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THE SELECTED TAXA VALUABLE AS FOOD FOR INSECT VISITORS IN AGRICULTURAL LANDSCAPE OF JASTKÓW, SE POLAND

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Abstract. The flora inventory was carried out in 2011-2012 in the Jastków manicipality in SE part of Poland. The aim of the study was to assign the condition of bee flora and establish the floristic richness on fallows, bush communities and fields margins in agricultural landscape. Flora of these biotops consists of 214 species, among them 80% were flow taxons. Apophytes (163 species – 78%) predominated on all types of biotops under consideration. Perennials predominated in flora of boundary strips and bush communities. Mainly hemicryptophytes and therophytes compose flora of fallows. Great number of plant taxons which are important as food for bee were originated to meadows, segetal or ruderal plants. Most flow plants compose loose patches but its successive blooming ensure source of food for Apoidea, and other pollinators i.e. Diptera, Syrphidae, Lepidoptera, Vespidae, Heteroptera and Coleoptera from early spring till the end of summer. The flora of boundary strips create the biodiversity in studied agricultural landscape. The treatments including sowing, mainly on fallows with nectariferous and polleniferous species would enrich generally weak flows in highly agricultural landscape.

Key words: agricultural landscape, refuge areas, pollenferous and nectariferous taxons, insect visitors

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Introduction

The awareness and interest in the demise of the world's wild bees is growing (Williams 1982; Williams et al. 1991; Van Opstal 2000). The decrease of their species diversity and population size may impact negatively on biocenoses structure and the ecosystems, including agroecosystems. The lack of pollinators may limit the pollen transfer and in consequence affect the world's economy (Torchio 1994). Apoidea bees are also economically important pollinators of crop plants (Dostatny 2006; Jabłoński & Kołtowski 1995). The value and management of alternative pollinators is attracting growing interest across the world becouse the agricultural productivity is directly dependant on pollinators' activity. Over 80% of angiosperms crops require insect pollination to produce seeds or fruits. The year service of pollinators for crop production is quantifiable in some millions dollars. Bees as pollinators of flowering plants play a key role in numerous terrestrial ecosystems ensuring the continued reproduction and survival of the plants and other organisms that live on these primary producers (Corbet *et al.* 1992). Service made by pollinators for spontaneous species, many of which are very important as e.g. medicinal herbs, protected species also depend on foraging insects. This service is not quantifiable but has essential value to preserve environment and plants diversity. In Europe declining of different Apoidea are documented in many countries (e.g Williams 1982; Banaszak 1992). Main reasons of pollinators' destruction are the habitat devastation and fragmentation. The environmental perturbations i.e. spread of large monocultures in agriculture impact on loss of many blooming plants in natural ecosystems. One of often used argument for the conservation of pollinators is the restitution or maintance of bee flora (Corbet *et al.* 1991; Denisow 2009a; Denisow & Wrzesień 2007).

The aim of the study was to identify the nectariferous and polleniferous taxa present

