Nectar secretion dynamics of Hungarian local pear cultivars

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Abstract. The dynamics of daily nectar secretion was studied in 28 local pear cultivars in a Hungarian cultivar collection and three main types were distinguished. 1. Cultivars secreting nectar continuously are the most favourable for pollinators, rewarding them both with nectar and pollen. 2. Cultivars with discontinuous nectar secretion have sufficient insect attraction only if anther dehiscence is continuous during the day. In the first two types nectar secretion peaks usually appeared at 9:00 or 10:00, 14:00 or 15:00 and 18:00 or 19:00, with 4–5-hour intervals. 3. In some cultivars no nectar secretion was observed in any or some of the studied years, these being the least attractive for pollinators. The cultivars studied did not necessarily show the same type of nectar secretion dynamics in each season. From the viewpoint of pollination it is also of high importance, in which developmental phase nectar secretion begins.

Key words: Insect attraction, local cultivars, nectar secretion dynamics, pear, *Pyrus communis* L.

For pollinators the most important primary attractants are pollen and nectar. The process of nectar production is governed by numerous endogenous and environmental factors (Walker et al. 1974, Cruden and Herman 1983). Some researchers (Pesti 1976, Orosz-Kovács 1992) have proposed that periodicity in nectar production is endogenous, as described in several plant taxa. Changes in nectar production and

composition during the day in the families Boraginaceae and Brassicaceae were characterised by Corbet (1978). Mačukanović and Blazenčić (1998) studied the diurnal and seasonal dynamics of nectar secretion in the Lamiaceae family. Witt et al. (1999) stated that in two genera of Caryophyllaceae the dynamics of nectar secretion differed from species to species, and also within species.

Nectar secretion dynamics of the Rosaceae family has been investigated by a number of researchers. Studying several taxa belonging to the subfamily Prunoideae, Orosz-Kovács (1991, 1992) and Orosz-Kovács et al. (1989, 1992, 1995) stated that homogamous flowers secreted nectar at 6 h intervals, whereas dichogamous cultivars secreted nectar at 12 hour intervals. In the subfamily Maloideae nectar production maxima could be detected every 4 hour in apple cultivars (Scheid-Nagy Tóth 1991, 2000; Orosz-Kovács et al. 1994; Szabó-Mühlenkamp 1994). According to nectar production studies on *Crataegus* species (also belonging to Maloideae), the concentration of nectar shows a strong correlation with ambient relative humidity, but microclimatic factors within and around the flower, as well as chemical effects may also have an important role (Corbet et al. 1979). In this genus nectar production peaks appeared in the morning, around midday and in the evening,

Fig. 1. Hourly mean nectar production and anther dehiscence in flowers of pear cultivars, Újfehértó, May 2, 1997

when secretion outweighed loss by reabsorption or insect visits.

Pear nectaries are automorphic and receptaculo-ovarial, situated on the adaxial side of the hypanthium and the apical part of the ovary (Fahn 1953, Frei 1955, Szilva 1969, Farkas and Orosz-Kovács 2001). In pear flowers the most abundant nectar production can

be observed in the morning hours, coinciding with the lowest sugar content of the secretory product (Nyárády 1958, Simidchiev 1970).

Since pear cultivars are mainly autosterile and entomogamous, investigating floral rewards is essential. The dynamics of nectar secretion (time and duration of secretory activity, volume and concentration of nectar), as well as

Fig. 2. Hourly mean nectar production and anther dehiscence in flowers of pear cultivars, Újfehértó, May 3, 1997

that of pollen shedding has to be studied carefully in order to be able to correlate these patterns with pollination requirements in pear orchards.

Variability in the dynamics of nectar secretion can be interesting also from the point of view of systematics. Investigating patterns of nectar secretion may help to clarify the genetic relationships and the origin of local cultivars.

Materials and methods

Nectar secretion dynamics was studied in 28 pear cultivars in the pear genebank of the Research and Extension Centre for Fruitgrowing, Újfehértó, Hungary. The genebank contains mainly Hungarian local pear cultivars, each represented by two specimens. Nectar was extracted hourly out of 15–20 numbered flowers from one or two trees

Fig. 3. Hourly mean nectar production and anther dehiscence in flowers of pear cultivars, Újfehértó, April 23, 1998

per cultivar. Among the flowers there were buds, buds in the balloon stage (just before opening), freshly opened flowers and flowers with some anthers already dehiscenced. The amount of the secretory product was determined by calibrated microcapillaries, nectar concentration was measured by a pocket refractometer (type OG-101/A, measuring in the range 0–85%). When calculating means, data of all flowers studied were taken into consideration (even those not having secreted any nectar in the given hour), in order to gain a general picture about nectar secretion patterns of the tree. Besides nectar volume and concentration the following parameters were recorded: time of sampling, air temperature (°C), relative air humidity (%), flowering stage, flower age (number of dehiscenced anthers, state of stigma) and the presence or absence of bees. Air temperature was measured by a thermometer hung up on the tree at the level of the flowers studied, relative air humidity was measured by a pocket psychrometer (type ‘Hygrocheck’). The flowers studied were covered by plain tulle net to prevent visits of pollinator insects.

