Evaluation of seed mixtures for subalpine pastures

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Abstract

Pastures within the sub-alpine and alpine vegetation belt belong to the most sensitive parts of the Alps. Therefore, seed mixtures used for such areas should combine different economic and ecological characteristics such as low demands on nutrients, satisfactory yield and digestibility, a closed sward, persistence and good adaptation to climate and soil.
At the location Hochwurzen (1.830 m a.s.l., Styria, Austria), one commercial seed mixture and one mixture containing site-specific subalpine and alpine species that are also useful for agricultural utilisation, were compared over a period of four years. With regard to the normally limited possibilities to reach and utilise such areas, only a single fertiliser application in the setup year was carried out. The assessed species were divided into 3 ecological groups, based on their adaptation to the site. Summarizing the valuable groups with expected sustainability, site-specific seed mixtures reached more than 80% cover with site-specific and site-adapted species. In comparison, the share of valuable groups from the commercial mixture remained about 50%. Results obtained generally showed an increase of positive ecological effects on plots where site-specific seed mixtures were used. Only the seed mixture containing a high share of site-specific and site-adapted species was able to guarantee a sustainable vegetation and sufficient protection against erosion.

Keywords: site-specific vegetation, subalpine pastures, low-input grassland, persistency of vegetation

Introduction

Permanent changes have taken place in the entire region of the Alps during the course of the last 50 years. Wide areas used for agrarian purposes have been reduced or abandoned. On the other hand, the widespread opening of power stations and intensive road building, torrent and avalanche barriers, as well as extensive infrastructural measures especially for winter tourism occurred. All of the measures described lead to intensive building each year, which then requires the restoration of the disturbed areas. However, as site conditions become more extreme, restoration is increasingly more difficult due to the rapidly worsening conditions. In most cases, a combination of usually cheap restoration procedures and cheap and non-site-adapted seed mixtures are turned to. The resulting ecological and often economic damage is comprehensive: inadequate vegetation cover, soil erosion, increased surface drainage, the high costs of ecologically dubious fertilisation measures and management, and introduction of alien species are some of the resulting effects that follow.
During the last seven years, two research projects were carried out at the Federal Research and Education Centre Raumberg-Gumpenstein (HBLFA) in order to investigate if site-specific and site-adapted vegetation leads to more stable, sustainable and ecologically site-adapted populations in comparison to commercial seed mixtures containing lowland species (Krautzer *et al.*, 2002; Graiss, 2004). To address this question for agriculturally utilised meadows in the subalpine vegetation belt, plant stands occurring from site-specific and commercial seed mixtures were assessed over a period of four years.

Materials and Methods

The effects of seed mixtures for subalpine pastures on agricultural utilization and nature conservation were studied over a period of four years on site Hochwurzen (Table 1).

Table 1. Experimental site, mean air temperature (MAT) during the growing season (July to August, average of 3 years) and soil chemical properties at trial establishment (Peratoner *et al.*, 2004)

Site	Country	Altitude (m); Aspect	MAT °C	Soil chemical properties pH $_{CaCl2}$	humus g kg^{-1}	N_{tot} g kg^{-1}	P (CAL) mg kg^{-1}	K (CAL) mg kg^{-1}
Hochwurzen	Styria, Austria	1.830; SE	11.3	6.6	40	2.1	13	47

Exact trials arranged as two factorial split-plot designs with plots of 21 m², replicated three times, were carried out from 1999 to 2002. Two different seed mixtures (SM1 = usual commercial seed mixture; SM2 = site-specific seed mixture, containing sub-alpine and alpine grasses, leguminosae and herbs) were established, using the application technique of hydroseeding (15 g m^{-2} mineral fertiliser (15N:15P:15K), 5 g m^{-2} Rekuform®, 15 g m^{-2} synthetic binder, 15 g m^{-2} seeds). In order to measure the ecological value of the different plots, a classification of the assessed species referring to their ecological value was made. Group 1: site-specific species, growing naturally under site conditions. Group 2: site-adapted species, not site-specific but sustainable under comparable site conditions. Group 3: non-site-adapted species, not occurring naturally under the specific climatic and site conditions. Protective vegetation cover and botanical composition (as share of protective cover of each single species) were assessed each year at the stage of flowering of *Festuca nigrescens*, in order to guarantee comparable conditions. The proportions of each species within each ecological group are summarised in Table 2. For the seed mixture, the total value of each group is expressed as percent by weight and the results of the field assessments are expressed as percent of projective cover. Due to the normally limited possibilities of reaching and utilising such areas, only a single fertiliser application in the setup year was carried out.

Table 2. Composition of seed mixtures and classification of all assessed species with a cover exceeding 1%, referring to their ecological group

Mixtures Species	SM 1 commercial seed mixture	SM 2 site-specific seed mixture	Ecological group	Mixtures Species	SM 1 commercial seed mixture	SM 2 site-specific seed mixture	Ecological group
Campanula barbarta		0.22	1	*Festuca ovina*	2.5		3
Festuca nigrescens		35.00	1	*Lolium perenne*	15.7	3.00	3
Phleum alpinum		10.00	1	*Phleum pratense*	19.9		3
Poa alpina		15.00	1	*Trifolium hybridum*	2.4		3
Trifolium nivale		7.00	1	*Vicia sativa*	3.4		3
Crepis aurea		0.50	1		43.9	3.00	
Poa supina		5.00	1	*Achillea millefolium*	0.7	1.00	2
Trifolium badium		5.00	1	*Agrostis capillaris*	4.6	4.00	2
		77.72		*Anthyllis vulneraria*		5.00	2
Species not contained in mixtures				*Festuca rubra*	31		2
Elymus repens			3	*Leontodon hispidus*		1.00	2
Chenopodium album			3	*Lotus corniculatus*	5	3.00	2
Persicaria lapathifolia			3	*Melandrium rubrum*		0.03	2
Rumex obtusifolius			3	*Poa pratensis*	10.6		2
Tussilago farfara			2	*Poa violacea*		5.00	2
				Silene vulgaris		0.25	2
				Triolium repens	4.2		2
					56.1	19.28	

