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SECONDARY SUCCESSION OF SPONTANEOUS FLORA AFTER DEFORESTATION AND SELF–REFORESTATION

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Abstract

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The experimental plots are located on a farm in a mountainous area at an altitude of 845 m above the sea level with the soil type cambisol. After leaving pasture grassland in about 50 years created a forest community with 45.06 per cent share of woody plants. After it has been deforested was doing research on a variant grazing with Charolais cattle and compared with deforested grassland without management leaving the development without human intervention. On the variant without management for three years we recorded 58 plant species with woody plants. Cover of grasses was reduced, for example *Agrostis capillaris* L. from 15 to 0.78% and *Festuca rubra* from 5,33 to the tracks, like the presence of herbs, on the contrary increased the percentage of woody plants as *Betula pendula* from 4.08 to 13.52%, *Cerasus avium* from 3.07 to 16 28% and *Populus tremula* from 16.22 to 47.88%. Proportion of woody plants in the third year of research accounted for up to 77.68 per cent stake. Dominant *Populus tremula* amounted to 2.50 m high and mean diameter 30 mm. Grazing control variant for three years consisted of community – *Agrostis Festucetum rubrae* with 66 plant species and dominance of other herbs (53.66%). Significantly increased the proportion of grasses, for example *Agrostis capillaris* from 5.67 to 15.61%, *Festuca rubra* from 5.02 to 8.42%, *Festuca pratensis* from 3.84 to 4.40% and *Dactylis glomerata* from 2.46 to 4.46%. The variant without management significantly increased levels of C : N at depths of 0–200 mm from 10.88–12.65 to 14–16.53, compared with a variant of grazing (from 9.36–12.41 to 6.93–10.46). The evaluation of phosphorus and potassium in two depths, in the C : N ratio, but also in botanical composition from 2006 to 2008, we found statistically highly significant differences in the variant with self–reforestation without management (BM) compared with grazing control variant after deforestation.

pasture, flora, deforestation, self–reforestation, secondary succession

Grassland is dependent on regular use (grazing, mowing, mulching). Neglect or lack of response may result in loss of functionality and grassland agroecosystem and secondary succession process occurs. In terms of specific species succession is a series of successive processes of colonization after the establishment of appropriate environmental conditions. Originally, more or less homogeneous structure of the grassland is gradually turning into a patchwork of new communities in which the most predominant one of the strongest competitive species (Novák, 2009).

In secondary succession development is on created soil base with soil organisms, where are in reserve diasporas in the latent state. Succession is influenced by baseline state of vegetation and stand conditions. One community of living organisms in a stand replaced the second (or pushes it) until there is no balance between abiotic (dead) and biotic (living) components of the environment (Odum, 1971; Moravec, 1994). Under favorable conditions, the migration is carried out by dissemination, reproduction of organs (diaspora), which include the generative organs e.g. seeds, fruits, spores, or vegetative, f.e. fragments of vegetative organs (stems, buds, etc.).

For spontaneous expansion of self–seeding voody plants to open grassland areas are critical sources of diasporas. Woody plants are self–expanding self–seeding of diasporas by the wind (anemochorism), animals (zoochorism), water (hydrochorism), birds, rodents etc. at various distances from the parent plant. They are largely characterized by rapid growth in the early years, stability and durability (Novák, 2008, 2009; Benčať, 2009).

