Flower visiting activity of honeybees on fruit species blooming subsequently*

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Summary: In the small demonstration orchard of the College Faculty of Horticulture at Kecskemét the blooming time, the flower density and the honeybee activity was observed at a number of cultivars of 20 flower species during four consecutive years.
Fruit crop species were in flower during 3–4 months altogether. The blooming period of them was classified into five groups as early (almond, apricot, gooseberry), middle early (sweet cherry, red currant, currant-gooseberry, black currant, white currant, peach, plum, sour cherry), middle late (pear, strawberry, apple), late (black elder, quince, medlar, raspberry, blackberry-raspberry) and very late blooming period (blackberry). The blooming period of the members of the groups of early and medium early blooming often coincided partly and the same happened between the medium and the medium late as well as between fruits of late and very late flowering.
The flower density of some fruit species is extremely variable (currant-gooseberry, medlar), while at others it is fairly stable and evenly dense in consecutive years (sour cherry, sweet cherry, strawberry). At other fruit species it is moderately changeable. Some fruit species tended to attract more honeybees than others (plum, apple, quince, medlar) and some of them tended to attract much less (black elder, pear) but most species can be regarded as of medium attractivity.
On the flowers of some fruit species (pear, strawberry, quince) honeybees gathered pollen predominantly. At most fruit species however pollen and nectar gathering behaviour seemed to be gradually changing during the season. Namely most honeybees tended to gather pollen at the flowers of the early blooming fruit species, but on the other hand typical foraging behaviour gradually shifted to nectar gathering at the flowers of fruit species of moderate and late blooming periods.

Introduction

Bee foraging on fruit species have been investigated by a number of authors for a long time (see in *Free* 1970, 1993, *McGregor* 1976, *Benedek* 1996). Observations were usually made with a single species or cultivar but no one compared the flower visiting activity of honeybees of several fruit species parallelly at the same site.

Material and methods

In the demonstration orchard of the College of Horticulture, Kecskemét (Central Hungary) 20 fruit species were planted next to each other in an area that is as small as 1 hectare only. Most of them are represented by several cultivars. The list of the fruit species and the number of their available cultivars (in brackets) are as below:

apple (25)
pear (5)
quince (3)
medlar (1)
peach (2)
apricot (9)
plum (9)
sweet cherry (5)
sour cherry (8)
almond (6)
gooseberry (4)
currant-gooseberry (1)
black currant (2)
red currant (2)
white currant (2)
blackberry (2)
raspberry (2
raspberry-blackberry (1)
black elder (1)
strawberry (10)

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We have taken this opportunity and have made parallel observations on the blooming times and on the activity of honeybees during the whole blooming period of those fruit species flowering subsequently.

The orchard had a flat surface and sandy soil. Its ecological homogenity and the small area of the demonstration orchard provided an excellent possibility to make comparisons on the blooming times and on the bee activity of fruit species excluding the effect of the soil and the effect of other ecological conditions because all of those were identical all along when different fruit species were in bloom simultaneously. No bee colonies were moved to the orchard but a number of apiaries were existing within a distance of a few kilometres around the demonstration orchards that was situated within the area of the town of Kecskemét.

The observations were made in four consecutive years between 1997 and 2000. The weather was different in the four consecutive years of the study.

1997: The early spring weather was the coolest of the experimental period. Namely the general tendency of the weather was rather cool early spring with some severe early morning frosts on some days in mid-April (–3, –5 °C). However later on, it turned extremely hot in May because the daytime maxima rose up as high as 30–40 °C on some days mid- and late-May but there was very little rain all along the spring period. In late May and early June there was some more rain and the weather was fairly favourable for the season.

1998: In late February there were some extremely hot days, but ambient temperature turned to be fairly normal for the season in March and April because it was gradually rising day by day in this period. However there were some severe morning frosts on the last few days of March and on the 1st of April (–2, –6 °C) causing some frost damage at the flowers of the early blooming fruit species. It turned warm in May but the temperature was not so hot as in the previous year. The daytime maxima seldom approached 25–30 °C. Early spring there was much less rain than normal but late May it turned rainy and the air temperature turned a bit cooler, so the weather finally turned to be normal for the season.