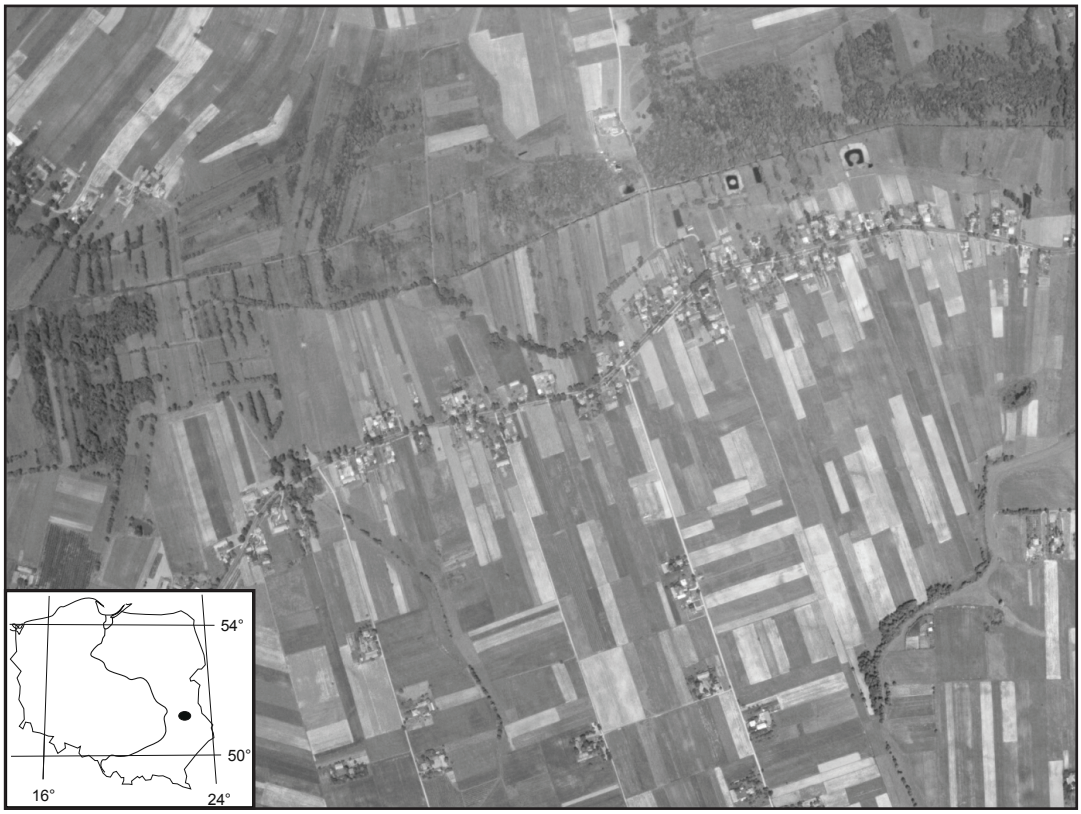

Fig. 1. Mosaic structure of Jastków landscape, SE Poland.

on the field margins, fallows and in bush communities in the vicinity of on Lublin Upland, Poland.

Material and methods

Observations of the entire flora were made up on fallows, bush communities and fields' margins, every two-three weeks during growing season to take seasonal blooming aspects and to assign the time and length of blooming. The list of nectariferous and polleniferous taxons was established on the basis of data from literature (Warakomska 1995, 1997; Wróblewska 2002; Denisow & Wrzesień 2007) and according to own observations. The record provides taxonomic nomenclature by Mirek *et al.* (2002) and the description of each taxon including its life span, geographic-historical status (Zając 1979; Tokarska-Guzik 2005), sinecological group (Matuszkiewicz 2008), the average time of blooming was assessed according to Denisow (2009b). The spectrum of nectariferous and polleniferous plants was established on the bases on the intensity of insect visitors present on flowers. The intensity of insect visitors foraging were estimated as averages on the basis of 30 min observations during transect walks and during sunny weather in most intensely forage hours (10.00-14.00 GMT+2h). The following range for bees' visits was applied: weak – 0-1 · m^{-2}; medium – 2-4 · m^{-2}; good – ≥5 · m^{-2}. The alphabetical list of nectariferous and polleniferous species consists only most intensly foraged taxa (see Appendix).

The study area

The investigated region is a part of Nałęczów Pletau and the Bełżyce Plain located on a highly undulated area at 180-252 m a.s.l. Most of soils are