After deforestation created semi-grass herbaceous vegetation are strongly influenced by the manner and intensity of management. Spontaneous natural succession areas are gradually overgrowned by vegetation. Succession is in progress quite differing ways, depending on soil type, type of biotop, contact the communities, or the nature and intensity of anthropogenic factors in the area. In the five successional sequences initially stage consists of annuals and semi–ruderal species, which passes into 2nd successional sequence semi– and ruderal vegetations. In 3rd sequence are formed the grass and grass–herb communities, often with *Elytrigia repens*. The fourth sequence of succession passes to the grass overgrow and in the absence of human impact forward spontaneously to the sequence of successional forest stands, introduced woody plants (Eliáš, 1996). In the mountain and high mountain areas, where grass seeds expand wind from the neighboring areas of semi–natural grasslands and a bank of seeds in the soil is rich, grass come immediately after the successional sequence of annual weeds (Novák, 1998). Human intervention should be regular, otherwise grasslands are gradually colonized and are gradually subject to very strong expansion of the forest, there is a gradual self–reforestation. Direct succession development lead up to climax stage of the forest community. Dispersion distance depends on height of trees and distribution of tree seeds, but also the weather conditions. In the absence of wind most of the seed falls near the parent tree crowns. Density of juvenile individuals also depends on the density of grass. Trees gradually grow and escape from the direct impact of expansion of high grasses, mainly *Calamagrostis epigejos* (Gömöry *et al*., 2006). Expansion of plant species, according to Krížová (1995) includes the penetration of domestic (indigenous) species of flora of contact phytocoenoses respectively ecosystems. Areas of grassland over time overgrow trees, and if one does not interfere with an additional energy into ecosystem a forest would be as a potential community there. Succession is the replacement of one species other species, it is a process lead up to climax stage of the ecosystem of the country, which is in our conditions forest (Forman, Godron; 1993).

MATERIALS AND METHODS

Experimental parcel are located in a mountainous area Diel. The experimental area is located in the western part of Stolické Vrchy in Slovenské rudohorie Mts., at an altitude of 845 above the sea level, in latitude 48° 33' N and longitude 19° 46' E. It has a southern exposure with a gradient of 15° and 20°. Soil–forming rocks are hybrid granodiorites with transitions until migmatits. Created soil type is cambisol (KM), subtype cambisol modal – a form of eroded (KMm^{e}). Soil profile is sandy–loamy in the all depth. Climatic area is in the slightly warm area, sub–humid, moderately warm district. Long–term average annual temperature is 5.10 °C, the growing season (IV.–X.) 10.51 °C. Long–term average rainfall is 926.72 mm, the vegetation period 629.81 mm (1961 to 2005). Average number of days with snow cover is the 80. In the past, the site was used as pasture after deforested. About fifty years ago, when private land passed under the management of coops have begun to lands overgrown trees and gradually created by succession forest with the dominance of white birch (*Betula pendula*). After the restitution of grounds in 1993 was returned they to original owners and started again used as the forest-grassland for grazing cattle without market milk production by Charolais breed. Animals are keep on a mountain pasture without housing, they graze on deforested areas during the growing season and in winter they are fed on hay and silage from own production of grassland. Load by animals range from 0.30 to 0.60 LU.ha^{-1} during the year.

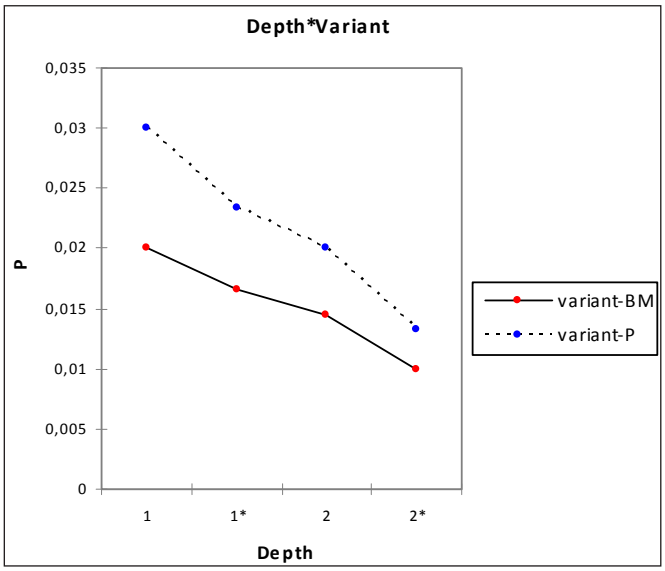
In 2005, on experimental unit was removed woody vegetation by cutting, tree–trunks was removed and branches burned. From 2006 to 2008 we established on the deforestation area experiment which was left without use to self–reforestation (variant without the management – BM). For comparison, we used as a control variant grazed by cattle (grazing variant – P). Research plots 3 × 5 m (15 m^2), together eight plots were arranged in a Latin square in three repetitions. Soil samples were taken by probes rod from depth of soil 0–100 and 101–200 mm in a quantity of 0.50 kg from 3 repetitions. In the soil depth from 0 to 100 and 101 to 200 mm available phosphorus was analyzed colorimetrically on a by spectrophotometer and potassium by atomic absorption spectrophotometry in flame absorption spectrophotometry Avanta by Mehlich III. From the values of C_{ox} (C_{ox} = humus/1.724) by Tjurin and N_t by Kjeldahl, we calculated the ratio C : N. In the spring, summer and autumn, we did floristic records by the reduced projective dominance method (D in %) – estimated method different types of coverage in a percentage according to Klapp (1965) in triplicate with the detection of floristic groups grass species, grass–like species, *Pteridophytes*, legumes and other herbs (Novák, 2004). Add to 100% were empty seats, mosses and lichens. The names of plant species are included in the List of lower and higher plants in Slovakia (Marhold and Hindák, 1998).