1999: Early spring was characterised by gradually rising day time temperatures in March and April but there were some early morning frosts on 20–21 April (–2.5 and –1.4 °C, resp.). There was little rain early spring, but we had a single very rainy day late April (some 40 mm precipitation per one day). The weather was normal for the season in May, namely air temperature was somewhat lower than in the previous year. Daily maxima remained around 20–23 °C. Precipitation was much less than usual. In late May and early June the temperature was somewhat higher and there was more rain than before.

2000: This was the hottest spring during the observations. It was much warmer than normal from mid March till early June. No spring frost but much less rain than normal during the whole period, however early May we had two very rainy days. The evenly very hot spring weather speeded up blooming of the fruit species, so their blooming commenced earlier than in the other three years of the study.

The blooming times of the fruit species were registered. The intensity of bee visits as well as foraging behaviour of honeybees were observed at a number of available cultivars of the fruit species during their whole blooming periods.

Flower density was also counted visually using a scale from 0 to 5 as follows: 0 = no flowers, 1 = very few individual flowers only, 2 = few flowers, scattered on the branches or on the plot, 3 = normal bloom with evenly distributed flowers, 4 = rich bloom with densely distributed flowers, 5 = trees, plants or plots completely covered with flowers.

Bee visits were observed at least on three days of the blooming period and the bee counts were taken in the morning (between 10 and 12 a.m.) and the afternoon (between 1 and 3 p.m.) each day on the northern and southern side of the trees, shrubs or plots of each fruit species inspected. The number of bee visits and the number of flowers visited by honeybees were counted on 50 open flowers during 10 minutes periods and the foraging behaviour of the bees was also registered. However only mean values are used in this report.

Results and discussion

The blooming periods of the fruit species being earliest in the season started in late February to late March and the flowering periods of the late blooming ones ceased early to late June depending on the year. Both the start of the blooming and the end of the in depended on the prevailing weather, of course. The blooming started earlier in 1998 and in 2000 than in the other two years. In 1998 it lasted longer and in 2000 ceased much earlier than in the other years. Investigation about the blooming time of the fruit species lasted for 91 to 121 days altogether in the four years of the study, so the duration of the blooming time of fruit species altogether varied between 3–4 months according to the year. It was longer in 1999 (121 days) and in 1998 (114 days) when the weather was not so hot as in 1997 (105 days) and especially in 2000 (91 days).

The duration of the blooming period of individual species however was much more variable (*Table 1*). Most species were in flower for 10–15 days when the blooming period was short. The long lasting bloom, at the other hand was as long as 3 weeks for most of the fruit species, but some species as medlar, quince and peach flowered for a much shorter time for at least 2 weeks only, even when the blooming period was extended. Some other fruits on the other hand had a blooming time as long as a whole month when the weather was cooler (almond, sweet cherry, black currant, sour cherry, apple, raspberry, blackberry-raspberry). A single fruit species, blackberry was in bloom for almost 2 months when the weather was unfavourably cool.

The blooming order of the investigated fruit species has been fairly stable during the consecutive years with varying weather so they could be classified into separate groups according to their blooming periods (*Table 2*). Almond was the earliest in blooming followed by apricot and gooseberry

Table 1 Duration of the blooming period and flower density of fruit species at Kecskemét, in the years of 1997–2000.

Fruit species	Commencement of blooming (date)	End of blooming (date)	Duration of blooming (days)	Mean flower density
Early blooming				
almond	27 Feb. – 29 Mar.	3 Apr. – 19 Apr.	17–36	3.0–4.9
apricot	3 Mar. – 31 Mar.	24 Mar. – 13 Apr.	10–22	3.8–4.8
gooseberry	29 Mar. – 2 Apr.	13 Apr. – 24 Apr.	15–24	2.5–4.8
Medium early blooming				
sweet cherry	2 Apr. – 9 Apr.	12 Apr. – 5 May	11–32	4.4–4.9
red currant	2 Apr. – 6 Apr.	16 Apr. – 30 Apr.	14–25	2.9–4.6
currant-gooseberry	3 Apr. – 6 Apr.	14 Apr. – 30 Apr.	12–25	0.8–4.3
black currant	2 Apr. – 4 Apr.	21 Apr. – 1 May	18–30	2.4–4.5
white currant	5 Apr. – 12 Apr.	22 Apr. – 7 May	18–26	2.9–5.0
peach	27 Mar. – 10 Apr.	6 Apr. – 21 Apr.	11–13	3.3–4.7
plum	31 Mar. – 9 Apr.	11 Apr. – 29 Apr.	12–26	3.5–4.7
sour cherry	1 Apr. – 11 Apr.	22 Apr. – 6 May	15–32	4.3–5.0
Medium late blooming				
pear	30 Mar. – 13 Apr.	15 Apr. – 5 May	12–30	2.1–4.6
strawberry	9 Apr. – 29 Apr.	24 Apr. –11 May	22–32	4.6–5.0
apple	2 Apr. – 21 Apr.	29 Apr. – 6 May	15–31	3.3–4.1
Late blooming				
black elder	28 Apr. – 20 May	20 May – 10 Jun.	22–26	2.4–4.8
quince	21 Apr. – 5 May	1 May – 12 May	9–14	2.7–5.0
medlar	27 Apr. – 7 May	9 May – 15 May	6–13	1.0–5.0
raspberry	28 Apr. – 20 May	15May – 11 Jun.	17–32	3.3–5.0
blackberry-raspberry	3 May – 20 May	19 May – 18 Jun.	13–33	3.1–4.6
Very late blooming				
blackberry	4 May – 28 May	21 Jun. – 30 Jun.	25–55	3.9–5.0

