Seedling Recruitment on an Early Abandoned Field

JINDRA ŠTOLCOVÁ

Research Institute of Crop Production – Division of Plant Medicine, Prague-Ruzyně, Czech Republic

Abstract

ŠTOLCOVÁ J. (2001): **Seedling recruitment on an early abandoned field.** Plant Protect. Sci., **37**: 121–127.

The effect of sporadic cultivation on seedling recruitment on a field abandoned for 1–4 years was investigated in small-plot trials at Prague-Ruzyně in the spring periods 1993–1995. Cultivation included autumn ploughing, spring harrowing and rolling on all plots that were subsequently left to spontaneous weed infestation. Some plots were then mowed or shallowly cultivated in mid-June and late July, others were left without treatment. No significant differences in seedling recruitment were found between plots with different treatments. The number of species varied between years, but without a trend to species enrichment or impoverishment. In all years most species were annuals, and species composition did not change in the course of the experiment. The dominant species were *Amaranthus retroflexus*, *Lamium amplexicaule*, *Echinochloa crus-galli*, *Chenopodium album*, *Silene noctiflora* and *Thlaspi arvense*. Species diversity during the experimental years increased due to decreasing dominance of *A. retroflexus*.

Keywords: fallow field; agrotechnical practices; soil cultivation; seedling recruitment; soil disturbance; abundance; species composition; diversity

Todays agricultural overproduction in Europe leads to a relative surplus of arable soil, which could be abandoned or conserved for future use. The quality of the soil can be influenced by the soil management during the first years after the last harvest. Plant succession on abandoned fields may influence the size of the weed soil seed bank. Germination and seedling establishment in the first year after soil disturbance on an old-field is considered as crucial in determination the subsequent community composition (HEITZMANN-HOFMANN 1995; MCGINLEY & TILMAN 1993). SQUIERS (1989) suggested that community structure in early successional old-fields depends on the relationship between time of soil disturbance and the germination patterns of the species present in the seed pool. According to OLFF (1994), interspecific differences in germination characteristics can cause species replacement during succession. Weed germination was usually studied on arable land (e.g. HÅKANSON 1992; SANS & MASALLES 1994; MULUGETA & STOLTENBERG 1997; ORYOKOT *et al.* 1997), but few studies deal with germination and seedling recruitment in old-fields (MULUGETA & STOLTENBERG 1998; LAVORELL *et al.* 1994; MEYER & SCHMID 1999) or grasslands and pastures (ESPIGARES & PECO 1993; WILLEMS 1995; BURKE & GRIME 1996).

This study investigates seedling recruitment on a field abandoned for 2–4 years, and maintained under conditions of soil disturbance (sporadic cultivation). It was part of a complex study (entomological and botanical) undertaken on a recently abandoned field. The botanical part was aimed at determining differences in secondary succession under conditions of various sporadic cultivations.

MATERIAL AND METHODS

Experimental ground. The experiment was performed at Prague-Ruzyně (50°06´N, 14°15´E, altitude 350 m above sea level) on a field used for small-plot experiments since the 1950's.

Before the experiment, the ground had been routinely cultivated each year (medium depth ploughing in the autumn, harrowing and rolling in the spring) and sown with different cover crops (mustard, oats and peas mixtures, millet) without fertilization. The experimental area comprised 25 plots of 5 × 5 m. The experiment was established

Supported by the Ministry of Agriculture, Grant No. EP096 0006441.

in 1992. In this article there are reported the data of the second to fourth year (1993 to1995) of the succession. Each year in November–December the experimental area of 25 × 25 m was ploughed to a medium depth (15–20 cm). Next spring (late March–early April) the ground was harrowed mechanically and rolled manually (to prevent uneven soil compression). Each year the arrangement of the plots was topographically identical. The weed communities on the plots were left to develop spontaneously. The experimental plots were arranged in the latin square design so that the same treatments were not repeated in the same row or column. There were five plots for each of the following five treatments: early mowing (in mid-June), late mowing (in the last decade of July), early mowing plus shallow cultivation of the superficial soil layer (on the same dates as early mowing), late mowing plus cultivation (on the same dates as late mowing), and without any treatment (control). Mowing consisted of manual cutting at a height of 5 cm. On cultivated plots the uppermost 5 cm of the soil was disturbed; roots and rootstocks were cut at a depth of 5 cm.

