SURVEY ABOUT THE WEED OCCURRENCE ON ARABLE LAND IN THE CZECH REPUBLIC*

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Current weed spectrum on arable land in the Czech Republic was analyzed and constancy for the individual species determined. Phytocoenological survey was conducted within 2006–2008 on 62 farms. The choice of field selection for sampling was winter cereals, spring cereals, and wide-row spring crops. In the central part of each field phytocoenological relevés sizing 100 m^2 were monitored. In total, 172 weed species (58 apophytes, 97 archaeophytes, and 17 neophytes) belonging to 32 families coming from 290 relevés were recorded. *Chenopodium album, Fallopia convolvulus*, and *Viola arvensis* were among the species with the highest constancy. Altogether 28 volunteer crops belonging to 8 families were determined (18 dicotyledonous and 10 monocotyledonous). *Trifolium repens* and *Brassica napus* subsp. *napus* were the most frequent volunteers.

weed spectrum; volunteers; constancy; phytocoenological relevé; *Chenopodium album*; *Trifolium repens*

INTRODUCTION

Weed flora is the natural part of plant communities on arable land. From the ecological point of view, weed vegetation on arable land stays still at the initial stage of succession and does not reach the later succession stages because of repeated cropping (Lososová et al., 2009). However, depending on frequency and timing of soil cultivation, different life-form types of weeds dominate in weed community (Holzner, 1982).

In Central Europe, about 300 species can be designated as arable weeds (Holzner, Immonen, 1982; Börner, 1995). Investigating Czech Republic's weeds, Kropáč (1986) detected about 260 species of higher plants (excluding bryophytes) and 12 volunteers. Besides the influence of ecological site conditions (e.g. soil, climate), human activities continually influence the weed species occurrence in agrophytocoenoses. Intensive farming is nowadays characterized by narrow crop rotations, intensive soil tillage, effective seed cleaning technology, usage of highly efficient herbicides, application of high fertilizer and lime rates, new harvesting technologies, etc. (Hilbig, Bachthaler, 1992). Significant changes in weed communities have been repeatedly confirmed and analyzed (e.g. Kropáč, 1988; Andreasen et al., 1996; Kohout et al., 2003; Lososová, Simonová, 2008; Májeková et al., 2010), namely as concerns species impoverishment and occurrence of species difficult to control including new alien plant species (Jehlík, 1998). The objective of this study was to analyze the current weed spectrum in the Czech Republic and to determine the constancy for the individual species.

MATERIAL AND METHODS

A phytocoenological survey on the area of the Czech Republic lasted from 2006 till 2008. Totally 62 farms (both conventional and organic) were chosen for the research. The elevation range of 175–650 m a.s.l. represented all areas suitable for agricultural production in the Czech Republic. Fields with winter cereals (winter wheat, winter barley, rye, spelt, triticale), spring cereals (spring barley, oat, naked oat, spring wheat), and wide-row spring crops (sugar beet, potatoes, maize, oil pumpkin, feeding carrots, fodder beet, beet-root) were selected for the sampling. For cereals the monitoring was performed in June and July, for wide-row crops in August and September, during the period of full vegetation. At each field, one phytocoenological relevé of a standard size of 100 m^2 was recorded in the central part of the field. The species cover was estimated using nine-degree Braun-Blanquet cover-abundance scale (Braun-Blanquet, 1964, adaptation Barkman et al., 1964). Plant species like (a) crops plants emerging from harvest losses of forecrop or (b) plants which are commonly grown as crops but can occur also in nature (their origin in

* Supported by the Ministry of Education, Youth and Sports of the Czech Republic (S grant).