in the group of early blooming. In the group of medium early blooming the bloom period of species overlapped largely in each year (*Table 1*). This group consisted of largest number of species starting with sweet cherry and closed by sour cherry. In this group the beginning of bloom showed a fairly stable order but the end of the blooming was often greatly extended by some species, so some early blooming members of the group were often in flower much longer than other species, which started blooming later.

The medium late group comprised pear, strawberry and apple and this group was followed by 5 late blooming fruit species and by the very late blooming blackberry.

The blooming period of the members of the groups of early and medium early blooming often coincided partly and the same happened between the medium and the medium late as well as between the fruits of late and very late flowering (*Table 1*). The coincidence however usually extended only to the second half of the blooming of the species with earlier and to the first half of the blooming of species with later blooming periods. It means that the species belonging to these groups are competitors to each other for honeybee visits for at least the half of their blooming periods.

The flower density of some fruit species was extremely variable (currant-gooseberry: 0.8–4.3, medlar: 1.0–5.0) during consecutive years (*Table 1*) consequently, their attractiveness to honeybees could be greatly variable, too. At some other species on the other hand flower density was fairly stable and evenly dense (4.3–5.0) in consecutive years of different weather conditions (sour cherry, sweet cherry, strawberry). These are evenly attractive to bees in different

Table 2 Mean intensity of honeybee visits at the flowers of fruit species at Kecskemét, in the years of 1997–2000.

Fruit species	Mean number of honeybee visits +	Mean number of flowers visited+
Early blooming		
almond	4.1	8.1
apricot	4.0	6.4
gooseberry	3.3	6.6
Average	*3.8*	*7.0*
Medium early blooming		
sweet cherry	4.3	7.5
red currant	3.6	8.5
currant-gooseberry	3.7	6.9
black currant	3.3	7.2
white currant	3.4	7.4
peach	2.9	6.0
plum	5.5	10.4
sour cherry	3.8	7.0
Average	*3.8*	*7.6*
Medium late blooming		
pear	2.5	4.8
strawberry	4.4	8.3
apple	7.2	11.7
Average	*4.7*	*8.3*
Late blooming		
black elder	0.1	0.2
quince	5.6	10.3
medlar	5.0	9.4
raspberry	2.8	5.9
blackberry-raspberry	3.6	7.0
Average (without black elder)	*4.2*	*7.4*
Very late blooming		
blackberry	3.7	8.2

+ On the basis of the ten-minute observations at 50 open flowers

years. Flower density of other fruit species was somewhat more variable (apple, peach, plum, apricot, almond, blackberry, raspberry, blackberry-raspberry) but no more than some moderate differences could be detected in consecutive years (3.1–5.0). Flower density of pear, quince, black elder as well as of currants and gooseberry was even more variable (2.1-5.0) depending on the year (*Table 1*). No relationship could be detected between time of blooming and flower density, since more or less variable figures are detected among the early, medium and late blooming groups, too (*Table 1*).

