CHANGES IN WEED COMMUNITIES ON SELECTED AREAS WITH 30 YEARS' INTERVAL*

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In 2005 the evaluation of weed infestation in field crop stands was carried out in sugar-beet production area in the middle and northern Bohemia. There were analyzed the same locations as in 1975. By that way, it was possible to compare the weed composition on chosen areas after 30 years, exactly. To unify and unbiase the monitoring, the same research methods were used and the comparable crops were evaluated. By that way, it was acquired 7 relevés, mainly in cereals. The results proved important changes of weed communities. The average coverage of weeds declined rapidly in 85.59% (1975 – 43.57%, 2005 – 6.28%), whereas on many locations the decline was much higher. From the point of view of the species richness, in individual relevés there was found decline about 46.10% (1975 – 32.86 taxa, 2005 – 17.71 taxa). Changes were recorded in a particular species' composition of agrophytocoenoses.

weed; changes; biodiversity; weediness; Czech Republic

INTRODUCTION

Plant communities on arable land – agrophytocoenoses – belong to artificial communities that are influenced by human activities. The fundamental part of agrophytocoenoses is cultivated crops, the so-called edificators (dominant species). The other present species are usually understood as undesirable ones – weed species (Kohout, 1997).

The occurrence of weed species in agrophytocoenoses is partly influenced by ecological conditions of site (e.g. soil, climate), but above all by human – producer – activity. Every operation in cropping process has impact on plant community composition. Weed communities have been influenced by humans in the whole history of agriculture, although the biggest changes have been realized with intensive farming. Intensive farming comprises of greater reliance on highly effective active ingredients of herbicides for weed control, changes in crop rotations, better seed cleaning technology, intensity of soil tillage, higher fertilizer and lime rates, new harvesting technologies etc. (Hilbig, Bachthaler, 1992). Changes in weed communities were analyzed in many foreign papers (Bachthaler, 1968; Ries, 1992; Albrecht, 1995; Györffy et al., 1995; Andreasen et al., 1996; Rich, Woodruff, 1996; Schumacher, Schick, 1998; Salonen, Hyvönen, 2000; Chirila, Berca, 2002; Robinson, Sutherland, 2002) as well as Czech ones (Kühn, 1987; Kropáč, 1988; Koblihová, 1989; Mikulka, Chodová, 2000; Kohout et al., 2003; Mikulka, Kneifelová, 2004). Their results confirmed that important changes in weed communities structure had occurred, namely in species impoverishment and in occurrence of important taxa, often difficult to control.

The aim of this study is to evaluate the changes in biodiversity and weed communities on selected locations in the Czech Republic.

MATERIAL AND METHODS

In the first half of July 2005, evaluation of weediness in the field crop stands was carried out in the middle and northern Bohemia (Mělník and Litoměřice region) – Fig. 1.

The area, where observations took place, is situated in warm to mild warm climatic region with average year air temperature of 8 °C and precipitation 500 to 600 mm. Locations are laid in the region of the north-Bohemian Cretaceous tableland on sandstone substrates and on the basic substrates of the Litoměřice group of the Bohemian highland. The main great soil group are haplic Luvisols. From the agroregionalization point of view the locations are situated in sugar-beet production area. The observed locations were taken from the paper of Volf et al. (1977), when authors made observation in June and July 1975. By doing this, the posibility to compare structure of weediness on selected areas after exactly 30 years was accomplished. To unify and objectify the observations the same methodology (area of relevé min. 100 m^2, homogeneous stands, estimation by Domin-Hadač scale of abundance and dominance – Table 1) was used. The locations with the same crop or crop belonging to the same biological group were studied. By that way 7 phytocoenological relevés were acquired, mainly in cereals (3 relevés winter cereals, 3 relevés spring cereals and 1 relevé root crops). Description of single locations is in Table 2.