Table 1. Families of species and volunteers recorded

Family	Species number		Family	Species number	
	weeds	volunteers		weeds	volunteers
Asteraceae	29	2	*Rosaceae*	3	0
Poaceae	16	10	*Rubiaceae*	3	0
Brassicaceae	15	3	*Amaranthaceae*	2	0
Caryophyllaceae	10	0	*Convolvulaceae*	2	0
Scrophulariaceae	10	0	*Fumariaceae*	2	0
Polygonaceae	9	0	*Malvaceae*	2	0
Chenopodiaceae	8	1	*Primulaceae*	2	0
Fabaceae	7	9	*Urticaceae*	2	0
Lamiaceae	7	0	*Violaceae*	2	0
Apiaceae	6	0	*Campanulaceae*	1	0
Boraginaceae	6	0	*Equisetaceae*	1	0
Ranunculaceae	5	0	*Juncaceae*	1	0
Euphorbiaceae	4	0	*Onagraceae*	1	0
Geraniaceae	4	0	*Portulacaceae*	1	0
Solanaceae	4	1	*Valerianaceae*	1	0
Papaveraceae	3	1	*Hydrophyllaceae*	0	1
Plantaginaceae	3	0			

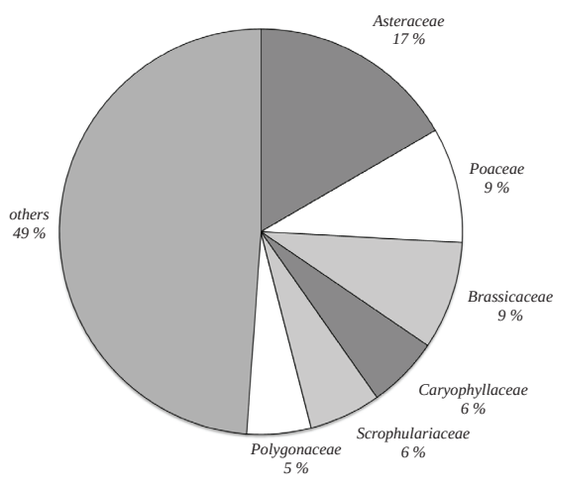

Fig. 1. The most frequent weeds families

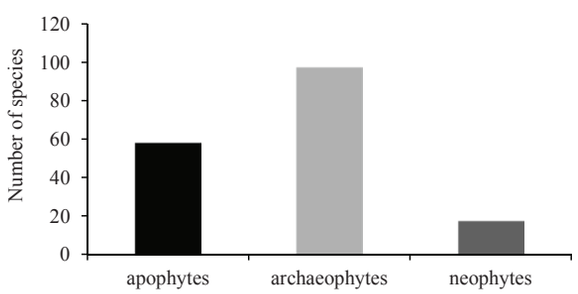

Fig. 2. Number of apophytes, archaeophytes and neophytes observed

field was unclear) were considered as volunteers and evaluated separately. Fungi, non-vascular plants, and self-seeded seedlings of trees were not considered for evaluations. The nomenclature followed K u b á t et al. (2002). Status of immigration time of each species was stated according to P y š e k et al. (2002).

At each species, number of fields with its occurrence (a_i) and constancy (C_i) were stated (M o r a v e c , 1994):

$$C_i = \frac{a_i}{n} \cdot 100$$

where:
C_i = constancy of the *i* species (%)
a_i = number of fields with occurrence of the *i* species
n = total number of relevés

