Floral attractivity of pear cultivar 'Cinderi'

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Key words: insect attraction, nectar, pear, pollen shedding

Summary: The regularities of primary attractivity have been studied at the pear cultivar 'Cinderi' for two years. Nectar quickly evaporates from the totally open nectary surface of pear flowers exposed to environmental effects, and the rhythmicity of nectar secretion can be determined with difficulty. Flowers do not function according to a unified endogenous rhythm, the whole tree becomes continuously attractive for insects, since it attracts insects on more occasions during the day with some of its flowers. During the warm afternoon hours there is usually no measurable nectar production. Pollen shedding is most intensive in the afternoon hours. Pear flowers produce little and diluted nectar, which often does not come up to apicultural expectations. The age of the flower does not significantly affect the quantity and refraction of nectar. The flowers of pear cv. 'Cinderi' are delayed homogamous.

Introduction

Nectar production is periodical in some plants. *Pesti* (1976) studied the daily rhythm of nectar secretion at Asteraceae species and claimed that the periodicity was of endogenous origin, and it was practically not influenced by environmental factors. He found the daily rhythm characteristic for the subfamilies.

The secretory rhythm may differ even within a species. *Orosz-Kovács* et al.(1989) described 3 types at Pándy sour cherry clones. The differing rhytmicity may have a great importance in the pollination of cultivars.

According to *Orosz-Kovács* (1990, 1991), among Prunoideae taxa the homogamous ones produce the most nectar every 6 hours, while dichogamous ones every 12 hours, in accordance with the function of reproductive organs. The endogenous rhythm of nectar secretion shows the flower biological type of the cultivar and the most efficient time of pollination. On the basis of this it can be stated whether the given cultivar is pollinated during daytime or/and at night.

According to studies by *Orosz-Kovács* et al. (1990), *Scheid-Nagy Tóth* (1991) and *Szabó-Mühlenkampf* (1994) nectar secretion of apple cultivars varies in the different stages of blooming. It increases from the beginning of blooming to the main blooming, whereas the quantity and sugar value of nectar decreases at the end of blooming. Nectar secretion of apple cultivars also shows a daily fluctuation, periodicity. The peaks of nectar secretion at the studied cultivars appeared regularly at 4-hour intervals.

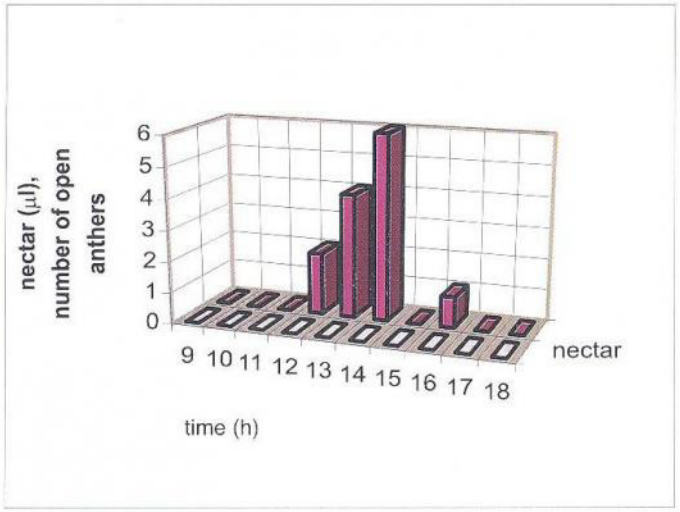
The quantity and quality of floral nectar may be influenced by several factors. *Kuliev* (1952) stated that the quantity and sugar percentage of nectar changes quickly due to external factors. Dry air increases evaporation, the secretory product becomes concentrated, while high air humidity dilutes the nectar.

The observations of *Cruden* (1976) reinforce earlier studies, according to which both air temperature and humidity influence nectar production. Low air temperatures may delay the beginning of nectar secretion or decrease the pace of secretion. The concentration of nectar increases, whereas its quantity decreases as a consequence of evaporation. Factors favourable for evaporation can be detected at noon and in the early afternoon, when air temperature is high and humidity is low. *Cruden* (1983) also claimed that the differences in nectar production may reflect the differences in soil moisture.

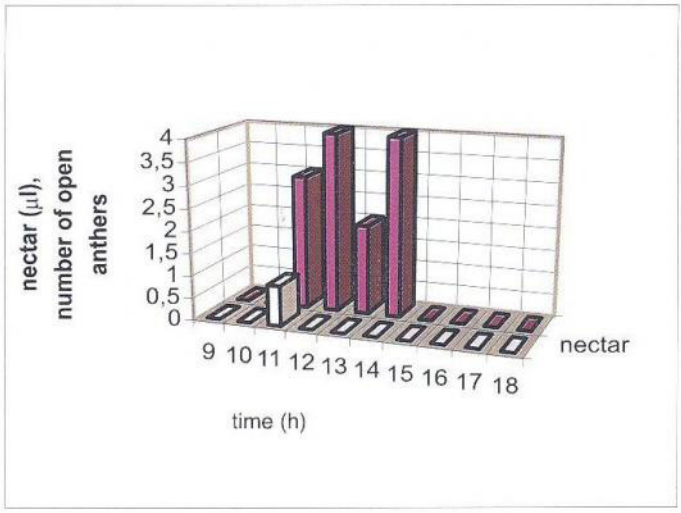
Scheid-Nagy Tóth (1991) determined the optimum curve of nectar production in some apple cultivars. The optimal temperature at the studied apple varieties was different for each cultivar, and varied between 20-24°C.