Data was statistically analysed in software Canoco for Windows 4.5 (ter Braak, Šmilauer, 2002). To this

* This work was supported by NAZV No. 1R55010 and by the Ministry of Education, Youth and Sports – project MSM6046070901.

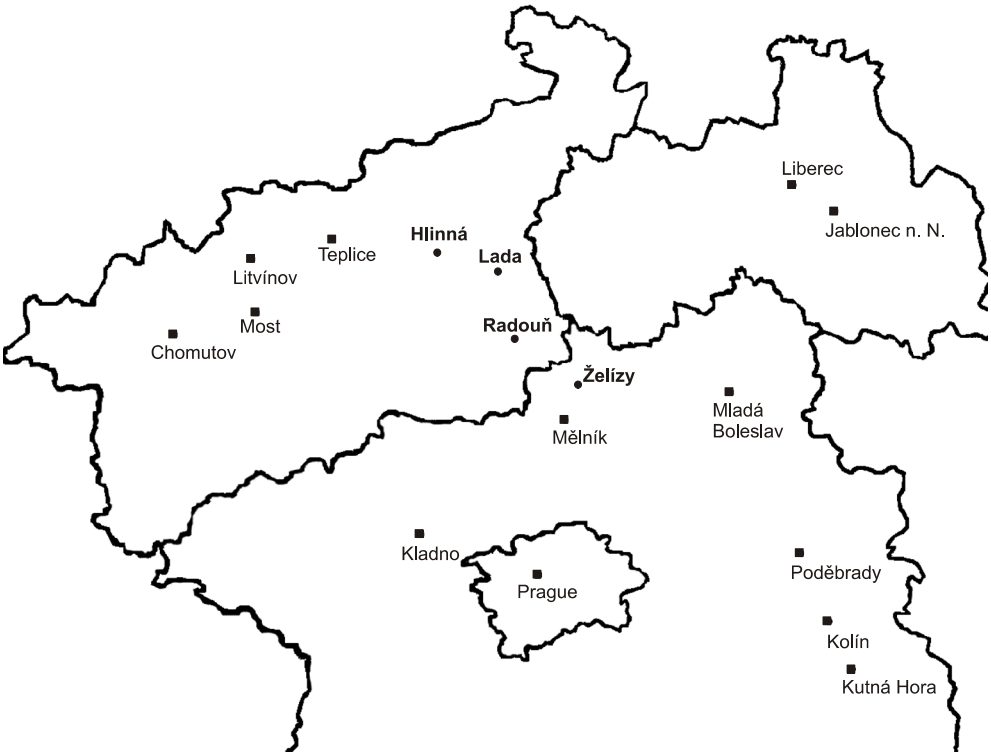

Fig. 1. Map of the middle and northern Bohemia with location of monitored sites

Table 1. Domin-Hadač scale of abundance and dominance (Hadač, Váňa, 1967)

+	Odd individuals, vitality reduced
1	rare (1–3 individuals)
2	sparse
3	frequent, cover below 5%
4	cover 5–15%
5	cover 15–25%
6	cover 25–33%
7	cover 33–50%
8	cover 50–75%
9	cover 75–90%
10	cover 90–100%

purpose the measured values in Domin-Hadač scale were adapted to the form, which can be used in multivariate analysis (scale 1 to 11). First, the DCA (Detrended correspondence analysis) was calculated, then Downweighting of rare species was done. The length of the longest gradient was 2.357, therefore redundancy analysis was used. Statistical significance was tested by Monte-Carlo permutation test, where *P*-value for 499 permutations reached 0.0320, thereby statistical significant differences in weed community in elapsed 30 years were confirmed. On account of preventing of mixing time and space variability, single locations were used as covariables and time records were randomised within blocks defined by covariables.

Botanical nomenclature was adapted according to Kubát et al. (2002).