Data collection. Seedling recruitment (of annuals and perennials) was recorded from the end of April till early June. In each experimental plot, five sub-plots of 0.125 m^2 each were selected in 1993, or 10–12 sub-plots of 0.05 m^2 in 1994 and 1995, on which the numbers of emerged plants were determined. Seedlings, from the growth stage of cotyledons on, were counted in weekly intervals. *Veronica persica* and *V. polita* could not be distinguished in early counting and were counted together.

Data elaboration. The seedling numbers determined by field counts were recalculated per 1 m^2 area. Calendary dates were recalculated as biological time, sums of day degrees. Average temperatures were calculated as means of temperatures at 07:00, 14:00, and 21:00 h obtained from the automatic meteorological station of the Research Institute of Crop Production, placed ca 150 m from the experimental field. Temperatures above the threshold of 5°C were summed each year from January 1.

Species diversity was calculated using Shannon's diversity index $H' = -\Sigma pi \log pi$, where pi is proportion of i-th species in the total sample. To compare between-year differences in species composition the abundance of species was expressed as percentage of the total number of germinating plants. To assess between-year variation in germination rates the regression of numbers of germinating plants on biological time was calculated. The annual differences in abundance and diversity were tested by analysis of covariance with years as factor, abundances or diversity data were response variables, and the date of data collecting (expressed as biological time) was a covariate.

The botanical nomenclature follows DOSTÁL (1989), HEJNÝ and SLAVÍK (1988, 1990, 1992) and SLAVÍK (1995, 1997, 2000).

RESULTS

Because there were no significant differences in seedling recruitment between different treatments, results from different plots were pooled.

Species richness. The number of species varied between years (35 species in 1993 and 1995, 43 species in 1994). Annuals (37 dicotyledons and one monocotyledon) formed 81% of the species, while biennials and perennials represented 19% (one and eight, resp., both dicotyledons).

Species composition. Species composition (Appendix 1) did not change during the experiment. The most frequent species among annuals were *Amaranthus retroflexus*, *Lamium amplexicaule*, *Echinochloa crus-galli*, *Chenopodium album*, *Thlaspi arvense*, *Silene noctiflora*, *Veronica persica* (incl. sporadic *V. polita*), *Fallopia convolvulus*, *Galinsoga parviflora* and *Anagallis arvensis*, while *Mercurialis annua*, *Geranium pusillum*, *Aethusa cynapium* and *Descurainia sophia* occured only rarely. Perennials, mostly *Taraxacum officinale*, *Artemisia vulgaris* and *Plantago major*, germinated only sporadically.

Abundance. Seedling abundance (Fig. 1) between years differed significantly (Table 1).

Seedling numbers (Fig. 1) in early May were lowest in 1993 (523 seedlings per m^2), and highest in 1994 (787 seedlings per m^2). Before early June the abundance approximately doubled (to 1074 and 1567 seedlings per m^2 resp.). Seedling numbers in 1995 were similar (549 seedlings per m^2 in early May) to those in 1993, however their number increased not so much (1015 seedlings per m^2 in early June). Seedling abundance increased steadily only in 1994; in 1993 and 1995 the numbers fluctuated. The slope of regression of seedling numbers on biological time (Fig. 1)

Table 1. Analysis of covariance of the annual differences in diversity and abundance of the weed communities. The years were dependent variable, abundance or diversity response variables, and biological time of sampling a factor

	Effect		Error			
	df	MS	df	MS	F	p
Abundance	2	3 704 860	324	133 908	27,7	0.0000
Diversity	2	2.197	324	0.0060	368,8	0.0000

