Umbelliferae | PF. | Late May | Mid June | | * | | | * | | |

*cont'd* Table 2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67 | Pterocephalus canus | Dipsaceae | PF. | May | June | * | | | | * | | | |
| 68 | Ranunculus sp | Ranunculaceae | PF. | May | June | | | * | | | * | | |
| 69 | Rheum ribes | Polygonaceae | PF. | - | - | - | - | - | - | - | - | - | |
| 70 | Rosa sp | Rosaceae | SH. | May | June | | | * | | | * | | |
| 71 | Salvia sp | Labiatae | PF. | May | June | | | * | | | * | | |
| 72 | Sanguisorba minor | Rosaceae | PF. | Late May | Mid June | | | * | | | * | | |
| 73 | Scariola orientalis | Compositae | PF. | Early September | Early July | | * | | | * | | | |
| 74 | Scrophullaria sp | Scrophullariaceae | PF. | Late May | late June | - | - | - | - | - | - | - | |
| 75 | Silene arbescula | Caryophyllaceae | PF. | May | June | - | - | - | - | - | - | - | |
| 76 | Silene sp | Caryophyllaceae | PF. | Mid May | June | - | - | - | - | - | - | - | |
| 77 | Stachys aserosa | Labiatae | SH. | Early June | Early July | * | | | * | | | | |
| 78 | Stachys inflata | Labiatae | PF. | late June | Late July | * | | | * | | | | |
| 79 | Stachys pilifera | Labiatae | PF. | June | July | * | | | | * | | | |
| 80 | Taraxacum polycphalum | Compositae | PF. | Early May | late June | | | * | | * | | | |
| 81 | Thalictrum isopyroides | Ranunculacea | PF. | Early May | Early June | | * | | | | | | * |
| 82 | Thymus kotschyanus | Labiatae | PF. | late June | Early August | * | | | * | | | | |
| 83 | Tragopagon caricifolius | Compositae | PF. | Late May | late June | | | * | | * | | | |
| 84 | Trigonella sp | Legominosae | AF. | Late May | Mid June | | | * | | * | | | |
| 85 | Trifolium repens L. | Legominosae | PF. | Mid June | Mid August | | | * | | * | | | |
| 86 | Tulipa sp | Liliaceae | PF. | Late April | Mid May | | * | | | | * | | |
| 87 | Valeriana officinalis | Valerianaceae | PF. | Early June | late June | - | - | - | - | - | - | - | |
| 88 | Veronica orientalis | Scrophulariaceae | PF. | Mid May | late June | | | * | | | * | | |

This symbol (*) demonstrates bees' activities on nectar, pollen, nectar and pollen, and each plant group: (-) Dash symbol shows inactivity of honybee.