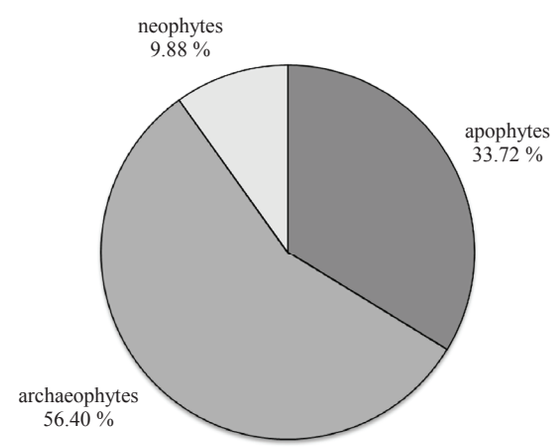

Fig. 3. Percentage of apophytes, archaeophytes and neophytes observed

RESULTS

In sum, 172 weed species (Table 2) referring to 32 families (Table 1) were recorded. More than 50% of the species referred to 6 families (*Asteraceae*, *Poaceae*, *Brassicaceae*, *Caryophyllaceae*, *Scrophulariaceae,* and *Polygonaceae*) (Fig. 1). *Chenopodium album* was the species with the highest constancy, followed by *Fallopia convolvulus*, *Viola arvensis*, *Cirsium arvense*, *Polygonum aviculare*, and other species (Table 2).

In total, 28 volunteers (18 dicotyledonous, 10 monocotyledonous) belonging to 8 families were encountered (Table 3). *Trifolium repens* and *Brassica napus* subsp. *napus* were the most common volunteers.

Altogether 58 apophytes, 97 archaeophytes, and 17 neophytes (excluding volunteers) (Fig. 2) with variable percentage (Fig. 3) were detected.

DISCUSSION

The estimated number of total weed species on the European continent considerably varies. Klika (1955) estimated the total number of weeds in Central Europe at 350 to 400 species, with 50 of them being the most commonly encountered. Estimations of Hanf (1979) for Europe were even 650 species. In his vocabulary of weeds, Williams (1982) comprised a total of 1043 plant species occurring in Western Europe. According to Williams, Hunyadi (1987), in Eastern Europe the number of the listed weed species was even greater (1780). On the other hand, in their European survey Weber, Gut (2005) mentioned just 281 weed species (176 genera and 48 families). The reason of such a vast disparity of data stated by some authors is undoubtedly based on various definitions of the weedy species, which were thus attributed different levels of significance.

Similarly, the estimates given by the individual authors for the Czech Republic differ. Kropáč (1986) identified about 260 weed species among higher plants. Lososová, Simonová (2008) reported a total of 303 weed species in Moravia in 2005. It is possible that the relatively low number of weed species recorded in the present research is due to the chosen methodology – the monitoring was performed only in the central parts of the fields with lower weed occurrence. Field margin vegetation is often more diverse affected by the adjacent neighbouring phytocoenosis (Marshall, Arnold, 1995). Nowadays, weed species with broad ecological amplitude and weeds naturally resistant to frequently used herbicides belong to those with the highest constancy. Lososová et al. (2009) identified *Chenopodium album* agg., *Cirsium arvense*, *Elytrigia repens*, *Fallopia convolvulus*, and *Viola arvensis* as the currently most abundant weeds.

The largest percentage of weed species (281 in total) found by Weber, Gut (2005) belonged to the *Asteraceae* (61), *Poaceae* (55), *Brassicaceae* (15), *Polygonaceae* (14), and *Apiaceae* (11) families. *Amaranthus* sp., *Bromus* sp., and *Rumex* sp. were identified as the most significant genera represented by 7 species each. Glemnitz et al. (2004) considered *Asteraceae, Poaceae, Polygonaceae, Caryophyllaceae, Brassicaceae, Papaveraceae,* and *Fabaceae* the largest families of weeds in Europe occurring along the observed transect (South–North of Europe). None of the above cited authors ranged the *Scrophulariaceae* among the most widespread families. Contrarily, we have recorded 10 species of this family, six of which belonging to the genus *Veronica*.

Out of the total number of found weeds (excluding volunteers), 33.72% were considered apophytes, 56.40% archaeophytes, and 9.88% neophytes. This finding correlates well with the data reported by Holec et al. (2008), who mentioned approximately 30% of apophytes, 60% of archaeophytes, and only 10% of neophytes among arable weeds occurring in the Czech Republic.