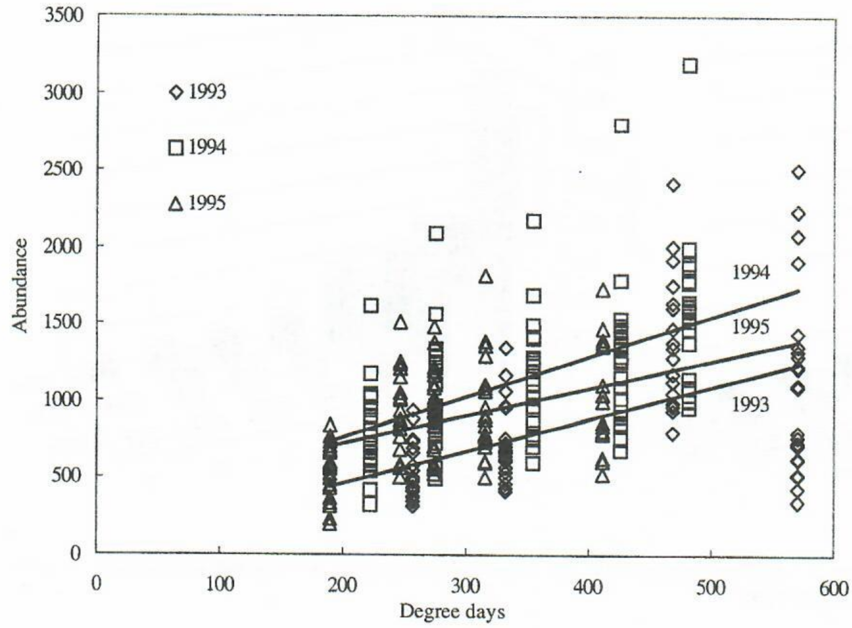


Fig. 1. Total weed seedling abundance in individual years (1993–1995). Biological time presented as degree days above 5°C from January 1

Table 2. Seedling abundance (average number of seedling/m²) of more abundant species in 1993–1995 (counting term 5)

Species	Abundance		
	1993	1994	1995
Amaranthus retroflexus L.	664	716	273
Anagallis arvensis L.	0	10	7
Chenopodium album L.	26	46	91
Echinochloa crus-galli (L.) Beauv.	80	221	199
Fallopia convolvulus (L.) A.Löve	1	8	11
Galinsoga parviflora Cav.	1	22	18
Galium aparine L.	5	5	2
Hyoscyamus niger L.	1	3	2
Lactuca serriola L.	0	2	1
Lamium amplexicaule L.	235	354	199
Matricaria maritima L.	0	4	2
Medicago lupulina L.	0	2	3
Persicara lapathifolia (L.) S.F.Gray	3	5	8
Polygonum aviculare L.	1	5	2
Silene noctiflora L.	13	56	68
Solanum nigrum L.	0	2	1
Sonchus asper (L.) Hill.	1	6	5
Sonchus oleraceus L.	1	5	1
Stellaria media (L.) Vill.	3	7	5
Thlaspi arvense L.	24	53	66
Tithymalus helioscopia (L.) Hill.	1	2	2
Urtica urens L.	4	6	3
Veronica spp.	5	19	41

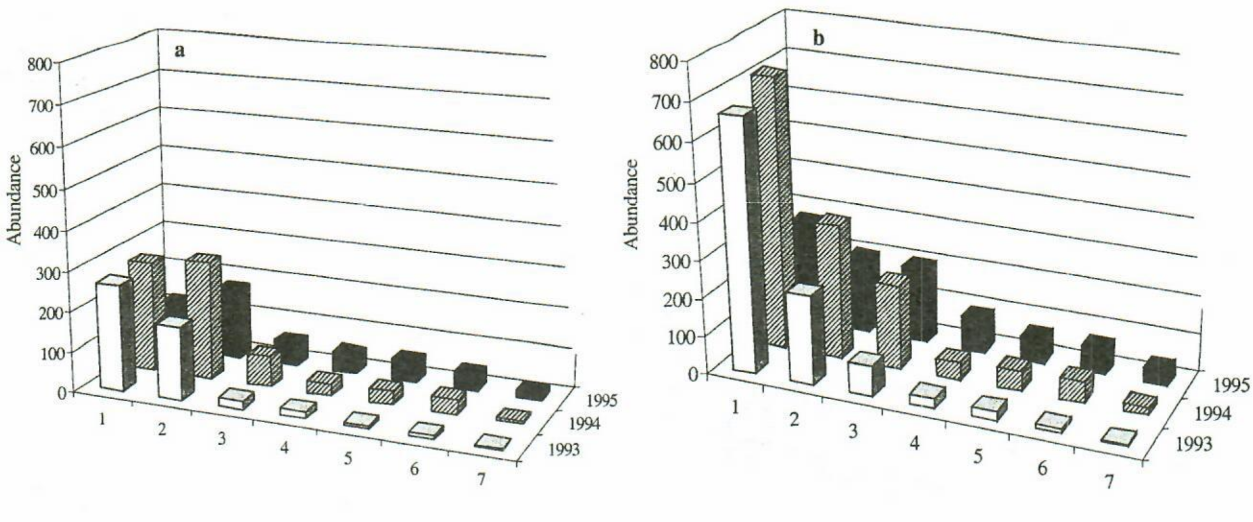
in 1993 ($y = 2.1035x + 39.99$) and 1994 ($y = 2.611x + 243.09$) showed similar emergence rates, higher than in 1995 ($y = 1.7934x + 363.83$).