RESULTS AND DISCUSSION

The overall results showed significant changes in weed communities in last 30 years. The average weed coverage (Fig. 2) fast dropped to 85.59% (1975 – 43.57%, 2005 – 6.28%), whereas on many locations the decline was much expressive. Permanent strong regulation pressure de-

Table 2. Description of locations

Number of relevé	Locality	Crop	
		1975	2005
1.	Hlinná – south edge of the village	spring barley	spring barley
2.	Lada – 0.5 km SN from the village	oat	spring barley
3.	Radouň 1 – 0.5 km E from the village	winter rye	winter wheat
4.	Radouň 2 – 0.8 km E from the village	winter wheat	winter wheat
5.	Radouň 3 – 1 km E from the village	winter wheat	winter wheat
6.	Želízy 1 – 0.5 km NE from the village	oat	spring barley
7.	Želízy 2 – 1 km NE from the village	potato	sugar-beet

Table 3. Weediness on arable land in the north Bohemia (1975) – Volf et al. (1977)

Relevé no.	1	2	3	4	5	6	7
Locality	Hlinná	Lada	Radouň 1	Radouň 2	Radouň 3	Želízy 1	Želízy 2
Crop	J	O	Ž	P	P	O	B
Total cover (%)	95	95	90	90	80	80	90
Cover of weeds (%)	55	60	45	45	25	30	45
Number of weed species	41	27	36	24	39	32	31
Achillea millefolium	+						
Aethusa cynapium	2	2	+				
Agrostis stolonifera			1				
Amaranthus retroflexus							1
Anagallis arvensis	3		2		1	3	2
Anthemis austriaca				5			
Apera spica-venti		1	+				
Aphanes arvensis			1		1		
Arabidopsis thaliana			+	1	4	+	
Arenaria serpyllifolia				N			
Artemisia vulgaris	1	+	2	2			1
Atriplex sagittata					N		
Avena fatua	2						1
Campanula rapunculoides	1						
Capsella bursa-pastoris		3	2	1	2	1	
Centaurea cyanus					1		
Cerastium holosteoides				1			
Chenopodium album		1	1		4	3	5
Chenopodium hybridum							N
Cichorium intybus	+						
Cirsium arvense	2	2	4	2	3		4
Consolida regalis			1				
Convolvulus arvensis	3			1	2		
Daucus carota							1
Descurainia sophia			3	3	3		
Echinochloa crus-galli							N
Elytrigia repens	4	3	3				3
Equisetum arvense		3					
Erodium cicutarium			1			1	2
Euphorbia exigua	3		3	2		1	
Euphorbia helioscopia		1	1		1	2	
Fallopia convolvulus	3	3	4	3	3	2	
Galeopsis tetrahit	2						
Galinsoga parviflora	1					2	5
Galinsoga quadriradiata	1						
Galium aparine	4				2		1
Galium spurium	3						
Geranium dissectum	1						
Geranium pusillum	1						2
Gnaphalium uliginosum					1		
Hypericum perforatum	+						
Juncus bufonius		+			2		
Lactuca serriola					1		+
Lamium amplexicaule				1		2	
Lamium purpureum	4					+	

