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EVALUATION OF DIFFERENT METHODS FOR RESTORATION OF SPECIES RICH GRASSLAND

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ABSTRACT

This work is concerned with the development of practical methods for restoration of species-rich meadows. One of potential methods for their restoration on arable land is sowing regional seed mixtures. The initial seed of 31 wild meadow species (6 grasses, 4 legumes and 21 herbs) was obtained by collecting on natural species-rich meadows and used at first for establishment of seed multiplication stands and then after propagation for creation of species-rich seed mixture. A field experiment was carried out in the years 2000-2003 on arable land with the aim of evaluating the development of species-rich meadows established by sowing different seed mixtures at two sowing rates (20 and 40 kg.ha^{-1}). The results of investigation showed different development and a different role of individual plant components during four years of cultivation.

INTRODUCTION

Historically, most of the meadows and pastures of the temperate zone were formed for long periods by agricultural activity of man and adapted to traditional farming. In the Czech Republic grasslands were managed quite intensively in the past decades, because they were used as a source of fodder for large numbers of farm animals. With a dramatic decline in the number of livestock and changes in the intensity and structure of agricultural production, the productive role of meadows and pastures, especially in the agriculturally marginal areas decreased and their non-productive function in the landscape is strongly emphasized. Species-rich meadows are highly suitable to play this role, as they not only perform erosion-control, soil-conservation, filtration and landscape roles, but are also characterized the richness of plant and animal species, predominantly due to flowering of dicotyledonous plants. They create a very pleasant aesthetic impression, that is often sought by man. They are of crucial importance for a well-balanced landscape, they can also be used in extensive animal farming. Permanent grassland has become an important source of plant genetic resources.

Species richness as a reflection of site conditions and the traditional farming system decreased significantly in the past decades, not only in our country, but also in other countries such as, for example, England, Switzerland or France (Muller et al., 1998; Nösberger and Kessler, 1997; Pywel et al., 2002).

One of possible ways of supporting revitalization of species-rich plant communities is sowing and over-sowing of seed mixtures containing wild species of grasses, legumes and other herbs related to the region of their origin (Jones and Hayes, 1999; Krautzer, 1996). The initial seed is obtained by collecting on natural species-rich meadows and used at first for establishment of seed multiplication stands and then, after propagation, for restoration and establishment of species-rich meadows, important for non-productive roles. The aim of the study was to evaluate the effect of the sowing rate of different species-rich mixtures and different methods of grassland establishment on development and changes in botanical composition of the sown stands in a field trial. The Czech Ministry of Agriculture (Project NAZV No. QD0006) funded this work).

MATERIALS AND METHODS

Location: experimental area of the Grassland Research Station at Zubří (355 m a.s.l.), characterized by average daily temperature of 7.6°C (13.6°C during the growing season) and annual precipitation of 903 mm (556 mm – growing

season). The experiment (Table 1) was conducted on June 6, 2000, with a standard size of an experimental plot 30 m^2, 4 replications in split-plot design, without fertilization. The canopy density, presence and dominance of individual plant species (Braun-Blanquet scale and cover percentage) over the years 2001–2003 were recorded. Three seed mixtures were sown:

a) regional mixture of 6 wild grasses (*Anthoxanthum odoratum, Briza media, Bromus erectus, Festuca rupicola, Koeleria pyramidata* and *Poa angustifolia*, 83% in the seed mixture), 4 legumes (*Anthyllis vulneraria, Onobrychis viciifolia, Trifolium montanum* and *Trifolium rubens*, 7%) and 21 herbs (*Betonica officinalis, Campanula glomerata, Centaurea scabiosa, Cirsium pannonicum, Dianthus carthusianorum, Galium verum, Helianthemum nummularium, Hypericum perforatum, Jacea pratensis, Knautia kitaibelii, Leontodon hispidus, Leucanthemum corymbosum, Leucanthemum vulgare, Plantago lanceolata, Primula veris, Prunella laciniata, Ranunculus arvensis, Salvia verticillata, Sanguisorba officinalis, Silene vulgaris* and *Tragopogon orientalis*, 10%);

b) commercial herb mixture of 6 wild grasses (10%), 4 legumes (16%) and 18 meadow herbs (74%);

c) commercial meadow mixture of 6 grass cultivars (*Arrhenatherum elatius, Dactylis glomerata, Festuca rubra, Festuca pratensis, xFestulolium* and *Trisetum flavescens*, 86%) and 2 legumes (*Lotus corniculatus and Trifolium repens*, 14%).

RESULTS

Vegetation observations included a phytosociological evaluation of the stands. Table 2 gives an average area proportion of agro-botanical groups in the stands and the number of species present in the plots in the fourth year of growing.