Seedling emergence and mortality might be affected by weather factors. The weather differed between years. The sum of degree days (above 5°C from January 1) in early May (first counting) was highest in 1993 (257°C), lower in 1994 (222.5°C) and lowest in 1995 (189°C). The increase in temperature during the vegetation season in 1993 and 1994 (570 and 481 degree days resp. before early June) was higher than in 1995 (411.5 degree days before early June), which could have stimulated the higher emergence rates in 1993 and 1994 compared to 1995 (Fig. 1).

Precipitation in April was low in 1993 (9 mm), but higher in 1995 (44.2 mm) and in 1994 (49.2 mm). The higher species richness and abundance in 1994 than in 1993 could be caused by higher precipitation in April, thus resulting in a favourable ratio of temperature and precipitation.

The abundance of particular species varied between years (Table 2, Fig. 2). The most abundant species in all experimental years were *Amaranthus retroflexus*, *Lamium amplexicaule* and *Echinochloa crus-galli*, followed by *Chenopodium album*, *Thlaspi arvense*, *Silene noctiflora* and *Veronica persica*. Perennial species were scarce. *Amaranthus retroflexus*, *L. amplexicaule* and *E. crus-galli* were most abundant in 1994 (716, 354 and 221 seedlings per m² before early June), but their abundance decreased in the following year. In contrast, the abundance of *Ch. album*, *T. arvense*, *S. noctiflora* and *Veronica* spp. increased (to 91, 66, 68 and 41 seedlings per m² in early June 1995). In 1993 the plants of *A. retroflexus* were vigorous, but in the following years they were stunted.

Species diversity. The dominance of abundant species was higher in 1993 than in the following years (Fig. 3). In



Species presented: 1 – *Amaranthus retroflexus*, 2 – *Lamium amplexicaule*, 3 – *Echinochloa crus-galli*, 4 – *Chenopodium album*, 5 – *Silene noctiflora*, 6 – *Thlaspi arvense*, 7 – *Veronica* spp.

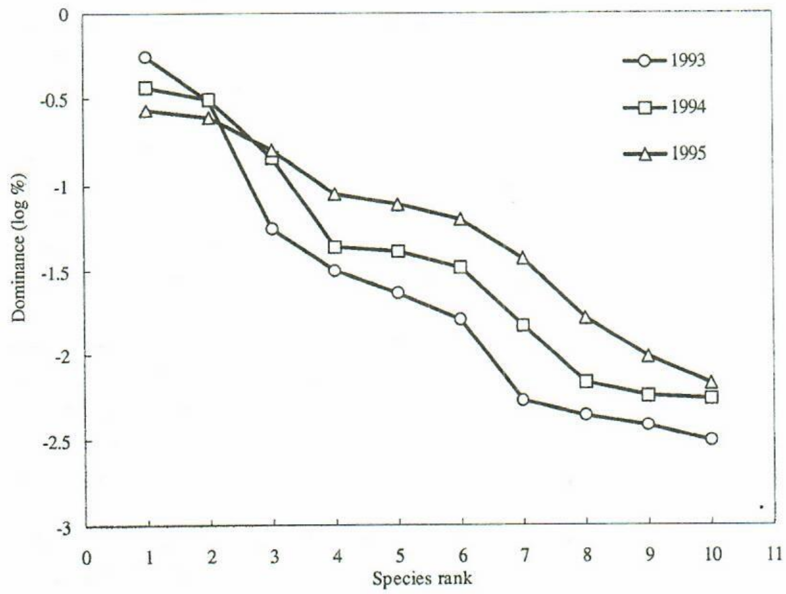
Fig. 2. Seedling abundance (seedling number per 1 m^2) of dominant species in 1993–1995 (a – counting term 1; b – counting term 5)