Relevé no.	1	2	3	4	5	6	7
Lapsana communis	4						
Linaria vulgaris	1						
Lycopsis arvensis						2	1
Matricaria discoidea		1	1		2	4	
Matricaria recutita			1		2		
Medicago lupulina						1	
Microrrhinum minus						3	
Myosotis arvensis	4				+		
Myosotis ramosissima						3	
Myosotis stricta					2		
Neslia paniculata		+	2				1
Papaver argemone					N		
Papaver dubium					N		
Papaver rhoeas			1	1		1	
Persicaria lapathifolia	4				3	2	3
Persicaria maculosa	3	2					
Plantago lanceolata							N
Plantago uliginosa	1	1	1	1			
Poa annua		3	1			3	2
Poa trivialis	1						
Polygonum aviculare	3	2	5	3	4	2	1
Raphanus raphanistrum		7	3	1	4	2	2
Rumex acetosella		4			+		
Rumex crispus	2	1			1		3
Scleranthus annuus		2			1		
Setaria pumila			+		+		1
Silene latifolia		1		+			
Silene noctiflora	3		4			3	1
Sinapis arvensis		2	1		3		1
Sonchus asper	2					1	1
Spergula arvensis		4			1		
Stellaria media	4	3	2	4		4	3
Thlaspi arvense	+		4		2	+	
Trifolium medium	N						
Tripleurospermum inodorum	2	4	4	4	4	2	
Triticum aestivum	4						
Valerianella dentata			3		2		
Valerianella locusta					N		
Veronica arvensis				3		1	
Veronica hederifolia				5	+		
Veronica persica	2		1			3	
Veronica polita			4	4	3	4	1
Veronica praecox				2			
Vicia angustifolia						1	
Vicia hirsuta	2						
Vicia tetrasperma	2					2	
Vicia villosa			1		1		1
Viola arvensis	2	2	4	3	3	3	1

Note 1: J – spring barley, O – oat, Ž – winter rye, P – winter wheat, B – potato, C – sugar-beet
Note 2: Taxa marked with N have not listed the value of abundance – dominance, these species had lower constancy and generally lower dominance and abundance

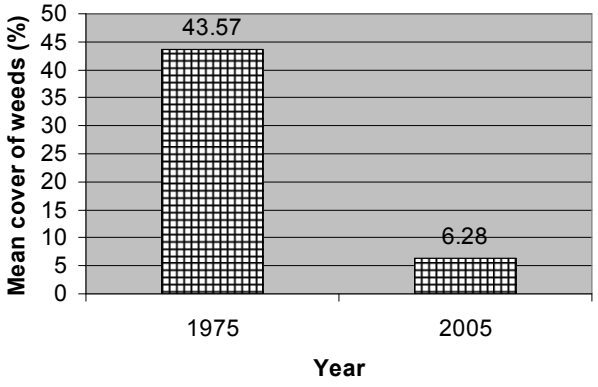

Fig. 2. Mean cover of weeds in analyzed years

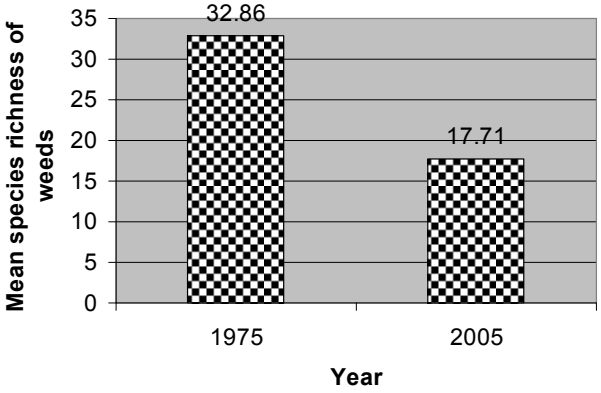

Fig. 3. Mean species richness of weeds in analyzed years

creased actual and potential weediness (Zemánek, Mydlilová, 1969; Ries, 1992; Marshall et al., 2003), which could lead to entire loss of some, mainly rare species. In some cases, long term repeated application of herbicides with the same efficacy leads to selection of tolerant, high competitive important species, their overproliferation and as a consequence the level of weediness does not decrease or, on the contrary, increases (Mahn, 1984; Mikulka, Chodová, 2000; Tyšer, Nováková, 2006). It can also occur resistance in some weed species (Nováková et al., 2006).

Within both researches (1975 and 2005) there were found 103 weed taxa in total, in 1975 93 taxa were identified and in 2005 44 taxa, respectively. The decline of 46.10% in weed species richness in single relevés was identified (1975 – 32.86 taxa, 2005 – 17.71 taxa) (Fig. 3). In many phytocoenological studies of weed flora lower numbers of weed species is observed as a result of intensive farming (Albrecht, 1989; Hilbig, Bachthaler, 1992; Ries, 1992). Kropáč (1986) based on 23 years' duration study of weediness of cultivated crops on the larger area of Czechoslovakia recorded decline from 30–35 species to 7–10 species.

