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An assessment of short-term cattle grazing effects on honeybee forage potential in Mediterranean rangelands

A. Kaminer*, J. Kigel*, A. Dag and Z. Henkin****

*The Robert H. Smith Institute of Plant Science and Genetics in Agriculture,
Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem,
Rehovot Campus 76100 (Israel)
**Agricultural Research Organization (ARO), The Volcani Center, Bet-Dagan 50250 (Israel)
e-mail: albert.kaminer@mail.huji.ac.il

Abstract. Beekeepers in Israel claim that cattle grazing during spring reduces honey production potential as a result of the removal of flowers. We studied the impacts of cattle grazing on honeybee forage during spring in a semi-arid Mediterranean habitat. Cattle was introduced to fenced plots in order to reach the required stoking rates and measurements of floral abundance and honeybee visits were carried out during five surveys. In this study, the impact of cattle grazing on honeybee forage activity appeared to be related to floral abundance and to the blooming periods of specific plant species rather than species richness. Crucifers and woody perennials, mainly Labiatae, seemed to be more attractive to honeybees than most herbaceous annuals. Overall, intensive grazing during the spring flowering season did not seem to suppress the full bloom potential or restrain flower production within local flora. Grazing at moderate to high levels (i.e. 0.4-0.8 cows/ha) may actually support natural honeybee forage by increasing the abundance of some important plant species. However it is recommended to restrict certain areas from grazing to support key species that are restrained by grazing and crucial for honeybee forage at the end of the season.

Keywords. Cattle grazing – Honeybee forage – Stoking rate – Floral abundance.

Evaluation des effets à court terme du pâturage de bovins sur le potentiel de butinage des abeilles dans les pâturages méditerranéens

Résumé. *Les apiculteurs en Israël soutiennent que le pâturage de bovins au cours de printemps réduit le potentiel de butinage des abeilles par le enlèvement des fleurs. Nous avons étudié les impacts du pâturage de bovins sur le potentiel de butinage des abeilles dans un habitat méditerranéen en Israël. Nous avons introduit des bovins dans des terrains clôturés afin d'atteindre les taux de chargement requis, puis nous avons mesuré l'abondance florale et les passages d'abeilles au cours de cinq relevés. Dans cette étude, l'impact du pâturage sur l'abondance des abeilles ne pouvait être expliquée par des changements dans la richesse des espèces en floraison. A l'inverse, cet impact semblait être lié à l'abondance florale et aux périodes de floraison de certaines espèces florales. Des crucifères et des plantes vivaces ligneuses, principalement des labiées, semblaient attirer davantage les abeilles que la plupart des herbacées annuelles. D'une manière générale, le pâturage intensif pendant la saison de floraison, au printemps, n'a semblé pas supprimer le potentiel de pleine floraison ou faire décliner la production de fleurs de la flore locale. Le pâturage à des niveaux de modérés à élevés (c.-à-d. 0.4 à 0.8 vaches/ha) pourrait en fait encourager le butinage naturel des abeilles en augmentant l'abondance de certaines espèces de plantes importantes, mais il est aussi recommandé d'exclure du pâturage certaines zones afin d'encourager d'autres espèces clé que le pâturage fait décliner et qui pourraient jouer un rôle important dans le butinage des abeilles en fin de saison.*

Mots-clés. *Pâturage de bovines – Butinage des abeilles – Pression de pâturage – Abondance florale.*

I – Introduction

A considerable fraction of Israel's natural open landscapes is exploited for both, livestock pasture and honeybee forage. Since these natural open areas in Israel are limited, rangelands for livestock grazing and natural honeybee forage spots often overlap. The consequences of

such overlaps become more pronounced during spring, when most of the honey surplus is stored in the hives and the cattle benefits from high quality pasture. Many beekeepers in Israel claim that cattle grazing in this critical season reduces the honey production potential in intensively grazed areas since the cattle removes most of the flowers, sometimes, before full bloom. Others believe that grazing may have positive effects on honeybee forage through increasing flower abundance in the area by suppressing grasses (Noy-Meir *et al*., 2006).