1994 and 1995 the dominance of *A. retroflexus* and *Ch. album* decreased, while the dominance of *E. crus-galli* increased (Fig. 3). As a consequence, the diversity (Fig. 4) of the seedling community significantly increased from 1993 to 1995 (Table 1). In 1993, the diversity was low because of the high abundance of *A. retroflexus* which represented 62% of the seedlings (Fig. 4). The negative slope of regression of diversity on biological time (–0.00002) in 1993 (Fig. 4) was caused by increasing dominance of *A. retroflexus*. By contrast, in 1994 and 1995 species diversity increased during the spring (Fig. 4).

DISCUSSION

The effect of autumn ploughing on seedling recruitment seems to be more important than mowing and shallow cultivation during the vegetation season.

Weather apparently influenced the variation of seedling recruitment between years. Higher emergence rates in 1993 and 1994 than in 1995 could be caused by the steeper increase temperature in May. FORCELLA *et al.* (1992) found that emergence rates of *A. retroflexus*, *Ch. album* and *S. viridis* varied between years with the annu-



Species rank: 1 – *Amaranthus retroflexus*, 2 – *Lamium amplexicaule*, 3 – *Echinochloa crus-galli*, 4 – *Chenopodium album*, 5 – *Thlaspi arvense*, 6 – *Silene noctiflora*, 7 – *Veronica spp.*, 8 – *Galinsoga parviflora*, 9 – *Fallopia convolvulus*, 10 – *Anagallis arvensis*

Fig. 3. Relative abundance of dominant species in 1993–1995 (counting term 1)

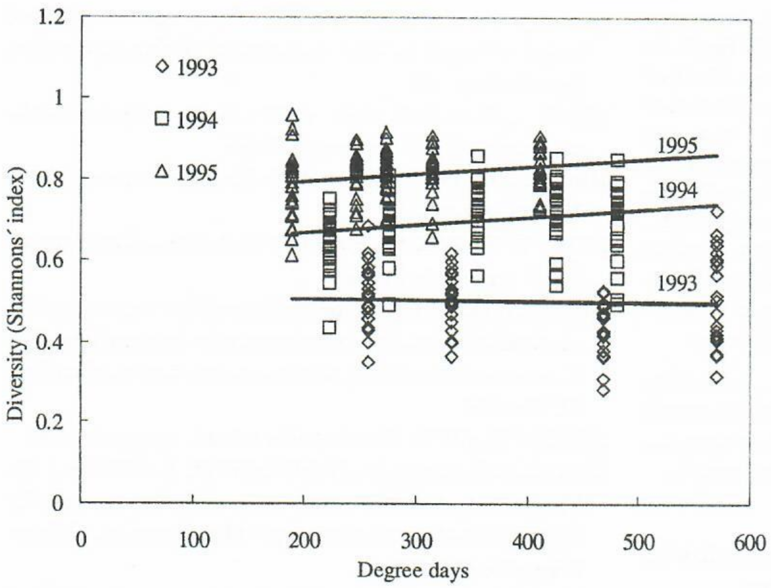


Fig. 4. Species diversity (Shannon's index) of the weed seedling community in individual years (1993–1995). Biological time pre-sented as degree days above 5°C from January 1

al variation in increase of degree days. Higher species richness and abundance in 1994 than in 1993 in this experiment could be due to the higher precipitation in April of 1994, resulting in a more favourable ratio of temperature and precipitation. In the temperate region, soil moisture is considered as a secondary factor, becoming important once the species-specific temperature requirements are satisified (GRUNDY & MEAD 2000).

Abundance could be also influenced by the magnitude of the soil seed bank (ROTHROCK *et al.* 1993; ZHANG *et al.* 1998) whose size is influenced by the annual variation of seed production.

