Nectar production and pollination in peach

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Summary: Observations were made at two growing sites, Siófok and Szatymaz, in the years 1998 and 1999, on 16 peach varieties. The production of nectar was measured, the foraging behaviour of bees, fruit set and the effect of exclusion of bee visits for different periods were observed systematically.

Production of nectar confirmed earlier data, 9.09 mg per flower in average. There was large variation due to variety and date of observation. Bee visits were relatively abundant. At favourable weather, 1 to 30 visits/flower/day occurred in the average. Artificial hand pollination increased fruit set, substantially. Open pollination yielded superior fruit set than self pollination, without bees. Supplementary bee pollination can be regarded to be beneficial to peach production as well.

Introduction

Peach is an early blooming fruit species. The majority of varieties is self-fertile, there are, however, male sterile varieties, too. The literature concerning basic questions of the technology of bee pollination is scarce. *McGregor* (1976) stated in his excellent handbook with an analytical touch: "Considering the economical importance of the peach crop, surprisingly little has been done about its pollination requirements". Essentially, that statement did not loose its actuality since then.

There are but a few publications, internationally, dealing with the blooming time and fertilisation of peach varieties. Results of Hungarian researches are summarised by *Nyéki & Szabó* (1999a and 1999b), *Nyéki* et al. (1998) and *Szabó & Nyéki* (2000). Insect pollination, especially the behaviour of bees and morphological properties of peach flowers has been studied, by *Benedek* et al. (1991) exhaustively. The present paper is focused to the interaction of nectar production and the behaviour of bees being a important aspect of bee pollination.

Material and methods

In both years, 1998, 1999, two growing sites, Siófok and Szatymaz, have been studied on 16 peach varieties, the list of which is presented here below:

Fresh market types:

Cresthaven
Early Redhaven
Gloria Red
Michelini
Starcres
Sunbeam

Industrial clingstones:

Babygold 6
Frederica

Nectarines:

Armking
Caldesi 2000
Fairlane
Fantasia
Harko
Red June

Venus
Weinberger

Nectar content of flowers

During bloom, whole branches have been isolated by covering with muslin bags for 24 hours in order to exclude visiting insects, which consume nectar. Several trees per variety were sampled, taking 3 × 10 flowers to suck the nectar by glass capillary tubes. The previously weighed tubes (with their plugs) were closed by the wax plugs at both ends and carried to the laboratory to re-weigh them on an analytical balance. The difference between the two weights is due to the mass of nectar. Parallelly, the dry matter content of the nectar was checked by refractometry.

Bee visits

At the medium height of the crowns, branches were sampled with counted number of flowers (about 100 each). Observation of visits is performed within two time-intervals, between 9–11 a.m. and 1–3 p.m. The counts of bee-visits on a given branch sample lasted 10 minutes. Meanwhile, the behaviour of bees was checked, as whether they were pollen-gatherers or nectar-suckers, those last ones may approach the flower from above by touching the stigma, or alternatively, from the side of the flower, between the petals and stamina, without touching the stigma (side workers). In addition, there were also mixed gatherers interested equally in pollen and nectar.

Fertilisation

In the two trees sampled per variety, on two opposite sides, branches were marked and bagged with parchment paper, about 100–140 flowers on each side, 200–300 flowers per tree. The number of flowers isolated was counted and registered under each bag. About 4–5 days after bloom, bags are opened in order to check the fruit set first, then about one week before maturity the second time.

At the same time, the same number of flowers was counted, marked and (later) re-counted near to the bagged ones in order to trace the effect of open pollination too.

Results

Nectar production

The nectar production reached 9.09 mg/flower, the high variation depends on varieties but also on sampling dates *(Table 1)*.

At first glance, large differences are observed between the flowers of peach varieties, but the individual data of the same variety are even more variable, the differences are hardly significant. Our measured data confirm those published earlier (*Benedek* et al., 1991). The segregation of nectar is cyclical also in peach (*Szabó* et al., 1994). The dry matter content of the nectar is in correlation with the quantity produced. The values vary between 13.5 and 27.8%, which is lower than found earlier. The sugar produced was less variable and corresponded to earlier data (*Benedek* et al., 1991).

Bee visit of flowers

The most important insect acting in the pollen transfer is the honeybee. They provide 80–100% of visitors in peach flowers.