More than twice higher number of volunteers (28) was registered on the territory of the Czech Republic compared to the 12 findings of Kropáč (1986). This significant difference is likely due to different criteria by which a given plant species was considered as volunteer. Another reason may be that the relevés were logged in organic fields, which are generally characterized by more diverse crop rotations with a wider variety of crops (Šarapatka, Urban, 2006); in the present study, only 12 volunteers were found in conventional farming and 26 in organic farming. Weed beet (*Beta vulgaris*) was also assigned to this group despite it is a hybrid between cultural beet (*Beta vulgaris* subsp. *vulgaris*) and landraces (sea beet, *Beta vulgaris* subsp. *maritima*) (Holec et al., 2007). To the Czech territory it was introduced along with the import of sugar beet seeds from the Mediterranean (Soukup et al., 2002). *Trifolium repens* was found to be the most common volunteer registered in 44 fields. Its frequency may be associated with its perenniality and growing of clover as a forage crop especially in organic farming. Herein it was assigned to volunteers despite it is not much grown nowadays and might be also introduced from the surroundings because *T. repens* is our second most significant clover in nature and permanent grasslands (Regal, Krajčovič, 1963). Its seeds can perceive for a long time in the soil-seed bank; they pass through digestive tract of animals without any damage and can be dispersed through the manure. The second most common (41 fields) volunteer was oilseed rape (*Brassica napus* subsp. *napus*). This is particularly due to its extensive growing in the Czech Republic, frequent high harvest losses (often much higher than normal seed rate), and long seeds persistence in the soil seed bank with the possibility of the many years' gradual emergence in succeeding crops (Kohout, Soukup, 1996).

Table 2. Weed species recorded (sorted by constancy)

Species	Family	a_i	C_i
*Chenopodium album agg.**	*Chenopodiaceae*	211	72.76
Fallopia convolvulus	*Polygonaceae*	189	65.17
Viola arvensis	*Violaceae*	171	58.97
Cirsium arvense	*Asteraceae*	157	54.14
Polygonum aviculare agg.	*Polygonaceae*	157	54.14
Tripleurospermum inodorum	*Asteraceae*	139	47.93
Elytrigia repens	*Poaceae*	121	41.72
Galium aparine	*Rubiaceae*	117	40.34
Capsella bursa-pastoris	*Brassicaceae*	116	40.00
Taraxacum sect. Ruderalia	*Asteraceae*	115	39.66
Stellaria media	*Caryophyllaceae*	113	38.97
Thlaspi arvense	*Brassicaceae*	101	34.83
Veronica persica	*Scrophulariaceae*	91	31.38
Convolvulus arvensis	*Convolvulaceae*	90	31.03
Anagallis arvensis	*Primulaceae*	74	25.52
Echinochloa crus-galli	*Poaceae*	72	24.83
Apera spica-venti	*Poaceae*	71	24.48
Myosotis arvensis	*Boraginaceae*	69	23.79
Euphorbia helioscopia	*Euphorbiaceae*	67	23.10
Lamium purpureum	*Lamiaceae*	67	23.10
Plantago major	*Plantaginaceae*	65	22.41
Amaranthus retroflexus	*Amaranthaceae*	61	21.03
Geranium pussilum	*Geraniaceae*	61	21.03
Persicaria lapathifolia	*Polygonaceae*	54	18.62
Avena fatua	*Poaceae*	53	18.28
Veronica arvensis	*Scrophulariaceae*	53	18.28
Silene noctiflora	*Caryophyllaceae*	51	17.59
Amaranthus powellii	*Amaranthaceae*	49	16.90
Chenopodium hybridum	*Chenopodiaceae*	43	14.83
Aethusa cynapium	*Apiaceae*	41	14.14
Galeopsis tetrahit	*Lamiaceae*	40	13.79
Papaver rhoeas	*Papaveraceae*	40	13.79
Sonchus arvensis	*Asteraceae*	40	13.79
Vicia hirsuta	*Fabaceae*	39	13.45
Persicaria maculosa	*Polygonaceae*	36	12.41
Fumaria officinalis	*Fumariaceae*	35	12.07
Lamium amplexicaule	*Lamiaceae*	34	11.72
Rumex obtusifolius	*Polygonaceae*	33	11.38
Lactuca serriola	*Asteraceae*	32	11.03
Veronica polita	*Scrophulariaceae*	32	11.03
Artemisia vulgaris	*Asteraceae*	31	10.69
Sonchus asper	*Asteraceae*	30	10.34
Erodium cicutarium	*Geraniaceae*	29	10.00
Poa annua	*Poaceae*	28	9.66

