LODGEPOLE PINE (*PINUS CONTORTA*) AS A PREPARATORY TREE SPECIES IN IMMISSION AREA ORLICKÉ HORY Mts.*

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Lodgepole pine (*Pinus contorta*) was among the introduced preparatory (pioneer) species planted in the immission areas with the aim to reforest large clear-cuts. The plantation extent is not very large, but the importance of this species was assumed considerable. On the other hand, nature conservation restricted and excluded the introduced species use almost totally. Today, the stands are existing, and the forest management has not knowledge about their soil-forming effects. The Orlické hory Mts. represent the area with some lodgepole pine plantations. The research plot was established in 1989 on the main ridge, in the altitude approximately 1000 m a.s.l., on the forest type group 7K. Surface humus thickness and its quality was assessed in the stand of lodgepole pine comparing to the stand of Norway spruce of the same age. In the pine stand, the humus thickness decreased, documenting the organic matter losses. Otherwise, the soil chemistry did not differ profoundly, the lodgepole pine stand did not form so effective shelter, causing the base losses in bigger extent. Stability of the forest stand was lower and the game damages were higher comparing to the Norway spruce.

species composition; lodgepole pine; Orlické hory Mts.; humus forms; site degradation

INTRODUCTION

The use of introduced tree species aimed at the aforestation of anthropogenically degraded and damaged sites was for decades and it is still a centre of a considerable interest. As a part of the forest restoration in immission areas, a wide range of tree species was tested. As one of options, the lodgepole pine (*Pinus contorta*) was planted. The plantations were established on immission clear-cuts in the Czech mountains: Ore Mts., Jizerské Mts., Giant Mts., Orlické Mts. (K a ň á k , 1988; ÚHÚL, 1995). Its use was based on the knowledge on its ecological character, this species represents a pioneer tree, occupying areas destroyed by natural disasters (fires, windbreaks etc.) and calamities, connected with forest regeneration in the boreal zone (B u r t o n et al. 2003). Despite a fact, that its spreading was suppressed by its silvicultural problems, biological characteristics and legislation problems, tens of hectares of lodgepole pine stands were established. The growth and development of these stands were evaluated only exceptionally, and the impacts and effects on the environment were almost totally ignored. The aim of this presentation is to evaluate the soil protection and forming functions in one of immission areas – in the Orlické hory Mts.

MATERIAL AND METHODS

The studied stand was established as a semi-practical plantation on SW slope of the Malá Deštná Mt. in 1989. The forest stand is marked as 7C2, the plot is located in the cadastre of the Deštná village, it is a property of Kolowratské lesy Rychnov n. Kn. Forests. The altitude of the plot is 1000 m a.s.l., the forest type is detected as 7K3 (acid beech-spruce site), the soil type is Cryptopodzol, the geological bedrock is formed by schists. The soil in the lodgepole pine stand was compared with the Norway spruce stand of the same age. The plantation was established by the two years old plantings, bare-root, of unknown origin, produced in the Forest Nursery Řečany. The restitution process caused the lost of original data at the beginning of 1990s, which were reconstructed with some problems.

Four soil pits were dug and the mixed samples were formed from 4 replications in each horizon, in both studied stands. The basic chemical characteristics were determined: soil reaction (in H_2O and KCl), soil adsorption complex characteristics by Kappen (S – bases content, H – hydrological acidity, T – cation exchange capacity, V – base saturation), the total nutrient content after mineralization by sulphuric acid and selene (in holorganic horizons), the plant available nutrients content (in 1% citric acid solution), the total nitrogen content (Kjeldahl method), humus content (Springer-Klee), and the exchangeable acidity characteristics (Table 1).

