POLLEN EFFICIENCY AND FORAGING BY INSECT POLLINATORS IN THREE CATNIP (Nepeta L.) SPECIES

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Summary

The trials were run at the collection of melliferous species of the Institute of Pomology and Floriculture, Apiiculture Division, Pulawy, in the years 1995 - 1997. Pollen efficiency and foraging by pollinating insects in three Nepeta L. species (f. Lamiaceae) - Nepeta L. var. citriodoris Dum, N. nuda L. and N. grandiflora M.B were studied. The lowest pollen mass was produced by N. citriodoris - 2.77 mg and the highest by N. grandiflora - 7.84 mg. The pollen efficiency per 100 flowers of N. nuda was 3.77 mg. The highest pollen efficiency from 1 ha was found in N. nuda - 48.4 kg followed by N. citriodoris - 34.7 kg, and the lowest - in N. grandiflora - 27.4 kg. The flowers of the three species were of different attraction to insects. N. nuda and N. citriodoris were most frequently visited by honeybees, the latter accounting for 99.2% and 83.3% of the total number of pollinators, respectively. Honeybees foraging on the flowers of N. grandiflora accounted for only 21.8% of the total number of pollinators. The average peak densities of honeybee workers per 1 m² of the field in full bloom during fine weather was 23 for N. nuda, 18 for N. citriodoris and only 2 for N. grandiflora. It is only from pollen of N. citriodoris and N. nuda that honeybee workers formed small creamy grey pollen loads.

Keywords: honey-producing plants, Nepeta L., pollen production, pollinators.

INTRODUCTION

The native Nepeta L. (f. Lamiaceae) species are reported as forage plants for the honeybee and for wild insect pollinators (Jabłoński 1993, Ruszkowski 1969, 1971, Ruszkowski et al. 1969, 1994a, 1994b, 1994c). The pollen efficiency of N. citriodoris is from 100 to 200 kg/ha and that of N. nuda can be as high as 600 - 900 kg/ha (Jabłoński 1993). The species Nepeta nuda has been included among herbaceous honey-producing plants which, once they are sown on an idle land, can survive without any management for a number of years providing a source of nectar and pollen to bee-like insects (Kottowski and Jabłoński 2001).

The pollen efficiency and foraging by pollinating insects of three Nepeta L. species: Nepeta cataria L. var. citriodoris Dum., N. nuda L. and N. grandiflora M.B were the subject of this study.

MATERIALS AND METHODS

The study was conducted at the collection of melliferous species of the Institute of Pomology and Floriculture, Apiiculture Division, Pulawy, in the years 1995 - 1997. Three Nepeta L. species were considered: Nepeta L. var. citriodoris Dum., N. nuda L. and N. grandiflora M.B. The plants were grown on plots 4 - 6 m² in size and they formed closed carpets at full bloom. In the spring they were given a multi-component fertilizer at a rate of 200 - 300 kg/ha. In the summer the plots were weeded by hand as the need arose. There was an apiary close by.
Flowering abundance was determined towards the end of blooming by cutting all flower-bearing shoots from an area of 1 m². Subsequently, flower heads were counted and an average number of flowers per flower head was determined. The diurnal dynamics of blooming was examined during 3 - 5 sunny days at full blooming by taking counts of freshly opened flowers at 1-hour intervals from 4:00 to 21:00. On the same days and at the same time of day counts were taken of all foraging insects over an area of 1 m² making the distinction among honeybees, bumblebees, solitary bees, flies and butterflies. Additionally, the number of worker honeybees with pollen loads was recorded.

Pollen efficiency was studied using the ether-weighing method by Warakomska (1972) as modified by Szklanowska (1984, 1995). Samples of 100 to 200 stamen heads each depending on the species were collected three times during flowering at four replications. The pollen weight obtained was converted to 100 flowers and then to 1 ha. The results of pollen abundance were analyzed statistically using Duncan’s test at a significance level α=0.05.

**RESULTS**

Over the study years *N. nuda* was the first to bloom - in the second half of June. The blooming period of that species lasted from 6 to 9 weeks depending on the weather in a given year. In the last year of

