Production and use of site specific seed in Austria

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Summary

A comprehensive programme for the development of site-specific seed mixtures for restoration in subalpine and alpine zones was carried out in Austria in the last 20 years. Selected from a pool of more than 80 species were those with the desired ecological properties, as well as giving rich seed production. In several selection stages the species that were rejected were those showing a poor germination capacity and undesired technical seed characteristics. In field experiments the work was concentrated on species with comparable good competitive strength, good seed production and relatively slight proneness to disease, as well as sufficient threshing suitability. Thus many grasses proved to be easily produced, and leguminosae as comparably difficult to reproduce, other than in a few exceptions, gardening methods had to be turned to for herbs. There is now a pool of 22 species available, which are currently reproduced in an area of 100 hectares by Austrian farmers.

In practical use, restoration with site-specific seed mixtures shows many advantages. Compared to common commercial mixtures of lowland grasses, site-specific alpine mixtures have a better sward connection, better persistence against the alpine climate and mechanical damage, and in most cases require no subsequent fertilisation and no further cultivation measures, which for many ski-run operators is also a strong economic argument for the use of site-specific seed mixtures.

Zusammenfassung

In den letzten 20 Jahren wurde in Österreich ein umfassendes Programm zur Entwicklung standortgerechter Saatgutmischungen zur Begrünung in subalpinen und alpinen Lagen durchgeführt. Aus einem Pool von mehr als 80 Arten wurden solche mit gewünschten ökologischen Eigenschaften sowie einer reichen Samenproduktion ausgewählt. In mehreren Selektionsschritten wurden jene Arten ausgeschieden, welche schlechte Keimfähigkeit und unerwünschte technische Saatguteigenschaften zeigten. In Feldversuchen konzentrierten sich die Arbeiten auf Arten mit vergleichsweise guter Konkurrenzkraft, guter Samenproduktion und relativ geringer Krankheitsanfälligkeit sowie ausreichender Druscheignung. Dabei erwiesen sich viele Gräser als gut produzierbar, Leguminosen als vergleichsweise schwer vermehrbar, bei Kräutern musste bis auf wenige Ausnahmen auf gärtnerische Methoden zurückgegriffen werden. Inzwischen steht ein Pool von 22 Arten zur Verfügung, welche derzeit auf hundert Hektar Fläche von österreichischen Bauern vermehrt werden.

Im praktischen Einsatz zeigen Begrünungen mit standortgerechten Saatgutmischungen viele Vorteile. Im Vergleich zu handelsüblichen Mischungen von Niederungsgräsern haben standortgerechte Alpinmischungen besseren Narbenschluss, bessere Persistenz gegen das alpine Klima und mechanische Schädigungen und brauchen in den meisten Fällen keine Folgedüngung und keine weiteren Pflegemaßnahmen, was für viele Schipistenbetreiber auch ein wichtiges wirtschaftliches Argument für die Verwendung standortgerechter Saatgutmischungen darstellt.

Introduction

Permanent changes have taken place in the entire region of the Alps in the course of the last 50 years. Large areas used for agrarian purposes were reduced or abandoned. On the other hand, intensive exploitation took place for power stations and road building, torrent- and avalanche

barriers and large areas of infrastructural measures, especially for winter tourism. 13,000 lifts and cable cars, 40,000 downhill ski runs amounting to 120,000 kilometres in length were built in the Alps in recent decades and used annually by 20 million tourists (VEIT 2002). All of the measures described lead every year to intensive building activity, which subsequently requires the restoration of the areas exploited and damaged. But at increasing altitude, restoration becomes more difficult due to rapidly worsening climatic conditions. Restoration is often relinquished in some Alpine regions due to costs, but a combination of cheap restoration methods and cheap site-alien seed mixtures are nearly always used. The resulting ecological and also often economic damage is comprehensive. Soil erosion, increased surface drainage, insufficient vegetation cover, high costs for ecologically questionable fertilisation measures and cultivation, and flora adulteration are only a few of the subsequent correlated effects. Winter tourism accordingly acquired a very negative image.

Intensive research by various institutes has also taken place for twenty years in the entire region of the Alps with the aim of undertaking permanent restoration in high zones. In various research projects (e.g. URBANSKA 1997, WITTMANN and RÜCKER 1999, KRAUTZER et al. 2003, KRAUTZER and WITTMANN 2005) it could in the meantime be proved that only the combination of high-quality application techniques and site-specific vegetation or seed leads to stable, enduring and ecologically adapted plant stocks with a high degree of nature conservation value.