Table 1 Nectar production of peach varieties (Szatymaz, 1999)

Variety	Date of sampling	Nectar volume (mg/flower)	Dry matter content (%)	Sugar value
Early Redhaven	April 12	9.09	16.1	1.46
Gloria Red	April 11	4.15	17.3	0.72
Michelini	April 12	6.36	22.9	1.46
Starcrest	April 11	6.95	15.1	1.05
Armking	April 11	2.59	19.3	0.50
	April 16	0.19	–	–
Fairlane	April 11	4.22	13.5	0.57
Fantasia	April 11	5.71	15.7	0.90
Red June	April 11	2.32	17.5	0.41
Venus	April 12	3.30	24.0	0.79
Babygold 6	April 12	6.25	15.6	1.23

Table 2 Bee visits of peach varieties (Siófok, 1998, April 1)

Variety	Day time	Temp. °C	Clauds %	Wind B°	Bloom %	Bee visits on 100 flowers over 10 minutes		Distribution of bees (%) What are gathering the bees		
						Flights	Visits	Pollen	Mixed	Nectar
Early Redhaven	a.m.	11–12	5	1	30	8	14	6.3	0	93.7
	p.m.	21	5	1–2		8	17	0	22.2	77.8
Subcam	a.m.	11–12	5	2	12	8	17	6.3	0	93.7
	p.m.	21	5	1–2		8	17	0	22.2	77.8
Babygold 6	a.m.	16	5	1	90	7	23	0	8.3	91.7
	p.m.	21	5	1–2		17	36	20.0	3.3	76.7
Frederica	a.m.	15	5	1	15	15	19	0	0	100
	p.m.	21	5	1–2		9	17	4.2	0	95.8
Caldesi 2000	a.m.	11–14	5	1	70	10	26	3.3	0	96.7
	p.m.	21	5	1–2		7	16	4.5	0	95.5
Red June	a.m.	15	5	1	70	18	32	0	16.7	83.3
	p.m.	21	5	1–2		19	38	2.2	24.4	73.4

Table 3 Bee visits of peach varieties (Szatymaz, 1999, April 9)

Variety	Day time	Temp. °C	Clauds %	Wind B°	Bloom %	On 100 flowers over 10 minutes		Distribution of bees (%) What are gathering the bees		
						Flights	Visits	Pollen	Mixed	Nectar
Cresthaven	a.m.	18	20	3	36.0	28	45	46.4	39.3	14.3
	p.m.	19	10	2	36.0	29	42	27.6	44.8	27.6
Fantasia	a.m.	18	20	3	51.3	11	16	36.4	45.4	18.2
	p.m.	19	10	2	51.3	28	46	25.0	39.3	35.7
Harko	a.m.	18	20	3	52.6	14	23	27.5	28.6	42.8
	p.m.	19	10	2	52.6	26	39	42.3	30.8	26.9
Red June	a.m.	18	20	3	58.6	20	27	45.0	45.0	10.0
	p.m.	19	10	2	58.6	34	47	50.0	38.2	11.8

Favourable weather of spring secures the activity of bees between 9 a.m. and 5 p.m., the day's maximum being between 11 a.m. and 3 p.m. Wild insects are mainly bound to a shorter interval near noon, however, bees start at morning and finish in the late afternoon.

Some typical days are presented in details. April 1, 1999 was a sunny, windless day at Siófok, bee activity was intense *(Table 2)*. Visitors preferred varieties of higher flower (blooming) density.

Our earlier data (derived from a host observations performed on 10 varieties) indicate that two third of the bees are nectar collectors. Somewhat less than one third of those gathers also pollen, another third belongs to the side-collectors and does not participate in pollination. The distribution of activity changes during the daytime. At Szatymaz in 1999, pollen gatherers and mixed gatherers were about equal in number, but nectar-suckers were at an inferior rate *(Table 3)*.

The cool and covered weather as well as the wind reduced dramatically the bee activity as expressed in *Table 4*.

Honeybees visited peach trees, intensely, at favourable weather. Observations prove that during 10 minutes, on 100 flowers, the number visits varied between 1 and 70.

Bees moved at sunny, warm weather with very slight wind, only. Calculating 7 hours per day as theoretically suitable for bee activity (which is possible but not always realised in springtime during peach bloom), summing up the whole time, 100 flowers received 110 to 3000 bee visits, i.e. 1 flower 1 to 30 visits per day. That number is judged to be highly sufficient to act positively on fruit set and yield.