Evaluation of differences selected indicators (P, K, C : N) in soil by impact factors (year, variant, depth) but also E_{GQ} in aboveground phytomass was assessed on the basis of multi–factorial analysis of variance of major factor ANOVA using Statistica program with interaction and testing contrasts with

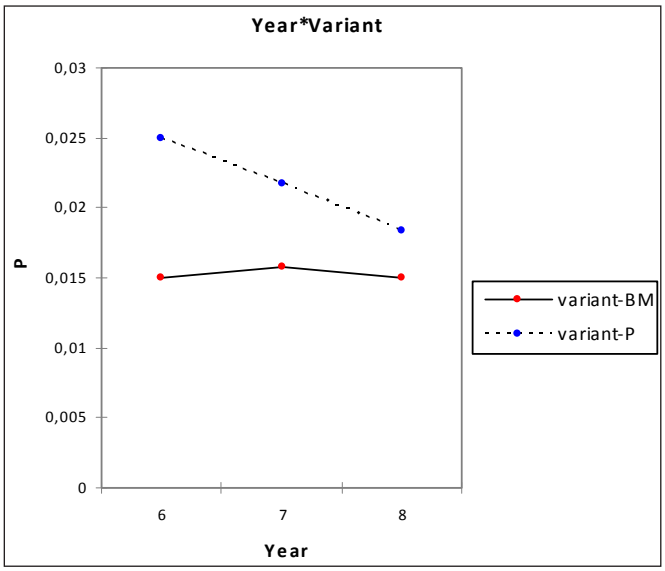
Tukey method (HSD). Floristic composition and variations we assessed in the analysis the CCA.

RESULTS AND DISCUSSION

After leaving the pasture grassland in about 50 years there was created a forest community with 45.06–percent share of woody plants, from their were dominated *Betula pendula* with the representation of 27.12%, *Corylus avellana* 6.60%, *Populus tremula* 4.70%, and *Fagus sylvatica* 3.40%. The trees reached an average height of 8 m of 0.20 m. Herbaceous vegetation growing in shade account for 17.84% of that *Fragaria vesca* 6.50%, *Galium odoratum* 2.50%, *Cruciata laevipes* 2.50% and *Veronica chamaedrys* 1.50%. Grasses are represented little, the highest proportion occurred only *Avenella flexuosa* (3.50%). Empty places were up 28.07 per cent proportion. In terms of geobotanical breakdown territory belongs to a broad association *Fagion sylvaticae* Pawł. 1982. After the removal of trees (deforestation) was pasture again renewed. On the variant without management (BM) was reduced the cover of the grass for three years *Agrostis capillaris* (from 15 to 0.78%) and *Festuca rubra* (from 5.33 to traces). Similarly, presence of herbs was reduced, f.e. *Fragaria vesca* (from 6 to 1.56%) and *Cruciata laevipes* (from 5, 44 to traces), on the contrary was increased the percentage of woody plants as *Betula pendula* from 4.08 to 13, 52%, *Cerasus avium* from 3.07 to 16.28% and *Populus tremula* from 16.22 to 47.88%. The proportion of woody plants already formed 77.68 percent proportion in its third year of research. Dominant *Populus tremula* grew up to 2.50 m and mean diameter was 30 mm. In compared with the control variant of the used of grazing (P) for