Detailed apicultural observations were not carried out, however it was recorded if on the whole bees visited the flowers of a tree or not.

From the 28 cultivars studied the following ones have been selected in this paper to represent the main types of nectar secretion dynamics:

Cultivar	Year of study	Flowering stage
Bajai 6	2000	End of bloom
Bőtermő Nyári Kálmán	2000	End of bloom
Clapp	1997, 1999	Full bloom
	1998	End of bloom
Horváth	1997	Full bloom
Jó szürke	1998	Full bloom
Mosoly	1999, 2000	Full bloom
Nagyasszony	2000	End of bloom
Nyári, Dunaföldvár	1997	End of bloom
Viki	1997	Full bloom
	2000	End of bloom

Fig. 4. Hourly mean nectar production and anther dehiscence in flowers of pear cultivars, Újfehértó, April 24, 1998

Results

On the basis of daily nectar secretion dynamics, the studied pear cultivars could be classified into three categories.

1. Some cultivars did not secrete any nectar in the years of study, as for example cv. 'Mosoly' in 1999 and 2000 (Fig. 8). The flowers of other cultivars yielded a minimal amount of secretory product only in some years (e.g. 'Clapp' – Figs. 2, 3, 5).
2. The cultivars in the second group secreted nectar continuously from morning to evening or at least for most of the day, like 'Nyári, Dunaföldvár' (Fig. 1) and 'Horváth' (Fig. 1). In some of these cultivars nectar production peaks appeared more or less regularly, with 4–5 hour intervals.
3. The majority of the cultivars could be characterised by a discontinuous nectar

secretion, as for example 'Nagyasszony' (Fig. 7) and 'Bőtermő Nyári Kálmán' (Fig. 6), where the secretory phase was followed by a shorter or longer break.

In most cultivars belonging to the last category nectar production could be observed at 9:00 or 10:00, then at 14:00 or 15:00, and finally at 18:00 or 19:00, again with 4–5-hour intervals, like in the case of 'Bajai 6' in 2000 (Fig. 6) and 'Jó szürke' in 1998 (Fig. 4) and 2000.

In some cultivars the early afternoon secretory activity was missing, probably due to the high temperatures measured in this period (e.g. 'Nagyasszony' – Fig. 7), whereas in others the evening nectar production peak could not be observed (e.g. 'Nyári, Dunaföldvár' – Fig. 1). Some taxa produced nectar only in the early and late morning, then

Fig. 5. Hourly mean nectar production and anther dehiscence in flowers of pear cultivars, Újfehértó, April 16, 1999

secretion ceased for the rest of the day, like in cv. 'Viki' (Figs. 2, 7).

The cultivars did not necessarily belong to the same type of nectar secretion dynamics in each year, in some cases they could be included in various categories depending on the season, weather and flowering stage (e.g. 'Clapp' – Figs. 2, 3, 5).

From the viewpoint of nectar secretion the sunny, but not too hot (20–27 °C) and windless weather proved to be favourable, with a relatively high air humidity (30–40%). In accordance with the highest temperatures, pollen shedding in most cases was most intensive in the early afternoon, although in a few cultivars most anthers opened in the late morning hours.

Discussion

From the point of view of insect attraction and pollination it is advantageous if a cultivar

offers both nectar and pollen to pollinating insects in the period of stigma activity. The most favourable situation is when a cultivar produces a high amount of nectar without disruption, besides offering abundant pollen, i.e. ensuring insect attraction during the whole day. At the same time the quantity and concentration of the secretory product should also be attractive enough for bees, since in this period other pollinators are not too frequent in the orchard, due to the relatively early flowering date and usually cool weather. Taking into consideration all the above aspects, only a few cultivars were highly attractive for honeybees: 'Csákvári téli', 'Horváth' and 'Nyári, Dunaföldvár'.