Fertilising- and cultivation measures can then be significantly reduced, which also makes these methods economically viable in the medium term. By the middle of 1980s, the former provincial inspector for alpine meadows in Carinthia, Univ. Prof. Dr. Erwin LICHTENEGGER, began the first experiments in this sphere (LICHTENEGGER 1994). In the following years, the basis for the production of seed from ecological alpine types was drawn up. This basic work was carried out by Dr. Bernhard KRAUTZER at the HBLFA Raumberg-Gumpenstein (KRAUTZER 1995). In the meantime site-specific seed mixtures for differing high zones and differing bedrock could be offered throughout Austria.

Production of site-specific seed

The choice of potentially interesting species for site-specific restoration mixtures is made according to several considerations. To be able to combine such mixtures to meet the most differing conditions, there needs to be a spectrum of species available with differing characteristics. On the one hand, a species must possess a potentially satisfactory seed yield. On the other hand it should show broad ecological amplitude or be specialised to meet conditions in extreme sites. To be able to use restoration mixtures in a practical way, the species should not be particularly hostile to fertiliser and not slow growing. It should germinate quickly and compactly, and in competition with other mixture partners be neither dominating nor too greatly subservient. Because many areas are also subject to agricultural- or landscape-cultivation aspects, a certain degree of tolerability to grazing or cutting is also advantageous. To allow a stable grass sward to be created from a seeding mixture, a certain share of leguminosae is necessary, and a share of herbs is desirable.

According to all of these differing aspects, in the course of several years seeds from more than 80 species were gathered at various subalpine and alpine locations throughout the entire region of the Austrian Alps (KRAUTZER 1995). All of the

Picture 1: Seed production of *Anthyllis vulneraria* ssp. *alpestris*

Table 1: Important characteristics of the described species (KRAUTZER et al. 2004)

Species	Distribution	Vegetation belt			Parent rock		Moisture	
		Montane	Subalpine	Alpine	Siliceous	Calcareous	Dry	Wet
Grasses								
Anthoxanthum odoratum	Europe	+	(+)	-	+	+	+	(-)
Avenella flexuosa	Worldwide	+	+	+	+	-	+	(-)
Bellardiochloa variegata	Middle/south Europe	-	+	+	+	(-)	(+)	(+)
Briza media	Europe	+	(+)	-	+	+	+	(+)
Bromus erectus	Middle/south Europe, North Am.	+	(-)	-	(-)	+	+	-
Bromus inermis	Europe, Asia, North America	+	(-)	-	+	+	+	(-)
Cynosurus cristatus	Euroasia, North America	+	+	-	(+)	+	(+)	(+)
Deschampsia cespitosa	Worldwide	+	+	+	+	+	(-)	+
Festuca nigrescens	Europe	+	+	+	+	+	+	+
Festuca picturata	Middle Europe	-	+	+	+	+	+	(+)
Festuca pseudodura	Middle Europe	-	(+)	+	+	(-)	+	(-)
Festuca supina	North/middle Eeurope	-	+	+	+	(-)	+	(-)
Festuca varia s.str.	Central Europe	(-)	+	+	+	(-)	+	-
Koeleria pyramidata	Europe	+	+	-	(-)	+	+	-
Phleum hirsutum	Middle/south Europe	(+)	+	+	(-)	+	+	(-)
Phleum rhaeticum	Middle/south Europe	(+)	+	+	+	(+)	(+)	+
Poa alpina	Europe, Siberia, North America	(+)	+	+	(+)	+	+	(+)
Sesleria albicans	Europe	+	+	+	(-)	+	+	-
Leguminosae								
Anthyllis vulneraria	Middle/south Europe	+	(+)	-	(-)	+	+	-
Anthyllis vulneraria ssp.*alpestris*	Middle/south Europe	+	+	+	(-)	+	+	-
Trifolium alpinum	Middle/south/west Europe	-	(+)	+	+	-	(+)	(+)
Trifolium badium	Europe, Siberia	(+)	+	+	+	+	+	+
Trifolium pratense ssp.*nivale*	Middle/south Europe	-	+	+	+	(+)	(+)	+
Herbs								
Achillea millefolium s.L.	Europe, Siberia	+	+	(+)	(+)	+	(+)	(+)
Leontodon hispidus s.L.	Europe	+	+	+	(+)	(+)	(+)	(+)