1: *Value of phosphorus (P) in 2 depths at variants*

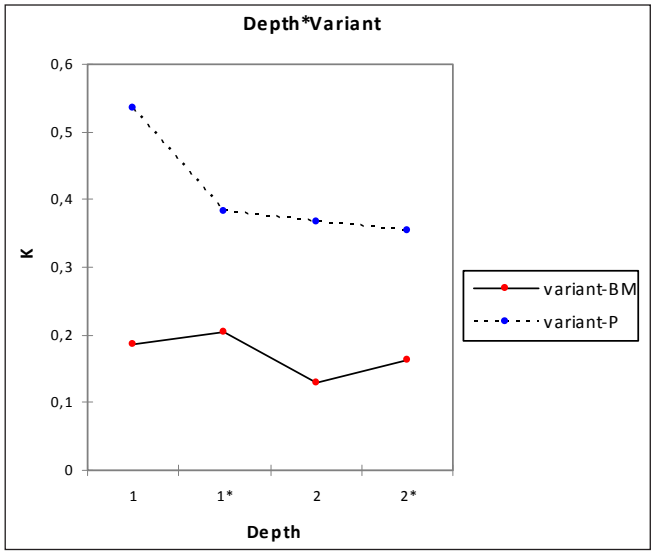


2: *Value of phosphorus (P) at variants in years*

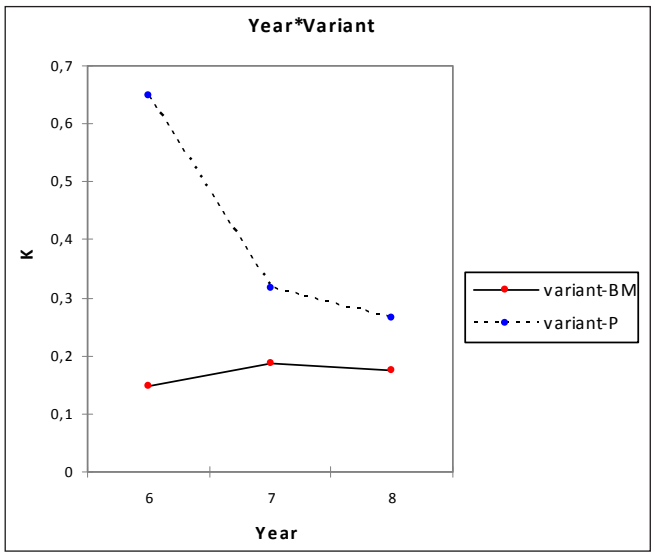
three years has increased the proportion of grasses, f.e. *Agrostis capillaris* from 5.67 to 15.61%, *Festuca rubra* from 5.02 to 8.42%, *Festuca pratensis* from 3.84 to 4.40% and *Dactylis glomerata* from 2.46 to 4.46%. Community of plants formed association *Agrostis-Festucetum rubrae*. *Agrostis capillaris* is perennial grass species, which occupies the large area by long processes that could assist in vegetative reproduction. Another grass species, which condenced sod of grassland was *Festuca rubra* with long underground processes. Proportion of legumes, f.e. *Trifolium repens,* significantly increased from 3.85 to 11.04%, also-like herbs f.e. *Taraxacum officinale* from 0.54 to 3.23%, *Plantago major* from 0.53 to 2, 76%, *Veronica chamaedrys* from 1.57 to 2.07%. There was a decline in *Cruciata laevipes* from 2.76 to 2.03%, *Campanula rapunculoides* from 1.49 to 0.57% and *Lysimachia nummularia* from 33.36 up to 12.64%. *Lysimachia nummularia* fared best in partial shade, while also was requiring sufficiently moist conditions. The variant without management (BM), we recorded 58 plant species and plants with air raids for three years. In the control variant with grazing (P) consisted of community with the highest number of perennial species (29) and the dominance of other herbs (53.66%) to 66 plant species.