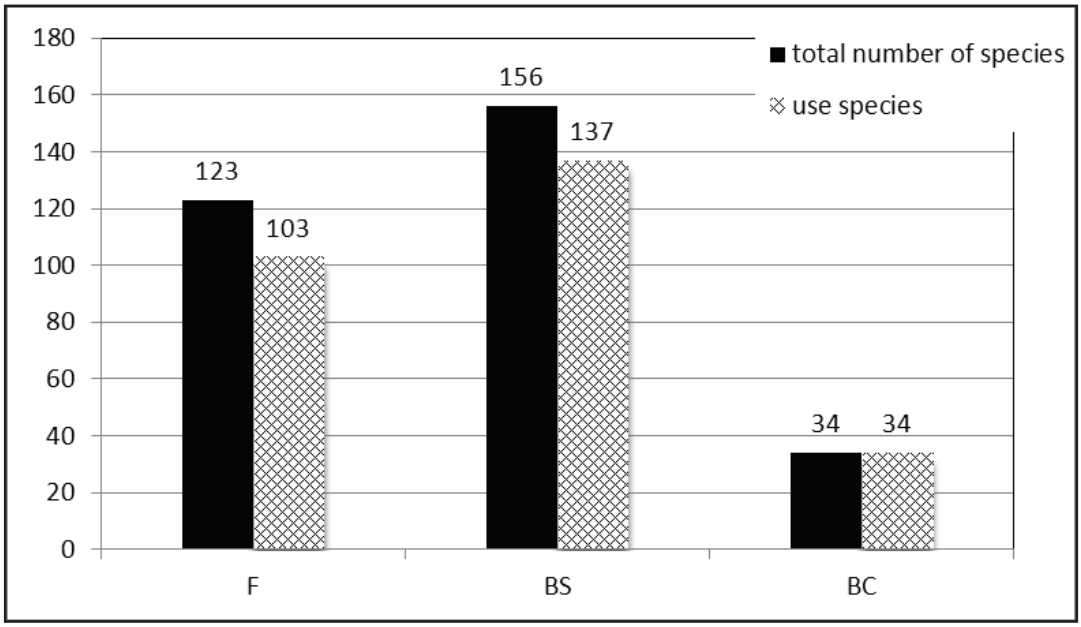

Fig.2. The total number of species noted and the number of nectariferous and polleniferous species observed in different biotops of agricultural landscape in Jastków, SE Poland: **F** – fallows; **BS** – bondary strips; **BC** – bush communities.

clay-dusty and sandy-dusty or loess-originated brown and grey-brown (Turski *et at.* 1993). The natural vegetation of the area is composed of the associations from the *Phragmitetea* class distributed along the Ciemięga valley stream. The wet, rarely mown meadows characteristic for the *Molinion* and *Caltion* alliances are widespread. The higher located meadows from *Arrhenatherion elatioris* class are subjected to standard mowing management. The most valuable as a source of bee flora is *Cirsietum rivularis* with predominance of *Cirsium rivulare* (Jacq.) All. and *Polygonum bistorta* L. The phytocenoses from *Scheuchzerio-Caricetea fuscae* and fragments of *Ribo nigri-Alnetum* are present. Forests are fragmented and most of them are from *Querco-Fagetea* class. The cultivated area includes 3500 ha, the farming and gardening build up the mosaic structure of landscape characteristic for eastern part of Poland with small fields (ca. 5-10 ha) and maintained field margins among fields (Fig. 1). The fallows represent up to 15% of arable lands. Most of the cultivated area is under cereals (50%) and about 12-18% is occupied by root crops (potato fields and sugar beet). The abundant nectar and pollen flow from crop plants was observed only in May, during both orchards and meadows blooming. The entomophilous crops such as rape plantations and perennial papilionaceous were very rare.

Results

The data concerning the diversity and distribution of bee flora in different agricultural biotops are given in Appendix and on Fig. 2.

Presently the flora of the anthropogenic refuge areas consists of 214 species belonging to 39 families of which the most abundant are Asteraceae, Fabaceae, Rosaceae, Caryophyllaceae, Brassicaceae and Lamiaceae. The great majority of taxons occurred on fallows – 153 species, among them 73% were identified as good bee plants. Then 124 different vascular plants were present on boundary strips, including 103 nectariferous and polleniferous. In the flora of margins a high participation of grass taxa (2%) was observed which is probably connected with high level of fertilisation on close fields. Least abundant were bush communities with only 34 species recorded and recognised as flow species.