As far as the mean intensity of bee visits of fruit species it is evident that most figures are between 3 to 4 on 50 open flowers per 10 minute periods (*Table 2*). Some fruit species however tended to attract more bees than others and some of them tended to attract much less. In fact most species are regarded to be of medium attractiveness but some of them could be counted as highly attractive while others are regarded as poorly attractive (*Table 3*). The mean number of flowers visited by bees at the 50 flowers observed reflected a fairly similar picture (*Table 2*). In the case of fruit species blooming at the same time flower density and the quantity of open flowers may have a role in the intensity of bee visits. In some cases the quantity of flowers, that is the flower density, had higher influence on the frequency of bee visits than the relative attractiveness of their individual flowers. Bees usually preferred the flowers of the currant-gooseberry to the red currant and the black currant, however it could only be seen in the case when their flower density was the same. On the other hand bees usually turned to the currant bushes being rich in flowers from blackberry bushes having few flowers.

The ratio of open flowers may have a role in the case of species blooming subsequently. Both sweet cherry and sour cherry trees usually had a lot of flowers, however honeybees preferred the flowers of the sweet cherry. This was true until some 20–30% of the flowers were open in the trees. On the other hand when the ratio of the open flowers at sweet cherry trees decreased down to 20% at the end of the blooming, bees turned to sour cherry trees.

Table 3 Relative attractiveness of fruit species to honeybee foragers according to the frequency of bee visits at their flowers at Kecskemét, in the years of 1997–2000.

Blooming time of species	Highly attractive	Medium attractive	Poorly attractive
Early		almond apricot gooseberry	
Medium early	plum	sweet cherry red currant currant-gooseberry black currant white currant peach sour cherry	
Medium late	apple	strawberry	pear
Late	quince medlar	raspberry blackberry- raspberry	black elder
Very late		blackberry	

The foraging behaviour of honeybees was different at the flowers of fruit species (*Table 4*). Pollen gathering has been found to be predominant (pollen gatherers plus mixed behaviour bees) at a number of fruit species and the nectar gathering behaviour was more typical at others (*Tables 4 and 5*). Very high proportion of pollen gatherers has been well demonstrated for pear and it could be seen also for strawberry and quince (counting pure pollen gatherers and mixed behaviour bees together). The outstanding high ratio of pure nectar gatherers was found to be typical at black currant, white currant, medlar, raspberry and blackberry-raspberry flowers. The high proportion of pollen gatherers and the conspicuously low appearance of nectar gatherer bees at pear, strawberry and quince (*Table 4*) was in a fairly good accordance with the earlier statements in the literature (see *Free* 1970, *McGregor* 1976, and *Benedek, Szabó & Nyéki* 2000 for quince only). However pollen and nectar gathering behaviour was found to be changing during the blooming season of other fruit species. Namely most honeybees preferred to gather pollen at the flowers of fruit species of earliest blooming periods and nectar gathering become gradually more and more frequent at fruit species of medium or late blooming periods (*Table 4*). On the other hand typical foraging behaviour shifted to be nectar gathering at the flowers of the late and very late blooming fruit species (*Table 4*). This showed that pollen or nectar preference of honeybee foragers at the flowers of fruit

Table 4 Foraging behaviour of honeybees at the flowers of fruit species at Kecskemét, in the years of 1997–2000.

Species	Pollen-gatherers (%)	Mixed behaviour (%)	Nectar-gatherers (%)
Early blooming			
almond	42	25	33
apricot	61	6	33
gooseberry	73		27
Average	*59*	*10*	*31*
Medium early blooming			
sweet cherry	72		28
red currant	25		75
currant-gooseberry	31		69
black currant	10	2	88
white currant	14	4	82
peach	70		30
plum	37	2	61
sour cherry	65		35
Average	*40*	*2*	*58*
Medium late blooming			
pear	98		2
strawberry	88	6	6
apple	36	18	46
Average	*74*	*11*	*15*
Late blooming			
quince	42	44	14
medlar	3	5	92
raspberry	12	7	81
blackberry-raspberry	10	4	86
Average	*7*	*5*	*88*
Very late blooming			
blackberry	6	7	87

Table 5 Typical behaviour of honeybees at the flowers of fruit species at Kecskemét, in the years of 1997–2000.

Blooming time of species	Pollen gathering is dominant (pure pollen gatherers plus mixed behaviour foragers)	Nectar gathering is dominant (pure nectar gatherers)
Early	almond apricot gooseberry	red currant currant-gooseberry black currant white currant plum
Medium early	sweet cherry peach sour cherry	
Medium late	pear strawberry apple	
Late	quince	medlar raspberry blackberry-raspberry
Very late		blackberry

species was greatly affected by the changing food demand of the bee colonies, since much more pollen than nectar was needed at the earliest part of the season when brood rearing has started to expand.

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