By the evaluation of phosphorus and potassium in all depths of soil (Fig. 1–Fig. 4), we found out statistically highly significant differences in variant without management (BM) compared with grazing control variant (P). Analogous results were also confirmed by a comparison of the experimental years (2006 to 2008).

In all investigated soil depths (Fig. 5) the relationship of C : N was statistically highly significantly higher in the variant without management (BM) compared with grazing control variant (P). With



3: *Value of potassium (K) in 2 depths at variants*

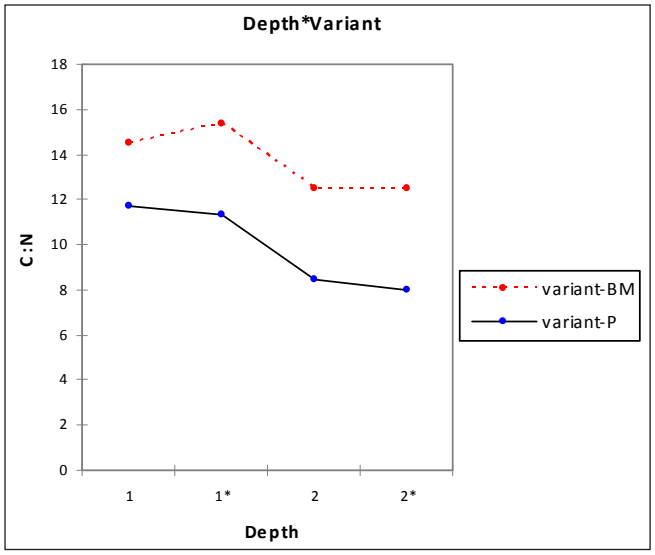


4: *Value of potassium (K) at variants in years*

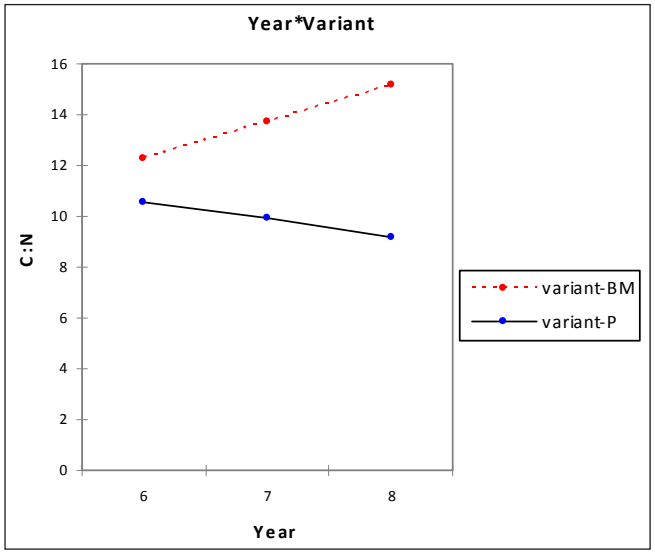
the increase of soil depth, the differences in the C : N between variants have not been exacerbated and remained at a constant level.

In the first stage of the woody secondary succession, as mentioned Danišová, Ťavoda (2006) and Daniš (2008) was not confirmed penetration autochthonous bushes to the ecosystem, but now the trees involved (Hilbert, 1981). Biocoenosis not only influenced the closeness of the forest, but the presence of potential stock of diasporas of woody species (seed bank) in the soil. Pavlů *et al.* (2005) show that after leaving the pasture is increased the cover of high grass in the community, f.e. *Alopecurus pratensis*, *Dactylis glomerata* and *Holcus mollis*, but also *Elytrigia repens* at the expense of low grass species due to better competitive ability to obtain light. This trend is also not confirmed in those circumstances. We share a similar view, as the Midriak (2004), that after leaving from traditional management overall dynamics of changes in mountain areas is affected not only the major anthropogenic influences, but also natural successional processes associated with the development of the country. We share with authors Benčať and Jančura (2008) that woody plants are landscaping element which shapes the landscape view. If grassland designated for use after leaving would loses its characteristic structure and irreversibly is converted into forest and scrubland community. Woody plants growing in the area of grassland also significantly change the characteristic landscape.