Species	Distribution	Tolerance against			Nutritional Value	Sward Density
		Fertilization	Cutting	Trampling		
Grasses						
Anthoxanthum odoratum	Europe	(-)	(+)	(+)	(-)	-
Avenella flexuosa	Worldwide	(-)	-	(-)	-	(-)
Bellardiochloa variegata	Middle/south Europe	(+)	(+)	(+)	(-)	(+)
Briza media	Europe	(+)	+	(+)	(+)	+
Bromus erectus	Middle/south Europe, North America	+	+	(-)	(+)	-
Bromus inermis	Europe, Asia, North America	+	+	(-)	(+)	(+)
Cynosurus cristatus	Eurasia, North America	+	+	+	+	+
Deschampsia cespitosa	Worldwide	+	(+)	+	-	(+)
Festuca nigrescens	Europe	+	+	+	(+)	+
Festuca picturata	Middle/south Europe	+	+	(+)	(+)	+
Festuca pseudodura	Middle Europe	(+)	-	(+)	-	(+)
Festuca supina	North/middle Europe	(+)	(-)	+	-	+
Festuca varia s. str.	Central Europe	(-)	-	-	-	(+)
Koeleria pyramidata	Europe	(+)	(+)	(+)	(-)	(+)
Phleum hirsutum	Middle/south Europe	+	+	+	(+)	+
Phleum rhaeticum	Middle/south Europe	+	+	+	+	+
Poa alpina	Europe, Siberia, North America	+	+	+	+	(+)
Sesleria albicans	Europe	(-)	(-)	(-)	(-)	(-)
Leguminosae						
Anthyllis vulneraria	Middle/south Europe	(+)	(-)	(+)	(-)	-
Anthyllis vulneraris ssp.*alpestris*	Middle/south Europe	(+)	(-)	(+)	(-)	-
Trifolium alpinum	Middle/south/west Europe	+	+	+	+	-
Trifolium badium	Europe, Siberia	(+)	+	+	+	(-)
Trifolium pratense ssp.*nivale*	Middle/south Europe	(+)	+	+	+	(-)
Herbs						
Achillea millefolium s.L.	Europe, Siberia	+	+	+	(+)	(+)
Leontodon hispidus s.L.	Europe	(+)	(+)	+	(+)	(-)

+ = very good (+) = good (-) = poor - = very poor

Picture 2: Seeds of *Phleum rhaeticum*

species were examined for seed characteristics and seed quality. Reproduction of the species showed a general increase of germination rates already in the first generation. Herbs, grasses and leguminosae with markedly inhibited germination or a hard shell were subsequently excluded. Technical seed characteristics, such as flow capacity and an achievable degree of purity, were examined as further selection criteria. According to this pre-selection, there remains 41 species (23 grasses, 8 leguminosae and 10 further herbs) of more than 130 different origins, which were examined in field tests for their suitability for seed production. The best origins of the selected species were made subject to lighter selection in the following years. The most important criteria are: uniform ripening, erect stand of the panicles, slight tendency for seed shattering, slight susceptibility to blight and other diseases, as well as good durability. At the same time great value was placed on genetic variability. The material that is passed on to farmers for reproduction is therefore a genotype mixture of up to six different origins. In the meantime 22 suitable species have been reproduced over a large area (KRAUTZER et al. 2004). *Table 1* shows a brief overview of all of the species currently being produced, and their most important restoration characteristics.

For innovative farmers and seed producers, the possibility of a lucrative, non-regulated production that can also contribute to ensuring the agricultural incomes of these enterprises has come into being. The demands placed on production technique are extreme. Seed production of site-specific ecological seed can therefore be described as the high art of plant growing. Only a few enterprises with many years of experience are in the position to fulfil the extreme demands of product quality with sufficient yields.

What all site-specific species have in common is that compared to species and types achieved through cultivation, they have slow juvenile development and slight competitive strength. All species require a perfectly prepared seed bed. Measures for plant protection must be made as early as possible to avoid a severe loss of yield. Organic planting is therefore impossible for most species. Above all site-specific grasses show high susceptibility to blight diseases. Only timely control with suitable fungicides can hinder large areas of damage to stocks. With the use of plant-protection agents, the regulations in respect of admission, use and safety measures are to be observed.

The production of site-specific species is much more risky and significantly more lavish than in conventional seed production. Above all production costs, yields and profits are essential for viable production.

Practical use of site-specific ecological seed

According to conservative estimation in Austria alone, areas amounting to 2,000 to 2,500 hectares require re-cultivation in high zones in which the use of site-specific seed mixtures are desirable or necessary each year. This estimation includes all of the restoration measures in the agricultural sphere (alpine-meadow paths, alpine-meadow improvements), for tourism exploitation

Picture 3: Harvest of *Festuca supina* (Marchfeld, Lower Austria)

(ski runs and lifts, tourism infrastructure), path construction, power-station construction, avalanche barriers and erosion protection. Europe-wide, the extent of the area is probably at least double. To this are added thousands of hectares of areas that require restoring. The potential need for Austria alone can be projected at about 200 tons of alpine seed annually, in the assumption that principally site-specific mixtures are used. Many failures, irrespective of whether in the restoration of banks, forest roads or ski runs, are to be traced back to false economy in the choice of seed mixtures, or the restoration technique chosen. Together with the basic scientific work that took place at the HBLFA Raumberg-Gumpenstein, a partner for the commercial realisation of the project was necessary. It was here that cooperation with the firm of "Kärntner Saatbau" took place. With a great deal of enthusiasm, the basis for the commercial production of these species was drawn up together. The research results and concepts of the HBLFA Raumberg-Gumpenstein were realised in practice by "Kärntner Saatbau" (TAMEGGER 2006). The result of these endeavours are restoration mixtures containing a high share of site specific seeds, processed at the HBLFA Raumberg-Gumpenstein, and reproduced by indigenous farmers on commission by "Kärntner Saatbau". "RENATURA" is the brand name for this innovative cooperation through science and practice.