Species	Family	a_i	C_i
Vicia tetrasperma	*Fabaceae*	28	9.66
Atriplex patula	*Chenopodiaceae*	27	9.31
Descurainia sophia	*Brassicaceae*	27	9.31
Lapsana communis	*Asteraceae*	27	9.31
Setaria pumila	*Poaceae*	27	9.31
Consolida regalis	*Ranunculaceae*	25	8.62
Chenopodium polyspermum	*Chenopodiaceae*	25	8.62
Centaurea cyanus	*Asteraceae*	24	8.28
Lycopsis arvensis	*Boraginaceae*	24	8.28
Solanum nigrum	*Solanaceae*	24	8.28
Galium spurium	*Rubiaceae*	23	7.93
Gnaphalium uliginosum	*Asteraceae*	21	7.24
Matricaria discoidea	*Asteraceae*	21	7.24
Rumex crispus	*Polygonaceae*	21	7.24
Sinapis arvensis	*Brassicaceae*	20	6.90
Arabidopsis thaliana	*Brassicaceae*	19	6.55
Equisetum arvense	*Equisetaceae*	18	6.21
Mentha arvensis	*Lamiaceae*	17	5.86
Mercurialis annua	*Euphorbiaceae*	16	5.52
Stachys palustris	*Lamiaceae*	16	5.52
Geranium dissectum	*Geraniaceae*	15	5.17
Vicia angustifolia	*Fabaceae*	15	5.17
Arctium tomentosum	*Asteraceae*	14	4.83
Euphorbia exigua	*Euphorbiaceae*	14	4.83
Galinsoga parviflora	*Asteraceae*	14	4.83
Spergula arvensis	*Caryophyllaceae*	14	4.83
Conyza canadensis	*Asteraceae*	13	4.48
Matricaria recutita	*Asteraceae*	13	4.48
Raphanus raphanistrum	*Brassicaceae*	13	4.48
Datura stramonium	*Solanaceae*	12	4.14
Galinsoga quadriradiata	*Asteraceae*	11	3.79
Setaria viridis subsp. *viridis*	*Poaceae*	11	3.79
Arenaria serpyllifolia agg.	*Caryophyllaceae*	10	3.45
Lathyrus tuberosus	*Fabaceae*	10	3.45
Persicaria hydropiper	*Polygonaceae*	10	3.45
Aphanes arvensis	*Rosaceae*	9	3.10
Conium maculatum	*Apiaceae*	9	3.10
Malva neglecta	*Malvaceae*	9	3.10
Papaver dubium agg.	*Papaveraceae*	9	3.10
Sonchus oleraceus	*Asteraceae*	9	3.10
Tussilago farfara	*Asteraceae*	9	3.10
Urtica dioica	*Urticaceae*	9	3.10
Achillea millefolium	*Asteraceae*	8	2.76
Atriplex sagittata	*Chenopodiaceae*	8	2.76