The species composition of the most abundant species in this experiment was similar to that of weed communities on arable land. These are sometimes considered as plant communities in the initial stage of secondary succession. Seed banks on recently abandoned fields are not dominated by invasive colonizers but by the ruderal weed community growing there before the cessation of crop management (OHTSUKA & OHSAWA 1994; OSBORNOVÁ *et al.* 1990).

Annuals dominated the community during all years of the study. This contrasts with a decrease in abundance of annuals on undisturbed old fields (BROWN *et al.* 1987; DEBUSSCHE *et al.* 1996; OHTSUKA 1998; OSBORNOVÁ *et al.* 1990). The persistence of annuals was probably caused by autumn ploughing, which restored the weed community to an initial stage of succession and facilitated the germination of weed species that tolerate disturbance. Consequently, the species composition of the seedling community was identical in successive years. Each year only a small part of seeds germinates from the soil seed bank (OSBORNOVÁ *et al.* 1990; FORCELLA 1992; ZHANG *et al.* 1998). Sporadic occurences of rare species in some years were probably caused by occasional invasion or their seeds being moved from lower soil layers by tillage. Although the weed community in this experiment was repeatedly restored to an initial succession stage by regular soil disturbance, a significant increase of species diversity, accompanying the process of succession (BEGON *et al.* 1997), was observed.

The lowest species diversity was observed in 1993. It was caused by increased abundance of *A. retroflexus*, probably facilitated by higher temperature and low total precipitation (KOHOUT 1997). Similar population explosion on a one year abandoned field was reported also in *Papaver rhoeas* by OSBORNOVÁ *et al.* (1990), *Setaria glauca* (GREGG jr. 1973) and, in the 2nd year after burning, in *Senecio sylvaticus* by HALPERN (1997). The authors explained these population outbreaks by accumulation of seeds in the soil during the previous history of the field and to subsequent nutrition depletion. However, the decrease of dominance observed in this experiment could hardly be caused by nutrition depletion due to ploughing. On the other hand, ploughing stimulated the expansion of *Cirsium arvense*. Allelopathic effects of *C. arvense* on *A. retroflexus* (HUME 1982) might contribute to decreased abundance and stunting of plants of *A. retroflexus* in this experiment. The spread of *C. arvense* limited the space available for seedlings of annuals. However, seedling abundance remained high during the course of the whole experimental period. Thus, the retreat of annuals from the weed community on an abandoned field was not due to decreasing abundance, but due to diminished gaps.

Appendix 1

Annuals: *Aethusa cynapium* L., *Amaranthus retroflexus* L., *Anagallis arvensis* L., *Arenaria serpyllifolia* L., *Capsella bursa-pastoris* (L.) Med., *Chenopodium album* L., *Ch. ficifolium* Sm., *Descurainia sophia* (L.) Beauv., *Echinochloa crus-galli* (L.)

Beauv., *Fallopia convolvulus* (L.) A. Löve, *Galinsoga parviflora* Cav., *G. urticifolia* (Humb., Bonpl. et Kunth) Benth. in Oerst., *Galium aparine* L., *Geranium pusillum* Burm.fil., *Hyoscyamus niger* L., *Lactuca serriola* L., *Lamium amplexicaule* L., *Malva neglecta* Wallr., *Matricaria maritima* L., *Medicago lupulina* L., *Mercurialis annua* L., *Persicaria lapathifolia* (L.) S.F.Gray, *Polygonum aviculare* L., *Portulaca oleracea* L., *Silene noctiflora* L., *Sinapis arvensis* L., *Solanum nigrum* L., *Sonchus asper* (L.) Hill., *S. oleraceus* L., *Stellaria media* (L.) Vill., *Thlaspi arvense* L., *Tithymalus exiguus* (L.) Hill., *T. helioscopia* (L.) Hill., *Urtica urens* L., *Veronica persica* Poiret, *V. polita* Fries, *Vicia angustifolia* L., *Viola arvensis* Murray.

Biennials and perennials: *Achillea millefolium* L., *Arctium tomentosum* Mill., *Artemisia vulgaris* L., *Convolvulus arvensis* L., *Plantago major* L., *Rumex crispus* L., *Sonchus arvensis* L., *Taraxacum officinale* Weber in Wiggers, *Trifolium repens* L.