AF. = Annual Forb PF. = Perennial Forb SH. = Shrub

BF. = Biennial Forb PG. = Perennial Grass BT. = Bush Tree

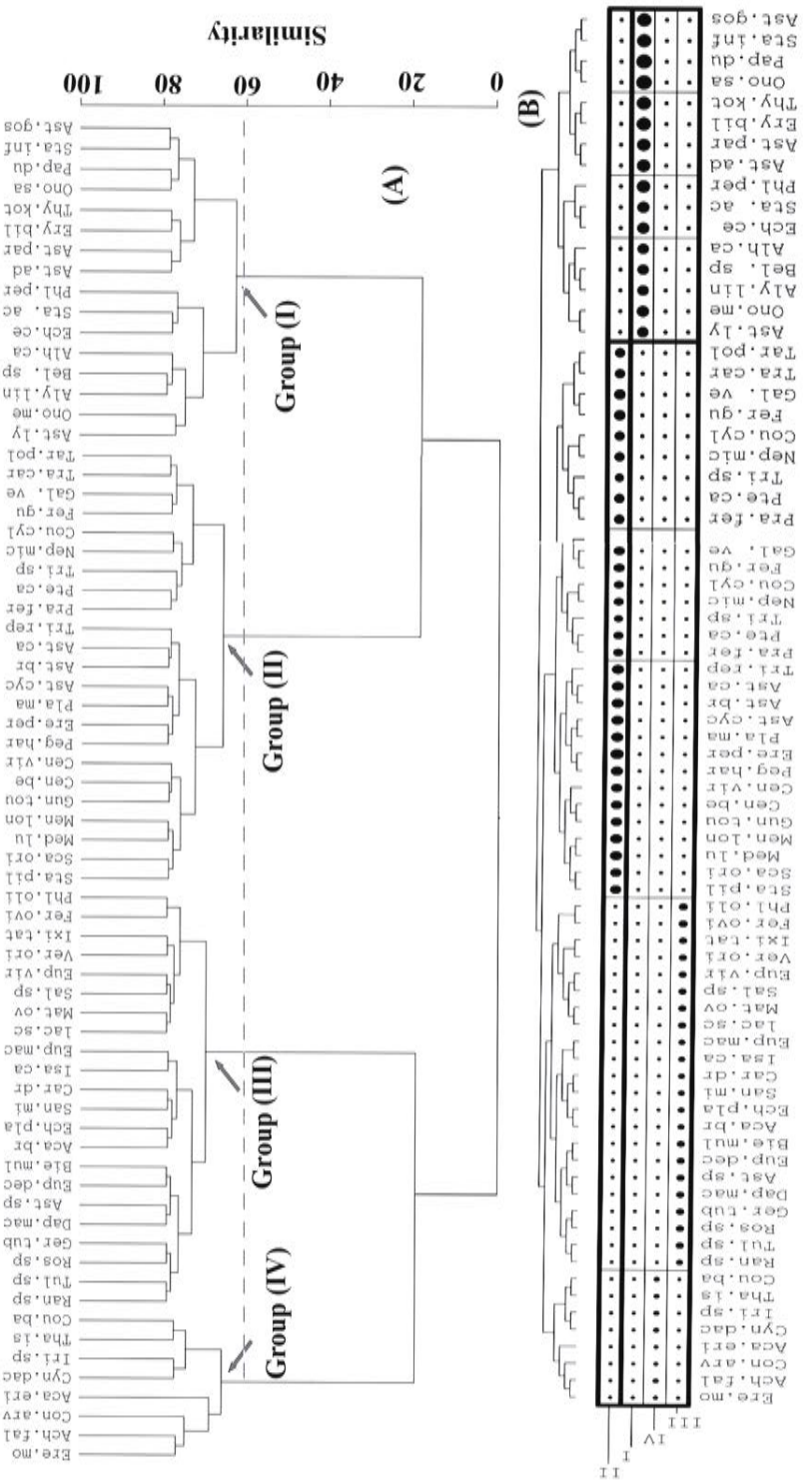


Fig.3: The cluster analysis of plants used by honeybees in the study area

*Species with Good Attractiveness (Group II)*

The results of the cluster analysis showed that at the similarity level of 75%, 3 subgroups were classified separately based on the number of visitor honeybees and the fairly high rate of bee settlement time on each plant species (Fig.3 a, b). Species located in subgroups based on the similarity percentage are presented separately (Fig.2 b). The number of visitor honeybees and the settlement time in this group are associated with *Eremurus persicus,* with an average of 12.7 visiting bees and a time of 172 seconds, yielding an average index of attractiveness of 92.35, while the lowest rate was associated with *Trigonella sp.*, with an average of 7.32 visiting bees and a time of 98.8 seconds yielding an average index of attractiveness of 53 (Table 2).

*Species with Average and Weak Attractiveness (Groups III and IV)*

In Group III, *Phlomis olivieri* species with an average of 6.5 visiting bees for a period of 85.3 seconds and *Isatis capadosica* with an average of 6.5 visiting bees for the same period of time resulting in attractiveness indices of 45.9 and 30.3 respectively, were the most and the least attractive species of this group. The most attractive index (48.1) in Group IV was associated with *Cousinia bachtiarica* with 4.1 visitor bees for a period of 26.1 seconds, while the least $A_{Index}$ (27.6) was associated with *Acantholimon erinaceum* with an average of 2.3 visiting bee numbers for a period of 14.9 seconds (Table 2). The results of the cluster analysis indicated that in Group III with 75% similarity level, there were 3 subgroups, while in the group IV with a 70% level there were 2 subgroups (see Fig.3a,b). The differences between the species of the two groups were the average low numbers of visitor honeybees and the average weak period of bee settlement of each species.