Nectar production and its dry matter content changes diurnally. Our observations of 1998 do not allow to draw

Table 4 Bee visits of peach varieties (Szatymaz, 1999, April 11)

Variety	Day time	Temp. °C	Clauds %	Wind B°	Bloom %	On 100 flowers over 10 minutes		Distribution of bees (%) What are gathering the bees		
						Flights	Visits	Pollen	Mixed	Nectar
Cresthaven	a.m.	20	40	5	80.2	2	4	50	–	50
	p.m.	19	50	5	80.2	2	4	–	50	50
Fantasia	a.m.	20	40	5	92.6	1	1	–	100	–
	p.m.	19	50	5	92.6	1	1	100	–	–
Harko	a.m.	20	40	5	84.8	1	3	–	100	–
	p.m.	19	50	5	84.8	2	2	50	50	–
Red June	a.m.	20	40	5	87.7	2	2	100	–	–
	p.m.	19	50	5	87.7	–	–	–	–	–

Table 5 Bee visits on the flowers of the variety Early Redhaven (Siófok, 1998, April 3)

Time of observation (hour)	Temperature (°C)	Nectar produced (mg/flower)	Dry matter content of nectar (%)	Number of bee visits per 100 flowers per 10 minute	Number of bee flights per 100 flowers per 10 minutes
9 a.m.	13	1.48	27.8	1.53	1.53
10 a.m.	14	1.41	20.8	5.10	3.57
11 a.m.	16	1.14	15.5	11.73	5.61
12 a.m.	18	0.81	22.5	11.22	5.10
1 p.m.	18	1.27	25.7	10.20	5.61
2 p.m.	21	2.71	22.4	6.30	2.55
3 p.m.	21	1.30	25.2	7.65	3.06
4 p.m.	20	3.55	19.3	8.16	2.55

Table 6 Fruit set of peach as a consequence of limitations of bee pollination (Szatymaz, 1998)

Variety	Isolated during bloom		Isolated during the first half of bloom		Isolated during the second half of bloom		Pollinated once		Open pollinated	
	Number of flowers	Fruit set %	Number of flowers	Fruit set %	Number of flowers	Fruit set %	Number of flowers	Fruit set %	Number of flowers	Fruit set%
Cresthaven	139	23.7	151	16.6	207	31.9			279	49.1
Fantasia	238	4.6	228	34.2	132	12.9	90	24.4	352	31.8
Harko	194	21.1	138	17.4	167	23.4	116	25.9	718	23.7
Red June	170	15.9	131	9.2	118	28.0	85	42.4	433	33.9
Mean		16.3		19.4		24.1		30.9		34.6

conclusions concerning the correlation between nectar content and intensity of bee visits.

Fruit set

The limitation of bee visits for different lengths of time caused reduction in fruit set *(Table 6)*. Flowers blooming freely being visited by bees all the time set fruit at much superior rates than those bagged, i.e. isolated from the insects. Flowers isolated during the second half of the blooming set more fruit than when isolated during the first half of the bloom. Isolated flowers, which received once hand-pollination with their own pollen set much more fruit than the isolated and untouched flowers.

Discussion and conclusions

Peaches are, in relation to other fruit species, excellent pollen and nectar producers. In nectar production, peaches are inferior to plums (*Szabó* et al., 1990), to apricots (*Benedek* et al., 1991) to sour cherries (*Benedek* et al., 1996) and to apples (*Benedek* et al., 1989), but the quantity produced is sufficient to attract bees, intensely, during a period when flowers are still scarce. The attractiveness stems from the relatively high sugar concentration of the nectar produced. Pollen production is also comparable with that of other fruit species, mentioned. *Halmágyi & Suhayda* (1966) proved, nevertheless, the honey yield appearing in the hives, even at favourable conditions, is not too much, all the same, it may be essential in the provision of that period.

Published data, confirmed by our own observations stated that the majority of peach varieties are self-fertile. Autogamous fruit set of some varieties is insufficient for acceptable yield as being in some years less than 20% at the actual flower densities.

In case of low flower density, increasing the rate of fruit set is necessary. The most effective way of aiming that is the enhanced bee pollination.

Our observations suggest that fruit set achieved by bee pollination doubled the rate of fruit set in relation to isolated flowers. Honeybees prefer the rose-flowers and high flower densities.

At growing sites of inferior quality, e.g. because of the frequency of winter and late frosts, bees may improve fruit set a lot.

Based on the accumulated experiences, the association of varieties in peach plantations for the purpose to improve fruit set is not recommended at optimal conditions because of the chances of "oversetting", consequently, increased need of fruit thinning. Therefore, varieties should be grouped in large blocks to be pollinated by their own pollen.

At risky growing sites with low security of yields and e.g. male sterile varieties, hovewer, the blocks of single varieties should not exceed the width of 4–6 rows. At low flower densities, the orchard should be supplied by 1–2 hives per hectare.

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