Acknowledgement: The author thanks RNDr. A. HONĚK, CSc., for his kind assistance and valuable comments.

References

BEGON M., HARPER J.L., TOWNSEND C.R. (1997): Ekologie: jedinci, populace a společenstva. Vyd. Univerzity Palackého, Olomouc.

BROWN V.K., HENDRIX S.D., DINGLE H. (1987): Plants and insects in early old-field succession: comparison of an English site and an American site. Biol. J. Linnean Soc., **31**: 59–74.

BURKE M.J.W., GRIME J.P. (1996): An experimental study of plant community invasibility. Ecology, **77**: 776–790.

DEBUSSCHE M., ESCARRE J., LEPART J., HOUSSARD C., LAVOREL S. (1996): Changes in Mediterranean plant succession: old-field revisited. J. Veget. Sci., **7**: 519–526.

DOSTÁL J. (1989): Nová květena ČSSR 1, 2. Academia, Praha.

ESPIGARES T., PECO B. (1993): Mediterranean pasture dynamics: the role of germination. J. Veg. Sci., **4**: 189–194.

FORCELLA F.(1992): Prediction of weed seedling densities from buried seed reserves. Weed Res., **32**: 29–38.

FORCELLA F., WILSON R.G., RENNER K.A., DEKKER J., HARVEY R.G:, ALM D.A., BUHLER D.D., CARDINA J. (1992): Weed seedbanks of the U.S. corn belt: magnitude, variation, emergence, and application. Weed Sci., **40**: 636–644.

GREGG W.P. JR. (1973): Ecology of the annual grass *Setaria lutescens* on oldfields of the Pennsylvania Piemont. Proc. Acad. Natur. Sci. Philadelphia, 1973, **124**: 135–196.

GRUNDY A.C., MEAD A. (2000): Modelling weed emergence as a function of meteorological records. Weed Sci., **48**: 594–603.

HALPERN C.B., ANTOS J.A., GEYER M.A., OLSON A.M. (1997): Species replacement during early secondary succession: the abrupt decline of a winter annual. Ecology, **78**: 621–631.

HÅKANSON S. (1992): Seasonal variation in the emergence of annual weeds from the seed bank in arable soils. 33rd Swedish Crop Protect. Conf. Weeds and Weed Control, Uppsala, 29–30 Jan. 1992: 1–26.

HEITZMANN-HOFMANN A. (1995): Sown agricultural Weed Strips: Changes in Plant Community during Succession. Agrarökologie, 13.

HEJNÝ S., SLAVÍK B. (Eds.) (1988): Květena České socialistické republiky. 1. Academia, Praha.

HEJNÝ S., SLAVÍK B. (Eds.) (1990): Květena České republiky. 2. Academia, Praha.

HEJNÝ S., SLAVÍK B. (Eds.) (1992): Květena České republiky. 3. Academia, Praha.

HUME L. (1982): The long-term effects of fertilizer application and three rotations on weed communities in wheat (after 21–22 years at Indian Head, Saskatchewan). Can. J. Plant Sci., **62**: 741–750.

KOHOUT V. (1997): Plevele polí a zahrad. Agrospoj, Praha.

LAVORELL S., LEPART J., DEBUSSCHE M., LEBRETON J.-D., BEFFY J.-L. (1994): Small scale disturbances and the maintenance of species diversity in Mediterranean old fields. Oikos, **70**: 455–473.

MEYER A.H., SCHMID B. (1999): Seed dynamics and seedling establishment in the invading perennial *Solidago altissima* under different experimental treatments. J. Ecol., Oxford, **87**: 28–41.

MCGINLEY M.A., TILMAN D. (1993): Short-term response of old-field plant communities to fire and disturbance. Amer. Midl. Natur., **129**: 409–413.

MULUGETA D., STOLTENBERG D.E. (1997): Seed bank characterization and emergence of a weed community in a moldboard plow system. Weed Sci., **45**: 54–60.

MULUGETA D., STOLTENBERG D.E.. (1998): Influence of cohorts on *Chenopodium album* demography. Weed Sci., **46**: 65–70.

OLFF H. (1994): Germination strategies during grassland succession. J. Ecol., Oxford, **82**: 69–77.