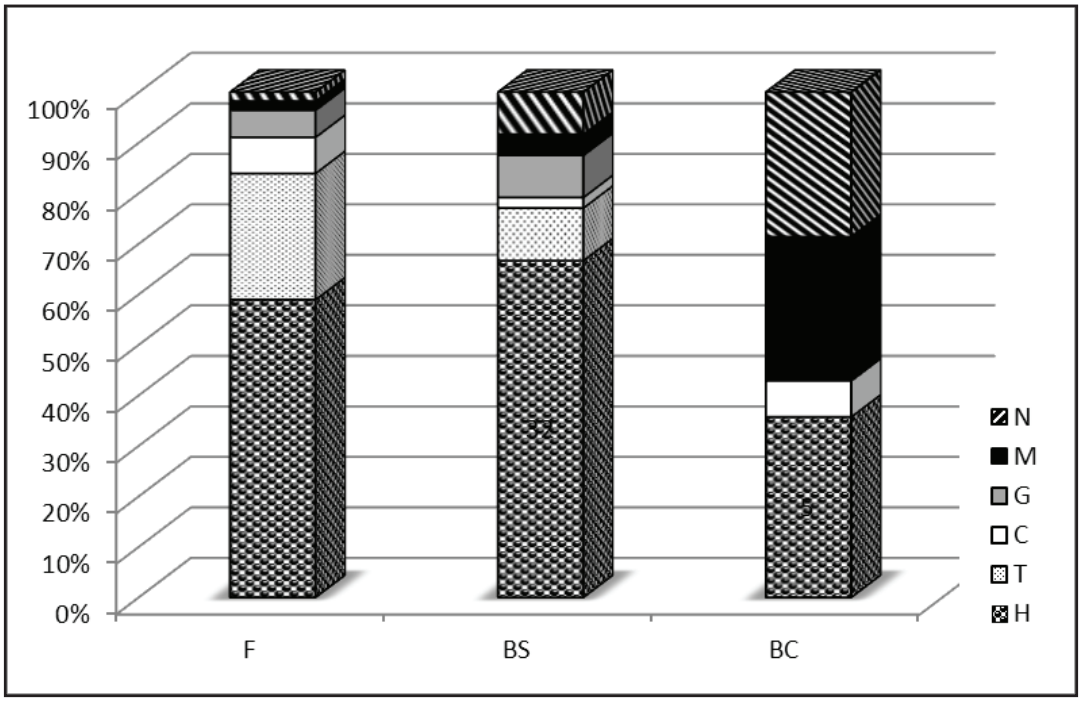

Fig. 3. Spectrum of life forms among species observed in different biotops of agricultural landscape in Jastków, SE Poland: **F** – fallows; **BS** – bondary strips; **BC** – bush communities; **H** – hemicryptophytes; **T** – therophytes; **C** – chamaephytes; **G** – geophytes; **M** – megaphanerophytes; **N** – nanophanerophytes.

Apophytes (162 species – 78%) predominated on all types of biotops under consideration. The alien species occurred less frequently and were represented by archeophytes (36 species – 17%), epecophytes (7 species – 3.3%), and of short duration agriophytes (only 4 species – 2%). Complete lack of efemerophytes indicates very low coefficient of synanthropization in analyzed biotops. Interesting that dynamic residential development during last 15 years and transformation of arable lands into fallows did not cause the inflow of alien species.

Hemicryptophytes predominated among species recorded on different refuge areas in studied agricultural landscape (Fig. 3). Therophytes were most frequently recorded among species registered on fallows (approx. 30%) and mega-, nanophanerophytes composed 50% of bush communities flora.

The spontaneously growing bushes most frequently develop on the edges of arable fields, the sunny slopes of loess ravines and were frequently covered by patches, different in size, predominated by *Prunus spinosa* L. which is very important during early spring. The other shrubs often present and intensely foraged were *Crataegus monogyna* Jacq., *Rosa canina* L., *R. dumalis* Bechst. Next species were mainly heliophytes of the edge communities and meadow taxons: *Clinopodium vulgare* L., *Prunella vulgaris* L., *Heracleum sphondylium* L., *Knautia arvensis* (L.) Coult. or *Agrimonia eupatoria* L. The two last mentioned are particularly attractive for bees.