Species	Family	a_i	C_i
Epilobium spp.	*Onagraceae*	8	2.76
Scleranthus annuus	*Caryophyllaceae*	8	2.76
Plantago uliginosa	*Plantaginaceae*	7	2.41
Veronica agrestis	*Scrophulariaceae*	7	2.41
Anthemis arvensis	*Asteraceae*	6	2.07
Cerastium spp.	*Caryophyllaceae*	6	2.07
Hyoscyamus niger	*Solanaceae*	6	2.07
Microrrhinum minus	*Scrophulariaceae*	6	2.07
Odontites vernus	*Scrophulariaceae*	6	2.07
Persicaria amphibia	*Polygonaceae*	6	2.07
Silene latifolia subsp. a*lba*	*Caryophyllaceae*	6	2.07
Stachys annua	*Lamiaceae*	6	2.07
Symphytum officinale	*Boraginaceae*	6	2.07
Veronica hederifolia agg.	*Scrophulariaceae*	6	2.07
Carduus acanthoides	*Asteraceae*	5	1.72
Digitaria sanguinalis	*Poaceae*	5	1.72
Erysimum cheiranthoides	*Brassicaceae*	5	1.72
Fumaria vaillantii	*Fumariaceae*	5	1.72
Chenopodium ficifolium	*Chenopodiaceae*	5	1.72
Linaria vulgaris	*Scrophulariaceae*	5	1.72
Neslia paniculata	*Brassicaceae*	5	1.72
Oxalis fontana	*Geraniaceae*	5	1.72
Potentilla anserina	*Rosaceae*	5	1.72
Sisymbrium officinale	*Brassicaceae*	5	1.72
Agrostis stolonifera	*Poaceae*	4	1.38
Bromus sterilis	*Poaceae*	4	1.38
Plantago lanceolata	*Plantaginaceae*	4	1.38
Ranunculus repens	*Ranunculaceae*	4	1.38
Rorippa sylvestris	*Brassicaceae*	4	1.38
Sagina procumbens	*Caryophyllaceae*	4	1.38
Senecio vulgaris	*Asteraceae*	4	1.38
Trifolium arvense	*Fabaceae*	4	1.38
Trifolium campestre	*Fabaceae*	4	1.38
Viola tricolor	*Violaceae*	4	1.38
Adonis aestivalis	*Ranunculaceae*	3	1.03
Calystegia sepium	*Convolvulaceae*	3	1.03
Consolida orientalis	*Ranunculaceae*	3	1.03
Glechoma hederacea	*Lamiaceae*	3	1.03
Myosoton aquaticum	*Caryophyllaceae*	3	1.03
Pimpinella major	*Apiaceae*	3	1.03
Poa trivialis	*Poaceae*	3	1.03
Portulaca oleracea subsp. *oleracea*	*Portulacaceae*	3	1.03
Aegopodium podagraria	*Apiaceae*	2	0.69
Anagallis foemina	*Primulaceae*	2	0.69
Anthemis austriaca	*Asteraceae*	2	0.69
Anthriscus sylvestris	*Apiaceae*	2	0.69
Carduus crispus	*Asteraceae*	2	0.69
Cirsium vulgare	*Asteraceae*	2	0.69
Echium vulgare	*Boraginaceae*	2	0.69
Chenopodium pedunculare	*Chenopodiaceae*	2	0.69
Juncus bufonius s. str.	*Juncaceae*	2	0.69
Papaver argemone	*Papaveraceae*	2	0.69
Ranunculus arvensis	*Ranunculaceae*	2	0.69
Rubus spp.	*Rosaceae*	2	0.69
Rumex acetosella	*Polygonaceae*	2	0.69
Setaria verticillata	*Poaceae*	2	0.69
Sherardia arvensis	*Rubiaceae*	2	0.69
Solanum physalifolium	*Solanaceae*	2	0.69
Spergularia rubra	*Caryophyllaceae*	2	0.69
Valerianella dentata subsp. *dentata*	*Valerianaceae*	2	0.69
Abutilon theophrasti	*Malvaceae*	1	0.34
Armoracia rusticana	*Brassicaceae*	1	0.34
Bidens tripartita	*Asteraceae*	1	0.34
Bromus hordeaceus subsp. *hordeaceus*	*Poaceae*	1	0.34
Calamagrostis epigejos	*Poaceae*	1	0.34
Camelina microcarpa subsp. *sylvestris*	*Brassicaceae*	1	0.34
Campanula rapunculoides	*Campanulaceae*	1	0.34
Cardaria draba	*Brassicaceae*	1	0.34
Cirsium palustre	*Asteraceae*	1	0.34
Coronopus squamatus	*Brassicaceae*	1	0.34
Daucus carota subsp. *carota*	*Apiaceae*	1	0.34
Diplotaxis muralis	*Brassicaceae*	1	0.34
Euphorbia falcata	*Euphorbiaceae*	1	0.34
Holcus mollis	*Poaceae*	1	0.34
Kochia scoparia	*Chenopodiaceae*	1	0.34
Lithospermum arvense	*Boraginaceae*	1	0.34
Myosotis stricta	*Boraginaceae*	1	0.34
Onopordum acanthium	*Asteraceae*	1	0.34
Phragmites australis	*Poaceae*	1	0.34
Rhinanthus alectorolophus	*Scrophulariaceae*	1	0.34
Senecio jacobaea	*Asteraceae*	1	0.34
Urtica urens	*Urticaceae*	1	0.34
Veronica chamaedrys s. str.	*Scrophulariaceae*	1	0.34
Vicia cracca	*Fabaceae*	1	0.34