OHTSUKA T. (1998): A comparative review of early herbaceous stages of secondary succession in temperate and tropical regions. Japan. J. Ecol., **48**: 143–157.

OHTSUKA T, OHSAWA M. (1994): Accumulation of buried seeds and establishment of ruderal therophytic communities in disturbed habitat, central Japan. Vegetatio, **110**: 83–96.

ORYOKOT J.O.E., HUNT L.A., MURPHY S., SWANTON C.J. (1997): Simulation of pigweed (*Amaranthus* spp.) seedling emergence in different tillage systems. Weed Sci., **45**: 684–690.

OSBORNOVÁ J., KOVÁŘOVÁ M., LEPŠ J., PRACH K. (1990): Succession on Abandoned Fields. Stud. Centr. Bohemia, Czechoslovakia. Kluwer Acad. Publ., Dordrecht, Boston, London.

ROTHROCK P.E., SQUIERS E.R., SHEELEY S. (1993): Heterogenity and size of a persistent seedbank of *Ambrosia artemisifolia* L. and *Setaria faberi* Herrm.. Bull. Torrey Bot. Club, **120**: 417–422.

SANS F.X., MASALLES R.M. (1994): Phenological patterns in an arable land weed community related to disturbance. Weed Res., **35**: 321–332.

SLAVÍK B. (Ed.) (1995): Květena české republiky. 4. Academia, Praha.

SLAVÍK B. (Ed.) (1997): Květena České republiky. 5. Academia, Praha.
SLAVÍK B. (Ed.) (2000): Květena České republiky. 6. Academia, Praha.
SQUIERS E.R. (1989): The effects of seasonal timing of disturbance on species composition in a first-year old-field. Bull. Torrey Bot. Club, **116**: 356–363.
WILLEMS J.H. (1995): Soil seed bank, seedling recruitment and actual species composition in an old and isolated chalk grassland site. Folia Geobot. Phytotaxon., **30**: 141–156.
ZHANG J., HAMILL S., GARDINER I.O., WEAVER S.E. (1998): Dependence of weed flora on the active soil seedbank. Weed Res., **38**: 143–152.

Received for publication April 15, 2001
Accepted for publication August 10, 2001

Souhrn

ŠTOLCOVÁ J. (2001): **Vzcházení rostlin na raném úhoru.** Plant Protect. Sci., **37**: 121–127.

V jarním období let 1993–1995 byl v Praze-Ruzyni sledován vliv sporadických agrotechnických opatření na vzcházení rostlin na 1–4letém simulovaném úhoru. Agrotechnická opatření představovala každoroční podzimní orba, jarní vláčení a uválení celého experimentálního pozemku, následně podrobeného spontánnímu samozaplevelení. V pokusu bylo uplatněno pět rozdílných agrotechnických zásahů: kosení v polovině června a v poslední dekádě července, plečkování v termínech shodných s kosením a kontrolní varianta bez zásahu. Výsledky ukázaly, že v průběhu tří experimentálních let efekt každoroční podzimní orby převládal nad účinky kosení a plečkování. V důsledku toho nebyly zjištěny průkazné rozdíly ve vzcházení rostlin mezi variantami s rozdílnými zásahy. Bylo zjištěno, že počet druhů mezi ročníky kolísal. Ve všech letech převažovaly jednoleté druhy a druhové složení se během experimentu nezměnilo. Mezi jednoletými druhy dominovaly *Amaranthus retroflexus, Lamium amplexicaule, Echinochloa crus-galli, Chenopodium album, Silene noctiflora, Thlaspi arvense*. Druhová diverzita se během doby trvání experimentu průkazně zvýšila v důsledku klesající dominance druhu *A. retroflexus*.

Klíčová slova: úhor; agrotechnická opatření; kultivace půdy; vzcházení rostlin; abundance; druhové složení; diverzita

Corresponding author:

RNDr. JINDRA ŠTOLCOVÁ, Výzkumný ústav rostlinné výroby, odbor rostlinolékařství, 161 06 Praha 6-Ruzyně, Česká republika
tel.: + 420 2 33 02 22 91, fax: + 420 2 33 31 36 36, e-mail: stolcova@vurv.cz