The most frequently found on fields margins were *Berteroa incana* (L.) DC., *Cichorium intybus* L., *Centaurea scabiosa* L., *Euphorbia cyparissias* L., *Hypericum perforatum* L., *Lamium album* L., *Lotus corniculatus* L., *Medicago falcata* L., *Potentilla anserina* L., *Sedum maximum* (L.) Suter, *Trifolium medium* L., *Verbascum densiflorum* Bertol., *Vicia cracca* L. The above species form dens patches or are characterised by long period of blooming.

Taking under consideration sinecological group the considerable participation of species

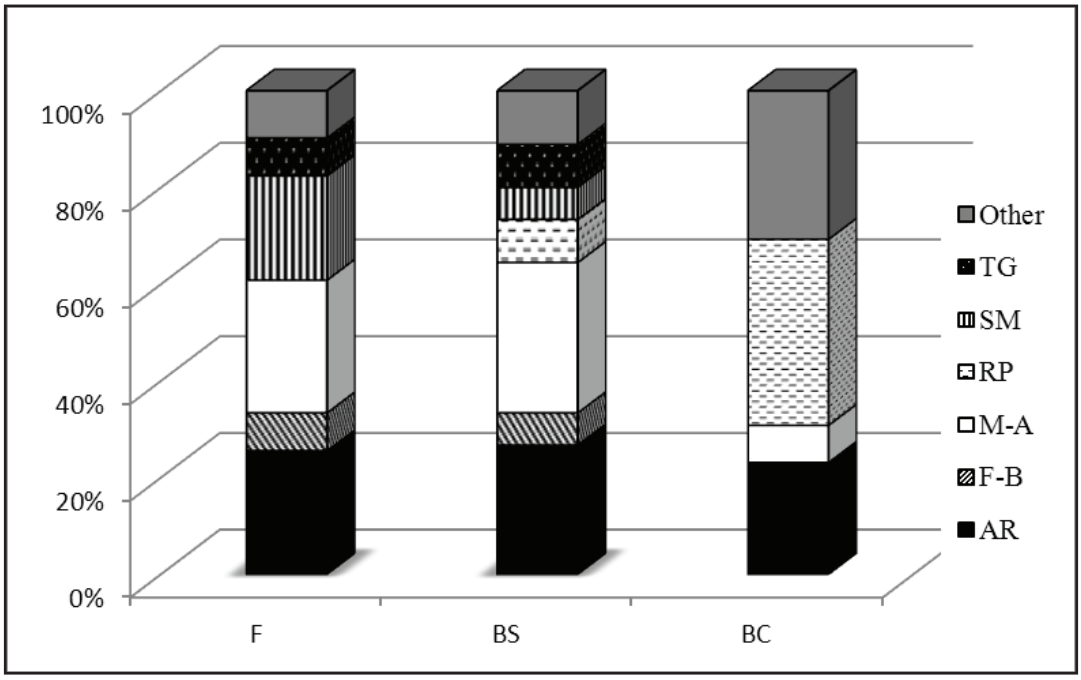

Fig. 4. The percentage participation of species in socio-ecological group among the flora observed in different biotops of agricultural landscape in Jastków, SE Poland: **F** – fallows; **BS** – bondary strips; **BC** – bush communities; **AR** – *Artemisietea vulgaris*; **F-B** – *Festuco-Brometea*; **M-A** – *Molinio-Arrhenatheretea*; **RP** – *Rhamno-Prunetea*; **SM** – *Stelarietea mediae*; **TG** – *Trifolio-Geranietea sanguinei*.

from *Artemisietea vulgaris, Stelarietea-medie* and *Molinio-Arrhenatheretea* classes on fallows was proved (Fig. 4). On boundary strips the segetal species from *Stelarietea-medie* were less abundant. The participation of meadows and ruderal taxons on both fallows and boundary strips was comparable. Ruderal species (*Artemisietea vulgaris* class) and thermophilous species (*Rhamno-Prunetea* class) predominated in the flora of bushes.