Changes were recorded in weed composition in agrophytocoenoses. Légère and Derksen (2000) indicate that changes in dominant species could have much

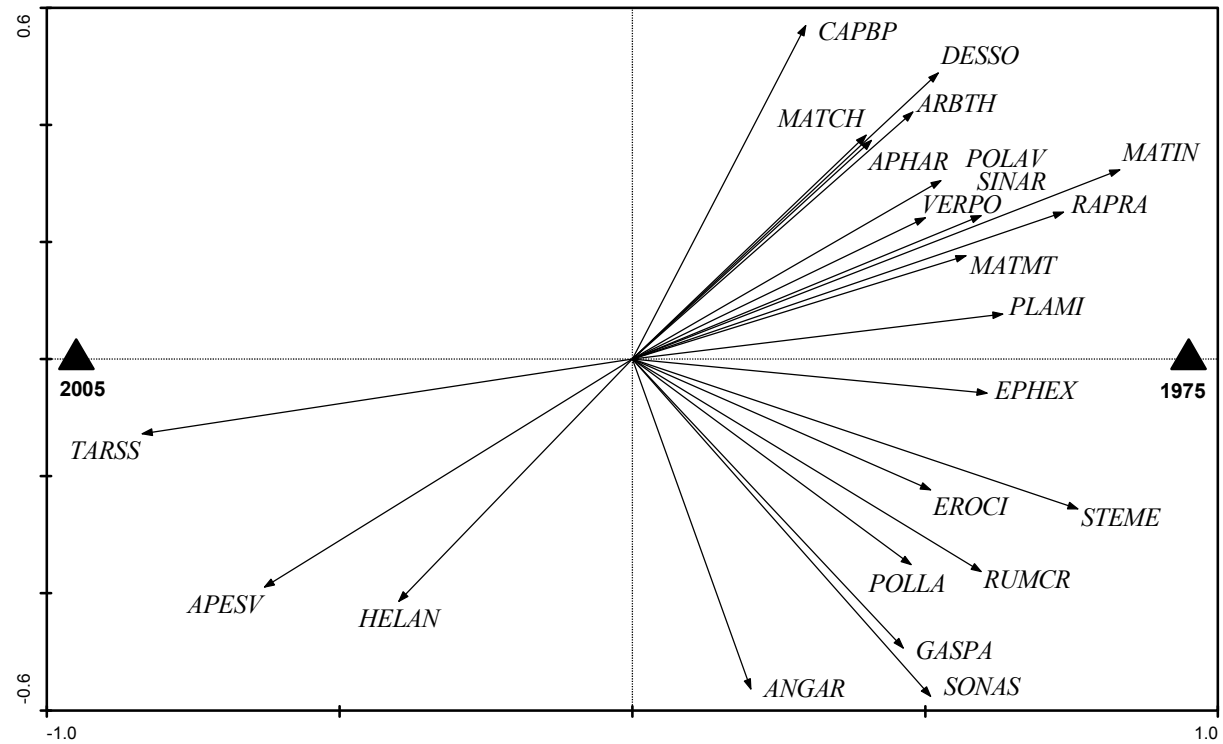

Fig. 4. Ordination diagram RDA. Minimum Species Fit Range 30% – 23 from 103. Plant taxa are described by Bayer Code: TARSS – *Taraxacum* spp., APESV – *Apera spica-venti*, HELAN – *Helianthus annuus*, CAPBP – *Capsella bursa-pastoris*, MATCH – *Matricaria recutita*, DESSO – *Descurainia sophia*, ARBTH – *Arabidopsis thaliana*, APHAR – *Aphanes arvensis*, POLAV – *Polygonum aviculare*, SINAR – *Sinapis arvensis*, VERPO – *Veronica polita*, MATIN – *Tripleurospermum inodorum*, RAPRA – *Raphanus raphanistrum*, MATMT – *Matricaria discoidea*, PLAMI – *Plantago uliginosa*, EPHEX – *Euphorbia exigua*, STEME – *Stellaria media*, EROCI – *Erodium cicutarium*, RUMCR – *Rumex crispus*, POLLA – *Persicaria lapathifolia*, GASPA – *Galinsoga parviflora*, SONAS – *Sonchus asper*, ANGAR – *Anagallis arvensis*

Table 4. Weediness on arable land in the north Bohemia (2005)

Relevé no.	1	2	3	4	5	6	7
Locality	Hlinná	Lada	Radouň 1	Radouň 2	Radouň 3	Želízy 1	Želízy 2
Crop	J	J	P	P	P	J	C
Total cover (%)	60	75	65	70	65	80	85
Cover of weeds (%)	25	1	4	6	2	2	4
Number of weed species	21	10	13	20	18	23	19
Aethusa cynapium	2				1		1
Amaranthus retroflexus							2
Anagallis arvensis			2	2	1	1	1
Apera spica-venti		2	3	3	2	2	
Arctium tomentosum					1		
Artemisia vulgaris				1		+	
Avena fatua	2	1		1		2	
Beta vulgaris							1
Brassica napus					+	+	1
Capsella bursa-pastoris		2				1	2
Chenopodium album	2	2	2	2	2	2	2
Cirsium arvense	3		1	1	1	2	1
Convolvulus arvensis	4		1	1			
Echinochloa crus-galli	2	1				2	
Elytrigia repens	4	1	2	2	2	2	2
Epilobium spp.					+		
Euphorbia helioscopia	1	+			1	1	1
Fallopia convolvulus	2		1	2	2	2	1
Fumaria officinalis						+	
Galium aparine	2			1			2
Galium spurium	1						
Geranium pusillum	2						
Helianthus annuus				2	1		
Lamium amplexicaule							1
Lamium purpureum	2					1	
Lathyrus tuberosus	2						
