From Forest Nursery Notes, Winter 2011

43. © Restoration of rocky slopes based on planted gabions and use of drought-preconditioned woody species. Beikircher, B., Florineth, F., and Mayr, S. Ecological Engineering 36:421-426. 2010.

Ecological Engineering 36 (2010) 421–426

Contents lists available at ScienceDirect

Ecological Engineering

journal homepage: www.elsevier.com/locate/ecoleng

Restoration of rocky slopes based on planted gabions and use of drought-preconditioned woody species

Barbara Beikircher[a,*], Florin Florineth[b], Stefan Mayr[a]

[a] Institute of Botany, University of Innsbruck, Sternwartestr. 15, A-6020 Innsbruck, Austria
[b] Institute of Soil Bioengineering and Landscape Construction, University of Natural Resources and Applied Life Sciences, Vienna, Peter Jordan Str. 82, A-1190 Wien, Austria

ARTICLE INFO

Article history:
Received 27 March 2009
Received in revised form 25 August 2009
Accepted 11 November 2009

Keywords:
Drought stress
Gabion
Quarry
Survival rate
Vulnerability
Water potential

ABSTRACT

The restoration of steep rock faces with shrubs and trees is difficult due to extreme microclimatic and edaphic conditions. In this study, we tested the applicability of free-standing planted gabions to improve the landscape and achieve protection against rockfall, erosion and enhanced surface flow. Furthermore, we analyzed the effect of preconditioning on drought tolerance of several planted species (*Ligustrum vulgare*, *Viburnum lantana*, *Juniperus communis* and *Pinus sylvestris*).

Planted gabions showed sufficient mechanical stability, but survival rates of planted shrubs and trees were reduced by drought stress. Soil water potential on the gabions decreased several times below −1.4 MPa and soil temperature increased up to 30 °C in summer and decreased below −6 °C in winter. The percentage of surviving individuals was correlated with the species' resistance to drought-induced embolism. Drought tolerance was overall higher in conifer species, while angiosperm species were able to shift their vulnerability thresholds upon preconditioning.

We conclude that free-standing planted gabions may be an alternative technique for restoration and securing of critical parts of steep rocky slopes. Preconditioning of plant material used for restoration of drought-prone sites can increase the drought tolerance of some species.

1. Introduction

Quarrying of natural stones often results in up to 90° steep and several hundred meter high artificial rocky slopes. These rock faces are a widely visible disturbance in the landscape, particularly in mountainous regions. Due to erosion, rockfall and enhanced surface flow, they can also represent a serious threat to neighboring settlements and streets (e.g. Yuan et al., 2006; Clemente et al., 2004). Thus, a securing of these sites, on the one hand, and an ecologically oriented, sustainable restoration, on the other hand, is often required. Bioengineering approaches thereby pose an enormous challenge due to extreme microclimatic conditions.

In addition to temperature stress with high temperature variations and high temperature extremes, drought is the most limiting factor on these sites for plant establishment. If any, soils are poorly developed which, together with a high evaporative demand, leads to an insufficient water supply (also see Wang et al., 2009). These conditions are particularly limiting for long-lived woody species, which are not able to survive adverse periods in desiccation-tolerant seed stages or succulent underground organs (Larcher, 1995), and the development of drought- and temperature-tolerant tissues goes at the expense of growth and reproduction. Furthermore, soil water conditions can also affect root distribution and consequently anchorage (Li et al., 2007) which in turn may be crucial for a successful restoration. Nevertheless, restoration of rocky slopes with woody plants is often desired as they provide cover to large areas of the unstructured, bare rock face and can protect better against rockfall than herbaceous plants. Restorations of quarries with woody plants are often carried out in form of planting vegetation on the debris cone and the berms which results in a so-called "Zeilenwald" (forest in terms of a line; Florineth, 2004), or by planting climbers (Li et al., 2007; Wang et al., 2009). A modern technique is hydroseeding after small controlled blastings which lead to a more structured and less steep rock face (Hüfing and Florineth, 2002; Florineth, 2004a) and outside soil spray seeding (OSSS) with optimized synthetic soils (Gao et al., 2007). However, woody plants show extremely low germination rates (Florineth, unpublished) and require a long time scale to fulfill their function. Regardless of the restoration technique, use of plants with

Abbreviations: k_s, specific hydraulic conductivity; PLC, percent loss of hydraulic conductivity; Ψ, water potential; Ψ_{10}, Ψ_{50}, Ψ_{90}, water potential at 10, 50 and 90% loss of conductivity.

* Corresponding author. Tel.: +43 512 507 5929; fax: +43 512 507 2715.
E-mail address: barbara.beikircher@uibk.ac.at (B. Beikircher).

0925-8574/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.ecoleng.2009.11.008