Season-long succession of bloom was observed on boundary strips and fallows. The species in bush communities bloom mainly on early spring and ensures first during the growing season nectar and pollen flow. As early spring taxons bloom very abundantly the expected food resources are rather abundant. Our observations have shown that the plants blooming on boundary strips and fallows create favourable conditions for feeding different Apoidea. Apart from *Apis mellifera*, bumblebees and solitary bees were present. Generally, the density of Apoidea changed during vegetation season and correlated with blooming spectrum on observed biotops. The largest density in bush communities occurred in April while on field margins and fallows in summer.

In summary, successive blooming of the nectariferous and polleniferous species in field associations ensures unbroken food flow from the early spring until the late summer and early autumn. Field margins make a valuable food potential to be important for the Apoidea before and after blooming of the main forage cultivated crops.

Conclusions

1. The flora of studied landscape comprises 214 species of which 80% were classified as nectariferous or polleniferous. The majority of taxa are apophytes which predominate over antropophytes. With connection of the area character was complete absence of efemerophytes.

2. The great majority of taxons that create food base for visiting insects are meadows, segetal or ruderal plants. Most nectariferous

or polleniferous taxons form loose patches, small number form dens surfaces but the time and period of its blooming ensure continuous, unbroken feeding band for Apoidea from early spring till late summer.

3. To enrich generally weak flows in highly agricultural landscape the sowing of nectariferous and polleniferous species seems to be necessary.

Acknowledgements

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Appendix. The characterization of nectariferous and polleniferous species observed on different biotops of agricultural landscape in Jastków, SE Poland (averages from 2011-2012). The taxa were selected according to the highest insect visitors' activity.

Explanations: Species (A); Life form (B): C – chamaephyte, **G** – geophyte, **H** – hemicryptophyte, **M** – macrophanerophyte, **N** – nanophanerophyte, **T** – therophyte; **Historical and geographical groups (C): Ap** – apophytes, **Arch** – archaeophytes, **Ep** – epecophytes, **Ag** – agriophytes; **Phytosociological units (D): AR** – *Artemisietea vulgaris,* **AIR** – *Agropyretea intermedio repentis,* **EP** – *Epilobietea angustifolii,* **F-B** – *Festuco-Brometea,* **IN** – *Isoeto-Nanojuncetea,* **KG** – *Koelerio glaucae-Corynephoretea canescentis,* **M-A** – *Molinio-Arrhenatheretea,* **NC** – *Nardo-Callunetea,* **Q-F** – *Querco-Fagetae,* **RP** – *Rhamno-Prunetea,* **SM** – *Stellarietea mediae,* **TG** – *Trifolio-Geranietea sanguinei*; **Basic flower colour (E): b** – blue, **p** – pink, **v** – violet, **w** – white, **y** – yellow; **Type of reproduction (F): s** – by seed, **sv** – by seed and vegetatively, **ssv** – mostly by seed, rarely vegetatively; **Fallows (G), Boundary strips (H)** and **Bush communities (I)**, degree of density: **1** – single, **2** – loose patches, **3** – dense patches; **Average time of blooming (J); Flower reward (K): N** – nectar, **P** – pollen.

Species	Life form	Historical and geographical groups	Phytosociological unit	Basic flower colour	Type of reproduction	Fallows	Boundary strips	Bush communities	Average time of blooming	Flower reward
A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Anchusa officinalis L.	H	Arch	AR	b	s	1	.	.	13.05 – 30.09	N+P
Ballota nigra L.	C	Arch	AR	v	s	.	.	2	01.07 – 05.09	N+P
Berteroa incana (L.) DC.	H	Ap	AR	w	s	2	2	.	05.05 – 30.09	N+P
Bunias orientalis L.	H	Ep	-	y	sv	.	.	.	10.05 – 10.06	N+P
Campanula patula L.	H	Ap	M-A	y	s	1	1	.	20.05 – 10.07	N+P
Campanula rapunculoides L.	H	Ap	TG	b	sv	1	1	.	10.06 – 01.09	N+P
Campanula rotundifolia L.	H	Ap	-	b	s	1	.	.	10.06 – 01.09	N+P
Capsella bursa-pastoris (L.) Med.	H	Ap	SM	w	s	2	1	.	25.04 – 10.10	N+P
Centaurea cyanus L.	T	Arch	SM	b	s	1	.	.	10.06 – 01.08	N+P

Appendix. Continued.