Szabó-Mühlenkampf (1994) observed at spur-type apple cultivars that temperatures above 20°C caused a stagnation at a lower level in nectar secretion, in contrast with the favourable effect of temperatures between 14-18 °C. Air humidity below 60% decreases nectar production, above this level the quantity and sugar value of nectar increases together with the increase of air humidity.

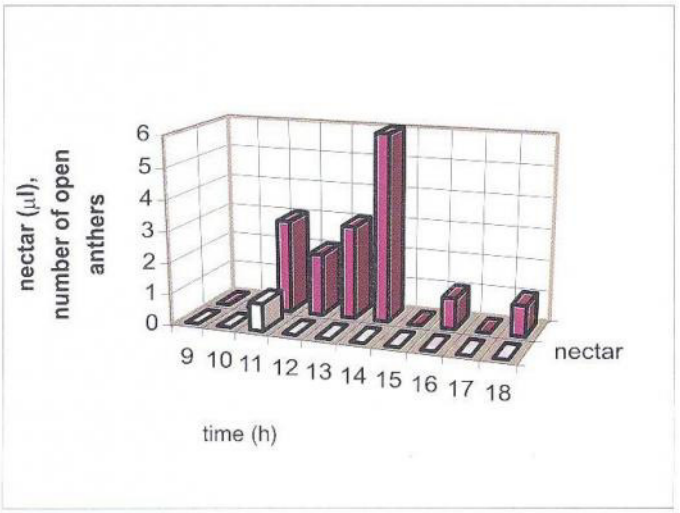
In Hungary pear is listed among medium-value melliferous plants. The reason for this is that bees do not visit pear flowers because of their unpleasant odour as frequently as the flowers of other fruit tree species. Moreover, not too much nectar is produced in pear flowers (*Péter* 1975).



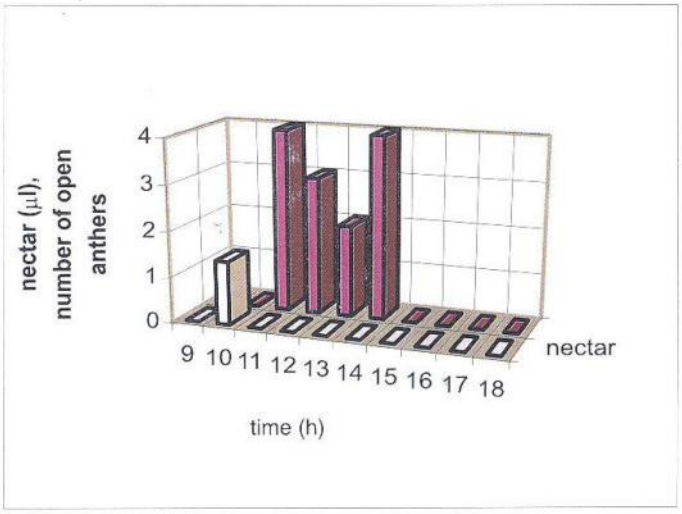
Flower 1 (bud)



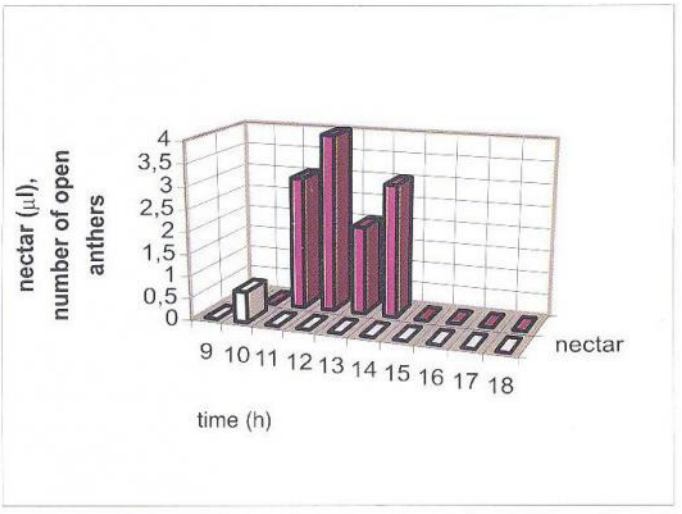
Flower 2 (bud)



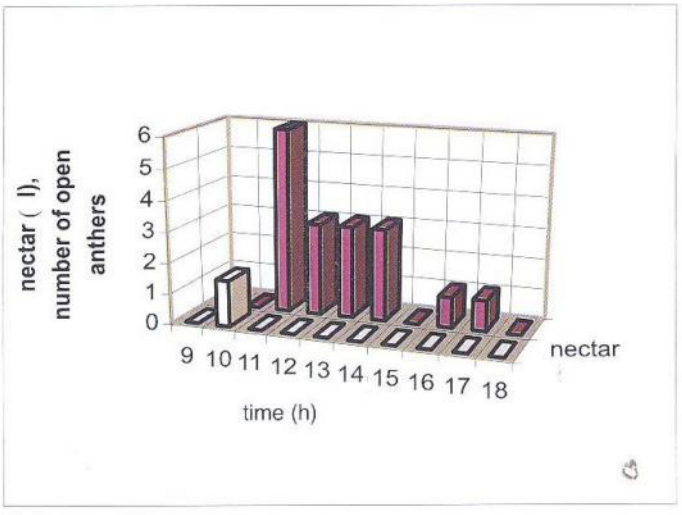
Flower 3 (bud)