Microrrhinum minus							1
Myosotis arvensis	2			1			
Papaver rhoeas				1			
Persicaria lapathifolia				1			1
Persicaria maculosa			+				
Poa annua						1	
Polygonum aviculare	2		2	2	2	1	2
Sambucus nigra						+	
Secale cereale					1		
Setaria pumila	+	+					
Silene noctiflora			1		1	1	
Stellaria media				1		1	
Taraxacum sect. Ruderalia	2	2	1	2	1	1	
Thlaspi arvense						2	2
Veronica persica	2			2	+	2	
Veronica polita			1	2			1
Vicia tetrasperma	1						
Viola arvensis	2	2	3	3	2	2	2

higher consequences for weed control than common changes in weed communities diversity.

As shown in ordination diagram of multivariable statistical analysis (Fig. 4) and single stand relevés (Table 3 and 4), when compare the periods 1975 and 2005 withdrawn or became extinct some species e.g. *Raphanus raphanistrum*, *Sinapis arvensis*, *Aphanes arvensis*, *Arabidopsis thaliana*, *Capsella bursa-pastoris*, *Descurainia sophia*, *Neslia paniculata*, *Euphorbia exigua*, *Galinsoga parviflora*, *Sonchus asper*, *Tripleurospermum inodorum*, *Matricaria discoidea*, *Anthemis austriaca*, *Stellaria media*, *Polygonum aviculare*, *Rumex crispus*, *Persicaria lapathifolia*, *Valerianella dentata*, *Vicia* spp. and others. Many of mentioned weeds belong to those, which react to agrotechnical operation and above all, chemical regulation by effective herbicides. On the other hand, which entry to add the agrophytocoenoses as a new species, we can include *Taraxacum* spp., *Apera spica-venti*, *Echinochloa crus-galli* and volunteers of cultivated crops (oil seed rape and sunflower). Higher number in occurrence of these species was recorded in Kohout (1996), Mikulka, Chodová (2000) and Soukup et al. (2006). Up to the present most frequent and important taxa in agrophytocoenoses belong to perennial weed species (*Elytrigia repens*, *Cirsium arvense*, *Convolvulus arvensis*), *Viola arvensis*, *Veronica* spp., *Apera spica-venti*, *Chenopodium album*, *Taraxacum* spp., *Fallopia convolvulus* and others.