A	B	C	D	E	F	G	H	I	J	K
Centaurea jacea L.	H	Ap	M-A	v	s	1	1	.	15.06 – 20.08	N+P
Centaurea pannonica (Heuff.) Hayek	H	Ap	F-B	v	s	.	1	.	18.06 – 20.08	N+P
Centaurea scabiosa L.	H	Ap	F-B	v	ssv	2	1	.	20.06 – 10.09	N+P
Centaurea stoebe L.	H	Ap	F-B	v	s	1	.	.	25.06 – 20.08	N+P
Centaurium erythraea Rafn	T	Ap	IN	v	s	2	.	.	25.06 – 30.08	N+P
Chamaenerion angustifolium (L.) Scop.	H	Ap	EP	v	sv	.	1	.	20.06 –20.07	N+P
Chamomilla suaveolens (Pursh) Rydb.	T	Ep	M-A	y	s	2	.	.	10.06 – 20.07	N+P
Cichorium intybus L.	H	Arch	AR	b	s	2	2	.	10.06 – 01.09	N+P
Cirsium arvense (L.) Scop.	G	Ap	AR	v	sv	2	1	.	30.06 – 20.08	N+P
Crataegus monogyna Jacq.	M	Ap	RP	w	s	1	1	2	15.05 – 30.05	N+P
Echium vulgare L.	H	Ap	AR	b	s	2	1	.	10.06 – 10.09	N+P
Epilobium montanum L.	H	Ap	AR	v	sv	.	1	1	15.06 – 30.08	N+P
Filipendula vulgaris Moench	H	Ap	F-B	w	sv	2	.	.	20.06 – 05.08	P
Galeopsis pubescens Besser	T	Ap	AR	v	s	1	1	.	15.06 – 01.09	N+P
Hypericum perforatum L.	H	Ap	-	y	sv	2	2	.	05.06 – 30.07	P

Knautia arvensis (L.) J.M. Coult.	H	Ap	M-A	v	s	1	2	.	10.06 – 30.07	N+P
Lamium album L.	H	Arch	AR	w	sv	1	1	1	20.04 – 30.09	N+P
Lamium purpureum L.	T	Arch	SM	v	s	1	.	.	15.04 – 01.09	N+P
Leontodon autumnalis L.	H	Ap	M-A	y	sv	1	2	.	20.06 – 30.09	N+P
Linaria vulgaris Mill.	G	Ap	AR	y	sv	1	1	.	15.06 – 20.09	N+P
Lotus corniculatus L.	H	Ap	M-A	y	ssv	2	2	1	10.05 – 15.09	N+P
Lychnis flos-cuculi L.	H	Ap	M-A	v	sv	1	1	.	10.05 – 25.06	N+P
Medicago falcata L.	H	Ap	TG	y	sv	2	2	.	10.06 – 15.09	N+P
Medicago sativa L.	H	Ag	-	b	s	2	2	.	10.06 – 15.08	N+P
Melilotus alba Medik.	T	Ap	AR	w	s	2	2	.	10.06 – 20.08	N+P
Melilotus officinalis (L.) Pall.	T	Ap	AR	y	s	.	2	.	01.06 – 20.07	N+P
Oenothera biennis L. s.s.	H	Ap	AR	y	s	1	.	.	15.06 – 15.08	N+P
Origanum vulgare L.	C	Ap	TG	v	sv	2	2	.	01.07 – 15.08	N+P
Padus avium Mill.	M	Ap	Q-F	w	s	.	.	1	20.04 – 20.05	N+P
Papaver rhoeas L.	T	Arch	SM	v	s	1	.	.	20.05 – 10.07	P
Pastinaca sativa L.	H	Ap	M-A	y	s	2	2	.	01.07 – 15.08	N+P

Appendix. Continued.