## DISCUSSION

Due to the differences in elevation and topography of the study area, there was high species diversity, while the presence of various species showed adaptations to local conditions. The most important plant families used by honeybees in the study area were Leguminosae, Compositae, Labiatae, Gramineae, Umbelliferae, Caryophyllaceae, Cruciferae and Liliaceae (Table 2).

Nazarian *et al*. (2006) reported the most important plant families as: Compositae, Leguminosae, Labiatae, Rosaceae, and Cruciferae, while Maskey (1992) in Kathmandu stated Rosaceae and Cruciferae as important families. The results of the present study when compared to previous studies showed that the plant families including Leguminosae, Compositae, Labiatae, Umbelliferae, Rosaceae and Cruciferae are very important families for bee keeping, especially in terms of the number of species, accumulation, dispersion, and attractiveness in addition to the production of nectar and pollen. These families have attractive and nutritious materials useful to honeybee nutrition are of significant importance (Nation & Robinson, 1968; Ebadi & Ahmadi, 2006). The results

obtained in this research correspond with similar studies carried out in Iran and elsewhere in the world. A comparison of the species in the area showed that most plants used by honeybees are species producing nectar and pollen. The results of the study showed that the number of plants producing nectar and pollen is more than the number of plants producing nectar or pollen.

The results of the classification analysis showed different levels of attractiveness (excellent, good, average and weak). The differences among the plant species mainly result from the density of flowers on each plant, density and dispersion of species in the area, physical characteristics of flowers, flowering date, climatic factors and plant distances from honeybee colonies. Hegland and Boeke (2006) found the diversity of floral resources and the diversity and abundance of pollinators in a temperate grassland community resulted in differences in attractiveness of different species to the bees.

The results of the classification analysis indicated that the species located in the low palatable class had the highest level of attractiveness in terms of apicultural applications and formed the species of Group I. Further, the flowering dates of these species may have been favourable and attracted the honeybees. In other words, the absence of competing plants can cause greater attraction of bees to one special species. Moreover, the results of Rabinowitch *et al*. (1993) showed that the distance of the colonies from flowers influences the attraction of bees to one effective species.

Lack of knowledge of the existing environmental resources in the area resulted in the utilization of these resources more for livestock production. However, the presence of plant species with potential for other usage, including recreation and bee keeping, can result in increased income. Behan (1984) stated that multiple usage of environmental resources should be based on scientific planning in agreement with politics, law, economy and sociology under the supervision of an authorized committee for decision making.

An increase in the number of livestock to increase income and fulfil the economic needs caused a change in the species composition and a decline in the diversity of plant species. An increase in the livestock caused extinction of palatable species and a decrease in livestock performance. According to the food communion of livestock and honeybees, early grazing before the flowering period of plant species will cause a decrease in forage produced in the following years and a decrease in the use of flowers during the flowering period by honeybees and soil degradation (Vulliamy *et al*., 2006). The entry date of livestock in the area should be after the flowering period so that the use of that particular bee species could be made possible. Among the invasive and secondary plant species unpalatable species not preferred by livestock are attractive and of interest for honeybees (Wilke & Irwin, 2010). Ralphs (2002) studied the ecological interaction among unpalatable plants in the west pastures of America and found that some species are useful for beekeeping.

## CONCLUSION

Knowledge on plants, their dispersion areas and phonology (especially flowering period) is an important planning tool for the protection of the natural environment and development of beekeeping. Awareness of honeybee biology, knowing the plants preferred by honeybees and studying plant cover types are necessary to raise honeybees. In the study area, the floristic list of available plants and plant types in terms of nectar and pollen producing were identified and classified. Considering the geographical width of the area and the climate, soil, and topography, the interacting characteristics provide a good natural environment to raise honeybees. The results of the study on the floristic composition, the climatic conditions and the presence of nectar and pollen producing species indicate good potential for rehabilitation of the area. Based on the diversity of the plant species available in the area, it can be concluded that the environmental resources indicate a strong potential for bee keeping.

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