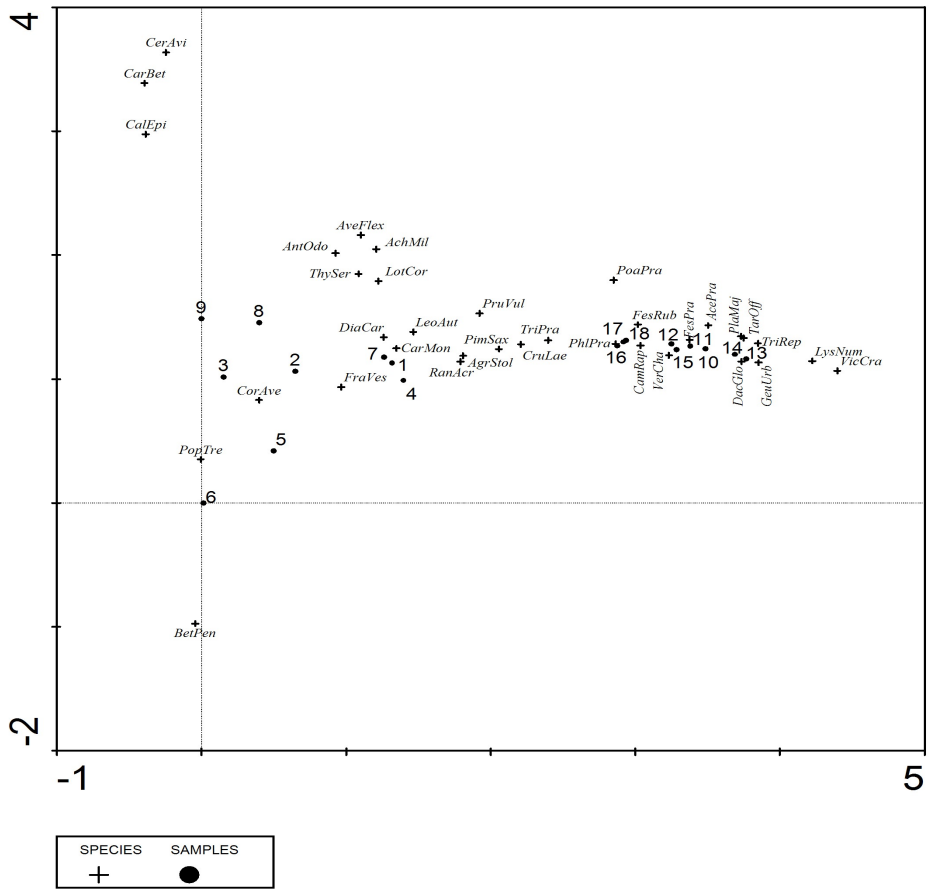
The results show that self–seeding plants with grasses, legumes and other herbs also perform non–productive functions. It covers and protects the soil from erosion, tree defoliation and death of the upper parts of vegetation after 2 years has contributed