A	B	C	D	E	F	G	H	I	J	K
Potentilla anserina L.	H	Ap	M-A	y	sv	2	2	.	10.05 – 20.07	P
Potentilla reptans L.	H	Ap	M-A	y	sv	.	2	.	05.05 – 10.09	P
Prunus spinosa L.	M	Ap	RP	w	sv	.	1	3	20.04 – 05.05	N+P
Raphanus raphanistrum L.	T	Arch	SM	y	s	1	.	.	10.06 – 10.10	N+P
Rosa canina L.	N	Ap	RP	p	s	.	1	2	15.05 – 15.06	P
Rubus caesius L.	N	Ap	AR	w	sv	2	2	.	25.05 – 10.07	P
Rubus idaeus L.	N	Ap	EP	w	sv	.	2	3	20.05 – 10.07	P
Sarothamnus scoparius L.	N	Ap	RP	y	s	.	.	2	15.05 – 15.06	N+P
Scabiosa ochroleuca L.	H	Ap	F-B	y	s	1	1	.	01.06 – 17.07	N+P
Scrophularia nodosa L.	H	Ap	Q-F	v	sv	.	.	1	20.06 – 20.08	N+P
Sedum acre L.	C	Ap	KG	y	sv	2	.	.	15.05 – 20.07	N+P
Sedum maximum (L.) Hoffm.	G	Ap	-	v	s	.	1	.	10.07 – 20.09	N+P
Sinapis arvensis L.	T	Ep	SM	y	s	1	.	.	15.05 – 15.10	N+P
Sisymbrium loeselii L.	H	Arch	SM	y	s	2	.	.	01.06 – 20.07	N+P
Sisymbrium officinale (L.) Scop.	H	Arch	SM	y	s	1	1	.	20.05 – 30.09	N+P

Solidago gigantea Aiton	H	Ag	AR	y	sv	3	.	.	20.07 – 15.10	N+P
Symphytum officinale L.	H	Ap	-	v	ssv	.	.	1	20.05 – 15.08	N+P
Taraxacum officinale F.H. Wigg.	H	Ap	M-A	y	s	2	2	.	05.05 – 25.05	N+P
Thymus pulegioides L.	C	Ap	-	v	sv	2	.	.	10.06 – 10.07	N+P
Thymus serpyllum L.	C	Ap	KG	v	sv	2	.	.	10.06 – 10.07	N+P
Tilia cordata L.	M	Ap	Q-F	y	ssv	.	.	1	30.06 – 20.07	N+P
Trifolium arvense L.	T	Ap	KG	v	s	2	2	.	01.06 – 05.08	N+P
Trifolium dubium Sibth.	T	Ap	M-A	y	s	1	.	.	01.06 – 30.07	N+P
Trifolium hybridum L.	H	Ap	M-A	w	s	.	2	.	01.06 – 30.07	N+P
Trifolium medium L.	H	Ap	TG	p	sv	.	2	.	01.06 – 30.07	N+P
Trifolium pratense L.	H	Ap	M-A	p	s	1	1	.	01.06 – 30.07	N+P
Trifolium repens L.	H	Ap	M-A	w	sv	2	2	.	20.05 – 30.08	N+P
Tussilago farfara L.	G	Ap	AIR	y	sv	2	2	.	01.04 – 25.04	N+P
Verbascum nigrum L.	H	Ap	EP	y	s	.	1	.	05.07 – 10.08	N+P
Verbascum phlomoides L.	H	Ap	AR	y	sv	1	1	.	10.06 – 05.09	N+P
Viburnum opulus L.	N	Ap	RP	w	s	.	1	1	10.05 – 10.06	N+P

Appendix. Continued.

A	B	C	D	E	F	G	H	I	J		K
Vicia cracca L.	H	Ap	M-A	b	ssv	2	2	.	10.06 20.08	–	N+P
Vicia hirsuta (L.) S.F. Gray	T	Arch	SM	w	s	1	.	.	10.05 20.07	–	N+P
Vicia sepium L.	H	Ap	TG	b	ssv	1	.	.	10.05 30.07	–	N+P
Vicia tetrasperma (L.) Schreb.	T	Arch	SM	w	s	1	.	.	15.05 15.08	–	N+P
Vicia villosa Roth.	T	Arch	SM	b	s	2	2	.	10.06 20.07	–	N+P