CONCLUSIONS

Finally, weed species in last 30 years came through extensive progress, when the important decline in weed species richness, as well as total weediness was observed. Considering the regulation strategy, the changes were recorded in occurrence of particular weed taxa.

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Received for publication on October 23, 2008
Accepted for publication on January 22, 2009

TYŠER, L. – HAMOUZ, P. – NOVÁKOVÁ, K. – NEČASOVÁ, M. – HOLEC, J. (Česká zemědělská univerzita, Fakulta agrobiologie, potravinových a přírodních zdrojů, Praha, Česká republika):

Změny plevelných společenstev na vybraných plochách s odstupem 30 let.

Scientia Agric. Bohem., *40*, 2009: 18–25.

V roce 2005 proběhlo hodnocení zaplevelení porostů polních plodin v řepařské výrobní oblasti středních až severních Čech (Mělnicko, Litoměřicko). Analyzovány byly stejné lokality, kde byl proveden výzkum zaplevelení v roce 1975. Tímto bylo dosaženo možnosti srovnání struktury zaplevelení vybraných ploch po přesně 30 letech. Pro sjednocení a objektivitu sledování byla použita shodná metodika výzkumu (velikost snímkované plochy minimálně 100 m^2, homogenní porosty, odhadová stupnice Domin-Hadačova) a byly analyzovány pouze lokality se stejnou plodinou či plodinou dané biologické skupiny. Takto bylo získáno 7 fytocenologických snímků, převážně obilnin (3 snímky ozimé obilniny, 3 snímky jarní obilniny, 1 snímek okopaniny). Statistická analýza dat byla provedena v programu Canoco for Windows 4.5.

Získané výsledky prokázaly významné změny plevelných společenstev. Průměrná pokryvnost plevelů zaznamenala prudký pokles o 85,59 % (1975 – 43,57 %, 2005 – 6,28 %), přičemž na mnohých lokalitách byl pokles ještě výraznější. Z hlediska průměrného druhového bohatství plevelných rostlin v jednotlivých snímcích byl zjištěn pokles o 46,10 % (1975 – 32,86 taxonů, 2005 – 17,71 taxonů). Změny byly zaznamenány rovněž v konkrétním druhovém složení agrofytocenóz. Z ordinačního diagramu mnohorozměrné statistické analýzy a jednotlivých snímků porostů vyplývá, že při srovnání období 1975 a 2005 ustoupily či vymizely některé plevele, jako *Raphanus raphanistrum*, *Sinapis arvensis*, *Aphanes arvensis*, *Arabidopsis thaliana*, *Capsella bursa-pastoris*, *Descurainia sophia*, *Neslia paniculata*, *Euphorbia exigua*, *Galinsoga parviflora*, *Sonchus asper*, *Tripleurospermum inodorum*, *Matricaria discoidea*, *Anthemis austriaca*, *Stellaria media*, *Polygonum aviculare*, *Rumex crispus*, *Persicaria lapathifolia*, *Valerianella dentata*, *Vicia* spp. aj. Naopak k taxonům výrazněji, často nově vstupujícím do agrofytocenóz je možné zařadit především *Taraxacum* spp., *Apera spica-venti*, *Echinochloa crus-galli* a výdrol kulturních plodin (výdrol řepky, slunečnice).

plevel; změny; biodiverzita; zaplevelení; Česká republika

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