Previous studies suggested that grazing may have negative effects on bees through changes in the abundance and diversity of flowers (Vulliami *et al*., 2006). The relationship between grazing, bees and flowering plant communities was mentioned also by Potts *et al*. (2003) who named grazing as one of the main disturbance factors affecting Mediterranean habitat dynamics, together with fire, habitat fragmentation and change in land use. Petanidou and Smets (1995) suggested that sustained extensive grazing may support commercial honey production from Mediterranean semi-natural ecosystems in Greek phrygana, but quantitative data due to the suggested grazing intensities are missing. Therefore, identifying the grazing regimes that can maintain or even enhance the abundance of important plant species for honeybee forage is crucial for sustaining apiculture in these areas. The main objective of this study was to produce a quantitive assessment of short term cattle grazing effects on honeybee forage during spring time in a Mediterranean ecosystem. We hypothesed that intensive grazing will reduce the amount of flowers for honeybee forage and as a result, will negatively influence forage quality and honey production in the grazed area.

II – Materials and methods

In order to test this hypothesis we studied the effects of cattle grazing in a semi-arid Mediterranean ecosystem during spring time. The research was carried out in Lachish rangelands located in Givat-Gad Nature Reserve, Israel (31^{o}32'00N, 34^{o}51'45E, 340 mm/y), characterized by an open shrubland dominated mainly by woody perennials. Grazing levels were obtained by introducing the required number of adult cross-breed beef cows and calves into fenced paddocks. We compared between grazed (0.04 cow/ha to 0.08 cow/ha: the approximate stoking rates used by farmers in the area) and ungrazed paddocks. Honeybee hives were present in all plots as well as in the rest of the area. Between mid March and late May 2009, surveys were completed covering most of the floral bloom and main spring honeybee activity period. The surveys were done between 08:00 and 16:00, to cover the main honeybee daily activity period and included measurements of flower abundance and honeybee visits counts along twelve fixed 20 m transects located in each plot. In order to identify the species most important for honeybee forage in the area, honeybee visits were recorded inside the 20 m transects. Each transect was crossed slowly during 15 minutes and all honeybees encountered within one meter from the observer were recorded. Simultaneously, all open flowers, likely to have nectar or pollen available to bees, were identified to species level and counted. When numbers were too high to count, a rough estimation was made using a 25 x 25 cm quadrate.

III – Results and discussion

Grazing seamed to have a positive effect on honeybee abundance from the beginning of the surveys in March, trough mid April ($p < 0.0001$, $F = 4.17$), estimated by visitation rate. During May, more visits were observed in patches which were excluded from grazing (Fig. 1a). On the last survey, in the beginning of June, no honeybees were observed visiting flowers inside the study enclosures. Accordingly, as seen in Fig. 1b, floral abundance was higher in grazed patches during the first half of the spring but lower during May ($p < 0.0001$, $F = 14.8$). From June on, floral abundance was low in all of the study area and did not differ among treatments. The correlation between honeybee forage activity and the general floral abundance was significant

but not strong (r^2=0.13, p=0.0083, F=7.3). Blooming species richness was positively affected by grazing (p=0.0027, F=11.47), but the correlation between blooming species richness and honeybee activity was weak and only marginally significant (r^2=0.08, p=0.058, F=3.7). The most attractive species to honeybees, according to our surveys were *Prasium majus*, *Sinapis alba*, *Teucrium capitatum*, *Coridothymus capitatus* and *Rhamnus lycioides*, which were responsible for more than 80% of the total visits. These species, excluding *Sinapis alba* (crucifers), are woody perennials including chamaephytes (dwarf-shrubs) and phanerophytes (trees and shrubs). Some of these species where more abundant in patches excluded from grazing, like *Teucrium capitatum* (Wilcoxon: p<0.0001) while others, like, *Sinapis alba* were more abundant in grazed patches (Wilcoxon: p=0.0144).