The table shows the results consistent with both sowing rates of the regional mixture both in the botanical composition and in the overall

Table 1. Experimental treatments

	Mixture	Abbr.	Method of sowing	Sowing rate (kg.ha^{-1})
	Fallow, control plot	F	–	–
a)	Regional	R20	Spread over all the experimental plot	20
	Regional	R40		40
	R20 in fallow	F+R20	Spread over subplot – central strip into the fallow	20
	R40 in fallow	F+R40		40
b)	Commercial herb	H	Spread over all the experimental plot	10
c)	Commercial meadow	C20		20
	Commercial meadow	C40		40

Table 2. Proportion of agro-botanical groups and number of species in the stand

	Treatment	Grasses		Legumes		Herbs		Overall
		%	Number of species	%	Number of species	%	Number of species	stand density (%)
	Fallow	58	11	32	4	10	18	79
a)	R20	35	9	35	8	30	17	80
	R40	35	8	35	8	30	15	79
	F + R20	49	12	39	4	12	15	80
	F + R40	52	10	32	6	16	18	80
b)	H	24	8	36	5	40	16	82
c)	C20	61	8	35	3	4	11	74
	C40	66	7	31	2	3	8	71

canopy density. This suggests a possibility of using a lower sowing rate in grassland establishment without any adverse effect on the potential abundance of stands. The proportion of their herb component (30%) is important, as it is close to optimal. A higher, but comparable proportion of herb species (40%) occurs only in the herb mixture that, however, contains a high proportion of herbs in the sown mixture (74%). The fallows are characterized by a low proportion of herbs (10–16%) in favour of grasses. In the commercial meadow mixture the presence of meadow herbs is rare.

The initial proportion of the species in the regional mixture and the abundance of individual plant components during three harvest years are given in Table 3. For simplification the relative proportion of species was calculated on a scale of 0 to 3. For comparison there is also an initial proportion of the species in the sowing rate. The best abundance of grasses over the 3 years was observed in *Anthoxanthum*

Table 3. Composition of a regional mixture (a) and abundance of components in the stand (3 – very good, >5%; 2 – good, 1–5%; 1 – poor, <1%; 0 – not found)

Species	Proportion in seed mixture (%)	Abundance in the stand		
		2001	2002	2003
Grasses (6 species)	82.86			
Anthoxanthum odoratum	3.77	3	3	3
Briza media	3.77	2	1	2
Bromus erectus	47.10	2	2	2
Festuca rupicola	14.10	1	1	3
Koeleria pyramidata	4.70	1	1	1
Poa angustifolia	9.42	1	1	2
Legumes (4 species)	7.05			
Anthyllis vulneraria	0.28	2	2	2
Onobrychis viciifolia	4.70	1	0	0
Trifolium montanum	0.94	1	2	2
Trifolium rubens	1.41	2	2	2
Herbs (21 species)	10.09			
Betonica officinalis	0.47	0	1	1
Campanula glomerata	0.20	0	1	1
Centaurea scabiosa	0.94	2	1	1
Cirsium pannonicum	0.47	1	1	1
Dianthus carthusianorum	0.28	0	1	2
Galium verum	0.47	2	2	2
Helianthemum nummularium	0.28	1	1	1
Hypericum perforatum	0.38	2	2	1
Jacea pratensis	1.41	3	3	3
Knautia kitaibelii	0.28	0	0	0
Leontodon hispidus	0.47	2	2	2
Leucanthemum corymbosum	0.28	2	2	2
Leucanthemum vulgare	0.47	2	1	2
Plantago lanceolata	0.47	3	3	2
Primula veris	0.47	0	0	0
Prunella laciniata	0.47	2	2	2
Ranunculus arvensis	0.47	1	0	0
Salvia verticillata	0.47	2	1	1
Sanguisorba officinalis	0.20	1	0	0
Silene vulgaris	0.20	1	1	2
Tragopogon orientalis	0.66	2	1	1
Total	100.00			

odoratum (3), medium abundance in *Briza media* and *Bromus erectus* (2). *Festuca rupicola* and *Poa angustifolia* after poor initial abundance (1) became dominant in the fourth year of growing (3 and 2, respectively).

All the legumes reached a good abundance (2) during all the experimental period, except *Onobrychis viciifolia*, which remained insignificant (0). The most widespread herb became *Jacea pratensis* (3). Good dominance was observed in a number of species, such as: *Dianthus carthusianorum, Galium verum, Leontodon hispidus, Leucanthemum corymbosum, Leucanthemum vulgare, Plantago lanceolata, Prunella laciniata* and *Silene vulgaris* (2). *Knautia kitaibelii, Primula veris, Ranunculus arvensis* and *Sanguisorba officinalis* were either not found at all or they completely disappeared (0).

CONCLUSIONS

Plant species show different development in restored species-rich grasslands. With regard to the potential future utilization of the newly established or restored stand and site conditions it is recommended to choose suitable components only.

Stands established with a reduced sowing rate of a regional mixture (20 kg.ha^{-1}) are fully comparable in their parameters with the double sowing rate. On the site with a very good seedbed preparation an expensive herb mixture may be sown at a lower sowing rate of 10 kg.ha^{-1}. The regional seed mixture with the sowing rate of 20 kg.ha^{-1} was found to be the most suitable to fulfil the above-mentioned aims.

In the strip sowing of fallows individual species from the regional mixture spread slowly and thus allow weed species to develop, which must be taken into account especially on highly weed-infested fields.

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