<table>
<thead>
<tr>
<th>Plant species</th>
<th>Year of study</th>
<th>Blooming period</th>
<th>Number per 1m² sprouts</th>
<th>Number per 1m² flowers in 10³</th>
<th>Weight of pollen per 100 flowers in mg *</th>
<th>Pollen efficiency in kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Nepeta cataria</em> L. var. citriodora Dum.</td>
<td>1995</td>
<td>02.07-09.08</td>
<td>48.0</td>
<td>86.5</td>
<td>3.20a</td>
<td>27.7</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>06.07-08.08</td>
<td>50.0</td>
<td>170.5</td>
<td>2.80a</td>
<td>47.7</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>14.07-12.08</td>
<td>59.0</td>
<td>124.2</td>
<td>2.32a</td>
<td>28.8</td>
</tr>
<tr>
<td>Average</td>
<td>-</td>
<td>52.3</td>
<td>127.1</td>
<td></td>
<td>2.77</td>
<td>34.7</td>
</tr>
<tr>
<td><em>Nepeta nuda</em> L.</td>
<td>1995</td>
<td>25.06-09.08</td>
<td>124.0</td>
<td>159.3</td>
<td>4.20a</td>
<td>66.9</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>11.06-29.07</td>
<td>99.7</td>
<td>136.4</td>
<td>3.60a</td>
<td>49.1</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>15.06-21.08</td>
<td>109.4</td>
<td>83.6</td>
<td>3.50a</td>
<td>29.3</td>
</tr>
<tr>
<td>Average</td>
<td>-</td>
<td>111.0</td>
<td>126.4</td>
<td></td>
<td>3.77</td>
<td>48.4</td>
</tr>
<tr>
<td><em>Nepeta grandiflora</em> M.B.</td>
<td>1995</td>
<td>29.06-18.08</td>
<td>70.3</td>
<td>34.3</td>
<td>8.80a</td>
<td>30.2</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>08.07-21.08</td>
<td>63.7</td>
<td>30.7</td>
<td>8.00a</td>
<td>24.6</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>10.08-20.09</td>
<td>72.5</td>
<td>40.9</td>
<td>6.72a</td>
<td>27.5</td>
</tr>
<tr>
<td>Average</td>
<td>-</td>
<td>68.8</td>
<td>35.3</td>
<td></td>
<td>7.84</td>
<td>27.4</td>
</tr>
</tbody>
</table>

* means followed by the same letter are not significantly different at α=0.05
6 weeks. The delayed flowering of *N. grandiflora* in the last year of the study was because it was the first season after the young plants had been planted on the plots.

*N. grandiflora* with the largest flowers, produced the fewest flowers per 1 m² averaging 35,300, the remaining species producing three and a half as many flowers - around 127,000 (Table 1). However, flowering abundance in *N. citriodori* and in *N. nuda* varied substantially over the years of the study. *N. nuda* produced an average of 111 shoots, *N. grandiflora* 70 shoots and *N. citriodori* 52 shoots per 1 m².

Averaged across the years of the study, pollen weight from a defined number of stamens varied among the taxons studied but within a species the year-to-year differences were found to be insignificant (Table 1). One hundred flowers of *N. citriodori* produced the lowest weight of pollen - 2.77 mg, the highest pollen weight being produced by *N. grandiflora* - 7.84 mg. The same value for *N. nuda* was 3.77 mg.

Pollen efficiency per unit crop area was found to vary extensively from year to year in *N. citriodori* and *N. nuda* which was mainly due to the differences in blooming abundance of those species (Table 1). On average, the greatest amount of pollen was supplied by 1 ha of *N. nuda* - 48.4 kg, the second greatest by *N. citriodori* - 34.7 kg and the least pollen was supplied by *N. grandiflora*.

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Fig. 1. Diurnal dynamics of blooming and bee foraging on flowers of 3 species of *Nepeta* L. (average for the 3 years): bars show the number of blooming flowers in 1-hour intervals in relation to sum of flowers blooming per plot during the whole day in %, the line shows similarly the density of honeybees and bumblebees per plot in %.
Table 2

The composition of pollinating insects (in%) on flowers of studied plants
(average from 3 years)

<table>
<thead>
<tr>
<th>Species of plant</th>
<th>Honeybees</th>
<th>Bumblebees</th>
<th>Solitary bees</th>
<th>Flies</th>
<th>Butterfly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nepeta cataria L. var. citriodora</td>
<td>83.3</td>
<td>15.9</td>
<td>0.5</td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>Nepeta nuda L.</td>
<td>99.2</td>
<td>0.5</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nepeta grandiflora M.B.</td>
<td>21.8</td>
<td>30.3</td>
<td>26.7</td>
<td>5.5</td>
<td>15.7</td>
</tr>
</tbody>
</table>

The diurnal dynamics of blooming had a similar pattern for all three species (Fig. 1). The buds kept opening almost uniformly from the morning until the evening (from 4(5):00 to 20:00). Within the space of an hour, the number of newly-opened flowers accounted for 10% of the total number of flowers that had developed on a given day. The lifespan of the flowers of *N. citriodora* was approximately 1.0 to 1.5 days, that of *N. grandiflora* ca. 2-3 days and that of *N. nuda* 3.5 - 4 days.

Foraging pattern by honeybees on *N. nuda* and on *N. citriodora* was similar (Fig. 1). The insects first appeared on the flowers starting from ca. 6:00 and they finished foraging around 20:00 with slightly increased foraging activity towards mid-day. A similar pattern of the diurnal foraging dynamics was shown by bumblebees on *N. citriodora*. On the other hand, high variation in foraging activity by honeybees and bumblebees on the plots with *N. grandiflora* could be related to a low attractiveness of the flowers of that species, particularly for honeybees.