Flower 4 (bud)

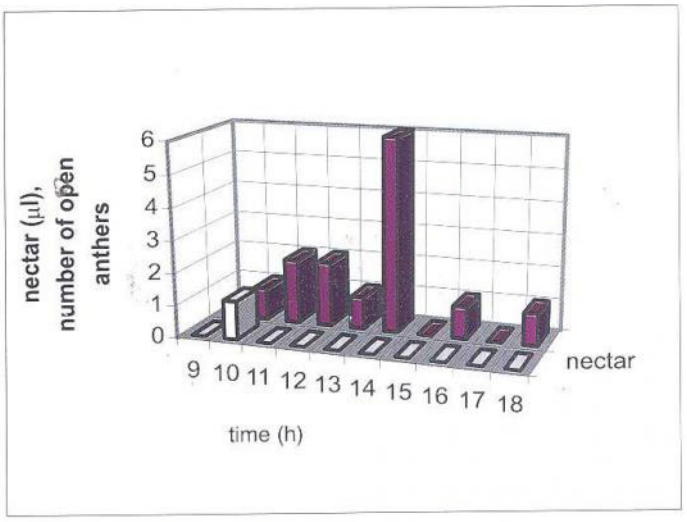


Flower 5 (half-blown)

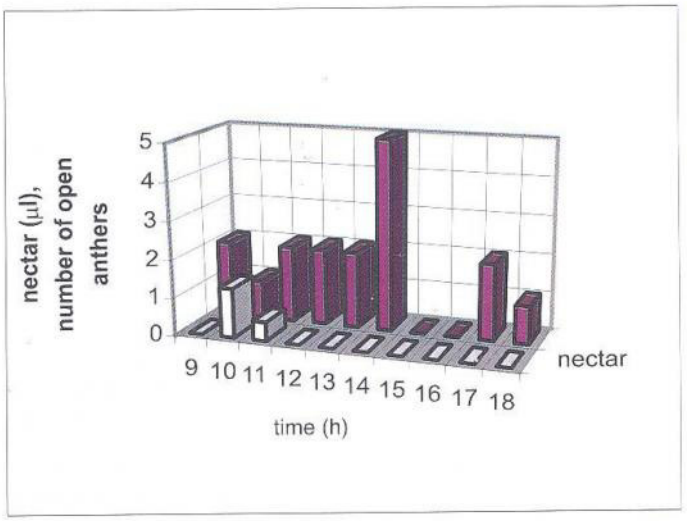


Flower 6 (half-blown)

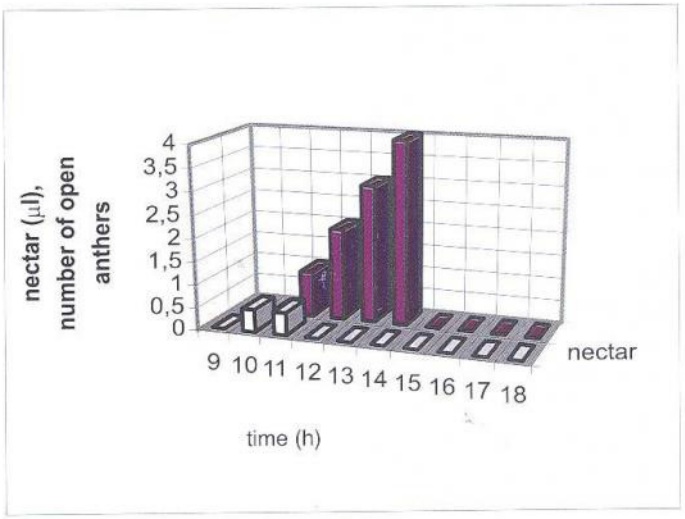
Figure 1 Hourly nectar production and anther opening of flowers in pear cultivar 'Cinderi' Újfehértó, 22. 04. 1994.



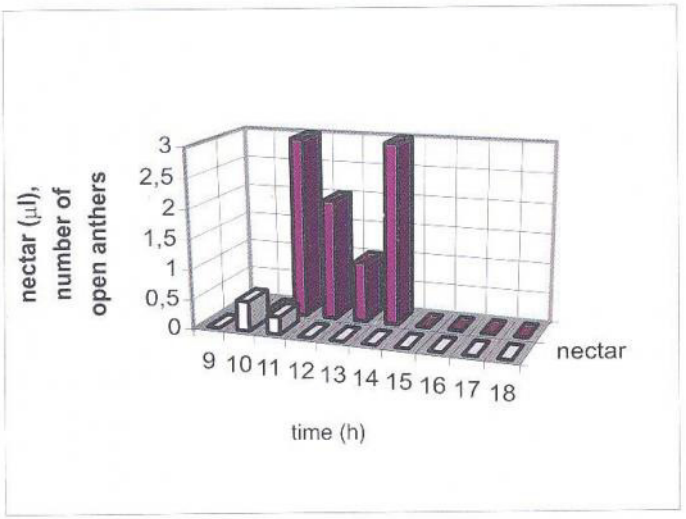
Flower 7 (half-blown)