RESULTS AND DISCUSSION

Visibly lower thickness of the surface humus was determined in the pine stand, which indicates faster organic matter mineralization and the losses. This was detected for both studied holorganic layers, i.e. litter + fermentation and humification layers. This fact corresponded also with more intense cover of grass/herb vegetation in the

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pine stand, leading probably together to the lower values of the soil reaction (expressed as pH), with the exception of the litter layer. The differences between tree species were in the range of the laboratory analysis error and at the significance limits. The base content values (S-values by Kappen) were very comparable in both stands, the same was detected for other adsorption complex characteristics. With respect to these characteristics, both tree species showed similar soil (humus form) formation effects.

The total nitrogen content was higher in holorganic layers of the pine stand, which reflects the ground vegetation effects and more rapid decomposition of the humus layer, enriching relatively the holorganic layers by this nutrient (Thietema, 1992). The danger of leaching increases in the same time, as for nitrates and accompanying cations. Humus content was practically identical in both stands. The phosphorus content showed a tendency of higher content in the pine stand, up to 10–20% in the total form, in the plant available form the higher values were detected in the pine stand (L + F layer), lower in the spruce one. The interpretation of the P dynamics is not possible, based on the today knowledge.

Very obvious is the decrease of the total as well as plant available potassium content (all horizons), connected with the organic matter and nitrogen mineralization and with nitrate leaching. Similarly, but more slightly, is affected the content of calcium and magnesium as well. The bases are leached more intensively in the soil of the pine stand and the Norway spruce shows more effectively the soil-protection function in the given site conditions. In the uppermost holorganic horizon of the pine stand, the highest values of the total exchangeable acidity and exchangeable aluminum were documented, indicating more intense acidification under pine.

There are not disposable any comparable soil data on the lodgepole pine soil effects, eventually the effects on the other ecosystem compartments. Where planted, the plantations were rapidly destroyed by the red deer rapidly, the evaluation being problematic then (Podrázský et al., 2003). Its soil effects resemble the European larch – this species also does not cover the soil very effectively, it is taking up the nutrients very intensively and it produces relatively acid and poor litter. Comparing to spruce, both species express lower soil-forming and soil-protective function (Podrázský, Ulbrichová, 2004).

For the Czech Forestry, the higher lodgepole pine plantation is not supposed, despite the fact, that the pro-

Table 1. Comparison of basic pedo-chemical characteristics in the soil of stand of lodgepole pine and Norway spruce on the Malá Deštná locality in the Orlické hory Mts.

Horizon	1	2	3	1	2	3
	L + F	H	Ah	L + F	H	Ah
Plot – Species	1 – *Pinus contorta*			2 – Norway spruce		
Thickness (cm)	4.5a	8.2	10.0	5.5b	10.8b	10.0
pH H_2O	4.88	4.12	3.60	4.68	3.98	3.52
pH KCl	3.95	3.40	2.85	4.05	3.22	2.80
S (mval/100 g)	35.3	23.9	1.92	41.8	20.0	2.22
H (mval/100 g)	30.3	49.3	10.6	29.0	46.6	13.0
T (mval/100 g)	65.6	73.2	12.5	70.8	66.6	15.2
V (%)	49.4	32.1	15.1	57.4	29.1	14.2
P_2O_5 (mg/kg)	285	247	99	263	255	130
K_2O (mg/kg)	291	198	35	556	272	56
CaO (mg/kg)	5207	1617	197	6246	1504	213
MgO (mg/kg)	2402	895	93	3089	882	99
Fe_2O_3 (mg/kg)	1197	1316	588	1497	2213	931
N (%)	1.54	1.67		1.50	1.64	
P total (%)	0.108	0.120		0.092	0.102	
K (%)	0.500	0.365		0.480	0.445	
Ca (%)	0.630	0.025		0.675	0.025	
Mg (%)	0.427	0.069		0.528	0.056	
Acidity exchangeable (mval/kg)	55.0	98.2	79.5	40.9	86.4	72.5
H^+ exchangeable (mval/kg)	1.62	1.82	0.250	1.15	1.22	0.075
Al^{3+} exchangeable (mval/kg)	53.4	85.2	72.4	39.8	96.4	79.2
Humus (Springel-Klee) (%)	49.5	55.0	49.5	48.2	53.5	48.2
N (Kjeldahl) (%)	1.42	1.60	0.21	1.25	1.50	0.30

Note: Different indexes indicate statistically significant results between corresponding horizons of particular stands, their absence means no differences are proved.

portion of introduced tree species should increase from 1.5% to 3–4% (Frýdl, Šindelář, 2004) or even 7% (ÚHÚL, 1995). Its stands are situated in areas of special nature conservation interest almost completely. In our conditions, the stands of this pine are endangered by wet snow, they are labile and only exceptionally they can replace domestic species.