Results

Figure 1 indicates the development of the share of grouped species over the years, compared to their share (in % by weight) in the seed mixtures SM1 and SM2. The percentage of species of the seed mixtures shows the initial situation. SM1 contained no site-specific species but more than 56% of site-adapted species, mainly *Festuca rubra*. The total vegetation cover developed from 73% in 1999 to nearby 80% in 2002. Since 2000, a slow immigration of site-specific species, mainly from neighbour plots, was noted. The share of site-adapted species decreased after the first two years and again reached 56% in 2002. The non-site-adapted species spread out for the first two years, probably because of the effect of fertiliser application in 1999. After 2000, their share decreased below 20%. In total, the share of the valuable groups with expected sustainability reached 59%.

Mixture SM2, contained only 3% of the non-site-adapted *Lolium perenne*, variety "Guru", as a fast-growing nursery crop. Nearby 78% by weight were allocated to the group of site-specific species and around 20% accounted for the group of site-adapted species. The total vegetation cover increased from 70% in 1999 to 94% in 2002, nearby 15% higher than SM1. The ratio of the different ecological groups did not differ very much between the years of observation. The share of non-site-adapted species increased to 11%, of which 7% was *Lolium perenne* "Guru", a variety that showed remarkable winter hardiness. In 2002 a share of 72% of site-specific species and 10% of site-adapted species could be assessed. In summary, the share of valuable groups exceeded 82% of vegetation cover.

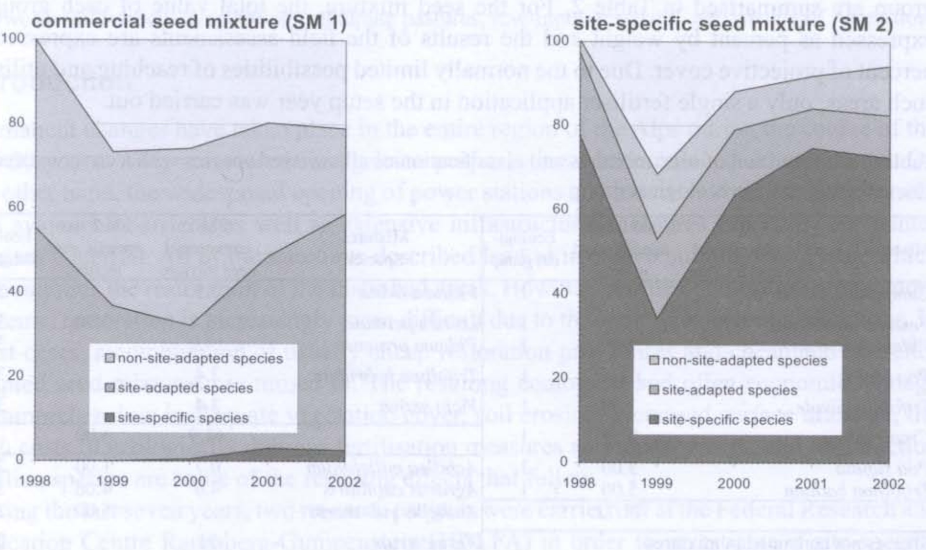

Figure 1. Average share of grouped species referring to their ecological value (1998 = % of weight in original seed mixture, 2000–2002 = species cover in %)

Discussion

The literature reports the use of a range of indicators to describe the ecological value of plant stands, e.g. weighted scores of the ecological indicators of Landolt (1977), indicator values following Ellenberg (1992) or an efficiency index (Parente *et al.*, 2002). In comparison, the present method of a grouping of species according to their ecological value allows a simple comparison of different sites and different seed mixtures.

In Austria, most subalpine and alpine grassland are utilised for agriculture during summer. The excellent suitability of site-specific seed mixtures for agricultural purposes is evident in previous publications (Krautzer *et al.*, 2004; Peratoner *et al.*, 2004). Nevertheless, a fast and enduring protection against erosion that only can be reached with the help of a dense sward is the first and most important target. In the short term, this can be assured by the use of a high quality application technique (Krautzer *et al.,* 2002). In the long run, a plant stand with sustainable, site-specific vegetation is necessary. Results of several assessments indicate that at altitudes between 1,200–2,400 metres, a minimum vegetation cover of 70–80% is required to avoid erosion (Tasser, 2003). The results obtained show that the share of non-site-adapted species and therefore the cover of plots with SM1 will continue to decrease. In a mid-term evaluation, the cover will fall below the critical value of 70% and problems with erosion can be expected. In practice, commercial seed mixtures, containing a high percentage of species that are not site-adapted to site conditions, would need repeated seeding and fertiliser application in order to achieve and maintain a vegetation cover ensuring sufficient protection against erosion. In a long-term perspective, the lack of sustainable site-specific species will thus result in repeated effort and thus expenditure, especially in the subalpine vegetation stage.

The share of valuable species of SM2 increased up to the last year of observation. A dense sward with cover values above 80 % can also be expected in a long-term view. In practice, restoration and reseeding of degraded areas in high altitudes should be done with the help of site-specific seed mixtures. They are able to stand the harsh climatic conditions of such sites and ensure sustainable vegetation with a sufficient long-term protection against erosion processes.

Conclusions

At altitudes above the subalpine vegetation stage, only seed mixtures containing a high share of site-specific and site-adapted species are able to guarantee a sustainable vegetation and sufficient protection against erosion.

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