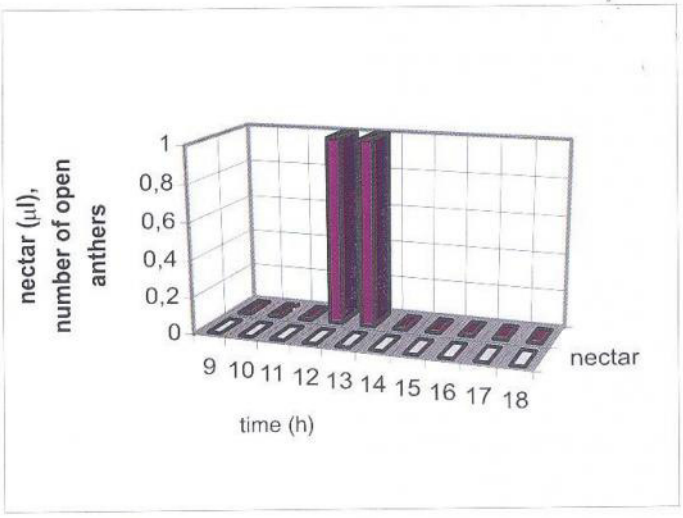
Flower 8 (young)



Flower 9 (pollen shedding)

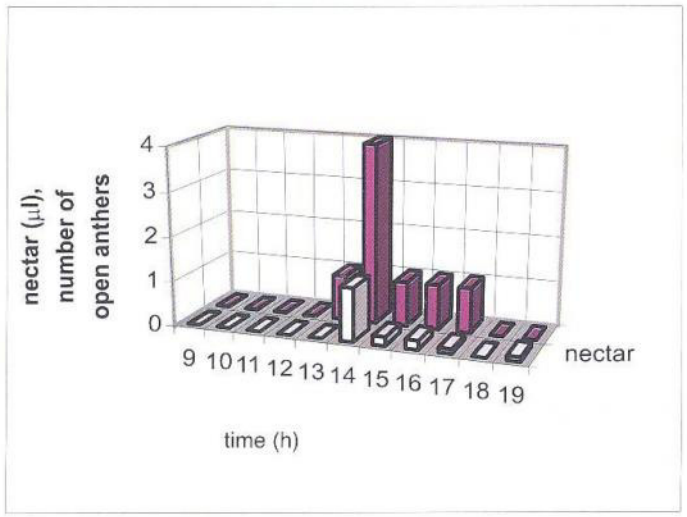


Flower 10 (pollen shedding)

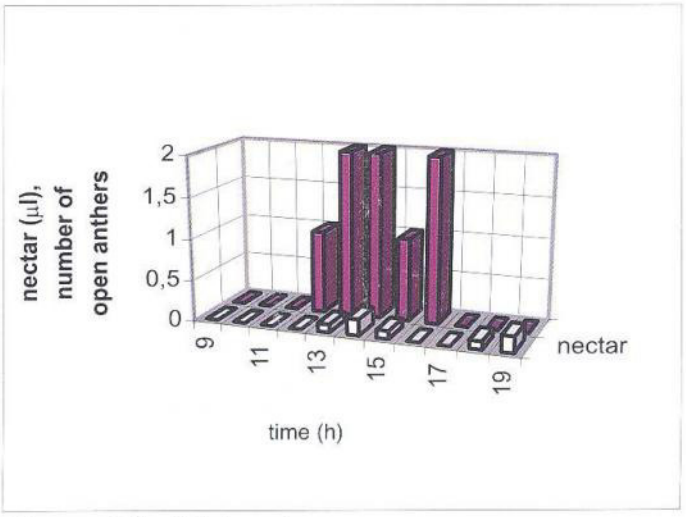


Flower 11 (pollen shedding)

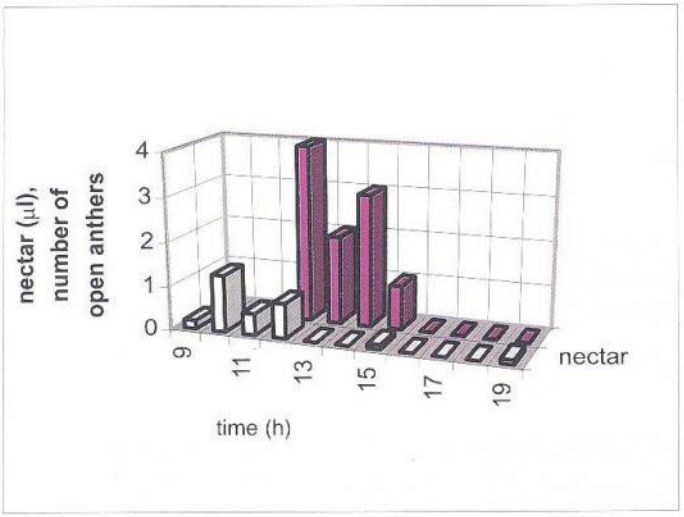
Figure 2 Hourly nectar production and anther opening of flowers in pear cultivar 'Cinderi' Újfehértó, 22. 04. 1994.