On the plots planted to *N. nuda* and *N. citriodora* honeybees were the most frequent foragers accounting for 99.2% and 83.3%, respectively, of total pollinators present. On *N. grandiflora* honeybees accounted for 21.8% of total pollinating insects. The flowers of the latter species were more frequently visited by bumblebees (30.3%) and by solitary bees (26.7%). A fairly large percentage of bumblebees (15.9%) was also found on the flowers of *N. citriodora*. The average peak density of worker honeybees foraging on 1 m² of a plot in full bloom and during fine weather was 23 for *N. nuda*, 18 for *N. citriodora* and only 2 for *N. grandiflora*.

Worker honeybees showed little interest in the pollen of those plants and they did not collect it at all from the flowers of *N. grandiflora*. Pollen foraging by those insects on *N. nuda* took place between 7:00 and 19:00 and on *N. citriodora* between 8:00 and 18:00. As a rule, the pollen loads were small, creamy grey in colour.

DISCUSSION

The results presented in this study do not have a counterpart in the literature. The average pollen efficiency per 1 ha varied from 27.4 kg for *N. grandiflora* to 34.7 for *N. citriodora*, to 48.4 for *N. nuda*. When compared to known pollen producing plants e.g. orange mullein (*Verbascum phlomoides* L.) or meadowsweet (*Filipendula ulmaria* (L. Max.) the output of which is 82 and 112 kg of pollen per 1 ha, respectively, the mint family plants reported here are characterized by a much lower pollen efficiency.

*N. grandiflora* was found to hold by far the least attraction to honeybees, an average of only two foragers per 1 m² having been recorded on flowers of that species during
the peak foraging hours. An identical density was reported by Demianowicz and co-workers (1963). Bumblebees were slightly more frequent visitors to the flowers of that species, an observation also in agreement with those reported by Ruszkowski et al. (1969, 1971).

CONCLUSIONS
1. Weight of pollen from 100 flowers was 2.77 mg for *N. citriodiris*, 3.77 mg for *N. nuda* and 7.84 mg for *N. grandiflora*.
2. The average pollen efficiency per 1 ha was 48.4 kg for *N. nuda* 34.7 kg for *N. citriodiris* and 27.4 kg for *N. grandiflora*.
3. The flowers of the species studied were of unequal attraction to the pollinating insects. *N. nuda* and *N. citriodiris* were most frequently visited by honeybees accounting for 99.2% and 83.3%, respectively, of the total number of pollinators. The percentage of honeybees foraging on *N. grandiflora* was only 21.8%.
4. Small creamy grey pollen loads were formed by worker honeybees exclusively from pollen of *N. citriodiris* and *N. nuda*.

REFERENCES


WYDAJNOŚĆ PYŁKOWA I OBLOT TRZECICH GATUNKÓW ROŚLIN Z RODZAJU KOCIMIĘTKA (*Nepeta* L.)

Bożek M.

**Streszczenie**

Doświadczenia przeprowadzono w latach 1995-1997 na terenie ISK Oddział Pszczelnictwa w Puławach w kolekcji roślin miododajnych. Badano wydajność pyłkową i oblot przez owady zapylające trzech gatunków roślin z rodzaju *Nepeta* L. (f. Lamiaceae): kocimiętkę właściwą odm. cytrynowa (*Nepeta* L. var. *citriodora* Dum.), nagą (*N. nuda* L.) i wielkokwiatową (*N. grandiflora* M.B.). Najniższą masę pyłku wytwarzało 100 kwiatów kocimiętki właściwej - 2,77 mg, a najwyższą kocimiętki wielkokwiatowej o największych kwiatach - 7,84 mg. Wartość ta dla kocimiętki nagiej wynosiła 3,77 mg. Najwyższą średnią wydajność pyłkową z 1 ha powierzchni określono dla kocimiętki nagiej 48,4 kg, dla kocimiętki właściwej - 34,7 kg/ha, a dla kocimiętki wielkokwiatowej 27,4 kg. Kwiaty badanych gatunków były niejednokrotnie atrakcyjne dla owadów. Kocimiętkę nagą i właściwą oblatywała najliczniej pszczoła miodna, której udział wynosił odpowiednio 99,2% i 83,3% ogółu zapylaczy, zaś na wielkokwiatowej stanowiła ona tylko 21,8%. Średnie szczytowe zagośczenie robotnic pszczoły miodnej pracujących na 1m² powierzchni kwitnącego poletka podczas pogodnych dni okresu pełni kwitnienia wynosiło: 23 szt. dla kocimiętki nagiej, 18 szt. dla właściwej i tylko 2 szt. dla kocimiętki wielkokwiatowej. Robotnice pszczoły miodnej formowały niewielkie, szarokremowe obnóża tylko z kwiatów kocimiętki właściwej i nagiej.

**Słowa kluczowe:** rośliny miododajne, *Nepeta* L., pylenie, owady zapylające.