With the resulting combined quality mixtures, all restoration spheres, from valley locations to extreme high zones, on limestone or on bedrock, can be covered (*Figure 4*).

Outlook

There are independent rules for niche sectors, such as site-specific seed mixtures for restoration in high zones. The market is relatively limited. A lack of legal regulations still permit, as before, the use of seed mixture comprising ecologically unsuitable species, but which are significantly cheaper. The site-specific seed mixture product can thus only be sold through intensive and high-grade expert consultation of the seed-buying consumer. Every year within the sphere of conferences, workshops, excursions and inspections,

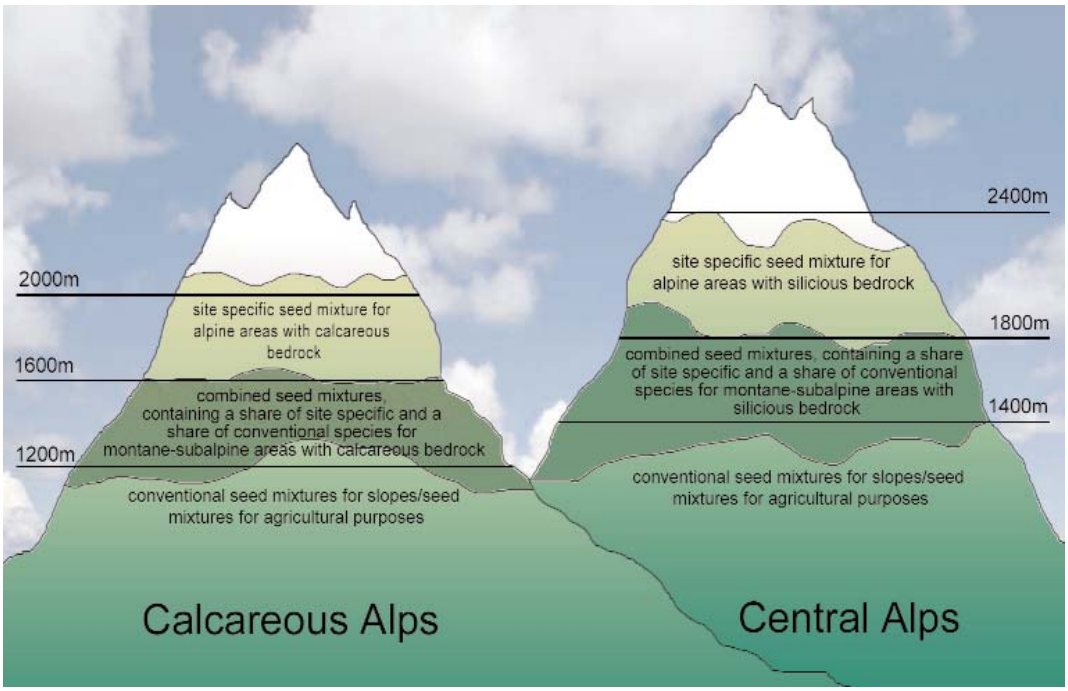

Figure 4: Gradation of seed mixtures depending on bedrock and altitude

the latest experience and knowledge can be passed on to groups of persons from the fields of ski-run operators, authorities, engineering offices, nature conservation, restoration firms, farmers as well as torrent- and avalanche barrier constructors.

An extremely pleasing trend was to be observed in recent years. Especially ski-run operators who have already had several years of experience with the use of high-quality ecological seed-mixtures, are in the meantime convinced of the quality of this product. In the medium-term calculation of costs for restoration, including subsequent costs for cultivation, fertilisation and maintenance, the "more expensive" site-specific mixtures prove to be clearly cheaper!

The spectrum of species is to be further extended during the next few years. Following the introduction of site-specific leguminosae into restoration mixtures, the increased use of deep-rooting herbs should make possible a further qualitative quantum leap in the development of Alpine mixtures.

Together with their use in the Alpine region, site-specific restoration finds increasing values following the construction of roads, water facilities or landscaping. A set up for the production of site specific seed for landscaping in lower locations is currently being worked on within the sphere of the "Natural Grassland Seed Project" together with the Province of Upper Austria department for nature conservation.

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