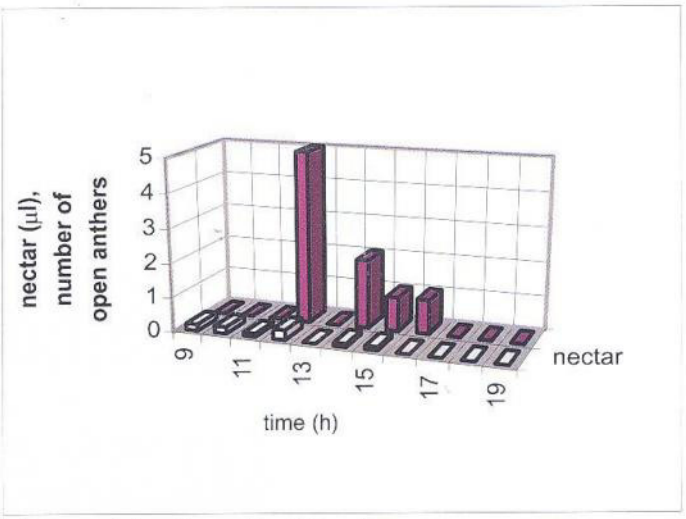
Flower 1 (half-blown)



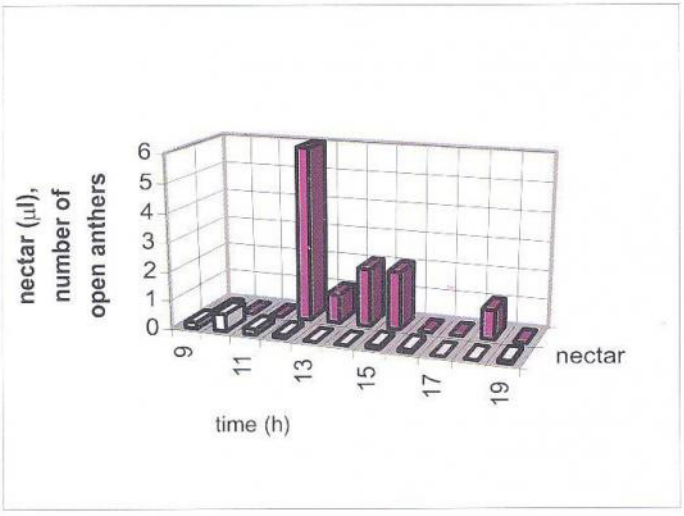
Flower 2 (half-blown)



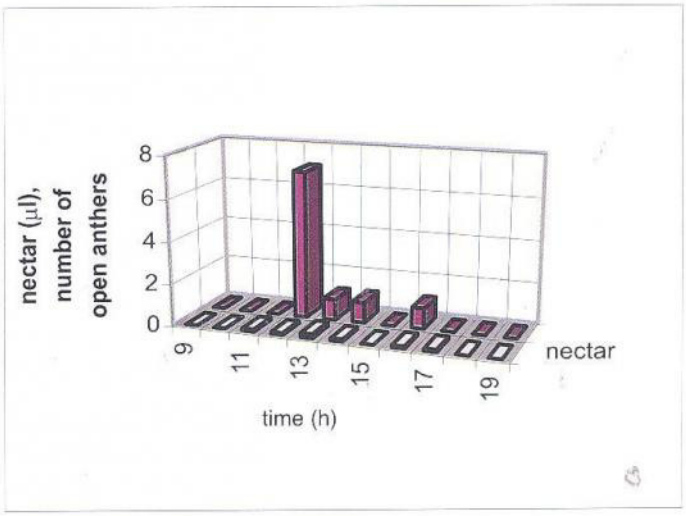
Flower 3 (young)



Flower 4 (pollen shedding)

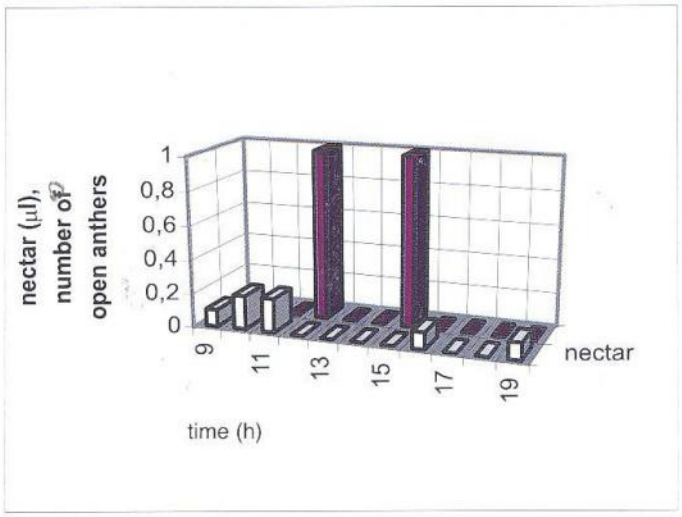


Flower 5 (pollen shedding)

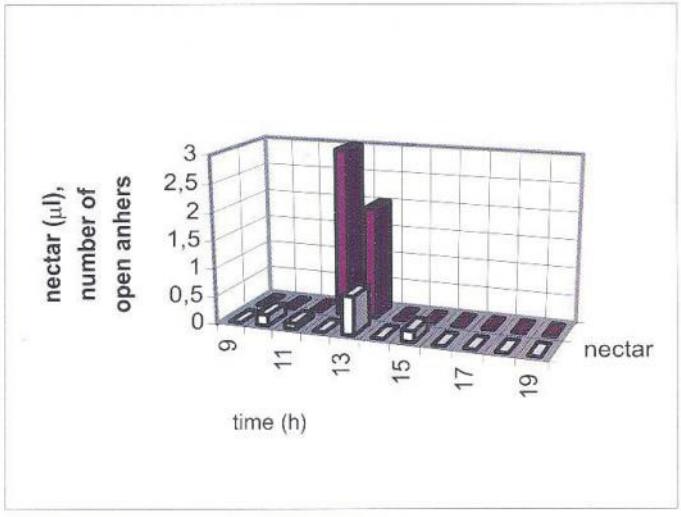


Flower 6 (pollen shedding)