Cultivars with discontinuous nectar secretion have sufficient insect attraction only if anther dehiscence is continuous during the day, ensuring the presence of at least one primary attractant. This could be observed in

Fig. 6. Hourly mean nectar production and anther dehiscence in flowers of pear cultivars, Újfehértó, April 20, 2000

cvs. 'Bőtermő Nyári Kálmán', 'Jó szürke', 'Nagyasszony', 'Nyárig tartó 6/19', 'Solymári cukor' and 'Viki'.

The least advantageous situation could be observed in cultivars which did not secrete any nectar, because here pollen was the only

reward available for pollinators. If these cultivars offer pollen abundantly, and anthers dehiscence continuously with great intensity, they may still be attractive for honeybees, and pollination can take place. Such was the case in cv. 'Mosoly' in both years of study (Fig. 8),

Fig. 7. Hourly mean nectar production and anther dehiscence in flowers of pear cultivars, Újfehértó, April 20, 2000

where flower-visiting honeybees were observed in great numbers on the whole tree. In some taxa the nectar produced could not be measured by microcapillaries, however, the glistening of the nectary surface showed a slight secretory activity of the gland, which can be also satisfactory from the viewpoint of insect attraction. For example cv. 'Viki' produced a

measurable amount of nectar only in the morning hours (Figs. 2, 7), but was visited by a high number of bees during the whole day.

The commencement of nectar secretion is also of great importance, especially in protogynous flowers, which frequently occur in pear cultivars (Péter 1975, Terpó 1980, Nyéki 1980, Davary-Nejad 1997). In certain cultivars (e.g.

Fig. 8. Hourly mean nectar production and anther dehiscence in flowers of pear cultivars, Újfehértó, April 21, 2000

‘Miklós’) the secretory product is already present in the balloon stage (just before flower-opening) and later in the opened flower, thus insect attraction is already ensured in the protogynous phase. In protogynous cultivars where nectar secretion starts only in the opened flower, pollination can only take place by wind or small sized beetles in the balloon stage (e.g. cvs. ‘Dániel’, ‘Horváth’). Only wind pollination can be expected in cultivars whose flowers do not secrete any nectar in the protogynous phase, preceding the pollen-shedding stage (e.g. cv. ‘Aratási cukor’). At the time of anther dehiscence, when bees appear, the stigma has already lost its receptivity and consequently bee-pollination cannot take place.

In the case of delayed homogamy – described earlier in sour cherry and apple cultivars (Orosz-Kovács 1991, Scheid-Nagy Tóth 1991), but also observed in some pear cultivars – flowers function first as protogynous, but the

stigma remains receptive also during pollen-shedding. As in protogynous cultivars, nectar secretion may start in the balloon stage (e.g. cv. ‘Clapp’) or only in the open flower (e.g. cvs. ‘Bőtermő Nyári Kálmán’ and ‘P3 Pettend’), whereas in some cultivars (e.g. ‘Jég’) no nectar production was observed.

In homogamous flowers stigma receptivity and pollen-shedding are simultaneous. Also in this floral type certain cultivars (e.g. ‘Bajai 6’, ‘Viki’) secrete nectar in the balloon stage and afterwards in the young open flower. In others (e.g. cv. ‘Cinderi’) secretion begins only in the opened flower, but preceding anther dehiscence. Nectar secretion can often be detected only in pollen-shedding flowers (e.g. cv. ‘Clapp’). The secretory product becomes available for pollinators after the filaments, originally curled down the stigma, have leaned away from it. Among cultivars with homogamous flowers no nectar secretion

was observed in cvs. 'Ötvös' and 'Zánkai magonc'.

In the Rosaceae family nectar production peaks can frequently be observed in the early morning, as for example in *Prunus spinosa* and *P. mahaleb* (Guitian et al. 1993) from the subfamily Prunoideae, and also in *Crataegus*, *Malus* and *Pyrus* species from the Maloideae (Nyárády 1958; Simidchiev 1970; Corbet et al. 1979; Orosz-Kovács et al. 1990, 1994). Similarly, in some Hungarian local pear cultivars the most abundant nectar production could be measured in the morning hours (e.g. cv. 'Viki'), however, other types of secretion dynamics could also be observed.

Similarly to apple cultivars and *Crataegus* species, nectar secretory peaks with 4-5-hour intervals could often be observed in pear cultivars (Corbet et al. 1979; Orosz-Kovács et al. 1990, 1994; Scheid-Nagy Tóth 1991, 2000; Szabó-Mühlenkampff 1994). In the case of pear, however, the secretory rhythm was not as regular as in apple, where production maxima appeared every 4 hour.

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