CONCLUSIONS

The lodgepole pine could be good preparatory species in the immission areas in the conditions, in which the domestic Norway spruce is not able to survive. The results of our unique experiment document some very important facts:

- this pine species does not shelter the soils as intensively as the Norway spruce does, its stands are more light accessible, the ground vegetation develops and more intense surface humus layer decomposition takes place,
- this is accompanied by the unfavorable nitrogen dynamics – after microbial decomposition, the leaching of soluble products is supposed,
- in connection, the bases are leached too, in the given site and geologic conditions especially the potassium, but also the calcium and magnesium,
- in the lodgepole pine stands, the nutrient losses and the soil acidification can be assumed,
- from the soil protection point of view, the Norway spruce stands seem to be more effective, with other climax tree species admixture, lodgepole pine can be used only on sites, where the Norway spruce cannot survive. Today, after the main air pollution load rapid decrease, could be only very rare case.

The cultivation of this pine species faces several decisive obstacles, among other things:

- main problems are of legislative and administration ones, the nature protection authorities do not allow its planting – all immission areas are covered with special nature protection care – Protected Landscape Areas or even National Parks. Introduced species are not acceptable there,
- very important is the big game attack, the stands of lodgepole pine are destroyed very rapidly by browsing and bark stripping,
- in the Czech conditions, the wet snow plays an important role in distinction to the native area and causes the pine damage.

The established stands of the lodgepole pine do not occupy large areas in the Czech Republic, but some management should be accepted for the existing ones. As a preparatory species, this pine fulfilled its ecological role and has to replace it by the climax native species, except for mining reclamation areas. Also in the high damage rate case, the replacing by less endangered species is topical. Use of under-plantings and enrichment plantings is topical as well. In the still vital stands, the progress should not be so quick, but the soil protection and stand environment desire faster beginning of the stand regeneration. As mentioned above, reclamation of vastly degraded and destroyed site is a proper way to use this species furthermore.

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Borovice pokroucená (*Pinus contorta*) jako přípravná dřevina v imisní oblasti Orlické hory.

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Borovice pokroucená (*Pinus contorta*) zaujímala původně význačné místo mezi introdukovanými přípravnými dřevinami vysazovanými na imisních holinách. Rozsah výsadeb není příliš velký, přesto se této dřevině přisuzoval značný význam. Později

ochranářské důvody vytěsnily tento druh zcela. Dnes jsou tyto porosty založeny a lesní hospodářství nemá představu o jejich environmentálních účincích. Orlické hory patřily mezi regiony s výsadbou borovice pokroucené. Sledovaná výzkumná plocha byla založena kolem roku 1989 na hlavním hřebeni, v nadmořské výšce kolem 1000 m n. m., SLT byl určen jako 7K. Byla sledována tloušťka nadložního humusu a základní pedochemické vlastnosti humusové formy, výsledky byly srovnávány se sousedním porostem stejně starého smrku ztepilého. V porostu borovice poklesla mocnost nadložního humusu, což indukovalo ztráty organické půdní hmoty. Půdní chemismus se sice výrazně nelišil, ale výsledky dokumentovaly méně efektivní půdoochrannou funkci borovice, způsobující ztráty bází ve větším rozsahu. Stabilita porostu byla nižší a ohrožení zvěří vyšší ve srovnání se smrkem.

druhové složení; borovice pokroucená; Orlické hory; humusové formy; degradace stanoviště

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