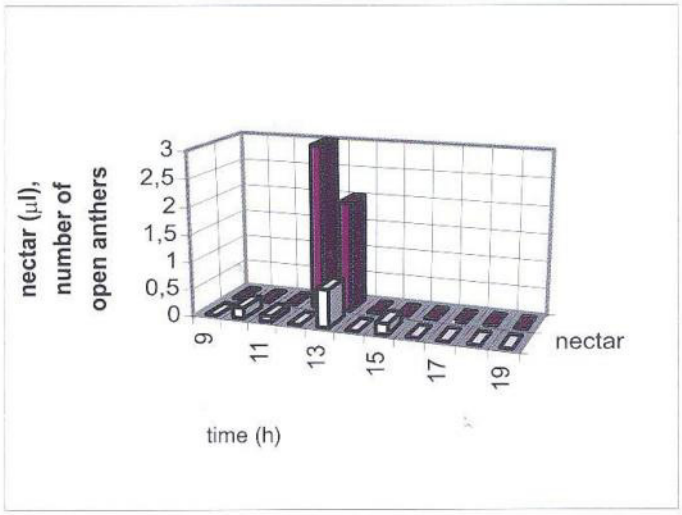
Figure 3 Hourly nectar production and anther opening of flowers in pear cultivar 'Cinderi' Újfehértó, 29. 04. 1995.



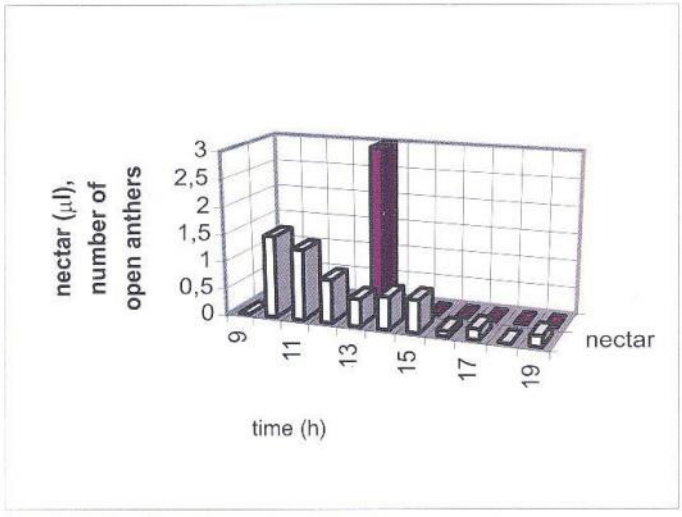
Flower 7 (pollen shedding)



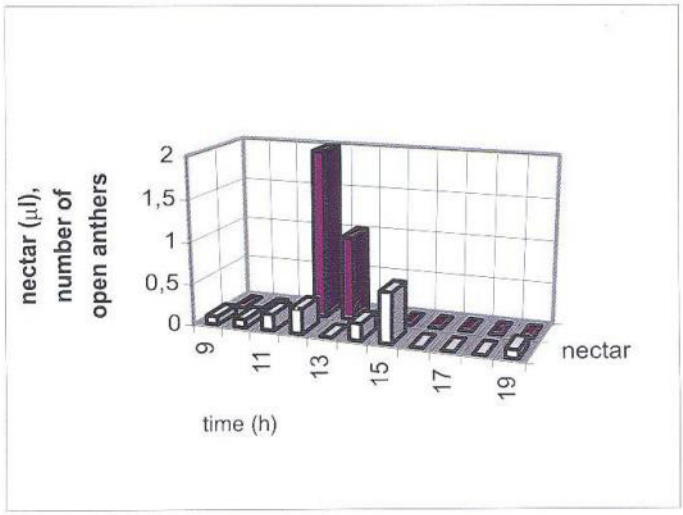
Flower 8 (pollen shedding)



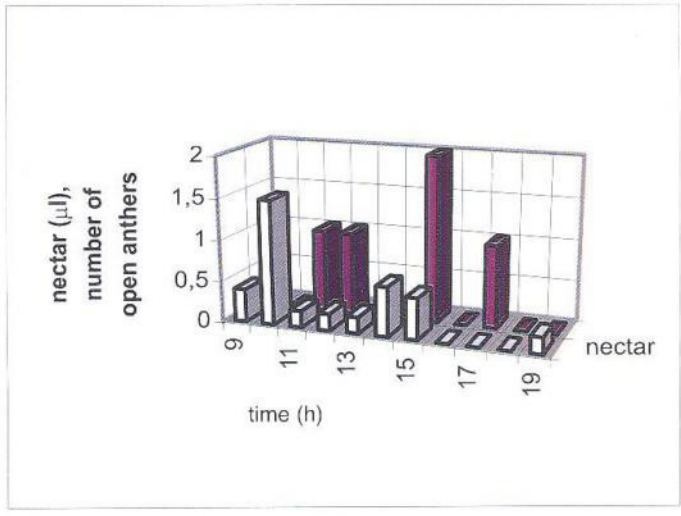
Flower 9 (pollen shedding)



Flower 10 (pollen shedding)



Flower 11 (pollen shedding)



Flower 12 (pollen shedding)

Figure 4 Hourly nectar production and anther opening of flowers in pear cultivar 'Cinderi' Újfehértó, 29. 04. 1995.