5: *Relationship C : N to soil depth at variants*



6: *Relationship C : N at variants in years*



7: *Exit chart analysis, CCA*

AgrCap – *Agrostis capillaris* L., AntOdo – *Anthoxanthum odoratum* L., AveFlex – *Avenella flexuosa* (L.) Parl., CalEpi – *Calamagrostis epigejos* (L.) Roth, DacGlo – *Dactylis glomerata* L., FesPra – Festuca *pratensis* L., FesRub – *Festuca rubra* L., PhlPra – *Phleum pratense* L., PoaPra – *Poa pratensis* L., CarMon – *Carex montana* L., LotCor – *Lotus corniculatus* L., TriPra – *Trifolium pratense* L., TriRep – *Trifolium repens* L., VicCra – *Vicia cracca* L., AcePra – *Acetosa pratensis* Mill., AchMil – *Achillea millefolium* L., CamRap – *Campanula rapunculoides* L., CruLae – *Cruciata laevipes* Opiz, DiaCar –*Dianthus carthusianorum* L., FraVes – *Fragaria vesca* L., GeuUrb – *Geum urbanum* L., LeoAut – *Leontodon autumnalis* L., LysNum – *Lysimachia nummularia* L., PimSax – *Pimpinella saxifraga* L., PlaMaj – *Plantago major* L., PruVul – *Prunella vulgaris* L., RanAcr – *Ranunculus acris* L., TarOff – *Taraxacum officinale* Web., ThySer – *Thymus serpyllum* L., VerCha – *Veronica chamaedrys* L., BetPen – *Betula pendula* Roth, CarBet – *Carpinus betulus* L., CerAvi – *Cerasus avium* (L.) Moench., CorAve – *Corylus avellana* L., PopTre – *Populus tremula* L.

to the formation of humus and with roots to aeration and improved soil structure. Soil cover has assisted in creating a suitable microclimate for growth. Reforestation also influenced soil conditions. After decomposition dead plant material, decline leaves of shrubs and trees, higher activity of microorganisms symbiotic N–fixation caused increases in the ratio C : N. The variant without management (BM) are significantly increased levels of C : N at depths of 0 to 100 mm from 12.65 to 16.53 and in depth from 101 to 200 mm from 10.88 to 14.00, compared with a variant of grazing (P) where there was lower values of growth (at a depth of 0 to 100 mm from 12.41 to 10.46 and the depth of 101–200 mm 9.36 to 6.93).

SOUHRN

Sekundární sukcese spontánní flóry po odlesnění a samozalesnění

Experimentálni parcely se nacházejí na farmě v horské oblasti v nadmořské výšce 845 m na půdním typu cambisol. Po opuštění pastevního porostu se v průběhu přibližně 50 let vytvořilo lesní společenství se 45,06% podílem dřevin. Po jeho odlesnění byl proveden výzkum na variantě se spásáním pastvin skotem Charolais a porovnáván s odlesněným porostem bez managementu ponecháním na samovývoj. Na variantě bez managementu jsme za tři roky evidovali 58 rostlinných druhů i s nálety dřevin. Pokryvnost trav se snížila, např. *Agrostis capillaris* z 15 na 0,78 % a *Festuca rubra* z 5,33

na stopy, podobně i prezence bylin, naopak vzrostl podíl dřevin *Betula pendula* ze 4,08 na 13,52 %, *Cerasus avium* z 3,07 na 16, 28 % a *Populus tremula* ze 16,22 na 47,88 %. Podíl dřevin již v třetím roce výzkumu tvořil až 77,68 %. Dominantní topol osikový v porostu dosahoval výšky až 2,50 m o průměru kmene 30 mm. Kontrolní variantu za tři roky tvořilo společenství *Agrostis–Festucetum rubrae* s 66 rostlinnými druhy a dominancí ostatních bylin (53,66%). Výrazně se zvýšil podíl trav, např. *Agrostis capillaris* z 5,67 na 15,61 %, *Festuca rubra* z 5,02 na 8,42 %, *Festuca pratensis* z 3,84 na 4,40 % a *Dactylis glomerata* z 2,46 na 4,46 %. Na variantě bez managementu se výrazně zvýšily hodnoty C : N v hloubce 0–200 mm z 10,88 až 12,65 na 14 až 16,53 v porovnání s pastvou (z 9,36 až 12,41 na 6,93 až 10,46). Při hodnocení fosforu a draslíku ve dvou hloubkách, v poměru C : N, ale také ve floristickém složení v letech 2006 až 2008 jsme zjistili statisticky vysoce průkazná rozdíly na variantě se samozalesněním bez managementu (BM) v porovnání se spásáním kontrolním variantou po odlesnění.

pastvina, sekundární sukcese, dřeviny, odlesňování, samozalesňování

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