a_i = number of fields where the species occurs, C_i = species constancy

*except *Ch. ficifolium* and *Ch. pedunculare*

Table 3. Volunteers recorded

Species	Family	*Criterion	a_i	C_i
Trifolium repens	*Fabaceae*	b	44	15.17
Brassica napus subsp. *napus*	*Brassicaceae*	a	41	14.14
Trifolium pratense	*Fabaceae*	b	29	10.00
Beta vulgaris	*Chenopodiaceae*	a**	23	7.93
Medicago lupulina	*Fabaceae*	b	16	5.52
Solanum tuberosum	*Solanaceae*	a	13	4.48
Triticum aestivum	*Poaceae*	a	11	3.79
Vicia villosa	*Fabaceae*	b	9	3.10
Hordeum vulgare	*Poaceae*	a	8	2.76
Medicago sativa	*Fabaceae*	b	8	2.76
Helianthus annuus	*Asteraceae*	a	7	2.41
Lolium multiflorum	*Poaceae*	a	6	2.07
Phleum pratense	*Poaceae*	b	6	2.07
Vicia sativa	*Fabaceae*	b	6	2.07
Phacelia tanacetifolia	*Hydrophyllaceae*	a	4	1.38
Secale cereale	*Poaceae*	a	4	1.38
Panicum miliaceum	*Poaceae*	a	3	1.03
Pisum sativum convar. *sativum*	*Fabaceae*	a	3	1.03
Raphanus sativus	*Brassicaceae*	a	3	1.03
Avena sativa	*Poaceae*	a	2	0.69
Leucosinapis alba	*Brassicaceae*	a	2	0.69
Lotus corniculatus	*Fabaceae*	b	2	0.69
Alopecurus pratensis	*Poaceae*	b	1	0.34
Papaver somniferum	*Papaveraceae*	a	1	0.34
Pisum sativum convar. *speciosum*	*Fabaceae*	a	1	0.34
Silybum marianum	*Asteraceae*	a	1	0.34
Triticum spelta	*Poaceae*	a	1	0.34
Zea mays	*Poaceae*	a	1	0.34

* criterion of classification as volunteer, see Methods

** Kohout (1996)

CONCLUSION

During the research, weed spectrum typical for current farming management practices was recorded in the central parts of fields with commonly grown crops. Especially weeds with wide ecological amplitude had the highest constancy. This group of species should be taken into account when developing future weed control programs and choosing herbicides. High occurrence of volunteers was observed; especially competitively significant volunteers like oilseed rape and weed beet are economically significant and problematic.

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Received for publication on February 7, 2013
Accepted for publication on May 21, 2013

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