According to studies on pear by *Nyéki* (1980), meteorological factors effect both the length of the receptive period of the style and pollen shedding.

Materials and methods

Daily secretion of floral nectar was studied at pear cv. 'Cinderi' in 1994 and 1995 in the pear cultivar collection of the Research Station for Fruitgrowing, Újfehértó. This cultivar was chosen because there were only few cultivars among the ones studied by us which produced measurable nectar. In the orchard, under natural conditions, nectar was sucked out of numbered flowers with calibrated glass microcapillaries every hour. Together with nectar measurements the number of open anthers and the time of stigma secretion was recorded. The concentration of nectar was determined by a refractometer.

Results

In 1994 in the studied pear flowers no nectar was found in the buds and the half-blown flowers (*Fig.1*, e.g. flower 1) (on the graphs the state of flower at the beginning of measurements is marked). Following the opening of the flowers, nectar secretion usually started, its maximal values were measured at 11 o'clock in flowers which opened at 10 o'clock (flowers 2 and 3), or at 10 o'clock in flowers which opened at 8 or 9 o'clock (flowers 4–7). In flowers which opened still earlier or on the previous day (*Fig. 2*, flowers 8–10), nectar secretion was measured both at 10 and 11 o'clock, which means that nectar production became partly continuous. In flowers where some of the anthers have already opened (flower 9, 10), smaller degree of nectar production was observed, and no nectar was found in the old flower (11). The nectar of pear cv. 'Cinderi' is quite diluted, its refraction varied between 6-13%, which means that it often does not reach the threshold level (10%) of bee visitation.

At the time of maximal nectar production, at 10 o'clock, air temperature was 20 °C, relative humidity was 76% (*Table 1*). It can be observed that in this year there was no nectar production above air temperature 24 °C. It can be assumed that above this temperature the secretory product evaporates as quickly from the open nectary surface of pear flowers as it is produced, or perhaps secretion ceases at this temperature. Insect attraction of flowers decreases in the noon hours, when no nectar can be found in the flowers. At the same time, anther opening is the most intensive just in this period, between 11 and 14 o'clock, usually with a maximum at 14 o'clock. According to our observations, bees visited the flowers in this period, too, but they collected mainly pollen.

Within a tree 3 different types can be distinguished concerning the activity and insect attraction of flowers. Half of the flowers started their function with nectar production, and it was followed by anther opening. At 30% of the flowers nectar secretion and pollen shedding began in the same hour. Only one out of the studied flowers began with anther opening previous to nectar production.

In 1995 periodicity studies were repeated at cv. 'Cinderi', to gain a better understanding of the effect of the year and weather on nectar secretion and anther opening.

During the development of flowers the quantity of nectar and the length of the secretory period showed different values.

In the half-blown flower (*Fig. 3*, flowers 1 and 2 until 12 o'clock), which stage generally lasted for several hours, no nectar was found this year, either. Stigma secretion has however already started at this time. Here the half-blown flower stage with no nectar secretion is equivalent to the pollination chamber stage (where there is only a little opening on the bud, into which the stigma gets wedged, there is nectar in the bud, and small beetles use this chamber for foraging and as a place of reproduction) characteristic for protogynous *Pyrus taxa*, described by *Gottsberger* (1977).

In flowers having opened on the day of measurements (flowers 1 and 2), pollen shedding started first out of the factors of primary attraction. Beginning of anther opening was followed by nectar secretion an hour later, and the maximal values of nectar production were measured at 14 o'clock (*Fig. 3*).

The young open flower 3 began its rhythm with nectar secretion, the most nectar was produced at 10 and 12 o'clock. The maximum of anther opening was recorded 2 hours later, at 12 o'clock.

Flowers in which some anthers have already opened at the beginning of measurements (flowers 4-9), showed only a smaller degree of nectar secretion in the morning hours, even at the time of maxima, which was followed by the intensive opening of anthers in the noon hours. Since until early afternoon there was also a minimal amount of secretory product in the flowers, they offered both nectar and pollen to the pollinators in this period (*Fig. 3* and *4*).

In flowers where at least half of the anthers have opened (*Fig. 4*, flowers 10-13), flowers attracted insects with a protracted nectar secretion, which became continuous. Here the quantity of the secretory product reached relatively

Table 1 Air temperature and relative humidity data, Újfehértó, 22. 04. 1994.

	10h	11h	12h	13h	14h	15h	16h	17h	18h
air temperature (°C)	20	24	25	27	24	20	22	24	20
relative humidity (%)	76	70	68	65	58	62	58	59	60

higher values (0,8-1,5 µl). Refraction of nectar was low, around 10%, it rarely reached 20%. From the point of view of nectar production it was advantageous that on the day of measurement the maximal temperature did not exceed 20 °C and there was no or little wind during the day. The stigma usually started to turn brown after half of the anthers have opened, but it secreted for some more time even in this stage. The fact that the stigma is already active in the half-blown flower, and its activity overlaps with anther opening, but does not last until the opening of all the anthers, refers to delayed homogamy.

There was usually no nectar produced in the old flower, which has already shed its pollen.

In 1995, in most studied flowers nectar secretion began first, and only a small percentage of them started with pollen shedding.