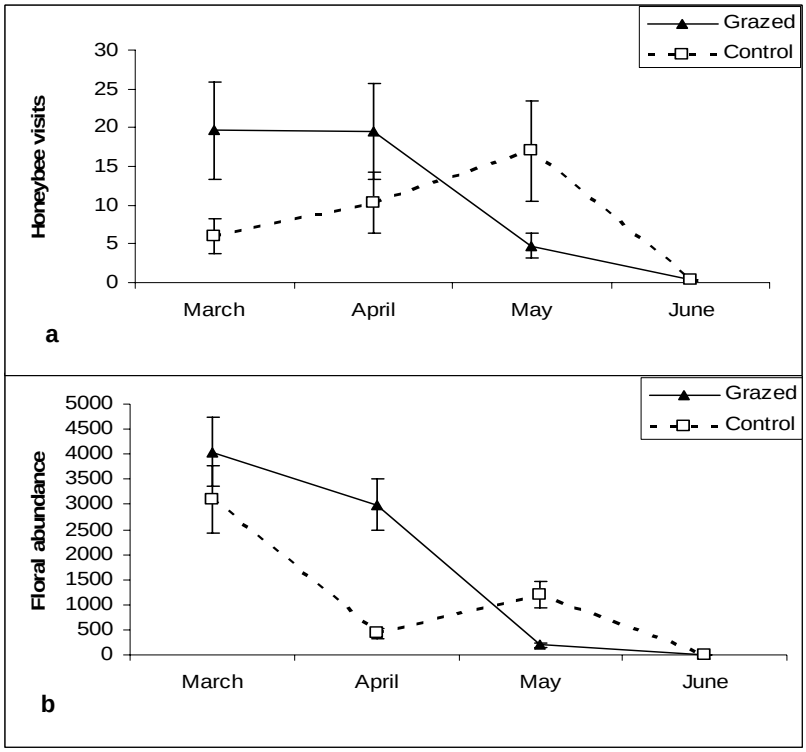

Fig. 1. **Cattle grazing effect on: (a) honeybee foraging activity (number of honeybee visits/40m^2) (b) floral abundance (number of flowers/40m^2) during spring 2009. Treatments: Grazed – 0.4-0.8 cow/ha; Control – protected from grazing**.

The impact of cattle grazing on honeybee forage activity was more pronounced in grazed patches comparing to ungrazed patches during the first stages of the spring, but a reversed trend was observed during the second half of the main blooming period (Fig. 1a). A similar pattern was recorded for floral abundance response to grazing (Fig. 1b), suggesting there might be a correlation between the two variables. Floral abundance explained only 13% of the variation in honeybee foraging activity among grazing treatments. This effect, however, may have been masked trough the variability in the level of attractiveness among different flower species to honeybees. Blooming species richness did not prove to be a good predictor for honeybee forage quality. Since honeybees feed exclusively on nectar and pollen, rewording flower availability is expected to be the main factor limiting honeybee abundance. Hence, the effect of grazing on honeybee forage activity was most likely, mediated trough specific plant groups (or even specific species) which probably provided more nectar than others. Overall,

annuals did not seem to play an important role in honeybee forage in the research area, however nearly 15% of the honeybees' visits recorded, nearly all in grazed pathes, were spotted on *Sinapis alba* flowers. Therefore, the importance of crucifers in Mediterranean honeybee forage should be better studied. In this ecosystem, woody perennials, mainly Labiatae, seemed to be more attractive to honeybees than herbaceous species. Petanidou and Smets (1995) found that Labiatae were the most rewarding species in Greek phrygana shrubland. Overall, intensive grazing during the flowering season in spring did not seem to suppress the full bloom potential or restrain flower production within the local flora and hence, the availability of nectar and pollen for honeybees was not likely to be reduced. It seems that some level of grazing is necessary to support natural honeybee forage by preserving a mixed structure of shrubs and open herbaceous patches, as suggested in other studies (Vulliamy *et al*., 2006; Koniak *et al*., 2009). We propose that grazing should be restrained from some areas in order to support important honeybee forage plant species which are sensitive to grazing, like *Teucrium capitatum*.

A main limitation in this study was the fact that honeybee foragers could reach distances much greater than our plot separation and, therefore, important forage resources may have been found outside our sampling areas. Further studies should focus on treating grazing as a continuous rather than categorical variable which may reduce constraints on treatment replication and maintain more statistical power.

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