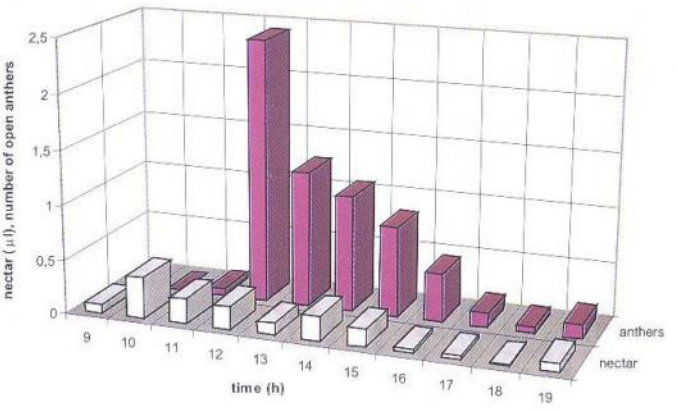


Figure 6 Hourly average nectar production and anther opening of pear cv. 'Cinderi' Újfehértó, 29. 04. 1995.

Discussion

As a summary it can be stated that from the open, exposed and little protected nectary surface of the studied pear flowers nectar evaporates quickly, and the real periodicity of nectar secretion can be determined with more difficulty than in the case of apple flowers, which have a more closed receptacle. The time of maximal nectar production varied at the different flowers: peaks of secretion were measured at 10 and 11 o'clock in 1994, and at 10, 11, 12 and 14 o'clock in 1995 (*Fig. 5*). This refers to

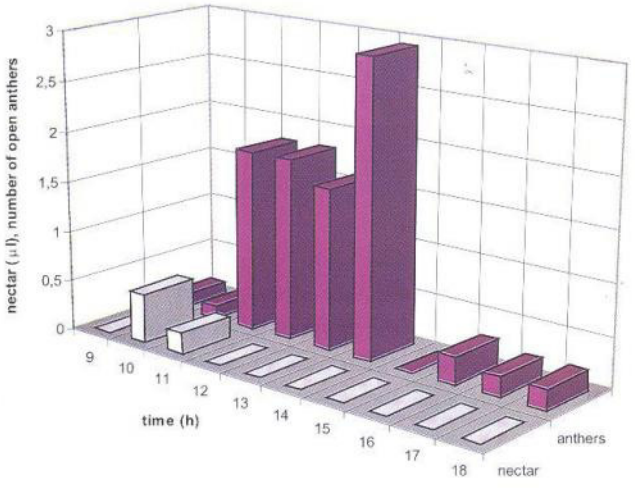


Figure 5 Hourly average nectar production and anther opening of pear cv. 'Cinderi' Újfehértó, 22. 04. 1994.

the fact that the flowers do not function according to a unified endogenous rhythm, but the whole tree has a continuous insect attraction by attracting insects with some of its flowers at several times during the day. The nectar production of the studied pear cultivar does not show such a regular 4-hour periodicity as that of several apple cultivars (*Orosz-Kovács* et al. 1990, *Scheid-Nagy Tóth* 1991, *Szabó-Mühlenkampf* 1994). In the warm afternoon hours secretion usually ceases (or the secretory product evaporates from the too exposed surface). Pollen shedding reacts strongly to the effect of temperature, with most anthers opening in the noon hours (*Fig. 5*).

According to our previous studies, quantity of nectar in apple may vary between 0,1-0,2 and 6-8 µl per flower, but in most cases it is 1-3 µl (*Orosz-Kovács* et al. 1990, *Scheid-Nagy Tóth* 1991). Pear flowers never produce great quantities of nectar, here a nectar production value around 1 µl per flower means good nectar production. Nectar refraction values in apple are usually above 10%, but often the secretory product can be concentrated, 30-60%. Péter (1972) measured 46,54-52,84% sugar content at the pear cultivar 'Erdei vajkörte' among favourable weather con ditions. In the pear cultivars studied by Simidchiev (1970) sugar value varied between 3,30-67,10%. At pear cv. 'Cinderi' the refraction values were low, 6-20%, which is not always attractive enough for bees. The age of the flower does not significantly influence quantity and refraction of nectar (*Table 2* and *3*).

Table 2 Changes in the quantity (µl) and refraction (%) of nectar according to the developmental stage of flowers in pear cv. 'Cinderi' (Újfehértó, 22. 04. 1994.)

age of flower	9 h	10 h	11 h	14 h
young	0	0	0	1,2 µl / 11%
young	0,2 µl	1,3µl / 20%	0,5µl	0
pollen shedding	0	1,5µl	1,3µl / 14%	0,6
pollen shedding	0,4µl / 10%	1,5µl / 11%	0,2µl	0,6µl /10%

Table 3 Changes in the quantity (µl) and refraction (%) of nectar according to the developmental stage of flowers in pear cv. 'Cinderi' (Újfehértó, 22. 04. 1994.)

age of flower	10 h	11 h
young	0	0,9 µl / 7%
young	0	0,9 µl / 7%
young	1,4µl / 6%	0
young	0,7µl / 7%	0
young	1,5µl / 10%	0
young	1,2µl / 6%	0
pollen shedding	1,3µl /7%	0,5 µl / 10%
pollen shedding	0,5µl / 9%	0,5 µl / 13% p
ollen shedding	0,5µl / 8%	0,3 µl

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